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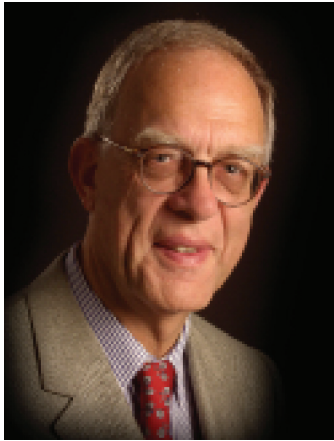
Proceedings of the 18th International Conference on Medical Physics

Incorporating the XVI Brazilian
Congress of Medical Physics and
held jointly with V Instrumentation
and Medical Imaging Symposium

April 17-20, 2011

Porto Alegre - RS - Brazil

Hosted by Pontifícia Universidade
Católica do Rio Grande do Sul - PUCRS



Prof. Dr. Fridtjof Nüsslin, President

INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS

Member of the International Union of Physical and Engineering Sciences in Medicine
(Union Member of the International Council for Science)

Welcome to the 18th International Conference on Medical Physics, 16th Brazilian Congress on Medical Physics, V Instrumentation and Medical Imaging Symposium, and 2nd Workshop of the Health Technology Task Group of the International Union for Physical and Engineering Sciences in Medicine.

It is my particular pleasure and honour, also on behalf of the co-presidents of the Latin American Association of Medical Physics (ALFIM) and the Brazilian Association of Medical Physics to cordially welcome all attendees of the ICMP2011 in Porto Alegre. For six days this place is the focus point of the global community of Medical Physicists, working in hospitals, universities, research institutions, health care organizations, industry and administration. For these few days Porto Alegre is the World market place of Medical Physics, the stock exchange for novel products, the agora for debating controversies and new ideas, and not least the school of teachers and students. All these facets of Medical Physics converge towards the advancement in patient care by disseminating knowledge on instrumentation, skills and competence. Nowadays, there is no branch of medicine which does not benefit from medical physics, and medical physics has been expanded far beyond the classical playground of applying ionizing radiation in radiological practice. Imaging technologies and instrumentation are hallmarks of current medical physics development. Image guidance in surgery, radiotherapy, cardiology, etc., ensure effective and less harming interventions at an ever earlier stage of disease. Laser based imaging methods such as phase contrast imaging provide access to nano-scale resolution with high potential in early cancer detection. The Science Committee chaired by Dr. Cari Borrás did a wonderful job compiling such a wide spread scientific program. However, despite the tremendous progress achieved so far, we are facing increasingly two major problems challenging the whole Medical Physics community, (i) the undersupply of developing countries with appropriate equipment and trained experts, and (ii) the general lack of qualified Medical Physicists worldwide, which of course threatens the developing countries mostly. Hence, we are grateful to the organizers of this conference that the program not only covers top Medical Physics science. The Education & Professional Committee chaired by Dr. Paulo Roberto Costa created a program emphasizing the importance of education & training. I am confident that the pre-conference activities will attract many young Medical Physicists. We are very pleased that the whole program has received accreditation by CAMPEP.

Among the large variety of lectures and sessions I want to mention a unique activity: with regard to the situation in the developing world challenging particularly the Medical Physicists, a joint session has been organized to bring together the IOMP, WHO, IAEA, ALFIM and PAHO and discuss problems of health care assessment, a field which requires much more attention by our community. Another subject which requires expertise from Medical Physicists is certainly radiation protection and radiation biology. Quite a few lectures and sessions are dealing with radiation protection ranging from patient care up to emergencies. In a session jointly organized by the IOMP and IRPA we will explore opportunities of collaboration, particularly in developing countries, by crossing the borders of the clinical and non-clinical radiation protection fields.

We want to thank the industry participating and sponsoring this conference. We are grateful for the opportunity to discuss at your booth products and latest innovations.

Last not least, our special thanks are dedicated to the organizers of this conference and their staff. We are sure the ICMP2011 will be an outstanding event which everybody will remember for a long time.

Just being more and more under economic constraints, it may be questioned to continue organizing such big meetings like the ICMP2011. One is tempted to believe that by applying the modern tele-conferencing-techniques we could save money and time whilst gaining the same educational effect. However, what about the coffee breaks and the local highlights? Isn't it one of the unforgettable benefits of a conference meeting people, making new friends, chatting with the old ones, enjoying the family spirit of our Medical Physics community? Quite so. It's a long trip to Porto Alegre, at least for some of us, but we wouldn't like to miss meeting you, and this city, and this wonderful country Brazil.

Enjoy ICMP2011, enjoy Porto Alegre, and enjoy Brazil!

Munich, April 2011



Fridtjof Nüsslin, President IOMP

Dear Conference Participants:

It is an honor and a pleasure to welcome you to Porto Alegre and the 18th International Conference on Medical Physics - ICMP2011.

This Conference is the IOMP's collaborative meeting with one of its chapter organization, the Latin American Association of Medical Physics (ALFIM - Asociación Latinoamericana de Física Médica) and the Brazilian Association of Medical Physics (ABFM - Associação Brasileira de Física Médica). It incorporates the XVI CBFM (Congresso Brasileiro de Física Médica), and the V SIIM (Simpósio de Instrumentação e Imagens Médicas).

The conference provides a comprehensive overview and in-depth, first-hand information on new developments, advanced systems and technologies, current and future applications in medical physics and biomedical technologies. This forum offers opportunities not only for dissemination of research information, but also for development of friendships among medical physicists and other health professionals from different countries.

The program is organized in invited lectures, keynote presentations, workshops, round table discussions, poster sessions, and scientific oral presentations. There are opportunities to foster continued professional development by considering educational, and professional matters. Remarkably, we would like to thank the Pontifical Catholic University of Rio Grande do Sul for all support and the local collaborators from Physics School.

This conference could not happen without the help of many dedicated people. Please take a moment to read the lists of scientific, educational/professional, international and local staff, and say thank you when you have a chance.

We want to express our appreciation to our sponsors for their generous support, to all the speakers for their educational contributions, and most especially to all of you for recognizing the importance of this conference by attending.

Finally, we are very thankful to the authors who have chosen ICMP2011 to present their works.

We hope you will have the opportunity to benefit from many or all the activities of ICMP2011, find time to establish new relations and networks, and get out to explore Porto Alegre and its surroundings.

Sincerely,

Ana Maria Marques da Silva, Dr.
President of ICMP2011

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IOMP - International Organization for Medical Physics -
www.iomp.org
ALFIM – Asociación Latinoamericana de Física Médica –
www.alfim.net
ABFM – Associação Brasileira de Física Médica –
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All registered delegates are requested to wear their badges during the period of the conference and its social events.

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Our secretariat staff can be easily identified at the registration desk. Please do not hesitate to approach them if you need assistance.

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Centro de Eventos da PUCRS – Building 41: Plenary Sessions, Keynote Lectures, Oral Presentations, Poster Presentations, Exhibition and Coffee Breaks.

Internet Facility: There are several permanent stations available to access internet service and wireless connection for notebooks. This service is provided free of charge. The password will be provided in the Secretariat.

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Tour Desk will be available on-site to assist you with inquiries and bookings for local tours.

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A message board will be placed by the registration desk beside the Secretariat.

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Please report lost article to the Secretariat staff, located at the registration desk.

Speakers' Room

Openhours: 17-20 April, 2011 from 8:00-19:00.

A computer will be available for speakers to review their presentation at the Speakers' Room. Please hand in your presentation to the technician at the Speakers' Room at least 3 hours prior to the sessions. Should your session take place in the morning, please deliver the presentation the day before. If you are bringing your own laptop, please check with the technician at the Speakers' Room to ensure that you are able to hook up your laptop to the data projector.

Oral Presentation Session

Each speaker has 10 minutes to make the presentation, followed by 2 minutes for discussion.

All presentations have to be held in English.

Poster Presentation

Posters will be displayed in the Exhibition area from 18-10 April, 2011, between 8:30 - 18:00.

Poster Dimensions: Maximum size is 90cm width (horizontal) x 120 cm height (vertical).

Fixing Material: These will be available on-site. Please note that the fixing material made available are the only type permitted.

Poster Mounting: Posters must be set up by Monday, April 18, from noon.

Posters will have to be removed on April 20, from 17:00 - 18:00 (you should not dismantle your poster before that date and time).

Authors who agree to have their contact details made available to delegates are asked to include the information (e.g. email address) on their posters.

All presentations have to be held in English.

Opening & Closing Ceremonies

All registered delegates are invited to participate in the Opening and Closing Ceremonies held in Hall A.

Certificate of Attendance

Certificate of Attendance will be given to all registered delegates.

11	Programa do V Simpósio de Imagens Médicas e Instrumentação
15	Oral
32	Poster
58	Program of the 18th International Conference on Medical Physics and XVI Brazilian Congress of Medical Physics
72	Pre-Conference Courses
78	Pre-Conference Workshops
80	Round Tables
82	Plenary Sessions
88	Special Sessions
93	Educational Sessions
98	Scientific Sessions
224	Poster Sessions
224	General Physics
227	Magnetic Resonance
235	Nuclear Medicine
255	Physiological and Biomedical Modelling
260	Ultrasound
263	X Ray Imaging
285	Brachytherapy
291	External Beam Radiotherapy
323	Medical Physics
339	Radiation Safety
369	Dosimetry Materials
380	Nanotechnology
385	Radiation Dosimetry

Sexta-Feira, 15 de Abril de 2011

8:30 - 9:00

Exhibition Hall

Inscrições e Entrega de Material – SIIM

9:00 - 12:30

Hall C

Instrumentação Biomédica

- 9:00 Abertura – Palestra: Os desafios do desenvolvimento da tecnologia de ultrassom para diagnóstico e terapia. Eduardo Tavares Costa
- 10:30 375 - Relationship between stopping power of protons and CT number of X-rays. Guilherme F. Inocente.
- 10:45 696 - Pulmonary Function Assessment Using A Portable Forced. Walderi Monteiro da Silva Junior.
- 11:00 832 - Avaliação da Dor Através da Análise das Ondas-M. Machado, Alessandro Ribeiro de Pádua.
- 11:15 838 - Avaliação de Temperatura Local a partir da Livre Emissão Acústica Aplicada à Tratamentos Utilizando Ultrassom de Alta Intensidade. André Luis Baggio.

12:30 - 14:00

Almoço

14:00 - 17:30

Hall C

Controle de Qualidade

- 14:00 Palestra: Biopotenciais: Suas origens e os Elementos Fundamentais Para Projeto de Instrumentos de Medição. Alcimar Soares Barbosa.
- 15:00 Coffee-Break
- 15:30 653 - Study of BD of Mongrel Dogs Comparing the MI and Radiological Densitometry. Dany Bruno Borella dos Santos Grossklauss.
- 15:45 809 - Computacional de Imagens e Correlação com Inspeção Visual Humana. Bruno Barufaldi.
- 16:00 842 - Metodologia de Avaliação de Qualidade de Mamografia Analógica por Técnica de Análise Digital de Imagem. Eny Moreira Ruberti Filha.
- 16:15 849 - Metodologia para Otimização das Doses Associadas a Qualidade das Imagens Mamograficas Geradas em Sistemas CR E DR. Silvio Ricardo Pires.
- 16:30 Palestra: Um Novo Método em Instrumentação Médica: Monitoração Não Invasiva da Pressão Intracraniana (PIC) e Aplicações. Sérgio Mascarenhas e Gustavo Frigieri.

Sábado, 16 de Abril de 2011

8:30 - 12:30

Hall C

Processamento de Sinais, Imagens e Visualização

- 8:30 810 - Um Framework para Implementação de Análises Cefalométricas. Michele Fúlvia Ângelo.
 8:45 813 - Redes Neurais Artificiais: Desenvolvimento e Aplicação de Algoritmo em Reconstrução de Imagem Tomográfica. Renato Glauco de Souza Rodrigues.
 9:00 816 - Aquisição, Processamento e Análise de Ressonância Magnética Funcional e Eletroencefalografia Aplicada ao Estudo da Epilepsia. Brunno Machado de Campos.
 9:15 830 - Otimização de Componentes para Interface de Visualização e Manipulação de Imagens em Sistemas de Treinamento Digital em Mamografia. Isabela M. Miziara.
 9:30 Coffee-Break
 10:30 501 - Massive Analysis of Sleep EEG Signals Using Computational GRID. Günther J. L. Gerhardt.
 10:45 817 - Otimização do Filtro Butterworth para Imagens Spect Com Tc-99m: Análise Quantitativa e Qualitativa. Lucas Narciso.
 11:00 844 - Análise SVD de Sistemas de Imageamento de Ultrassom Baseado na Reconstrução Inversa. Leonardo Geovany da Silva Zanin.
 11:15 850 - Uso do Método Rmse para Identificação de Característica na Análise da Relação entre Tremor Fisiológico e Idade. Bruno Coelho Calil.
 11:30 799 - Segmentação de Imagens de Nódulos Reais e Simuladas em US de mama através da Rede Neural Artificial SOM. Karem Daiane Marcomini.

Telemedicina

- 11:45 474 - Sensor Network for Assessment of Energy Expenditure Design Based on Android. Leonardo Juan Ramirez Lopez; Daniel Gustavo Goroso; Linamara Rizzo Batistella.

12:00 - 14:00

Almoço

14:00 - 17:30

Hall C

- 14:00 Palestra: a confirmar
 15:00 Mesa Redonda: Diagnóstico por imagem digital: como as ferramentas de imagens digitais podem melhorar a acurácia diagnóstica?
 O que mudou para o radiologista (vantagens e desvantagens da migração analógica/digital). Giselle Guedes N. de Mello.
 Como a instrumentação da imagem digital pode melhorar a acurácia diagnóstica? Simone Elias.
 Linhas de pesquisa em instrumentação de imagem mamográfica digital. Homero Schiabel.
 16:30 Sessão de Posters – SIIM – Coffee-Break
 Controle de Qualidade (Codes 420; 422; 423; 650; 811; 839; 666; 800; 812; 836).
 Processamento de Sinais, Imagens e Visualização (Codes 494; 642; 803; 829; 833; 837; 841; 845; 851; 853; 854).
 Telemedicina (Codes 361; 770; 835; 899).
 17:30 Encerramento e Premiação do SIIM

Saturday, April 16, 2011

8:00 - 8:30

Exhibition Hall

Registration – ICMP2011 Courses

8:30 - 12:30

Hall D

C1 - Modern Radiotherapy: Risks and Benefits.

Chair: Yakov Pipman

Hall E

C2 - Adapting Traditional Clinical Medical Physics to Digital Radiography.

Chair: Charles Willis

12:30 - 14:00

Lunch

14:00 - 17:30

Hall D

C1 - Modern Radiotherapy: Risks and Benefits.

Chair: Yakov Pipman

Hall E

C2 - Adapting Traditional Clinical Medical Physics to Digital Radiography

Chair: Charles Willis

Sunday, April 17, 2011

8:00 - 8:30

Exhibition Hall

Registration – ICMP2011 Courses and Workshops

8:30 - 12:30

Hall A

W1 - HTTG - Defining the medical imaging requirements for a health station (Open for ICMP2011 Attendees)

Chairs: Barry Allen, Cari Borrás

Hall B

C3 - PET/CT Acceptance Testing and Quality Assurance and Quantitative PET/CT Imaging

Chairs: Osama Mawlawi and Cecil Robilotta

Hall C

C4 - Recent Advances in Radiation Therapy: Planning, Delivery and Methods of QA

Chair: Laura Natal Rodrigues

Hall D

C5 - Dose and image quality assessment in Computed Tomography

Chair: Denise Nersissian.

Hall E

W2 - IOMP/IAEA-Radiation Protection of Children (Open for ICMP2011 Attendees)

Chair: Madan Rehani

Hall F – Building 10**C6 - Atualização para Técnicos em Radioterapia (in Portuguese)***Chair: Anna Maria C. Araujo***12:30 - 14:00****Lunch****14:00 - 17:30****Hall A****W1 – HTTG: Defining the medical imaging requirements for a health station***Chairs: Barry Allen, Cari Borrás***Hall B****C3 - PET/CT Acceptance Testing and Quality Assurance and Quantitative PET/CT Imaging***Chairs: Osama Mawlawi and Cecil Robilotta***Hall C****C4 - Recent Advances in Radiation Therapy: Planning, Delivery and Methods of QA***Chair: Laura Natal Rodrigues***Hall D****C5 - Dose and image quality assessment in Computed Tomography***Chair: Denise Nersissian.***Hall E****15:30 – 16:30 - IOMP-EXCOM Meeting****Hall F– Building 10****C6 - Atualização para Técnicos em Radioterapia (in Portuguese)***Chair: Anna Maria C. Araujo*

STUDY OF BD OF MONGREL DOGS COMPARING THE MI AND RADIOLOGICAL DENSITOMETRY

Dany Bruno Borella Dos Santos Grossklauss¹; Joel Mesa Hormaza¹; Marcos Antonio de Rezende¹; Vladimir Eliodoro Costa¹; Vania Maria de Vasconcelos Machado²; Alfredo Lima²

¹Instituto de Biociências de Botucatu/Departamento de Física e Biofísica; ²Faculdade de Medicina Veterinária e Zootecnia de Botucatu/Departamento de Reprodução Animal e Radiologia Veterinária

Bone quality is related to the effects of skeletal factors that contribute to resistance, however, can not be judged by measures of mass, but rather by its density. Bone density (BD) is a biophysical parameter of paramount importance, experimental clinic, because it assesses the process of bone mineralization. Calcium is the most abundant mineral in the skeletal system, and this is associated with several metabolic functions, such as bone growth. Several pathologies in vertebrates are associated with bone structure that directly affect the locomotor system. Being an endoskeleton, the diagnosis of these diseases becomes abstruse in vivo. Physical characterization of the bone structure of healthy animals post mortem is a valuable tool for comparative diagnosis of animals in vivo. On this basis the project aims to evaluate, discuss and compare the methodologies of radiological density and immersion in water. Concomitantly, the immersion method (MI) is used to evaluate the effect of weight, sex, age and calcium content in bone tissue of the canine strain, correlating with the bone density of the right forelimb region of the humerus-radio-ulnar.

Keywords— Bone, radiology densitometry, immersion method

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CONTROLE DE QUALIDADE DE MAMÓGRAFOS POR DE ANÁLISE COMPUTACIONAL DE IMAGENS E CORRELAÇÃO COM INSPEÇÃO VISUAL HUMANA

Bruno Barufaldi¹; Santana, Eduardo¹; Cavalcanti, Amanda¹; Batista, Leonardo¹; Schiabel, Homero²; Carvalho, Jose Fernando³

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The cancer control represents one of the greatest challenges that public health faces nowadays, since breast cancer is the first cause of mortality among Brazilian women. The use of breast phantoms allows the application of tests to measure the mammography acceptance and the daily, monthly and yearly testing of constancy of the mammography quality control programs. Even so, evaluation by technicians still suffers its own limitations caused by visual inspection by human beings, such as long-time of benchmarking and subjectivity. It has been developed a computerized system, called QualiMamo, that analyses radiological images of breast phantoms with human visual perception to eliminate this subjectivity and assure the consistence of the system. The results indicate that the software developed allows to determine with efficiency the visibility of structures of interest in the phantoms images, according to the thresholds of visibility imposed by technicians performing the visual inspections of images. Therewith, the system becomes a tool of great utility aiding to medical diagnosis.

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METODOLOGIA DE AVALIAÇÃO DE QUALIDADE DE MAMOGRAFIA ANALÓGICA POR TÉCNICA DE ANÁLISE DIGITAL DE IMAGEM

Eny Moreira Ruberti Filha¹; Ana Claudia Patrocínio²; Regina Bitelli Mdeiros¹

¹Universidade Federal de Sao Paulo; ²Universidade Federal de Uberlandia

Presently it is mandatory to use the mammograms to get better results in the early detection of breast cancer. CAD tools have been used with the purpose of decrease subjectivity effect. The aim of this work is to evaluate image quality whether such method can be useful in the image qualification process associated with the quality control tests. Phantom images generated in some diagnosis centers were analyzed through optical density, the quality control test results, average glandular dose and mean pixel value. Signal-to-noise ratio (SNR) calculation can contribute for image analyze. This method can be used for a detailed analysis of digital and digitized images.

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METODOLOGIA PARA OTIMIZAÇÃO DAS DOSES ASSOCIADAS A QUALIDADE DAS IMAGENS MAMOGRAFICAS GERADAS EM SISTEMAS CR E DR

Silvio Ricardo Pires; Eny Moreira Ruberti; Fatima Faloppa Rodrigues Alves; Regina Bitelli Medeiros

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Mammography is the most reliable test for early detection of cancer. Recently, have seen an evolution in technology like Computed Radiography (CR) and Digital Radiography (DR). Digital technology expands the range of X-ray spectrum use. The goal was to develop a specific methodology to reduce process time optimization of average glandular doses depending on the contrast to noise ratio of the image. We conclude that this method reduces the subjectivity of the optimization process, preserving the mammography equipment and support all the criteria of quality assessment described in international standards.

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RELATIONSHIP BETWEEN STOPPING POWER OF PROTONS AND CT NUMBER OF X-RAYS

Guilherme Franco Inocente; Renata L. Buschini; Gabriela V. Stenico; Joel Mesa Hormaza

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In conventional treatment plans in proton therapy, patients will often undergo X-ray Computed Tomography (xCT). It is well known that there are remarkable differences between the interaction processes of protons and photons with matter. The most important parameter characterizing the energy loss of an incident proton is the stopping power, which is mean energy loss per unit path length in a material, which is a function of the electron density in the target. In this sense, it is necessary to define the electronic density distribution in patient body. The attenuation of x-ray beam is controlled by the linear attenuation coefficient, which is intrinsically inapplicable to get a description direct of proton reactions in target. In this work we calculated the stopping power of protons in different materials of radiological interest with two codes: SRIM 2008, which only consider elastic interactions and MCNPX v2.5, which also included nuclear non-elastic processes.

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PULMONARY FUNCTION ASSESSMENT USING A PORTABLE FORCED

Walderi Monteiro da Silva Junior¹; Bruno B Costa²; Edênia Lima Costa¹; Tássia Virgínia de Carvalho Oliveira¹; Valter J. Santana-Filho³; Raimundo C. S. Freire²; José F. da Silva⁴; Cid M. David⁵

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The purpose of this research was to analyze the pulmonary function in patients with chronic obstructive pulmonary disease (COPD) using a new device of forced oscillation techniques (FOT). The sample was composed of 24 individuals of both genders, aged between 50 to 70 years old. Group I was composed of 12 healthy individuals and group II, 12 patients with clinical diagnosis of COPD by spirometry data with FEV1 <80% of FVC. The variables analyzed were: age, gender, body mass index (BMI), respiratory rate (RR), minute volume (MV), maximal inspiratory pressure (MIP), maximal expiratory pressure (MEP) and Tobin index through manometer, respirometry and BMI of the patients. Statistical analysis was performed using the Student t test and chi-square test with $p < 0.05$. There were statistically significant difference between group I and group II in the variables: FR, VC, MIP, PE and Max Tobin index. Patients in group II had an average of MIP, MEP decreased compared to group I showing respiratory muscle weakness; Tobin index and respiratory rate were increased featuring increased work of breathing and decreased tidal volume that may be associated to biomechanical disadvantage presented by COPD patients. We have concluded that mechanical ventilation of COPD patients compared with healthy patients is altered. Key-words: Manometer; Ventilation; COPD and pulmonary function.

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Code: 832

AVALIAÇÃO DA DOR ATRAVÉS DA ANÁLISE DAS ONDAS-M

Alessandro Ribeiro de Pádua Machado; Oliveira, Iraides Moraes; Resende, Laise Oliveira; Pereira, Adriano Alves; Andrade, Adriano Oliveira

Universidade Federal de Uberlândia

The aim of this study is to use electrical stimulation as a way of verifying painful stimulation with the m-waves responses and correlating the parameters. Six male individuals, aged between 18 and 30 years participated in this research. Each volunteer attended the laboratory for five days to make five identical tests on each day of the experiment. On all days of experiment, the volunteers attended the laboratory at the same time of day. This is to the subject keep in the same period of the circadian rhythm. The analysis of the M wave lower peak was conducted. Electromyography is an important tool that has a great potential to assist or even be the main tool to quantify pain. It was concluded that increasing the stimulus intensity is directly related to increased pain. The results of this study provide significant clues for future experiments using the same biopotential for the objective quantification of pain.

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AVALIAÇÃO DE TEMPERATURA LOCAL A PARTIR DA LIVRE EMISSÃO ACÚSTICA APLICADA À TRATAMENTOS UTILIZANDO ULTRASSOM DE ALTA INTENSIDADE

André Luis Baggio; Ebenezer S. Cavalcanti; Anonio Adilton Oliveira Carneiro

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Neste trabalho apresentamos um método para avaliar a temperatura local para uma possível aplicação em tratamentos com ultrassom de alta intensidade (HIFU). Métodos atuais utilizam técnicas ultrassônicas ou ressonância magnética nuclear para medir temperatura. Neste método mostramos ser possível utilizar o próprio transdutor focalizado de alta intensidade para provocar um impulso mecânico que faria o tecido vibrar e as características do som emitido por essas vibrações poderiam ser relacionadas às propriedades mecânicas do tecido que são associadas com a temperatura. Para simular um tecido, uma gelatina foi preparada de modo a ter propriedades mecânicas similares a um tecido mole e um termopar foi inserido próximo ao ponto de excitação para servir de referência. Um transdutor ultrassônico focalizado foi utilizado para aplicar pulsos curtos de alta intensidade em um pequeno volume de modo a fazer vibrar uma pequena porção do tecido simulando o comportamento no tratamento de HIFU. O som emitido foi adquirido por um hidrofone, processado e a amplitude de um dos modos vibracionais livres foi relacionado com a temperatura e comparado com o esperado a partir dos módulos de Young medidos para diferentes temperaturas. Os resultados preliminares mostraram que é possível monitorar a temperatura de modo relativo a partir da emissão acústica. Com o aperfeiçoamento da técnica acredita-se ser possível oferecer um método alternativo para acompanhar o sucesso do tratamento envolvendo ultrassom de alta intensidade com a vantagem de utilizar o próprio transdutor de HIFU minimizando assim a complexidade da instrumentação envolvida atualmente, baixando os custos e melhorando o correto registro.

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MASSIVE ANALYSIS OF SLEEP EEG SIGNALS USING COMPUTATIONAL GRID

Ney Lemke¹; Diego Z. Carvalho²; Emerson L. de Santa-Helena³; Suzana V. Schönwald²; Guilherme Dellagustin²

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This study presents a systematic analysis of Matching Pursuit decomposition of sleep EEG signals from obstructive apnea patients. Individualized amplitude thresholds are used for data collection. Atoms in the frequency of spindles are collected using different dictionary sizes, with and without a frequency modulation function for signal description. Using atom parameters as input for a decision tree-based classifier, it was possible to obtain a classification according to apnea-hypopnea index group and see how atom parameters such as frequency and amplitude are affected by the presence of sleep apnea.

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SEGMENTAÇÃO DE IMAGENS DE NÓDULOS REAIS E SIMULADAS EM US DA MAMA ATRAVÉS DA REDE NEURAL ARTIFICIAL SOM

Karem Daiane Marcomini; Ribeiro, Patricia Bellin; Carneiro, Antonio Adilton Oliveira; Schiabel, Homero

USP

This work proposes the development of image processing techniques, using mathematical methods, applied to 70 regions of interest of breast ultrasound images (20 simulated and 50 real) in order to reduce the speckle noise, and then delimit and determine the boundaries of lesions through the segmentation technique using artificial neural network Self-Organizing Map (SOM). The result obtained using the segmentation technique was visually validated by a radiologist, and the sensitivities that were verified for real and simulated images were, respectively, 84% and 65%.

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UM FRAMEWORK PARA IMPLEMENTAÇÃO DE ANÁLISES CEFALOMÉTRICAS

Michele Fúlvia Angelo¹; Mauricio Cunha Escarpinati²; José Amancio Macedo Santos¹;
Lucas Lima Batista¹; Luis Bernardo Souza e Souza¹; Raphael Silva Marques¹

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This paper presents the development of a framework that contains the functions to implement the cephalometric analysis more used in the clinics of dental radiology. The purpose of this framework is to receive as input parameters the coordinates of the cephalometric points, the radiographic image and the cephalometric analysis chosen. And, after processing these data, calculate the straight lines, angles and bisectors and generate a report with all measurements and drawing of the cephalometric tracing.

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REDES NEURAIS ARTIFICIAIS: DESENVOLVIMENTO E APLICAÇÃO DE ALGORITMO EM RECONSTRUÇÃO DE IMAGEM TOMOGRÁFICA

Renato Glauco de Souza Rodrigues; Abib, Gabriel; Gerra, Aline Ditz; Góes, Evamberto
Garcia; Rodrigues, Renato Glauco de Souza

Universidade Federal do Rio Grande

Neural networks with common topology of layers totally connected, without no major relationships with the tomographic image reconstruction problem, are great and very complex. We considered a new parallel and distributed method of tomographic image reconstruction on the basis of the geometry of the problem. An isomorphism between the Inverse Radon Transform, mathematical base for the tomographic image reconstruction, and a neural network partially connected, was found. Simulated and experimental results had confirmed the validity of our method.

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AQUISIÇÃO, PROCESSAMENTO E ANÁLISE DE RESSONÂNCIA MAGNÉTICA FUNCIONAL E ELETROENCEFALOGRAFIA APLICADA AO ESTUDO DA EPILEPSIA

Brunno Machado de Campos; Guilherme Côco Beltramini; Ana Carolina Coan; Roberto José Maria Covolan; Fernando Cendes

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This work describes the methodology of the simultaneous acquisition of EEG (electroencephalography) and fMRI (functional magnetic resonance imaging) in patients with epilepsy, a promising technique which combines the high temporal resolution of EEG with the high spatial resolution of fMRI. Moreover each exam provides information about a different aspect of the brain function: while EEG measures electrical activity of synchronous neurons, fMRI measures hemodynamic response, which is correlated with neuronal activation. However there are some difficulties in the measurement and processing. We report the results obtained for 15 patients: 2 were discarded due to excessive head motion, 6 had no epileptiform activity, 1 had incompatible result with the clinical history, and 6 had compatible results.

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OTIMIZAÇÃO DO FILTRO BUTTERWORTH PARA IMAGENS SPECT COM TC-99M: ANÁLISE QUANTITATIVA E QUALITATIVA

Lucas Diovani Lopes Narciso; Casagrande, Saman; Marques da Silva, Ana Maria

PUCRS/Faculdade de Física - Núcleo de Pesquisa em Imagens Médicas (NIMed)

Filtered backprojection method (FBP) is large used in SPECT images reconstruction. In FBP reconstruction the ramp filter is associated with the Butterworth smoothing filter. The optimization of this filter depends on many factors including the type of assessment adopted. Aiming to ascertain the best values of free parameters of the Butterworth filter, there was an acquisition of SPECT NEMA IEC Body acrylic phantom with Tc-99m. The images were analyzed without correction, with attenuation correction and with attenuation correction and scatter. Moreover, these images underwent variation in its cutoff frequency (f_c) - 0.30 Nq to 0.50 Nq - and their order - orders 7 and 8. Was analyzed quantitatively the contrast, noise and spatial resolution and a qualitative analysis was performed by medical imaging specialists in nuclear medicine. No significant difference in the images with different orders was found, but the best parameters for the filter depends on the type of approach used. In quantitative analysis, the images without any correction and lower f_c achieved the best results. In qualitative analysis, the images with attenuation correction and scatter and f_c 0.36 Nq and 0.40 Nq are considered the best results.

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OTIMIZAÇÃO DE COMPONENTES PARA INTERFACE DE VISUALIZAÇÃO E MANIPULAÇÃO DE IMAGENS EM SISTEMAS DE TREINAMENTO DIGITAL EM MAMOGRAFIA

Ana Claudia Patrocínio; Isabela M. Miziara; Mariana Cardoso

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The digital mammography is already reality in diagnosis centers in Brazil, but the transition from hard copy to soft copy image reading is not an automated task. A system of training in reading digital mammography is already in use on UNIFESP. At a later stage should be made to these professional cases of actual mammograms and encourage them to training evaluation of cases, preparation of reports and use of digital tools to aid diagnosis as CAD (Computer-Aided Diagnosis) schemes. This work aims at developing a prototype training system through an interface whose tools for opening files and manipulating the images are being developed with greater portability and in ways that benefit the computational cost of processing and displaying images. For this project it was developed a prototype software that can open and manipulate images in TIFF format. Using the programming language C# (C-sharp) and software development for Microsoft Visual Studio 2010 has been possible to develop a code capable of opening images in TIFF format with 12 bits of contrast resolution. The platform .Net provides a set of libraries that allows the creation of any graphical interface in addition to being the basis for software development. In communication with the platform, the library Crownwood, Magic Docking, performs the function of manipulating the components of the platform at run-time software, so the user can manipulate the position and size of the windows of their views of the images.

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ANÁLISE SVD DE SISTEMAS DE IMAGEAMENTO DE ULTRASOM BASEADO NA RECONSTRUÇÃO INVERSA

Leonardo Geovany da Silva Zanin; Fábio Kurt Schneider; Marcelo Victor Wüst Zibetti

Universidade Tecnológica Federal do Paraná

Ultrasound image reconstruction based on inverse problems has attracted attention of the ultrasonic imaging research community. Different from standard beamforming techniques, this new imaging method seeks to solve a linear system $g=Hf$ for reconstructing the ultrasound image. In order to understand the behavior of this imaging system, it is important to analyze the matrix H . In this paper, we analyze the acquisition matrix using singular value decomposition, considering some important aspects in an ultrasound system, such as: the resolution grid of the image, the number of elements in the ultrasound array, and the physical size of the sensor array. This analysis provides some interesting insights in the understanding of some aspects of ultrasonic imaging system design when inverse reconstruction is used as an imaging method.

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USO DO MÉTODO RMSE PARA IDENTIFICAÇÃO DE CARACTERÍSTICA NA ANÁLISE DA RELAÇÃO ENTRE TREMOR FISIOLÓGICO E IDADE

Bruno Coelho Calil; Andrade, Adriano O.

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Physiological tremor is normally observed in any age group and some factors can make it become intense. This work made an analysis using electromyography to study a relation between physiological tremor and ageing. Surface electromyography were collected from 10 subjects with age in the range of 20-29 years and 10 in the range of 70-79 years. Through data analysis, it was observed, therefore, that there is greater stability in most of the characteristics in persons of the later group. Moreover, the application of RMSE (root mean square error) is in accordance with the literature.

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A COMPARISON BETWEEN A SUBJECTIVE AND A QUANTITATIVE METHOD OF MEASURING THE RES

Alexandre França Velo¹; Matheus Alvarez¹; José Ricardo de Arruda Miranda¹; Diana Rodrigues de Pina²; Sérgio Barbosa Duarte³

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In present study we develop a computational procedure to treatment of mammographic phantom image which permit to quantify some visual property of digital images (DICOM). We selected a region of interest in the phantom to determining computationally the resolution of the system, and then comparing with those determined by three different radiologists. The main objective is to use an alternative method to determine the resolution of mammography.

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COMPARISON OF MULTIPLE PHANTOMS IN MRI QUALITY CONTROL: SNR AND SU ANALYSIS

Arthur Felipe Nisti Grigoletto Borgonovi¹; Ribeiro, Leandro²; Otaduy, Maria¹

¹Hospital das Clinicas; ²IEE - USP

In the present work signal to noise ratio (SNR) and signal uniformity (SU) measurements from magnetic resonance images using different quality control phantoms were compared in order to verify the reproducibility of the results. Images from four different phantoms were acquired with a 3 Tesla MRI scanner (Intera Achieva, Philips, Netherlands) using quadrature head coil and equipment body coil. Spin echo sequences was used to acquire three different projections (axial, sagittal and coronal) with the following parameters: TR/TE = 550/30 ms, FOV = 25x25 cm, acquisition matrix 512x512, Slice Thickness = 5 mm, Gap = 5 mm, 9 slices. It was used a spherical GE phantom (GE, Milwaukee), head Philips phantom (Philips, Netherlands), ACR phantom (American College of Radiology, USA) and Nuclear Associates 76-94 MRI-Multi Purpose Phantom (Fluke Co., USA). Images acquired were also reconstructed from raw data using a parameter called guniformity correction h available in MRI scanner, which provides an image with improved SU adjusting the signal over the field of view. It was verified that the parameter guniformity correction h really improves the SU over the field of view when quadrature head coil is used. Body coil acquisitions do not benefit from the use of the parameter. SU results have shown differences of 10% at the axial projection and SNR results has shown a maximum variation of 100% between different phantoms at the same projection. These differences can be a source of error to determine if the system is in the conformity or not with the established limits of NEMA Standards Publication MS 3-2008. The results demonstrate the importance of using well established parameters according to the phantom to be used and the necessity of using of the same phantom to analyze the reproducibility of particular equipment.

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A NON-SUBJECTIVE METHOD OF DETECTING MASSES AND NYLON FIBERS FOR QUALITY CONTROL

**Matheus Alvarez¹; Diana Rodrigues de Pina²; Sérgio Barbosa Duarte³; Alexandre França
Velo¹; Rafael Toledo Fernandes de Souza¹; José Ricardo de Arruda Miranda¹**

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This work presents methods for detection of masses in the breast phantom images for quality control of mammography. The methodologies for both are based on Discrete Wavelet Transform (DWT) where the low frequency present in the x-ray image is suppressed, then morphological operations that result in a good location of these objects in the radiograph simulator of the breast are made to quantify the subjective evaluation of specialists in radiology and apply the results of tests in the daily Quality Control (QC).

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STUDY OF BONE DENSITOMETRY OF MONGREL DOGS COMPARING THE METHODS OF IMMERSION AND RADIOLOGICAL DENSITOMETRY

Dany Bruno Borella Dos Santos Grossklauss¹; Joel Mesa Hormaza²; Marcos Antônio de Rezende²; Vladimir Eliodoro Costa²; Alfredo Lima³; Vania Maria de Vasconcelos Machado

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Bone quality is related to the effects of skeletal factors that contribute to resistance, however, can not be judged by measures of mass, but rather by its density. Bone density (BD) is a biophysical parameter of paramount importance, experimental clinic, because it assesses the process of bone mineralization. Calcium is the most abundant mineral in the skeletal system, and this is associated with several metabolic functions, such as bone growth. Several pathologies in vertebrates are associated with bone structure that directly affect the locomotor system. Being an endoskeleton, the diagnosis of these diseases becomes abstruse in vivo. Physical characterization of the bone structure of healthy animals post mortem is a valuable tool for comparative diagnosis of animals in vivo. On this basis the project aims to evaluate, discuss and compare the methodologies of radiological density and immersion in water. Concomitantly, the immersion method (IM) is used to evaluate the effect of weight, sex, age and calcium content in bone tissue of the canine strain, correlating with the bone density of the right forelimb region of the humerus-radio-ulnar.

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A NEW BIOMAGNETIC METHOD TO EVALUATE GASTROINTESTINAL TRANSIT TIME AND GASTRIC EMPTYING IN SMALL ANIMAL MODELS

Caio César Quini; Daniel Bueno Xavier e Silva; Marcos Felipe Calabresi; Paulo Roberto da Fonseca; José Ricardo de Arruda Miranda

IBB - Unesp

The motor activity of the gastrointestinal tract (GIT) poses an important role in transit and motility study. Many methods are used to evaluate the mechanical activity of the gastrointestinal tract. However, those methods are invasive, involve radiation or, regarding animal models, it is common to use a series of sacrifices in a controlled time interval to establish a temporal model. The biomagnetic methods constitute an interesting alternative for the study of the GIT properties for they are potentially non-invasive, free from radiation and safe. The sensor ones more important for that purpose they are the coil induction, Hall effect sensor, fluxgate and the Superconducting Quantum Interference Device (SQUID). This paper presents the use of a new method in the gastrointestinal tract studies. The technique consists of the association of magnetic induction coils, working as magnetic sensors, with liquid or solid magnetic markers. Using this method, it is possible to obtain information regarding gastric emptying, orocecal transit and contraction activity in any region of the GIT with great accuracy and without the use of invasive techniques or by requiring the sacrifice of a large number of animals.

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TRANSMITÂNCIA ULTRAVIOLETA DE CÓRNEAS IN VITRO DURANTE O PROCEDIMENTO DE INDUÇÃO DE “CROSSLINKING”

Victor Antonio Cacciacarro Lincoln¹; Ventura, Liliane¹; Faria e Sousa, Sidney J.²

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O procedimento do “crosslinking” vem se tornando uma prática muito utilizada para o tratamento e prevenção de certas patologias oculares. O tratamento atual é dividido em 3 estágios: desepitelização da córnea; instilação de Riboflavina a cada 5min, durante 30min; aplicação de radiação ultravioleta, com pico em 365nm à 3mW/cm², durante 30min adicionais, combinado com instilação a cada 5min. O objetivo do estudo foi medir a transmitância ultravioleta através de córneas humanas In Vitro durante o procedimento do crosslinking, uma vez que é mandatário pela literatura que apenas 5% da luz irradiada chegue até o endotélio, causando danos para irradiações acima de 0,35mW/cm². Foram utilizadas 20 córneas humanas preservadas em OptisolGS com média de 6 dias de captação e espessura média de 570µm. As córneas foram lavadas com soro e posicionadas em um suporte de acrílico. Uma fibra óptica conectada a um espectrofotômetro (USB2000 Ocean Optics) foi posicionada abaixo da córnea próxima ao endotélio, alinhada e centralizada com o feixe de UV emitido pelo crosslinking. Após a completa desepitelização da córnea, uma gota de riboflavina 0,1% foi instilada na córnea a cada 5min, totalizando 60min e 12 instilações. A emissão de UV (365±5nm, 3mW/cm², 1.51mW, 5.405J/cm², 8mm de diâmetro, 45mm de distância) foi iniciada após a sétima instilação. As medidas foram realizadas 4min depois de cada instilação, e o tempo médio para aquisição de cada espectro foi de 2s. Os resultados mostram que a transmitância média da córnea sem riboflavina foi de 62%, já ao final dos 30min de instilação de riboflavina, obtivemos uma transmitância média de 32%, e na última etapa obteve-se uma transmitância média após cada instilação, da sétima até a décima segunda, de respectivamente 30%, 28%, 26%, 24%, 22%, 21%. Assim as transmitâncias obtidas estão acima do limite de segurança de toxicidade do endotélio assumidas, que é de 5%. Sugere-se que o procedimento atual seja revisto para a rotina clínica.

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ANÁLISE DO CONTROLE DE QUALIDADE APLICADO A ULTRASSOM MODO - B

Daniel Silva de Souza

PUCRS

The aim of this study is to analyze the importance of assessing quality indicators of ultrasound equipment. Because of this, it is necessary to apply quality control tests based on the AAPM standards checking the accuracy and reliability of equipment. Were analyzed four echographs considering for three of the four facilities examined all the tests were approved while for a two unit tests failed. Considering the results, equipment with longer use flunked the tests of vision and depth distance between vertical and horizontal structures. The Quality Control demonstrated the need for repairs on one of echographs showing possible errors that can directly influence the final report of the examination.

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DESENVOLVIMENTO DE EQUIPAMENTO PARA DIAGNÓSTICO DE CÂNCER DE PELE POR IMAGENS DE FLUORESCÊNCIA

Mardoqueu Martins da Costa¹; Kurachi, C.²; Bagnato, V.S.²; Ventura, L.¹

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A mortalidade e morbidade devido a vários tipos de câncer podem ser reduzidos através de uma identificação precoce de células anormais. O Brasil, sendo um país com grande dimensão e localizado próximo da Linha do Equador, onde a incidência solar é extrema, apresenta um alto índice de câncer de pele, o principal tipo na população brasileira, e que provocou, segundo o Instituto Nacional de Câncer (INCA, Brasil), cerca de 113.850 novos casos do câncer do tipo não-melanoma e cerca de 5.930 de casos do tipo melanoma, no ano de 2010. Diante deste grande número de casos de câncer, algumas medidas devem ser tomadas para redução destes, como: ações preventivas e educacionais, e ainda, investimentos na área de pesquisa do câncer para uma detecção mais precoce, favorecendo um tratamento mais efetivo. A fluorescência por imagem é uma técnica que apresenta o potencial de aumentar o poder de discriminação de tecidos, podendo constituir uma importante ferramenta de detecção de lesões como câncer de pele. Neste trabalho, apresentamos o desenvolvimento e aplicação de um sistema de fluorescência para diagnóstico de câncer de pele composto por iluminação à base de LEDs de alta intensidade, com uma banda de emissão entre 400-460 nm para excitação da protoporfirina IX (PpIX), e filtros para visualização da fluorescência da PpIX na região do vermelho do espectro. Para a aplicação do diagnóstico por fluorescência, foi utilizado uma solução do ácido 5-aminolevulínico (15%) aplicada topicamente sobre as lesões e a formação/produção de protoporfirina IX (PpIX) foi monitorada, com o equipamento, de 4-6 horas após a aplicação. O sistema de diagnóstico desenvolvido, possibilitou o monitoramento da formação/produção PpIX e o estudo de uma modalidade relativamente nova de técnica não invasiva para o diagnóstico de câncer de pele por imagens de fluorescência.

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ELETRÔNICA PARA MEDIDAS DE TRANSMISSÃO MÉDIA DE LUZ VISÍVEL EM LENTES DE ÓCULOS

Marcio Makiyama Mello; Victor Antonio Cacciacarro Lincoln; Liliane Ventura

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This work is part of a larger project to develop an equipment to test optical lenses, which is the development of opto-electronic system in order to investigate the category of lens (0 -4), for which is permitted a different percentage for transmission of ultraviolet and infrared radiation, according to Brazilian standard sunglasses lens. In this work, a device opto – electronics was mounted for measuring the average transmission of white light in ophthalmic lenses, thus, automatically recognize the category of the same. This system will in future be coupled to a system of ultraviolet measurement (UVA and UVB) for investigation of glass lenses. The transmission of ultraviolet and infrared radiation on glass lenses are standard requirements for certification of these lenses, since electromagnetic radiation with frequencies in the bands of ultraviolet light (100nm - 400nm), visible (400nm - 700nm) and infrared (700nm - 1400nm) can cause serious eye damage, and each component of the eye absorbs a specific amount of each radiation.

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ANÁLISE COMPARATIVAS DE PROTOCOLOS DE PROGRAMAS DE GARANTIA DE QUALIDADE PARA IMAGENS MAMOGRÁFICAS

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The goal of the program of quality assurance of radiological equipment is to produce quality images that allow for an accurate diagnosis. For this to occur is essential to ensure the image quality generated by means of testing the quality control of mammography system, image processing and medical analysis. The quality is composed of a few parameters that need to be adequate, they are: spatial resolution, contrast resolution, noise and artifacts. The implementation of quality assurance program is a requirement of the relevant regulatory agencies in Brazil. Health authorities recommend a set of systematic activities necessary for the production of images (some based on European standards and procedures) to ensure the successful diagnosis and minimize risks to patients, as well as the uniformity of the quality of radiological services provided to the population. This work was a comparative study of the recommendations of both the Ordinance 453/1998 when the European protocol (European guidelines for quality assurance in breast cancer screening and diagnosis - EUREF) of the measured parameters and tests to be carried out systematically in quality assurance programs. The study was conducted in three stages. First survey was conducted tests recommended by decree 453/1998 and the European protocol for the analog images, including tests performed on equipment provided by measurements made on films. In a second step we studied the recommended tests for digital images that are provided only at the European protocol. And in a third step was analyzed images collected from nine different diagnostic centers. By analyzing the concordance of two protocols for it is possible to observe a discrepancy of 44.4% of the equipment examined.

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STUDY OF COMPUTER ALGORITHMS APPLIED IN DERMOSCOPIC IMAGES FOR DIAGNOSIS OF SKIN

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This work studies the diagnosis method of malign melanoma based on the ABCD rule, it discusses the techniques of evaluation of dermoscopic images and it analyzes two groups of images of cutaneous lesions using digital processing of images with the softwares Adobe Photoshop and IMAGEJ. The obtained results indicate that the method can be used for differentiation among the skin lesions as for the malignancy degree, and it can aid the dermatologist in the clinical routine serving with a second therapeutic opinion and minimizing the possible inherent mistakes of the visual evaluation of these lesions.

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BREAST DENSITY BY DIGITAL IMAGE PROCESSING

Laura Leticia Palacios Perez; T. Rivera

CICATA Legaria, IPN

Breast cancer is a malignant tumor that originates from the accelerated proliferation disordered and uncontrolled cells with mutated genes. Breast cancer is more common in women, regardless of races or ethnic group; is the most common cause of cancer death among Latin American women. In Mexico, this neoplasm according to the national statistics reported is the leading cause of cancer death in women since 2007. There exist three main techniques to detect breast cancer; breast self examination, clinical examination and mammography. Mammography is the most reliable study for the detection of breast cancer. This study is an image of the breast obtained through X rays and it is made with a specialized X ray equipment. In a study of mammography, it is interesting to know the average absorbed dose of radiation into the glandular tissue, known as mean glandular dose. Mexican Official Standard NOM-229-SSA1-2002, indicates that a cranio caudal view of a phantom to simulate a 4.2 cm compressed breast thickness, should not have a higher mean glandular dose to 3 mGy with a composition of breast tissue 50% glandular and 50% fat. Breast density depends on the amounts of fat and glandular tissue, (connective tissue and glandular) in the breast. The proportion of glandular tissue and determine the density varies with ages and patient physioanatomy. The aim of this study is to determinate breast density in a digital mammogram using digital techniques of image processing.

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AVALIAÇÃO DA INFLUÊNCIA DE UM ESQUEMA CADX NO DIAGNÓSTICO MAMOGRÁFICO: CLASSIFICAÇÃO DE NÓDULOS SUSPEITOS

Bruno Roberto Nepomuceno Matheus; Verçosa, Luciana Buffa; Schiabel, Homero

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Este trabalho tem como objetivo apresentar uma avaliação do uso de um sistema CAD de classificação de nódulos quando utilizado como uma segunda opinião a um radiologista. O programa utilizado nestes testes segmenta os nódulos e classifica os mesmos por contorno apenas, fornecendo ao radiologista a opinião em porcentagens de similaridades com as cinco classes de contorno definida no esquema BI-RADs (circunscritos, obscurecidos, microlobulados, mal definidos e espiculados). A opinião do radiologista é requisitada antes e depois da saída do sistema CAD ser apresentada. Os resultados obtidos demonstram que não só a opinião do radiologista se altera com os resultados do programa como houve uma melhora considerável na classificação do radiologista.

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SEGMENTAÇÃO DE IMAGENS DE ENXERTOS ÓSSEOS UTILIZANDO OS ALGORITMOS WATERSHED E K-MÉDIAS

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This paper proposes a new method of histological image segmentation for evaluation of the bone neoformation under bone graft repair. The method uses color-based segmentation in L*a*b color space combining watershed and k-means algorithms. The main goal is to decrease human interference and subjectivity.

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ANÁLISE ACÚSTICA NÃO LINEAR (ANL) DO PADRÃO VISUAL DE DINÂMICA VOCAL (PVDV) DE HOMENS ADULTOS

Debora Godoy Galdino; Lídia Cristina da Silva Teles

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Introdução. O conceito de qualidade vocal se refere à voz saudável, ou seja, sem alterações nos formantes e ausência de ruído. Para avaliação da qualidade vocal, utilizamos escalas de avaliação da voz, escalas estas perceptivas auditivas e também acústicas e objetivas. A análise acústica da voz tem sido utilizada na prática clínica de forma a enriquecer o diagnóstico e tratamento de distúrbios da voz. Atualmente, muito do que temos na área médica são devido às aplicações de abordagens lineares, ou seja, aqueles que levam em consideração proporcionalidade entre duas ou mais variáveis e nas quais essas relações são descritas por equações lineares. Cada vez mais as teorias não lineares têm sido utilizadas para a interpretação, explicação e previsão dos comportamentos de fenômenos físicos biológicos. **Objetivo.** Este projeto tem como objetivo estabelecer um banco de dados do padrão visual da dinâmica vocal, por meio da técnica de análise não linear de homens adultos e correlacionar estes achados com os dados da análise acústica clássica. **Metodologia.** Serão analisados sinais de voz humana de sujeitos do sexo masculino de idade entre 20 a 40 anos e que não apresentem queixas relacionadas à voz. Para avaliação perceptiva da voz, será utilizada a escala GRBAS. Dentre os parâmetros da análise acústica da voz adotados, teremos: Frequência fundamental (F0), Jitter, ou perturbação de frequência, Shimmer, perturbação de ruído e Harmônico ruído. Para a análise não linear será adotado o programa ANL do pacote TISEAN. Na avaliação qualitativa dos padrões visuais de dinâmica vocal, serão considerados três aspectos da configuração: número de laços; traçado das orbitas e convergência das orbitas.

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AVALIAÇÃO DA QUALIDADE DAS IMAGENS MAMOGRÁFICAS SIMULADAS SOB DIFERENTES PADROES DE IMPRESSAO

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CIRS model 011A Phantom images generated at FujiFilm FCR Profect One system were evaluated on monitors and on a printed image in hardcopy devices using two kinds of mammographic films. The goal of this work was to qualify these images under different processing and printed conditions based on objects detection. The images were also evaluated on medical monitor. The printed image evaluation shows both kinds of film (DI-ML and DI-HL) were appropriate for mammographic printed images. Some microcalcifications and masses were not detected using DI-ML at default CR console processing (P1) with LUT 53 in DryPix 4000. Using the edge enhancement processing (P2) the results were better at this same LUT. These results suggest the LUT and processing conditions should be selected carefully. The detection performance on monitor (3 megapixel and 500 cd/m² of brightness) was achievable for all evaluated images suggesting the radiological analysis should be preferred done on this kind of device.

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PROGRAMAÇÃO DE FPGA PARA ACIONAMENTO DE TRANSDUTORES MATRICIAIS EM UM SISTEMA DE ULTRASSOM DIAGNÓSTICO

Henrique Ferreira Lopes; Costa, Eduardo Tavares

UNICAMP

The activation of array transducers has strict time constraints, requiring fast and accurate excitation signals in each of their elements. FPGA has proved a good choice for this task, fast enough to meet the time requirements and flexibility in generating the excitation profiles in different configurations of ultrasound field generation. We have implemented FPGA programming for a 20 element ultrasound array transducer as part of a system under construction in our laboratory for research and teaching purposes. The system encompasses hardware and software and in this paper we describe how transducer elements are activated to produce several focusing and steering ultrasound wavefronts.

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ANÁLISE DE SINAIS DE CULTURAS NEURAIS ENVOLVENDO OS ESTÁGIOS INICIAIS ATÉ A FASE DE MORTE CELULAR

Suélen Moreira Marques¹; Mauro Guilherme Guzo²; Ricardo Camargos Lopes¹; Ariadne de Almeida Branco Oliveira¹; Luiz Otávio Murta Júnior²; João Batista Destro Filho¹

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This paper analyses electrical activity recorded during the maturation of embryonic hippocampal dissociated cultures, based on Multielectrode Array (MEA) devices, starting from the culture deposition until its death, during 0-88 days in vitro (DIV). Classical spike analysis is applied to three different cultures, pointing out the evolution of spikes and bursts. Particular attention is devoted to the last step associated with cellular death, for which unexpected raise of electrical activity amplitude is assessed.

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ON THE CLUSTERING OF MOTOR UNIT ACTION POTENTIALS BASED ON DIFFERENTIAL EVOLUTION ALGORITHM

Angela Abreu Rosa¹; Alcimar Barbosa¹; Adriano Andrade¹; Slawomir Nasuto²

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The decomposition of electromyography signals is a very important tool to evaluate the nervous systems. Many techniques have been developed with this aim. Although, there is no other related work that have used the evolutionary algorithm called Differential Evolution (DE), which is a tool for efficient optimization and includes Evolution Strategies and Genetic Algorithms. As is already known, for the process of EMG decomposition is required six steps: signal detection, data acquisition, signal filtering, detection or regions of activity, feature selection and data clustering. This work proposes the use of the DE on the last step of EMG decomposition, data clustering.

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ANALYSIS OF PARTIAL CORRELATIONS BETWEEN LINEAR AND NONLINEAR MEASURES OF HEART RATE VARIABILITY

Mauro Guilherme Guzo; Murta, Luiz Otávio

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This study aims to investigate partial correlations between linear and nonlinear measures of heart rate variability (HRV) time series. HRV is an important carrier of autonomic nervous system (ANS) physiological status and provides a sensitive estimation of physiologic conditions and early indicator for some diseases. Although there are fundamental paradigmatic differences on linear and nonlinear models, both interpret HRV representing the same observable physiological dynamics, and therefore is expected to have partial relationships among their results. In linear model scope, a set of statistical measurements are considered in time domain, such as square differences in normal beats (SDNN), SDNN index, root mean square of successive differences in beat intervals (RMSSD), number of pairs of successive beat intervals differing in more than 50 ms (NN50), NN50 proportion (pNN50) and HRV triangular index. Measurements in frequency domain allows quantification of HRV physiology in dynamic components, namely very low (VLF), low (LF), high (HF) frequency band and their ratio (LF / HF). Nonlinear models are based on the assumption that the behavior of a system is consequence of nonlinear combinations of autonomic nervous system parts, when responding to various physiological variables. We have evaluated Detrended Fluctuation Analysis (DFA), Hurst exponent, Poincaré Plots measurements, Symbolic Dynamics and Entropy measures. Correlations are investigated in pairs of linear and nonlinear measurement. HRV time series obtained from electrocardiograms of healthy individuals, patients with atrial fibrillation and heart failure were selected in this study to investigate existence of correlations between the various measurements and the validity domain ranges for such correlations. Results obtained can help to elucidate the existing relationship different in different HRV model, and suggest some physiological and clinical validity domain range for correlations.

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DETECÇÃO AUTOMÁTICA DE MARCAS DE ROLO EM IMAGENS DE SIMULADORES RADIOGRÁFICOS DE MAMA

Amanda Barreto Cavalcanti¹; André Fonseca Costa¹; Leonardo Vidal Batista¹; José Fernando Carvalho²

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Breast cancer is one of the most frequent death causes among adult women. One of the most effective prevention methods is periodical mammograms, in order to detect cancer in an early stage. The Certification Program of Mammography Quality from the Brazilian College of Radiology requires that mammography services regularly check the quality of their mammographies, using a breast simulator, also known as phantom. This paper introduces a method to detect roller marks, a type of artifact, in phantoms, through analysis in the frequency domain.

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TELEMEDICINE IN THE ACQUISITION OF KNOWLEDGE APPLIED TO HEALTH

Paulo Loncarovich

UNOESTE AND UNESP

Telemedicine in medical education is currently defined as the use of information by electronic communication to the patient's health and education of health professionals. It is characterized by the use of electronic signals to transfer information from one place to another, in order to improve access to data.

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SENSOR NETWORK FOR ASSESSMENT OF ENERGY EXPENDITURE DESIGN BASED ON ANDROID

Leonardo Juan Ramirez Lopez¹; Daniel Gustavo Goroso²; Linamara Rizzo Batisttella²

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The society changes and worldwide nutrition transition are driving the obesity epidemic. Brazil has undergone a gradual increase in the number of overweight people, and these people needs a monitoring system of energy expenditure to self control - management during several physical activities under free-living conditions, which medical staff requires for rehabilitation processes. The body sensor networks have numerous applications to health and wellness monitoring, for this fact, we used a sensor network composed of motion, temperature and heart rate sensor for assessment energy expenditure in free-livings conditions based on Android platform which is a new generation of smart mobile phone platform that provides different services of interconnection with sensor network. Our aim was to apply an energy expenditure model inside of mobile phone based on Android to connect a sensor network and transmit prevention alarms to prevent cardiovascular accident. Such information has the potential to improve changes to a healthy life.

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REPORTS OF CHEST X-RAY UNDER THE PRINCIPLE OF LEAST EFFORT

Leandro Zerbinatti; Lincoln A. Moura Jr

Fundação Atech

Parts of the Electronic Health Record (EHR) are written in free text. This practice does not promote the use of information for evidence-based decision making. Vocabulary standards and models are needed to promote semantic interoperability between clinical information systems. All clinical organizations may benefit from the extraction of semantic knowledge from free-text reports. In his "Human Behavior and the Principle of Least Effort", George.K.Zipf concludes that people act to minimize their work. The evidence of this theory is revealed through the statistical distribution of language. According to his theory, both the individual who is speaking and the one who is listening try to minimize the communication effort. A decrease in the speaker's effort means a trend to use the smallest possible vocabulary, using words that are believed to be in the speaker-listener common knowledge. The listener's effort decreases if the speaker uses specific words to describe specific objects. Two thousand radiology reports, written in Portuguese, were used for the extraction of knowledge by identifying the words, n-grams and phrases of reports. The tokenization process identified that, despite the large number of tokens that appeared in the corpus (153,896), the number of words is much smaller (1,067). By taking away only 44 words, such as articles and prepositions (resulting in 1,023 words), there is a large decrease in the amount of tokens in the corpus (96,798). Care has been proven to Zipf's law for the corpus used. This law provides an overview of few words we use to communicate, and is based on the principle of least effort. We identified that just over 100 words are responsible for the vast majority of words in the corpus (95.22%), whereas others have much fewer occurrences. This finding shows that, as expected, even in Portuguese, Zipf's law works in a straight way.

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TRANSFERINDO VALORES DA CURVA ROC PARA O RETICULADO DE HASSE NA LÓGICA PARACONSISTENTE ANOTADA COM DOIS VALORES SISTEMA DE APOIO A DECISÃO E INTELIGÊNCIA ARTIFICIAL (MEDICAL PHYSICS EDUCATION)

Paulo Roberto Schroeder de Souza; Samaris Ramiro Pereira

Sociedade Brasileira de Engenharia Biomédica

Abstract - This paper was prepared through an analog study between the quantitative and qualitative methods used in medicine where we apply the lattice representative of Paraconsistent Logic annotations of two values (LPA2v). This new concept of medical decision support was one of the works developed during the research thesis which will clarify better this article. The proposal offered is the creation of a new theory applied to ROC curves in the lattice LPA2v. What surprised this technique is the coincidence of the equivalence of paraconsistent logic with the textual names of Health as false-positive and false-negative patients and no patients presented among other classifications. We will obtain an overview of the analysis of the outcome of the disease allowing a degree of evidence favorable or unfavorable in this study. Keywords: paraconsistent. LPA2v. ROC. false-positive. false-negative.

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TELEMEDICINE APPLICATION IN GENETIC COUNSELING

Paulo Loncarovich

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Telemedicine in medical treatment is currently used for the use of information by electronic communication to the patient's diagnosis and promote interaction among health professionals. In the environment of access to genetic geneticist during pregnancy is important because it directly facilitates the diagnosis of a fetal ultrasound, biochemical evaluation, data collection or family of a genetic or hereditary disease and previously diagnosed or suspected as malformation of a child earlier, the chromosome abnormality or mental retardation, growth retardation in children or other relatives also motivate the query. It is characterized by the use of electronic signals to transfer information from one place to another, in order to improve access to data. Objectives - Facilitate access to information and knowledge exchange among health professionals and patient care.

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Sunday, April 17, 2011

17:30 - 18:30

Hall A

Opening Ceremony**18:30 - 20:30**

Exhibition Hall

Welcome Party**Monday, April 18, 2011**

8:30 - 9:30

Hall A

PSI-MO-A - Harmful Tissue Effects: Is there always a Dose Threshold?*Jolyon Hendry**Chair: Ana Maria Marques; Co-Chair: Simone Kodulovich.***9:30 - 10:45**

Hall A

SS1-MO-A - Stereotactic Radiosurgery and Stereotactic Body Radiation Therapy*Chair: Timothy D. Solberg; Co-Chair: Cecília Haddad.*

9:30 SS1-MO-A-ka - Quality and Safety in Stereotactic Radiosurgery and Stereotactic Body Radiation Therapy: More can be Done. Keynote: Timothy D. Solberg.

10:00 SS1-MO-A-01 – (744) Results of the Dose Intercomparison at the RCP Phantom of Pelvis and Head and Neck Used for the Validation of IMRT Technique at the Centro Control de Cancer. Vasquez, Jaider; Arbelaez, Juan Carlos; Bobadilla, Iban; Español, Ricardo; Gaitan, Armando; Torres, Luis Felipe.

10:15 SS1-MO-A-02 – (749) Absolute Absorbed Dose Rate in Water Measured in Small Radiotherapy Fields. G. Massillon-JL; D Cueva-Prócel; P Dias-Aguire; X Dominguez-Ojeda; M Rodriguez-Ponce

10:30 SS1-MO-A-03 – (743) Implementation of A 3D Quality Control System with Anatomical Correlation to Intensity Modulated Radiation Therapy (IMRT). Vasquez, Jaider; Arbelaez, Juan Carlos; Bobadilla, Iban; Español, Ricardo; Gaitan, Armando; Torres, Luis F.

Hall B

SS1-MO-B - Image Quality and Dose in Computed Tomography*Chair: John M. Boone; Co-Chair: Eder Rezende Moraes.*

9:30 SS1-MO-B-ka - Image Quality Metrics for Computed Tomography – Keynote: John M. Boone

10:00 SS1-MO-B-01 – (517) Optimization of the Scan Protocol in the Measurements of Coronary Artery Calcium. Oliveira, Larissa; Gottlieb, Ilan; Carvalho, Fabrício; Pinheiro, Larissa; Kodulovich, Simone; Mecca, Fernando; Lopes, Ricardo.

10:15 SS1-MO-B-02 – (524) Evaluation of the Image Quality in Computed Tomography: Different Phantoms. Silveira, Vinicius; Delduck, Rômulo; Kodulovich, Simone; Oliveira, Larissa; Mecca, Fernando; Silva, Humberto.

10:30 SS1-MO-B-03 – (529) Optimization of Pediatric CT Protocols: Abdomen and Chest. Thalís Leon de Ávila Saint Yves; Fernando Augusto Mecca; Simone Kodulovich Dias.

Hall D**SS1-MO-D - Functional Magnetic Resonance Imaging with High and Ultrahigh Magnetic Fields***Chair: Bashar Issa; Co-chair: Roberto Covolan.*

- 9:30 SS1-MO-D-ka - Frontiers in Biomedical Imaging with Ultrahigh Magnetic Fields – Keynotes: Kamil Ugurbil, Bashar Issa.
- 10:00 SS1-MO-D-01 – (732) Effect of the Scanner Background Noise on the Resting Brain Networks Detected by fMRI. Rondinoni, Carlo; Antonio Carlos dos Santos; Carlos Ernesto Garrido Salmon.
- 10:15 SS1-MO-D-02 – (354) Study of mdx Mouse by Nuclear Magnetic Resonance Spectroscopy (MRS). Cervantes, HJ; Bloise, AC; Bach, ABM; Rabbani, SR.
- 10:30 SS1-MO-D-03 – (134) A Tool for Converting & Correction of MRSI Images in to DICOM Format. S.Rabee Mahdavi; S.Rabee Mahdavi; Bahram Bolouri; Reza Alinaghizadeh.

Hall E**EP1-MO-E - Radiation Safety in Pediatric Radiology: what we can do as a Medical Physicist?***Charles Willis**Chair: Donald McLean; Co-chair: Denise Nersissian.***10:45 - 11:00****Exhibition Hall****Coffee Break****11:00 - 12:30****Hall A****SS2-MO-A - Quality Assurance in Radiation Therapy***Chair: David Followill; Co-chair: Laura Natal Rodrigues.*

- 11:00 SS2-MO-A-ka - The Role of Anthropomorphic Phantoms in Clinical Trial Quality Assurance: The Radiological Physics Center's (RPC) Experience - David Followill, A. Molineu, P. Alvarez and G. Ibbott.
- 11:30 SS2-MO-A-01 – (381) Acceptance and Commissioning of the XVI System at Icesp, Sao Paulo. Rodrigues, Laura Natal.
- 11:45 SS2-MO-A-02 – (606) Tomotherapy Dose Rate Analysis and Considerations for Absolute Calibration. Dany Simard.
- 12:00 SS2-MO-A-03 – (492) A Risk Management Approach to Credentialing of Radiotherapy Centers for Clinical. Kron, Tomas; Haworth, Annette; Foroudi, Farshad; Ball, David; Hatton, Joan; Cornes, Deidre.
- 12:15 SS2-MO-A-04 – (109) Statistical Process Control: Quality Control of Accelerator Beam Steering. Able, C. M.

Hall B**SP-MO-B – Joint IOMP/WHO/ALFIM/PAHO Special Session: Health Technologies - More than a Niche for Medical Physicists***Chair: Fridtjof Nüsslin; Co-Chair: Ruzica Maksimovic.*

- 11:00 Introduction - Fridtjof Nüsslin.
- 11:05 WHO Global Initiative for Health Technologies and the Outcomes from the 1st Global Forum on Medical Devices - Pablo Jimenez, PAHO.
- 11:25 Challenges to Implement the New Technologies in Latin American and Caribbean Countries - Simone Kodlulovich, ALFIM.
- 11:40 The Role of the Medical Physicist in Health Technology Assessment and Management - Cari Borrás, IOMP.
- 11:55 The need for Health Technology Assessment Policies: The Brazil Experience – DECIT Representative.
- 12:05 Health Technology Regulations and Medical Devices Registration in Brazil – ANVISA Representative.
- 12:15 Discussion with panel.

Hall C**SS2-MO-C - Nuclear Medicine Imaging***Chair: Cecil Chow Robilotta; Co-chair: Osama Mawlawi*

- 11:00 SS2-MO-C-ka - Quantitative Emission Tomography. Keynote: Cecil Chow Robilotta.
- 11:30 SS2-MO-C-02 – (683) A Simple Segmentation Algorithm to Measure Gastric Contraction on Scintigraphies. Fonseca, Paulo; Fanelli, Rafaela; Américo, Madileine; Ietsugu, Marjorie; Quini, Caio; Miranda, José Ricardo.
- 11:45 SS2-MO-C-03 – (751) Establishment of a Brazilian Database for Assessment of Neurodegenerative Disorders. Kubo, TTA; Cavalcanti, JL; Machado, L; Doring, T; Gasparetto, EL; Domingues, RC.

Hall D**SS2-MO-D - Radiation Biology and Physiological Modeling***Chair: Jolyon Hendry; Co-chair: Emico Okuno.*

- 11:00 SS2-MO-D-01 – (687) Evaluation of Physiological Time Series with Nonadditive Approximate Entropy Rate. Luiz Eduardo Virgilio Silva; Luiz Otavio Murta Junior.
- 11:15 SS2-MO-D-02 – (172) NSECT Applied to the Assessment of Calcium Deposition Due to the Presence of Microcalcifications Associated with Breast Cancer. Viana, Rodrigo; Yoriyaz, Hélio.
- 11:30 SS2-MO-D-03 – (150) Bradykinin B2 Receptor is not Required for Tumor Growth Regression by Radiotherapy. Doales, Ana Cristina Murta; Scharfstein, Julio.

Hall E**EP2-MO-E-Innovations in Medical Physics Education***Chair: Raymond Wu; Co-chair: Marcelo Freitas.*

- 11:00 EP2-MO-E-ka - Innovations in Medical Physics Education. Keynote: William Hendee; Slavik Tabakov.
- 11:30 EP2-MO-E-kb - Emitel E-Encyclopaedia of Medical Physics And Dictionary of Terms – Keynote: Tabakov, S ; Smith P; Milano F; Strand S-E; Lewis C; Stoeva M.

12:30 - 14:00**Lunch****Hall A****VARIAN Session: Varian Knowledge Circuit.****14:00 - 15:00****Hall A****PSII-MO-A - Novel Dosimetry Concepts based on Nanodosimetry***Hans Rabus**Chair: Barry Allen, Co-chair: Patrícia Nicolucci.***15:00 - 16:15****Hall A****SS3-MO-A - Intensity Modulated Radiation Therapy***Chair: Patrick F. Cadman; Co-chair: André Mozart de Miranda Vieira.*

15:00 SS3-MO-A-ka - IMRT Commissioning: How Close is Close Enough? Keynote: Patrick F. Cadman.

15:30 SS3-MO-A-02 – (577) Geometric Accuracy Evaluation of Stereotactic Body Radiation Therapy Through an End-To-End Test. Mancini, Anselmo; Nascimento, José Eduardo; Neves-Junior, Wellington; Pelosi, Edilson; Alves, Tatiana; Silva, João; Haddad, Cecilia.

15:45 SS3-MO-A-03 – (594) Feasibility of Stereotactic Treatment Planning Through Indices of Conformity. Fabio Alves dos Santos Junior; Cassio Queiroz Tannous.

Hall B**SS3-MO-B - Computed Tomography Dosimetry****Chair: J. Anthony Seibert; Co-chair: Teógenes Augusto da Silva.**

15:00 SS3-MO-B-ka - Effect of Noise Reduction Algorithms on Patient Dose. Keynote: J. Anthony Seibert.

15:30 SS3-MO-B-01 – (227) Study of the CT Dose Profiles in a Chest Phantom. Oliveira, Bruno Beraldo; Mourão, Arnaldo Prata; da Silva, Teógenes Augusto.

15:45 SS3-MO-B-02 – (337) Dosimetry in Computed Tomography Using a Smart Electronic Detector. Magalhães, Cinthia M. S; Souza, Divanizia N, Santos, Luiz A. P.

16:00 SS3-MO-B-03 – (575) Estimation of Patient Dose in CT: An Extension of IAEA Project in Brazil. Delduck, Rômulo; Silveira, Vinicius; Kodlulovich, Simone; Oliveira, Larissa; Silva, Humberto; Khoury, Helen; Andrade, Marcos; Nader, Alejandro.

Hall C**SS3-MO-C - Quality Assurance in Nuclear Medicine***Chair: Roger Fulton; Co-chair: Lorena Pozzo.*

15:00 SS3-MO-C-01 – (656) Preliminary Results of QUANUM Implementation in Cuban Nuclear Medicine Services. Marlenin Díaz Barreto; Consuelo Varela Corona; Gladys M. López Bejerano; Adlin López Díaz; Leonel A. Torres Arocha; Marcos A. Coca Pérez.

15:15 SS3-MO-C-02 – (717) Misalignment Evaluation for PET/CT. Fernandes, Fernando de Amorim; Boanova, Luciane Guerra.

15:30 SS3-MO-C-03 – (746) Parametric Characterization of Non-Imaging Intraoperative Gamma Probes. Consuelo Varela Corona; Norberto J. Abreu; Dayana Ramos; Aley Palau; Carlos F. Calderón.

16:15 - 16:30**Exhibition Hall****Coffee Break**

16:30 - 17:30**Hall A****ELEKTA Session: Advanced Technology/Integrated Workflow in Radiotherapy. Volker Steil.****Exhibition Hall****PO-MO – Poster Session***Chairs: Tania Furquim; Maurício Annés; Cássio Stein Moura.**Themes: X-ray Imaging (XI), Magnetic Resonance (MR), Ultrasound (US), Nuclear Medicine (NM), Physiological/Biological Modeling (IB), General Physics (GP).***17:30 - 18:30****Hall A****SS4-MO-A - Symposium on Image Guided Radiation Therapy***Chair: Habib Zaidi; Co-chair: Thomas Kron*

17:30 SS4-MO-A-ka - Molecular PET-CT Imaging-Guided Radiation Therapy Treatment Planning. Keynote: Habib Zaidi.

18:00 SS4-MO-A-kb – Adaptive Radiation Therapy. Keynote: Tomas Kron, Daniel Pham, Paul Roxby, Aldo Rolfo and Farshad Foroudi.

Hall B**SS4-MO-B - Radiation Protection Programs***Chair: Madan M. Rehani; Co-chair: Elisabeth Yoshimura.*

17:30 SS4-MO-B-ka - Patient Radiation Exposure Tracking – Keynote: Madan M. Rehani.

18:00 SS4-MO-B-01 – (662) Program of Radiation Protection of Patients (Argentina). Rodolfo Touzet; Alfredo Buzzi; Daniel Andisco.

18:15 SS4-MO-B-02 – (670) Assessment of Safety Culture in Medical Practices Utilizing Ionizing Radiation I. Abdus Sattar Mollah.

Hall C**SS4-MO-C - Film Dosimetry for Radiation Therapy***Chair: Hans Rabus; Co-chair: Sérgio Faermann.*

17:30 SS4-MO-C-01 – (295) Sensitometric Curves as a Tool for Evaluation of the Off-Axis Softening Effect I. Dan Epstein; Alex Tsechanski; Sergio Faermann.

17:45 SS4-MO-C-02 – (481) Sensitivity of Film Measured Off-Axis Ratios to Film Calibration Curve Using Radiochromic Film. García-Hernández, Diana; Lárraga Gutiérrez, José Manuel.

18:00 SS4-MO-C-03 – (222) Surface and Peripheral Dose Measurements with Wedge Filters for Photon Beams. Lahooti, Afsaneh; Takavar, Abbas; Nedaei, Hassan Ali; Allahverdi, Mahmood.

Hall D**SS4-MO-D - Magnetic Resonance Imaging and Nanoparticles as Contrast Agents***Chair: Bashar Issa; Co-chair: Ricardo Papaléo.*

17:30 SS4-MO-D-ka - Magnetic Nanoparticles Contrast Agents in MRI – Keynote: Bashar Issa, S. Qadri, I.M. Obaidat, A.P. Habeeb, R.W. Bowtell, Y. Haik.

18:00 SS4-MO-D-01 – (658) Influence of Brain ROI Location for ADC Maps Calculation for Reference Values to be Used in the In Vivo Characterization of Brain Tumors MRI Images. Edna Marina de Souza; Gabriela Castellano; Eduardo Tavares Costa.

18:15 SS4-MO-D-02 – (369) Hippocampal Asymmetry in Subjects: A Structural Connectivity Study Using DTI. Gravinatti, Milena Cristina; Salmon, Carlos Ernesto Garrido; Santos, Antônio Carlos dos; Iturria-Medina, Yasser.

Tuesday, April 19, 2011**8:30 - 9:30****Hall A****PSIII-TU-A - Clinical Implementation of Volumetric Modulated Arc for Conventionally Fractionated and Stereotactic Body Radiation Therapy***Vitali Moiseenko**Chair: Cecília Haddad; Co-Chair: Tomas Kron.***9:30 - 10:45****Hall A****SS1-TU-A - Dosimetry and Quality Assurance for New Radiation Therapy Modalities***Chair: Vitali Moiseenko; Co-chair: Edilson Pelosi.*

9:30 SS1-TU-A-ka - International Traceability for Radiation Dosimetry - P.J. Allisy-Roberts; C. Borrás.

10:00 SS1-TU-A-01- (694) Initial Experience of Patient Specific Quality Assurance for RapidArc using ArcCheck at Hope at Guatemala. Ixquiac Cabrera, Milton Estuardo; Ixquiac Cabrera, Jorge Marcelo.

10:15 SS1-TU-A-02- (108) Comparison of RapidArc and Intensity Modulated Radiotherapy Treatment Plans. Sathiyar, S.; Ravikumar M; Arthur L Boyer; Jason Shoales.

10:30 SS1-TU-A-03- (765 - Poster) Development of the Dedicated Phantom System with Rolled Radiochromic Films for VMAT QA. Park, Ji-Yeon; Lee, Jeong-Woo; Choi, Kyoung-Sik; Lee, Jung Seok; Suh, Tae-Suk.

Hall C**SS1-TU-C - New Dosimetry Materials and Technologies in Medical Applications***Chair: Oswaldo Baffa; Co-chair: Divanizia do Nascimento Souza.*

9:30 SS1-TU-C-ka - Future Trends of EPR in Medical Applications – Keynote: Oswaldo Baffa

10:00 SS1-TU-C-01 – (433) Long-Lasting Phosphorescence Scintillators for Use in Radiological Protection. Zelia Soares Macedo; Amanda Barreto Nunes; Jamille da Silveira Almeida; Carolina Melo de Abreu; Ronaldo Santos da Silva.

10:15 SS1-TU-C-02 – (478) Radiation Detectors Based on Self-Sustainable Films of Scintillator and Polymer. Novais, S.M.V.; Jesus, F.A.A.; Silva, E.S.S.; Macedo, Z.S.; Schimitberger, T.; Ferreira, G.R. and Bianchi, R. F.

10:30 SS1-TU-C-03 – (311) Nanoparticle Increases Dosimetry Sensitivity of Magic-F to Radiation Therapy. Marques, Tatiana; Guidelli, Éder J.; Schwarcke, Marcelo; Baffa, Oswaldo; Nicolucci, Patrícia.

Hall D**SS1-TU-D - Ultrasound Imaging***Chair: Paul Carson; Co-chair: Antonio Adilton Carneiro.*

9:30 SS1-TU-D-ka - Ultrasound Imaging for Diagnosis and Guidance of Treatment Emphasizing Breast Cancer – Keynote: Paul L. Carson.

10:00 SS1-TU-D-01 – (595) A Comparative Study Using Both Coded Excitation and Conventional Pulses in the Evaluation of SNR Sensitivity and Axial Resolution in Ultrasonic A-Mode Scan. Tiago de Moraes Machado; Eduardo Costa Tavares.

10:15 SS1-TU-D-02 – (693) Similarity Metrics Comparison in Nonrigid Registration in Contrast Ultrasound Images. Luiz Otavio Murta Junior; Erbe Pandini Rodrigues.

10:30 SS1-TU-D-03 – (582) Analysis of Different Fluids by Ultrasound Radiation Force. Almeida, Thiago W. J.; Pavan, Theo Z.; Carneiro, A. A. O.

Hall E**SS1-TU-E - Experiences in Education and Training in Medical Physics***Chair: Slavik Tabakov; Co-chair: Paulo Costa*

- 9:30 Presentation of the book MEDICAL PHYSICS AND ENGINEERING EDUCATION AND TRAINING – Part I. Editors: S Tabakov, P Sprawls, A Krisanachinda, C Lewis.
- 10:00 SS1-TU-E-02 – (434) Virtual Collaborative Environment for Nuclear Medicine Training: A Pilot Study - Brambilla, Cláudia Régio; Dalpiaz, Gabriel; Marques da Silva, Ana Maria; Giraffa, Lucia Maria Martins.
- 10:15 SS1-TU-E-03 – (445) Medical Physics Education in Sergipe: History, Challenges and Perspectives. Maia, Ana.
- 10:30 SS1-TU-E-04 –(284) Development of A Residency Program In Radiation Oncology Physics: An Inverse Planning Approach. Khan, Rao; Dunscombe, Peter.

10:45 - 11:00**Exhibition Hall****Coffee Break****11:00 - 12:30****Hall A****SS2-TU-A - Symposium on New Radiation Technologies***Chair: Harald Paganetti, Co-chair: Cari Borrás.*

- 11:00 SS2-TU-A-ka - Patient Responses in a Phase 1 Clinical Trial of Targeted Alpha Therapy for Metastatic Melanoma. Keynote: Barry J Allen.
- 11:25 SS2-TU-A-kb - Current Challenges in Proton and Light Ion Therapy. Keynote: Harald Paganetti.
- 11:45 SS2-TU-A-01 – (133) A Beamline for Medical Imaging and Therapy at Sesame Synchrotron. Keynote: Feras Ramadan Afaneh.
- 12:00 SS2-TU-A-kc - Assessment of New Technologies in Radiation Medicine: Diagnostic and Therapy. Keynote: William Hendee.

Hall B**SS2-TU-B - Computed Radiography, Digital Radiology and Mathematical Image Manipulation***Chair: Kwan Hoong Ng; Co-chair: Ana Figueiredo Maia.*

- 11:00 SS2-TU-B-ka - Will DR Replace CR? Keynote: Kwan-Hoong Ng.
- 11:30 SS2-TU-B-01 – (297) Radioprotection in Interventional Radiology. Rodolfo E. Touzet; Oscar Peralta; Daniel Andisco.
- 11:45 SS2-TU-B-02 – (348) Characterization of Digital Images Generated by X-Radiation Equipment Using Different Transducers: Computed Radiography VS Digital Radiography. Hoff, Gabriela; da Luz, Renata Matos; Dalenogare, Maiara Oliveira; Nunes, Rafael Menezes and Lykawka Rochelle.
- 12:00 SS2-TU-B-03 – (447) Simulated Intensity Profiles for Cylindrical Objects in Magnification Mammography. Karla Palma-Alejandro, ME Brandan, A Valdeolivas, T Alieva, M Chevalier, E Guibelalde.
- 12:15 SS2-TU-B-04 – (325) Image Processing Techniques to Evaluate Mammography Screening Quality. Clara Inês Quintana Zurro; Germán Tirao; Mauro Valente

Hall C**SS2-TU-C - Internal Dosimetry***Chair: Michael Stabin; Co-chair: Linda Viola Caldas.*

- 11:00 SS2-TU-C-ka - Dosimetric Quantities and Methods in Diagnostic and Therapeutic Nuclear Medicine. Keynote: Michael G. Stabin.
- 11:30 SS2-TU-C-01 – (344) Influence of Morphology on Nuclear Medicine Dosimetry Based on Patients Images. Hadid, Lama; Grandgirard, Noe; Pierrat, Noelle; Desbree, Aurelie.
- 11:45 SS2-TU-C-02 – (436) Primary and Scattering Contributions to Beta Scaled Dose Point Kernels by Means of Monte Carlo Simulations. Mauro Valente; Dottsa. Francesca Botta; Lic. Pedro Pérez; Dott. Guido Pedrolì.
- 12:00 SS2-TU-C-03 – (220) Estimation of Human Effective Absorbed Dose of 67GA-DTPA-Gonadorelin Based on Bi. Saeed Shanehsazzadeh; Afsaneh Lahooti
- 12:15 SS2-TU-C-04 – (141) Determination of Human Absorbed Dose of 201 TL(III)-DTPA-HIGG Based on Biodistribution. Alireza Khorrami Moghaddam; Amirreza Jalilian; Vali Hayati; Saeed Shanesazzadeh.

Hall D**SS2-TU-D - Laser Applications in Medicine and Effects of Magnetic Fields***Chair: Elisabeth Yoshimura; Co-chair: José Ricardo de Arruda Miranda.*

- 11:00 SS2-TU-D-ka - Lasers in Medicine. Keynote: Elisabeth Mateus Yoshimura.
- 11:30 SS2-TU-D-01 – (93) Light Distribution in Phantoms. Sousa, M. V. P. Ramos, A. L. O. Magalhães, A. C. Saito, M. T. Yoshimura, E. M.
- 11:45 SS2-TU-D-02 – (328) Reproducibility of Radiant Energy Measurements Inside Light Scattering Liquids. Ana Carolina de Magalhães; Elisabeth M. Yoshimura.
- 12:00 SS2-TU-D-03 – (731) A Pilot Study - Acute Exposure to Low-Intensity, Low-Frequency Oscillating Magnetic Field: Effects on Carrageenan-Induced Paw Edema in Mice. Tania Mateus Yoshimura; Daiane Thais Meneguzzo; Rodrigo Álvaro Brandão Lopes Martins.
- 12:15 SS2-TU-D-04 – (685) Treating the Problem of Diagnostics of Oncological Post-Operative Condition by the Method of Chemiluminescenc. Oliynyk, Iryna; Hotra, Zenon; Halay, Oleg.

Hall E**SS2-TU-E - Status and Future Development of Education and Training in Medical Physics and Engineering***Chair: Maria do Carmo Lopes, Co-chair: Marlen Diaz.*

- 11:00 Opening. Maria do Carmo Lopes.
- 11:10 SS2-TU-E-ka - IOMP project for model curriculum and assessment of MSc-level courses. Slavik Tabakov.
- 11:30 Status in Latin America. Maria Ester Brandan.
- 11:50 Status in Brazil. Ricardo Terini.
- 12:10 Round Table Discussion. Paulo Costa (moderator).

12:30 - 14:00**Lunch****14:00 - 15:00****Hall A****PSIV-TU-A - Medical Physicists Board Certification: Looking Ahead***Raymond Wu**Chair: Fridtjof Nüsslin; Co-chair: Cecília Haddad.*

15:00 - 16:15**Hall A****RT1-A - Revised International Basic Safety Standards for Protection against Ionization Radiation and for the Safety of Radiation Sources (BSS)***Moderator: Pablo Jimenez.**Speakers: John LeHeron; Ruzica Maksimovic.***Hall B****RT2-B - International Collaboration Within the United States National Cancer Institute Sponsored Clinical Trials: The Need for Radiotherapy Quality Assurance***Moderator: David S. Followill.**Speakers: Milan Tomsej; Tomas Kron; Anna Maria Campos de Araújo.***Hall C****RT3-C – New Advances in Nuclear Medicine***Moderators: Cecil Chow Robilotta and Osama Mawlawi.**Speakers: Barry Allen; Habib Zaidi; Roger Fulton; Osama Mawlawi.***Hall D****RT4-D - Biological Effects of Non Ionizing Radiation: Ultraviolet Rays, Extremely Low Frequency, Radio-frequency and Magnetic Fields in MRI/MRS***Moderator: Kwan Hoong Ng.**Speakers: Emico Okuno; Jorge Skvarca; Alessandro Mazzola.***Hall E****RT5-E - Certification of Medical Physicists***Moderator: Raymond Wu**Speakers: Rena Lee; Tae Suk Suh; Shigekazu Fukuda; María-Ester Brandan; Valdemar Z. Gonzalez.***16:15 - 16:30****Exhibition Hall****Coffee Break****16:30 - 17:30****Exhibition Hall****PO-TU – Poster Session***Chairs: Ricardo Terini; Homero Lavieri; Regina Bitelli Medeiros; Elaine Evani Streck.**Themes: Medical Physics Education (ED), External Beam Radiotherapy (TT), Brachytherapy (BT), Radiation Safety (SR).***17:30 - 18:30****Hall A****SS4-TU-A - New Dosimetry Techniques for Brachytherapy and Total Body Irradiation***Chair: Larry DeWerd; Co-chair: Renato Di Prinzio.*

17:30 SS4-TU-A-ka - Brachytherapy Dosimetry. Keynote: Larry DeWerd.

18:00 SS4-TU-A-01 – (593) ¹⁵³Sm-EDTMP Absorbed Dose Evaluation for Under Bone Metastasis Treatment Patient by Monte Carlo Method. Karimian, Alireza; Eghbali, Ziba; Farrokhi, Samad; Jabbari, Iraj; Azarnoush, Ali

18:15 SS4-TU-A-02 – (598) Dosimetric Characterization of Optically Stimulated Luminescence Dosimeters. Laura Furnari; Ana Paula Vollet Cunha; Camila Pessoa de Sales; Gabriela Reis dos Santos; Marcos Vinicius Nakaoka Nakandakari; Cristian Mergen.

Hall B**SS4-TU-B - Radiation Protection Optimization for Adults and Children undergoing Radiological Procedures***Chair: John Le Heron; Co-chair: Helen Khoury.*

- 17:30 SS4-TU-B-ka - Diagnostic Reference Levels in Radiology. Keynote: John Le Heron.
- 18:00 SS4-TU-B-01 – (601) Radiation Doses in Pediatric Interventional Cardiology Procedures. Maria do Socorro Rocha da Silva; Cari Borrás; Helen Khoury; Santiago Raul Arrieta; Juliana Rodrigues Neves; Luiz Felipe da Silva Andrade Lima; Alejandro Nader
- 18:15 SS4-TU-B-02 – (674) Radiation Dose to Pediatric Patients In Computed Tomography In Sudan. Abdelmoneim Sulieman; Hiba Omer; Hamid Osman.

Hall D**SS4-TU-D - Innovations in Biological Imaging***Chair: Fridtjof Nüsslin; Co-chair: Cecil Robilotta.*

- 17:30 SS4-TU-D-ka - Innovations in Biological Imaging and the Clinical Impact on Cancer Diagnosis and Treatment. Keynote: Fridtjof Nüsslin.
- 18:00 SS4-TU-D-01 – (626) X-Ray Fluorescence Scanning of Human Teeth and Dedicated Image Processing. Rodolfo Figueroa; Díaz, Alfredo; Flores Marco; Valente. Mauro; Tirao, Germán
- 18:15 SS4-TU-D-02 – (720) In Vivo XRF Scanning Analysis of Human Nail. Iván Chavez; Rodolfo Figueroa

Hall E**Assembléia da ABFM****Wednesday, April 20, 2011****8:30 - 9:30****Hall A****PSV-WE-A - Cell Tracking and In Vivo Single Cell Imaging using MRI and Nanotechnology***Brian Rutt**Chair: Oswaldo Baffa; Co-chair: Jolyon Hendry***9:30 - 10:45****Hall A****SS1-WE-A - Novel Dosimetry Systems for Radiation Therapy***Chair: Geoffrey Ibbot; Co-chair: Laura Furnari.*

- 9:30 SS1-WE-A-ka - 3D Dosimetry Systems for Advanced Technology Radiation Therapy. Keynote: Geoffrey S. Ibbott, Ryan L. Grant, David S. Followill.
- 10:00 SS1-WE-A-01 – (310) MRI Gel Dosimetry: Uncertainties Evaluation in 1.5T, 3T and 4.5T. Marques, Tatiana; Schwarcke, Marcelo; Garrido, Carlos E.; Baffa, Oswaldo; Nicolucci, Patricia.
- 10:15 SS1-WE-A-02 – (127) Evaluation of the Pre-Dose Influence on Rad-Hard Epitaxial Silicon Diodes Response in Radiotherapy Photon Beam Dosimetry. T. C. dos Santos, J. A. C. Gonçalves, M. M. Vasques, W. F. P. Neves-Junior, C. M. K. Haddad and C. C. Bueno.
- 10:30 SS1-WE-A-03 – (700) Dosimetry of Cones for Radiosurgery System. Furnari, Laura; Sales, Camila Pessoa de; Santos, Gabriela Reis dos; Silva, Marco Antonio da; Menegussi, Gisela

Hall B**SS1-WE-B - Patient Dose Management in Radiology***Chair: Colin Martin; Co-chair: Márcia de Carvalho Silva.*

- 9:30 SS1-WE-B-ka - Setting up a Programme for Patient Dose Management in Radiology. Keynote: C J Martin.
- 10:00 SS1-WE-B-01 – (502) Development of Gonads Protectors for Use in Pediatric Radiology. Sousa, Carlos H. S.; Menezes. Israel V.; Medeiros, Dayanna O.; Nunes, Miguel M.; Pinheiro, Ricardo A.
- 10:15 SS1-WE-B-02 - (213) Method for Reducing Ovarian Doses in Procedures of Uterine Artery Embolization (UAE). Marcia de Carvalho Silva; Felipe Nasser; Breno B. Affonso; Eduardo Zlotnik; Marcos L. Messina; Seleno Glauber de Jesus Silva.

Hall C**SS1-WE-C - Monte Carlo Modeling***Chair: Gabriela Hoff; Co-chair: Mauricio Moralles.*

- 9:30 SS1-WE-C-01 – (755) A Comparison Between MCNPX and Geant4 Codes for γ -Particle Microdosimetry. Elbast, Mouhamad; Saudo, Arnaud; Petitot, Fabrice; Franck Didier; Desbree, Aurelie.
- 9:45 SS1-WE-C-02 - (353) A Comparison Between MCNPX and Geant4 Codes for γ -Particle Microdosimetry. Elbast, Mouhamad; Saudo, Arnaud; Petitot, Fabrice; Franck Didier; Desbree, Aurelie.
- 10:00 SS1-WE-C-03 – (343) Contamination Mapping with in Vivo Measurements and Monte Carlo Calculations. Farah, Jad; Leone, Debora; Marzocchi Olaf; Navarro Juan Fransisco; Perez, Begona; Lucena, Eder; Lopez, Maria Antonia; Breustedt Bastian; Broggio, David; Franck, Didier.

Hall D**SS1-WE-D - Nanotechnology for Biomedical Applications***Chair: Brian Rutt; Co-chair: Ricardo Papaléo.*

- 9:30 SS1-WE-D-01 – (491) FLTC Labelled, Magnetic Nanoparticles Conjugated D-Penicillamine-Anti-Metadherin. Perihan Unak; Ozlet Akca; E. İlker Medine; Caglar Ozdemir; Serhan Sakarya; Suma Timur.
- 9:45 SS1-WE-D-02 – (309) Attenuation of Gold Nanoparticle in Radiation Therapy Assessed by TLD Dosimetry. Marques, Tatiana; Barbi, Gustavo; Schwarcke, Marcelo; Baffa, Oswaldo; Nicolucci, Patrícia.
- 10:00 SS1-WE-D-03 – (463) Photoactive Magnetic Nanospheres for Nanomedicine. V. F. Castro; A.A.A. De Queiroz.
- 10:15 SS1-WE-D-04 – (254) Size-Controlled $Y_2O_3:Eu^{3+}$ Nanoparticles for Luminescent Probes. Maria de Andrade Gomes; Mário Ernesto Giroldo Valerio; Zélia Soares Macedo.

Hall E**EP3-WE-E - Professional Status of the Medical Physicists in Latin America and the Caribbean***Chair: Simone Kodlulovich; Co-chair: Slavik Tabakov.**Speakers: Cecilia Haddad, Maria Ester Brandan, Graciela Velez.***10:45 - 11:00****Exhibition Hall****Coffee Break**

11:00 - 12:30**Hall A****SS2-WE-A - Treatment Planning for External Beam Therapy including Intraoperative Radiation Therapy***Chair: Milan Tomsej; Co-chair: Renato Assenci Ros.*

- 11:00 SS2-WE-A-ka - Challenges of Treatment Planning with New Technologies and Treatment Techniques. Keynote: Milan Tomsej.
- 11:30 SS2-WE-A-01 – (602) Lévy Metric and the Design of TCP Based Constraints for Plan Optimization. Francisco Cutanda Henríquez; Silvia Vargas Castrillón
- 11:45 SS2-WE-A-02 – (489) Influence of High-Density Inhomogeneities in Stereotactic Radiosurgery With 6 MV. C. Mancilla; G.H. Píriz; E. Lozano
- 12:00 SS2-WE-A-03 – (608) Implementation of Intraoperative Radiotherapy (IORT) on A Varian. Claudio S. Mancilla; Gustavo Hector Píriz Monti; Enrique Lozano Quiroga; Yolma Aide Banguero Villegas; Carlos Fernando Varón Tobón; Cristián Alejandro Parra Becerra
- 12:15 SS2-WE-A-04 – (613) Implementation of Intraoperative Radiation Therapy Technique: A Pediatric Case. Graciela Alejandra Brito Roco; Gabriel Zelada Silva; Marcia García Arencibia; Karen Goset Poblete; Francisco Ossandón; Andrés Córdova Bernhart; Alejandro Berlín Rosenblut

Hall B**SP-WE-B - IOMP/IRPA Special Session: Radiation Protection of the Patient and beyond: Challenges for joint activities of IOMP and IRPA***Chair: Paulo Costa; Co-Chair: Helen Khoury.*

- 11:00 Challenges for Cooperation between IOMP and IRPA in developing countries. Fridtjof Nüsslin, IOMP President.
- 11:20 IRPA - IOMP Cooperation in Education and Qualification for Radiation Protection. Kenneth Kase, IRPA President.
- 11:40 Radiation Protection in the Health Sector -Some Issues. Robert Corbett, IRPA.
- 12:00 Specific Functions of the Medical Physicist and the Radiological Protection Specialist in Medical Facilities. Cari Borrás, IOMP.

Hall C**SS2-WE-C - Instrumentation for Dose and Image Quality Assessment in Diagnostic Radiology***Chair: Donald Mclean; Co-chair: João Emílio Peixoto.*

- 11:00 SS2-WE-C-ka - Applications of the IAEA Dosimetry in Diagnostic Radiology Code of Practice. Keynote: Donald McLean.
- 11:30 SS2-WE-C-01 – (320) Calibration of PKA Meters Against Ion Chambers of Two Geometries. Ricardo Andrade Terini; José Neres de Almeida Junior; Silvio Bruni Herdade; Marco Aurélio Guedes Pereira.
- 11:45 SS2-WE-C-02 – (208) Development of a Parallel Plate Ion Chamber for Radiation Protection Level. Bottaro, Marcio; Morales, Mauricio; Landi, Mauricio.
- 12:00 SS2-WE-C-03 – (583) Estimation of Absorbed Dose of Human Tissues During Bmd Scan by TLD Chips And Monte Carlo Method. Karimian, Alireza; Hajarizadeh, Atefeh; Abdi, Mohammadreza
- 12:15 SS2-WE-C-04 – (488) A New Mammography Dosimetric Phantom. Peixoto, João Emílio; Almeida, Cláudio; Coutinho, Célia; Dantas, Bernardo

Hall E**SS2-WE-E - Tomosynthesis, Digital Mammography and Dental Cone-Beam CT***Chair: Anders Tingberg; Co-chair: Denise Nersissian*

- 11:00 SS2-WE-E-ka - The Role of Tomosynthesis in Routine Clinical Applications. Keynote: Anders Tingberg.
- 11:30 SS2-WE-E-01 – (567) Image Quality Analysis in Dental Cone-Beam Computed Tomography. Hoffmann, Elias Cantarelli; Marques da Silva, Ana Maria.
- 11:45 SS2-WE-E-02 – (718) Subtraction of Mammographic Images Using a Contrast Medium. Maria-Ester Brandan¹, Y. Villaseñor, L. Benitez-Briebesca, FE Trujillo, H. Perez-Ponce, H. Galvan, E. Bargallo, I. Rosado-Mendez.
- 12:00 SS2-WE-E-03 – (597) Enhancement Detection of Microcalcifications in Mammographic Film Images by Denoising and Image Processing Techniques. Karimian, Alireza; Yazdani, Sepideh.
- 12:15 SS2-WE-E-04 – (587) Detection and Classification of Benign and Malignant Microcalcification Clusters With Cellular Automata in Mammography Images. Moradmand, Hajar; Setayeshi, Saeed; Karimian, Alireza; Sirous, Mehri; Khazaei Targhi, Hossein.

12:30 - 14:00**Lunch****14:00 - 15:00****Hall A****PSVI-WE-A - Current Motion Tracking and Motion Correction Technologies for Medical and Preclinical Imaging***Roger Fulton**Chair: Ana Maria Marques; Co-chair: Cari Borrás.***15:00 - 16:15****Hall A****SS3-WE-A - Brachytherapy Treatment Planning and Clinical Outcome***Chair: Victor Bourel; Co-chair: Yakov Pipman.*

- 15:00 SS3-WE-A-ka - Inverse Planning in Brachytherapy. Keynote: Victor Bourel.
- 15:30 SS3-WE-A-01 – (548) Dose Computation for a 103PD Stent Source Used in Intravascular Brachytherapy by Monte Carlo Code. Omid Kiavar; Mahdi Sadeghi; Pooneh Saidi; Rozhin Fatehi.
- 15:45 SS3-WE-A-02 – (334) Dose Computation for a 103PD Stent Source Used in Intravascular Brachytherapy by Monte Carlo Code. Omid Kiavar; Mahdi Sadeghi; Pooneh Saidi; Rozhin Fatehi.
- 16:00 SS3-WE-A-03 – (460) Evaluation Critical Dose of Rectum During HDR Brachytherapy. Ramin Jaber; Mina Sarkhosh; Mahmoud Allahverdi; Ramin Jaber; Akbar Adelnia

Hall B**SS3-WE-B - Patient Doses in Interventional Radiology**

Chair: Anna Benini; Co-chair: Lucía Canevaro.

- 15:00 SS3-WE-B-ka - Doses to Patients in Interventional Cardiology. Keynote: Anna Benini, Frants Pedersen, Erik Jorgensen.
- 15:30 SS3-WE-B-01 – (676) Evaluation of Patients-Skin Dose Undergoing Interventional Cardiology Procedure. Oliveira da Silva, Mauro Wilson; Dias Rodrigues, Bárbara Beatriz; Canevaro, Lucía Viviana.
- 15:45 SS3-WE-B-02 – (678) Investigation of Doses to Cardiologists in Hemodynamic Interventional Procedures. Dias Rodrigues, Bárbara Beatriz; Oliveira da Silva, Mauro Wilson; Canevaro, Lucía Viviana; Silva Lima, Ana Luiza; Maurício, Claudia Lúcia de Pinho.
- 16:00 SS3-WE-B-03 – (466) Evaluation of Staff Radiation Dose in Cardiac Catheterization. Abdelmoneim Sulieman; Hiba Joda; Mohamed Hamadelneel.

16:15 - 17:15**Exhibition Hall****PO-MO – Poster Session**

Chairs: Patrícia Nicolucci; Camila Pessoa de Sales; Ricardo Papaléo.

Themes: Radiation Dosimetry (RD), Dosimetry Materials (DM), Nanotechnology (ON).

17:15 - 18:30**Hall A****Closing Ceremony****Awards**

C1 - MODERN RADIOTHERAPY: MITIGATING RISK**Yakov Pipman - Chair (USA)****William Hendee (USA)****Derek Brown (Canada)****Ishmael Parsai (USA)****Maria do Carmo Lopes (Portugal)****Tim Solberg (USA)**

The goal of this course is to review the experience and lessons learned from past events where harm has resulted in the course of applying radiation to patients.

The introduction and adoption of new technologies and radiotherapy techniques keeps accelerating and expanding. This is a good development in general since it implies that more patients have access to more effective treatment and a better chance at controlling their disease with fewer side effects.

When patients enter into the radiotherapy environment they expect a significant health benefit in the treatment of a very serious disease. This environment is probably among the most complex that a patient may encounter. The complexity arises from the mixture of professionals that take part in the patient's treatment, from the complexity of the equipment and the multiple types of equipment needed in the process, and from the crucial part played by software, hardware and communications, both electronic and human.

In the last several years, with the increase in complexity of the equipment, and of the techniques that it allows, there have been many more documented cases of errors and accidents. In the most publicized cases, unintended but severe harm has occurred. Analysis of these events showed repeatedly that various factors were involved and compounded.

While these cases represent a very small fraction of the total number of patients that routinely benefit from radiotherapy, the high visibility of recent cases, the severity of the outcomes, and the fact that radiation is involved, has shined an intense light into our field of work. It is imperative that as a profession we use this opportunity and put into practice tools to reduce the risks much more than they currently are.

We anticipate that participants will learn about the lessons from recent events and about some of the methods and tools that are being explored to reduce risk in the radiation therapy process. We expect that some of these will be adopted and put into practice.

April 16th	
Saturday	
8:00 – 9:00	Registration
9:00 - 9:15 am	Welcome
9:15 - 9:45 am	Background on Radiation Therapy accidents –Yakov Pipman
9:45 - 10:15 am	Recent US Radiation Therapy Incidents and Public Hearings – William Hendee
10:15 - 10:45 am	Break
10:45 - 11:15 am	Definitions and an international consensus on language – Yakov Pipman
11:15 – 11:55 am	Review of IAEA Incidents and Summary of Published Recommendations – Derek Brown
11:55 am - 12:45 pm	Errors in Radiation Therapy - Root Cause Analysis, mitigation steps and outcomes - US examples – Ishmael Parsai
12:45 - 2:00 pm	Lunch
2:00 - 2:30 pm	Incident reporting systems: from local to national and international levels –Part 1- Maria do Carmo Lopes
2:30 - 3:00 pm	Incident reporting systems: from local to national and international levels –Part 2- Maria do Carmo Lopes
3:00 - 3:30 pm	Quality and Safety - Stereotactic Radiosurgery and Stereotactic Body Radiation Therapy – Tim Solberg
3:30 – 4:00 pm	Break
4:00 - 4:30 pm	New Technologies - Prospective Risk Analysis – Derek Brown
4:30 - 5:00 pm	Safety Recommendations in Radiation Oncology: Where Are We and Where Do We Want To Be?- William Hendee
5:00 - 5:30 pm	Closing remarks – Yakov Pipman

C2 - ADAPTING TRADITIONAL CLINICAL MEDICAL PHYSICS TO DIGITAL RADIOGRAPHY

Charles Willis - Chair (USA)

J. A. Seibert (USA)

Larry Filipow (USA)

Digital radiography (DR) will ultimately replace conventional screen-film radiography. This workshop examines the impact of digital imaging technology on the Medical Physicist's traditional roles, and describes new opportunities in clinical and academic service. Broad topics of discussion include Comparisons of CR and DR, QC in the Digital Environment, and Professionalism. The new digital technology comes at a premium cost. Two competing technologies, CR and DR, have specific advantages in certain settings, but distinctions between the two are disappearing. Tests for DR systems can be extrapolated from conventional radiography; however, some must be modified to be meaningful. Full-field digital mammography is an example of how conventional testing has been adapted to digital systems. When DR systems are integrated into a PACS, specific accommodations are required to assure image fidelity from acquisition to display, and measurements based on pixel values are dependent on location in the imaging chain. The DICOM header contains a wealth of image information, and the Medical Physicist should know how to exploit this. Reject analysis can be adapted to the digital environment. A Medical Physicist's training and experience provides significant value during the conversion to digital operations. In-depth knowledge of the technology helps in the selection and purchase of appropriate DR systems. Knowledge of and adherence to radiation regulations permits proper and effective implementation via routine testing and commissioning of DR systems. Medical Physicists have a key responsibility for ensuring that clinical staff are properly educated as to how DR technology works and how to achieve "best practices". DR can easily promote unnecessary radiation. The Medical Physicist can assist in maintaining oversight of DR practice and performance. For example, the Medical Physicist can help to establish regional Diagnostic Reference Levels (DRLs) to achieve and maintain optimized image quality and minimized patient dose.

April 16th	
Saturday	
8:00 - 9:00	Registration
9:00 - 9:15 am	Welcome – Charles Willis - UT M. D. Anderson Cancer Center
9:15 - 9:45 am	The cost of implementing digital imaging - Larry Filipow – University of Alberta
9:45 - 10:15 am	CR or DR? Does it matter? – Anthony Seibert – UC Davis
10:15 - 10:45 am	Break
10:45 - 11:15 am	A model for initial testing of DR systems - Charles Willis - UT M. D. Anderson Cancer Center
11:15 - 11:45 am	Objective measurements of DR performance in a digital environment - Charles Willis - UT M. D. Anderson Cancer Center
11:45 - 12:15 am	Assuring digital radiography image fidelity from acquisition to display - Anthony Seibert – UC Davis
12:15 am - 12:45 pm	Ten things techs and radiologists don't understand about DR (and the consequences) - Charles Willis - UT M. D. Anderson Cancer Center
12:45 - 2:00 pm	Lunch
2:00 - 2:30 pm	Professionalism in training technologists and radiologists - Larry Filipow – University of Alberta
2:30 - 3:00 pm	Mining the DICOM header - Anthony Seibert – UC Davis
3:00 - 3:30 pm	Reject analysis in a digital imaging operation - Charles Willis - UT M. D. Anderson Cancer Center
3:30 - 4:00 pm	Break
4:00 - 4:30 pm	Establishing regional DRLs for digital radiography - Larry Filipow – University of Alberta
4:30 - 5:00 pm	An American approach: MQSA for FFDM - Anthony Seibert – UC Davis
5:00 - 5:30 pm	Vendor-specific requirements for testing of FFDM - Larry Filipow – University of Alberta

C3 - PET/CT ACCEPTANCE TESTING AND QUALITY ASSURANCE AND QUANTITATIVE PET/CT IMAGING**Osama Malawi – Chair (USA)****Roger Fulton (USA)****Cecil Robilotta (Brazil)**

The use of PET/CT imaging has consistently increased over the past few years primarily due to this imaging modality's ability to merge functional and anatomical information in a single imaging session thereby improving the radiologist's confidence in patient management and the medical oncologist in the assessment of a patient's treatment response. These improvements however depend on whether the scanner is properly calibrated and tuned. In this regard, a quality control/assurance (QC/QA) program must be performed at regular intervals to ensure the proper functioning of the equipment and to identify any degradation in performance before it has a significant impact on image quality. For a PET/CT system, this means that the operational integrity of the system is checked to ensure that all detectors and associated electronics are working properly. In addition, some of the system calibrations should be checked at regular intervals. The purpose of an effective quality control program is to catch potential problems early before they become more serious and may require repeat scans of the patients. The QC procedures become especially important if it is expected that the PET system produces accurate quantitative values such as SUVs that some clinicians use along with the images for patient management. PET scanner acceptance testing and accreditation are components of a QA/QC program. In this session we will describe PET/CT scanner QA and QC procedures and focus on acceptance testing of these systems as well as discuss accreditation criteria as per the American college of radiology (ACR). In addition the work of the AAPM task groups TG 145 and TG 126 will also be discussed and some of the challenges will be described. Factors affecting PET image quantification and current methods to mitigate these effects will also be described. The session will also include talks on basic physics of PET/CT imaging, data acquisition, and image generation as well as the emerging technologies in this imaging modality.

April 17th	
Sunday	
8:00 - 9:00 am	Registration
9:00 - 9:15 am	Welcome and Introduction
9:15 - 10:15 am	PET/CT basics - Cecil Chow Robilotta – University of Sao Paulo
10:15 - 10:45 am	Break
10:45 - 11:45 am	PET QA/QC and TG updates - Osama Mawlawi - MD Anderson Cancer Center
11:45 - 12:45 am	PET/CT quantification and artifacts - Cecil Chow Robilotta– University of Sao Paulo
12:45 - 2:00 pm	Lunch
2:00 - 3:00 pm	PET motion mitigation techniques - Roger Fulton - Westmead Hospital
3:00 - 3:30 pm	PET acceptance testing - Osama Mawlawi - MD Anderson Cancer Center
3:30 - 4:00 pm	Break
4:00 - 4:30 pm	PET accreditation - Osama Mawlawi- MD Anderson Cancer Center
4:30 - 5:30 pm	PET recent technology updates - Osama Mawlawi- MD Anderson Cancer Center

C4 – RECENT ADVANCES IN RADIATION THERAPY: PLANNING, DELIVERY AND METHODS OF QA**Laura N. Rodrigues (Brasil) Chair****Timothy Solberg (USA)****Linda Hong (USA)****Volker Steil (Germany)****Bill Salter (USA)**

The goal of this course is to present an overview of recent developments in radiation therapy equipment, associated hardware and software, methods of commissioning and QA.

As a parallel subject, the implementation of new clinical procedures made possible by these new technological developments will be presented. An overview of similar procedures as offered in radiation therapy equipment from different commercial providers will be addressed. New treatment protocols and dose prescription regimens made possible by these technological advances will be addressed.

As an illustration of the constant effort to keep these new treatment methods safe to patients, different methods of treatment delivery verification and its QA: EPID, CBCT, and others, are addressed, illustrating the importance of assuring the safety of these highly sophisticated methods of treatment delivery. Acknowledgment, analysis and evaluation of the dose contribution resultant from these setup verification methods will be addressed.

On other aspects of quality control and assurance, methods of quality control for the verification of the accuracy of treatment plans will be discussed. Safety methods and rigorous quality control procedures established which highly contribute to keeping possible errors to less than one tenth of a percent of all fields treated, are presented. In light of the high visibility recently placed on mistakes occurring in the field of radiation therapy, while we recognize that no mistake should happen during patients' treatments, the very strong or large effort placed on QA for treatment planning prior to and during treatment delivery by most institutions must also be emphasized.

Keywords: New Therapy Treatment delivery methods, Rapid Arc, VMAT, "True Beam", Frameless SRS, SBRT, Radiation Therapy QA.

April 17th	
Sunday	
8:00 - 9:00	Registration
9:00 - 9:15 am	Welcome
9:15 - 9:45 am	Stereotactic Body Radiation Therapy - Timothy Solberg (UT Southwestern Medical)
9:45 - 10:15 am	Frameless Stereotactic Radiosurgery - Timothy Solberg (UT Southwestern Medical)
10:15 - 10:45 am	Break
10:45 - 11:45 am	VMAT overview - Volker Steil (University Medical Center, Mannheim)
11:45 - 12:45 am	Rapid Arc overview - Linda Hong (Montefiore Medical Center)
12:45 - 2:00 pm	Lunch
2:00 - 3:00 pm	IMAT overview - Bill Salter (University Utah)
3:00 - 3:30 pm	Hands-on (I) - BrainLab
3:30 - 4:00 pm	Break
4:00 - 4:30 pm	Hands-on (II) - Elekta
4:30 - 5:00 pm	Hands-on (III) - Varian
5:00 - 5:30 pm	Hands-on (IV) - Siemens

C5 - DOSE AND IMAGE QUALITY ASSESSMENT IN COMPUTED TOMOGRAPHY**Denise Nersissian (Brazil) – Chair****John M. Boone (USA)****Anthony J. Siebert (USA)****Paulo Schwartzman (Brazil)****Donaldo Mclean (Austria)****Cari Borrás (USA)**

The bases of computed tomography (CT) dosimetry use measurement methodologies of thirty years old. Beginning with axial to helical mode and more recently with the multislice detectors, these huge transformation on tomography equipment have been changed the way we must evaluate radiation dose to patient and how this affect the image quality.

This course intends to present the new trends of dose measurements, new phantoms for tomography dose, image quality control and the patient radiation dose registry. The standardization required by the American College of Radiology (ACR) Accreditation Programme and the image quality assessment in CT of the International Commission on Radiation Unit (ICRU) Program will be shown.

Following these topics, physical and clinical bases of dual energy CT and cardiac CT exams will be shared and some discussion will take place in a round table at the end of the day course regarding all topics included.

April 17th	
Sunday	
8:00 - 9:00 am	Registration
9:00 - 9:15 am	Welcome and Introduction - Paulo R. Costa (moderator)
9:15 - 9:45 am	Methods and Instrumentation of TG-111 - John M. Boone – UC Davies
9:45 - 10:15 am	New Phantoms for CT Dose / Image Quality Assessment [TG-200] - John M. Boone – UC Davies
10:15 - 10:45 am	Break
10:45 - 11:15 am	Radiation Dose Registry for CT - Anthony J. Siebert – UC Davies
11:15 - 11:45 am	CT Dosimetry for the Pediatric Patient [TG-204] - John M. Boone– UC Davies
11:45 - 12:15 am	CT accreditation in the United States: A model program - Anthony J. Siebert– UC Davies
12:15 am - 12:45 pm	Results of a measurement free-in-air dosimetry: IEE/USP experience [TG111] - Denise Y. Nersissian - USP
12:45 - 2:00 pm	Lunch
2:00 - 2:30 pm	Image Quality Assessment in CT: The ICRU Program - John M. Boone – UC Davies
2:30 - 3:00 pm	Bases of Dual Energy CT - Denise Y. Nersissian - USP
3:00 - 3:30 pm	Cardiac CT - Paulo Schwartzman
3:30 - 4:00 pm	Break
4:00 - 4:30 pm	Dosimetry for wide beam angles – Donald Mclean - IAEA
4:30 - 5:00 pm	High dose on Head CT: What had happen e how the USA dealt with that – Cari Borrás
5:00 - 5:30 pm	Discussion and questions – Paulo R. Costa (moderator), Cari, Boone, Siebert

C6 – ATUALIZAÇÃO PARA TÉCNICOS EM RADIOTERAPIA**Anna Maria C. De Araujo (Brazil) – Chair****Roberto Salomon de Souza (Brazil)****Zulma dos S. Casquilha (Brazil)**

O Programa de Qualidade em Radioterapia - PQRT do Instituto Nacional de Câncer / Rio de Janeiro, através de suas avaliações locais vem, desde 2000, atuando em todo o Brasil e constatando a escassez de material didático em português, para auxiliar os físicos no treinamento de seus técnicos em radioterapia.

Com esse objetivo, o PQRT elaborou um curso de atualização, complementar ao treinamento básico mínimo necessário.

O material didático desse curso é composto de um livro e um CD, com 10 roteiros detalhados sobre práticas de oficina e de simulação. O nivelamento dos assuntos abordados tem como foco o conhecimento mínimo esperado para o Brasil de norte a sul.

Nossa proposta neste curso é apresentar todo esse material visando, principalmente, àqueles profissionais responsáveis pelo treinamento de técnicos em radioterapia (físicos e supervisores técnicos).

A apresentação desse material será enriquecida pela experiência profissional de técnicos que viajam pelo Brasil e conhecem suas diferentes realidades.

Como esse material foi produzido também em espanhol, para ser disponibilizado para toda a América Latina e Caribe, esse curso pode ser interessante também para os colegas latinoamericanos.

April 17th	
Sunday	
8:00 – 9:00	Registration
9:00 - 9:15 am	Welcome and Introduction – Anna Maria C. de Araujo (moderator)
9:15 - 9:45 am	Objetivo e metodologia - Anna Maria C. de Araujo
9:45 - 10:15 am	Abordagem histórica – Roberto Salomon de Souza
10:15 - 10:45 am	Break
10:45 - 11:45 am	Equipamentos e Acessórios – Zulma dos Santos Casquilha
11:45 - 12:45 am	Oficina de Moldes – Zulma dos Santos Casquilha
12:45 - 2:00 pm	Lunch
2:00 - 2:30 pm	Oficina de Moldes – Zulma dos Santos Casquilha
2:30 - 3:30 pm	Simulação e Posicionamento – Zulma dos Santos Casquilha
3:30 – 4:00 pm	Break
4:00 - 4:30 pm	Simulação e Posicionamento – Zulma dos Santos Casquilha
4:30 - 5:00 pm	Abordagem psicológica - Anna Maria C. de Araujo
5:00 - 5:30 pm	Encerramento - Anna Maria C. de Araujo

**SECOND MEDICAL PHYSICS WORKSHOP OF THE HEALTH TECHNOLOGY TASK GROUP OF THE IUPESM
DEFINING THE MEDICAL IMAGING REQUIREMENTS FOR A HEALTH STATION, 17 APRIL 2011, PORTO ALEGRE, BRAZIL**

Time	Topic	Main Speaker
8 – 8.30 a.m.	Registration	
8.30 – 8.35 a.m.	Welcome on behalf of the IUPESM	Barry Allen, Australia
8.35 – 8.40 a.m.	Workshop objectives	Cari Borrás, Brazil
8.40 - 9.10 a.m.	WHO/HQ Perspective on Health Technologies and Radiation Safety (by video)	Adriana Velazquez, WHO and Maria del Rosario Perez, WHO
Part I: Medical and Public Health Needs		
9.10 – 9.30 a.m.	Review of medical equipment needs in Vanuatu, an island in the South Pacific	Barry Allen, Australia
9.30 – 9.50 a.m.	The problem in mainland China	Yimin Hu, China
9.50 – 10.05 a.m.	Discussion. Recommendations for Part I	
10.05 – 10.20 a.m.	Coffee Break	
Part II: Medical Imaging Modalities		
10.20 – 10.40 a.m.	Clinical significance of medical imaging modalities in different health care levels	Ruzica Maksimovic, WHO
10.40 – 11.00 a.m.	Medical imaging equipment characteristics at the health station level: Overview	Bill Hendee, USA
11.00 – 11.20 a.m.	Technical specifications: X-Ray units	Slavik Tabakov, UK
11.20 – 11.40 a.m.	Technical specifications: Ultrasound units	Kwan-Hoong Ng, Malaysia
11.40 – Noon	Discussion. Recommendations for Part II	
Noon – 1.30 p.m.	Lunch Break	
Part III: Planning a Medical Imaging Department		
1.30 – 1.50 p.m.	Procurement - Donated vs purchased equipment	Cari Borrás, Brazil
1.50 – 2.10 p.m.	Physical infrastructure: space, shielding, patient flow	Anna Benini, Italy
2.10 – 2.30 p.m.	Staff: Basic training and continuing education	Slavik Tabakov, UK
2.30 – 3.15 p.m.	Teleradiology and networking	Sandra Rocha, Mexico
3.15 – 3.30 p.m.	Discussion. Recommendations for Part III	
3.15 – 3.30 p.m.	Coffee Break	
Part IV: Operational Considerations		
3.45 – 4.05 p.m.	Quality control and maintenance programs	Cari Borrás, Brazil
4.05 – 4.25 p.m.	Radiation protection: Personnel dosimetry and patient safety	Anna Benini, Italy
4.25 – 4.55 p.m.	Patient referral to secondary and tertiary health care levels	Pat Cadman, Canada
4.55 – 5.10 p.m.	Discussion. Recommendations for Part IV	
5.10 – 5.30 p.m.	Summary of recommendations. Conclusions	Cari Borrás, Brazil

IOMP/IAEA Seminar on Radiation Protection of Children	IOMP/IAEA Seminar on Radiation Protection of Children
Sunday 17th April 2011	Sunday 17th April 2011
08:00- 08:30	Registration
08:30- 08:40	Opening (IAEA)
8:40 – 9:10	IAEA activities on radiation protection of children - Madan Rehani (IAEA)
9:10 – 9:35	Image Gently: The Campaign and tools - Sue Creviston Kaste
9:35 – 10:00	Medical Physics fundamentals for radiation protection of children in imaging - Charles E Willis
10:00-10:15	Break
10:15 – 11:30 With break	Ground realities, challenges faced, needs and how problems were solved in different countries: in Radiation Protection of Children in CT in IAEA Project (4 min each): Participants in the IAEA network - Argentina, Bolivia, Brazil, Chile, Costa Rica, Cuba, Honduras, Jamaica, Mexico, Nicaragua, Peru, Uruguay, Venezuela
11:30 – 12:05	Panel discussion: Challenges, means and solutions to protect children - Madan Rehani, Sue Creviston Kaste, Charles Willis
12:05 – 12:15	Conclusions and closing remarks

RT1 - INTERNATIONAL COLLABORATION WITHIN THE UNITED STATES**National Cancer Institute Sponsored Clinical Trials:
The Need for Radiotherapy Quality Assurance**

Introduction	Moderator: David S. Followill Radiation Physics, UT MD Anderson Cancer Center, Houston TX, USA
The Perspective from Europe	Milan Tomsej Radiation Oncology Dept, CHU Charleroi (Site Vésale), Montigny-le-Tilleul, Belgium
The Perspective from Asia	Tomas Kron Peter MacCallum Cancer Centre Melbourne, Australia
The Perspective from Latin America and the Caribbean	Cecilia Haddad Hospital Sírio Libanês, Sao Paulo, Brazil
Questions/Comments	All

RT2 - INTERNATIONAL COLLABORATION WITHIN THE UNITED STATES**National Cancer Institute Sponsored Clinical Trials:
The Need for Radiotherapy Quality Assurance**

Introduction and International Collaboration Within the United States National Cancer Institute Sponsored Clinical Trials: The Need for Radiotherapy Quality Assurance	Moderator: David S. Followill Radiation Physics UT MD Anderson Cancer Center Houston TX, USA
The Perspective from Europe: Quality Assurance in clinical trials	Milan Tomsej Radiation Oncology Dept CHU Charleroi (Site Vésale) Montigny-le-Tilleul, Belgium
Assessing different levels of technology in clinical trials: an Asia Pacific perspective	Tomas Kron Peter MacCallum Cancer Centre Melbourne, Australia
The role of the National Cancer Institute/ Radiotherapy QA Programme in implementation of QA in Brazil and Latin America- Onsite and Postal Audits	Anna Maria Campos de Araujo National Cancer Institute Sao Paulo, Brazil
Questions/Comments	All

RT3 - NEW ADVANCES IN NUCLEAR MEDICINE

Introduction	Moderators: Cecil Chow Robilotta São Paulo University, São Paulo, Brazil Osama R Mawlawi MD Anderson Cancer Center Houston TX, USA
Systemic vs local radiotherapy: Time to change priorities?	Barry Allen International Union for Physical and Engineering Sciences in Medicine Australia
Multimodality imaging: current status and future perspectives	Habib Zaidi PET Instrumentation and Neurosciences Laboratory, Division of Nuclear Medicine Geneva University Hospital Geneva, Switzerland
The promise and challenges of PET/MR	Roger Fulton University of Sydney Sydney NSW, Australia
Advances in quantitative PET/CT	Osama R Mawlawi MD Anderson Cancer Center Houston TX, USA

RT4 - BIOLOGICAL EFFECTS OF NON IONIZING RADIATION: ULTRAVIOLET RAYS, EXTREMELY LOW FREQUENCY, RADIO-FREQUENCY AND MAGNETIC FIELDS IN MRI/MRS

Introduction	Moderator: Kwan Hoong Ng
Biological Effects of Cell Phone Radiation	Department of Biomedical Imaging, University of Malaya Medical Centre, Kuala Lumpur, Malaysia
Biological Effects of Ultraviolet Radiation	Emico Okuno Institute of Physics, University of S. Paulo, São Paulo, Brazil
Biological Effects of Extremely Low Frequency Radiation	Jorge Juan Skvarca WHO Expert Advisory Panel on Radiation, Buenos Aires, Argentina
Biological Effects of Magnetic Fields of MRI	Alessandro Mazzola Hospital Moinhos de Vento, Porto Alegre, Brazil

RT5 - CERTIFICATION OF MEDICAL PHYSICISTS

Introduction	Moderator: Raymond Wu
Certification of Medical Physicists	Barrow Neurological Institute, St Joseph's Hospital, Phoenix, USA
Education, Training, and Certification of Medical Physicists in Korea	Rena Lee, Tae Suk Suh Korean Society of Medical Physics, Korea
Certification System of Medical Physicists in Japan	Shigekazu Fukuda Japanese Society of Medical Physics, Japan
Clinical Medical Physicists Certification Process in Mexico: Latest Update	María-Ester Brandan, Valdemar Z. Gonzalez Mexican Federation of Organizations for Medical Physics, Mexico

HARMFUL TISSUE EFFECTS: IS THERE ALWAYS A DOSE THRESHOLD?

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The recommendations of the International Commission on Radiological Protection (ICRP) in 2007 provided dose limits for stochastic effects and tissue reactions (deterministic effects) in occupational and public settings. Further consideration was planned for two tissues, regarding cataracts in the lens of the eye and circulatory disease (heart disease and stroke). These tissues have long latency periods before expression of injury, more than 20 years for cataracts and 10 years for circulatory disease, which is one of the reasons for the elucidation of the full dose response relationships only recently. Current evidence indicates that dose thresholds for such injury in both tissues are likely to be low, with confidence intervals which include zero dose in some studies. Generally, uncertainty ranges are large if sample sizes are small, and heterogeneity of the sample and uncertainty in doses can increase the overall uncertainty but selection bias can reduce it. Hence, evidence based on statistical uncertainty needs to be augmented by plausible biological mechanisms of the effects, which strengthens the arguments in favour of either the presence or the absence of a dose threshold. The lack of a dose threshold supports the pragmatic judgement to use a linear-no-threshold model, which is made for practical protection purposes regarding the stochastic clonal development of radiation induced cancers. For cataracts, there is no direct evidence that a single injured lens epithelial cell can give rise to a cataract, but there are plausible arguments that this might occur. For circulatory disease, the mechanism remains unknown, although again there are some plausible possibilities albeit not based on single cell responses. The presence of a dose threshold, or the lack of it, for these particular tissues is an important consideration for any long term risks associated with occupational exposures and successful medical procedures, and examples of these will be presented.

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NOVEL DOSIMETRY CONCEPTS BASED ON NANODOSIMETRY

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Conventional dosimetric quantities like kerma and absorbed dose are well suited for quality assurance in therapeutic or diagnostic radiology. As the definition of these quantities involves averaging over macroscopic volumes, however, an elaborate system of auxiliary quantities (e.g. relative biological effectiveness) is needed to account for the effect of radiation quality. The latter is determined by the microscopic particle track structure, where the stochastics of radiation interactions occurring within target sizes in the order of the diameter of the DNA double helix (i.e. a few nanometers) is decisive for the biological effectiveness. Therefore, nanodosimetry aims to establish a concept of radiation quality building on measurable features of the track structure of ionizing radiation, such as the formation of ionization clusters in specified target volumes comparable in mass per unit area to a DNA segment. Numerical-simulation and measurement techniques have been developed to determine the probability distribution of the ionization cluster size (i.e. the number of ionizations produced within the target by a passing primary particle and its secondary electrons) for such target volumes. Comparisons to radiobiological data suggest a correlation between the probability for initial DNA damage and track structure parameters derived from ionization cluster size distributions in nanometric water cylinders or equivalent gaseous nitrogen targets in a nanodosimeter. This correlation may provide the basis for establishing novel ionizing radiation quantities with an inherent biological weighting, in analogy to the physiological weighting implicated in the definition of the photometric unit candela. After a review of the basics of nanodosimetry, the paper will highlight a few examples of recent progress in nanodosimetric modeling and experiment; finally the potential of a nanodosimetry-based dosimetric concept built on the aforementioned analogy will be discussed.

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CLINICAL IMPLEMENTATION OF VOLUMETRIC MODULATED ARC FOR CONVENTIONALLY FRACTIONATED AND STEREOTACTIC BODY RADIATION THERAPY

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Volumetric modulated arc therapy (VMAT) is a novel form of optimization and delivery of gantry arc-based intensity modulated radiotherapy (IMRT). It allows dose delivery to a patient during gantry rotation while multileaf collimator leaf positions, dose rate and gantry speed are varied simultaneously. Certain benefits of VMAT, such as less monitor units and treatment time compared to fixed gantry IMRT have been conclusively demonstrated. However, dosimetric advantages are debatable. Overview of planning studies for a variety of sites will be presented. As any other novel technology, use of VMAT requires understanding of its practical and fundamental benefits and limitations. This lecture will describe clinical implementation of VMAT at the Vancouver Cancer Centre, from planning strategies to quality assurance. Benefits and challenges of clinically implementing VMAT will be illustrated. Specific examples of radiotherapy of prostate with simultaneous intraprostatic boost and whole brain plus metastases will be presented in detail. Single-arc and two-arc solutions will be compared. Stereotactic body radiotherapy (SBRT) using VMAT for lung and spine will be discussed in conjunction with multimodality imaging, immobilization and image guidance. There are many practical challenges physicists and physicians face when implementing VMAT. For example, lung SBRT patients are typically scanned with the arms down. This requires either excluding angles or accounting for attenuation through the arms. Some special situations, solutions and practical guidelines will be presented. Accurate dose calculation is paramount for SBRT. Different methods available from treatment planning systems will be compared against Monte Carlo, the latter serving as the gold standard. Advanced use of VMAT accounting for organ motion requires gating or tracking. Approaches put forward for this by vendors and researchers will be discussed.

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MEDICAL PHYSICS BOARD CERTIFICATION: LOOKING AHEAD

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A Constituting Panel was established in 2008 by the American College of Medical Physics (ACMP) to consider and formulate guidelines for certification of clinical medical physicists working in radiation oncology and diagnostic imaging throughout the world. The specific objectives of the Constituting Panel are to: (a) Review the need for a standardized medical physics certification process in countries and regions throughout the world where certification opportunities do not currently exist; (b) Develop international standards and procedures for a certification process; (c) Recommend qualification guidelines for candidates requesting examination for certification; (d) Provide assistance in arranging, controlling and conducting examinations for testing the competence of certification candidates; (e) Consider the logistical, financial and administrative requirements for implementing certification processes. The 16 member Constituting Panel includes liaisons from international medical physics organizations and additional individuals who have had significant experience with certification programs in their own countries. It is not the mission of the Constituting Panel to assume responsibility for direct operations of certification activities, but rather to serve as an expert consulting resource in support of these activities. It is anticipated that the consensus guidelines developed by the Panel will assist the international medical physics community in achieving both performance excellence and appropriate recognition for our many important contributions to health care. The guidelines are well suited for the management, operations and sustainable improvement of medical physics certification programs. To implement the recommendations and move forward the certification initiative originated by many national medical physics organizations, eleven of them formed an organization called International Medical Physics Certification Board (IMPCB) in May, 2010. This followed the IOMP resolution to create a work group to assist with this initiative, the discussions in Munich during the World Congress 2009, and several International Symposia during the ACMP Annual Meetings. The member organizations are ABFM, ACMP, ACPSEM, CSMP, CSMPT, FMOFM, HKAMP, IMPS, KSMP, LAMP, and NAMP¹. Several member organizations and other invited speakers will participate in the 90 minute session. In this Workshop, we describe how applying these approaches can facilitate medical physics performance enhancement in an increasingly complex healthcare environment. We also describe the current status of certification programs in several countries. A panel of participants will lead a discussion after the presentations. Footnote: ¹The acronyms stand for Associação Brasileira de Física Médica, American College of Medical Physics, Australasian College of Physical Scientists and Engineers in Medicine, Chinese Society of Medical Physics, Chinese Society of Medical Physics – Taipei, Federación Mexicana de Organizaciones de Física Médica, Hong Kong Association of Medical Physics, Iraqi Medical Physics Society, Korean society of Medical Physics, Lebanese Association Of Medical Physics, and Nepalese Association of Medical Physicists.

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CURRENT MOTION TRACKING AND MOTION CORRECTION TECHNOLOGIES FOR MEDICAL AND PRECLINICAL IMAGING

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Motion of the subject during data acquisition in single photon emission computed tomography (SPECT), positron emission tomography (PET), x-ray computed tomography (CT) and magnetic resonance imaging (MRI) causes blurring and other distortions of the reconstructed images. Such distortions hamper accurate interpretation of the images in both clinical and research settings. Motion is a particularly severe problem when imaging pediatric patients and patients with dementia. In dual modality imaging techniques, such as PET/CT, the impact of motion in one of the modalities is compounded when those images are used in conjunction with the other modality. This paper reviews the status of current motion compensation techniques for these modalities, their limitations and the scope for future improvements. Available techniques generally require knowledge of the motion that occurred during data acquisition, and motion correction is effected by modeling knowledge of the motion in the image reconstruction process. Information about rigid head motion for motion correction in brain imaging can be obtained relatively easily through the use of an optical motion tracking system, or data driven techniques in which motion parameters are estimated directly from projection or image data. However the non-rigid motion of internal structures due respiratory and cardiac motion is much more difficult to estimate, and effective compensation is more difficult. This paper reviews recent developments in motion tracking and motion correction for medical imaging, and presents case studies to illustrate the successful application of motion tracking and motion correction techniques in SPECT, CT, PET-CT, MR-PET and preclinical PET imaging. It thus provides an insight into benefits that could eventuate from the wider adoption of these technologies in the clinical and research settings.

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CELL TRACKING AND IN VIVO SINGLE CELL IMAGING USING MRI AND NANOTECHNOLOGY

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The field of cellular imaging is a newly emerging discipline of imaging research that has been broadly defined as the application of imaging techniques for the non-invasive and repetitive imaging of targeted cells and cellular processes in living organisms. Cellular magnetic resonance imaging combines the ability to obtain high resolution MR data with the use of magnetic contrast agents for labeling specific cells, thereby enhancing their detectability. MRI has a number of characteristics that make it ideal for cell tracking. MRI can produce images with high spatial resolution (tens of micrometers) and exquisite soft tissue contrast. MRI is noninvasive, nondestructive and 3D. Unlike histological analyses, which provide only a "snapshot" of the overall process, cellular MR imaging can provide a more dynamic view of cellular events. In comparison, MR imaging delivers faster results, requires fewer animals, is free from sectioning related artifacts and may provide a more complete picture of the overall biological process under investigation. Superparamagnetic iron oxide (SPIO) nanoparticles represent a class of contrast agents used for cellular MR imaging. SPIO contrast agents consist of a magnetite core(s) surrounded by a matrix material such as dextran. The presence of this magnetic label causes a distortion in the magnetic field and leads to abnormal signal hypo-intensities in T2 or T2* weighted images. Areas containing SPIO labeled cells therefore appear as regions of low signal intensity on MRI images; creating negative contrast. In vivo single cell detection has been demonstrated. The development of a broad repertoire of SPIO contrast agents, as well as techniques for incorporating these labels into cells, has stimulated a variety of applications of this cell-tracking MRI technique, such as the tracking of T-lymphocytes, macrophages, cancer cells, and stem cells with minimal impact on cell function over a period of several weeks and over multiple cell divisions.

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JOINT IOMP/WHO/ALFIM/PAHO SPECIAL SESSION: HEALTH TECHNOLOGIES - MORE THAN A NICHE FOR MEDICAL PHYSICISTS

Pablo Jimenez, Simone Kodlulovich, Cari Borrás.

Health technologies have a critical role in the prevention, diagnosis and treatment of illness and disease. Medical physicists have a key role in the safe and effective use of many health technologies, especially those involving radiation. However, access to health technology remains a challenge, particularly in developing countries. The World Health Organization (WHO) has an on-going “Global Initiative on Health Technologies” to help make available the benefits of core health technologies at an affordable price, particularly to communities in resource-limited settings, in order to effectively control important health problems. WHO held the first “Global Forum on Medical Devices” in Bangkok, Thailand, in September 2010 which brought together 500 stakeholders including: policy makers, professional, international, UN and nongovernmental organizations, funding agencies and users of medical devices. The International Organisation for Medical Physics (IOMP) and the Pan American Health Organisation (PAHO) participated both in the planning and the deliberations of the forum. The session will review some of the issues involved and consider the recommended actions resulting from the forum that should be taken for the improvement in availability, accessibility, appropriate selection, assessment, regulation, management, safety and use of medical devices. The role of the medical physicist in health technology assessment and the acquisition of radiotherapy and imaging equipment will be discussed. Another aspect of the session will examine how professional organisations, such as IOMP and the Latin American Medical Physics Association (ALFIM), can contribute to issues such as access to appropriate technologies and procurement of health technologies through direct programmes, such as donation of equipment, or through preparation of best practices advice, tools and guidelines on medical devices, in conjunction with international bodies such as WHO and PAHO, for integration into national health plans.

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CHALLENGES FOR COOPERATION BETWEEN IOMP AND IRPA IN DEVELOPING COUNTRIES

Fridtjof Nüsslin

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In a recently signed MoU the IOMP and the IRPA set a framework for future cooperation. One important field where both organizations are specifically challenged to bundle their forces is radiation protection in the low and medium income countries. With the background of the lack of experts in radiation protection in those countries, at least for an intermediate time, joint actions in education and training may bridge the gaps. However, any form of cooperation requires to identify what these countries need. The domain of the IOMP, which represents the global medical physics community, is the radiation protection of the patient in health facilities. In accordance with the definitions of the roles and responsibilities of medical physicists as stated by the IOMP and ILO and described in the new draft Basic Safety Standards (BSS) issued by IAEA & WHO, medical physicists are 'professionals with education and specialist training in the concepts and techniques of applying physics in medicine' (IOMP, Policy Document 1, 2010). Medical physics education includes training in radiation protection of the patient and also, to some extent, in staff and public radiation protection. Some medical physicists also undertake further specific training in radiation protection and can fulfill the requirements to act as radiation experts in all aspects of radiation protection of staff and the public in health facilities. Interfacing matters between IOMP and IRPA will be discussed within the scope of the roles and responsibilities assigned to the medical physicists (MP) and the radiation protection officers (RPO) in the new BSS. Comparing the competences of MPs and RPOs in health facilities understaffed in radiation protection it is considered more appropriate that MPs undertake the RPO duties rather than vice versa. In particular, with the background of the increasing incidence of cancers in developing countries and the enormous deficit of equipment and experts, IOMP & IRPA should cooperate to improve patient health care by recruiting and broadly educating medical physicists aiming to cover patient radiation protection and selected responsibilities of the RPO.

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IRPA - IOMP COOPERATION IN EDUCATION AND QUALIFICATION FOR RADIATION PROTECTION

Kenneth Kase

IRPA President

IRPA is an international association of radiation protection societies with about 17,000 individual members worldwide. Its goals are to be recognized as the international voice of the radiation protection profession and to promote excellence in radiation protection. Radiation protection of patients, staff and the public in the medical application of radiation-producing devices and radioactive materials is of special interest. Consequently, IRPA is committed to partnering with IOMP to achieve excellent radiation protection in medical settings while making effective use of radiation technology for excellent patient care. Medical institutions and practices must realize the importance of proper education and training for the staff that operate and use radiological technologies and the importance of having a well-qualified radiation protection staff. These staff may be qualified radiation protection professionals or they may be medical physicists that have received appropriate education and qualification in the principles and application of radiation protection specific to the medical field. IRPA and IOMP can collaborate in education and training in radiation protection. Radiation protection professionals and medical physicists can be instrumental in creating and enhancing a radiation protection culture in the institution. There is still a wide variation among countries in E&T methods as well as certification and recognition systems for radiation protection and medical physics professionals. IRPA Societies are not universities and their E&T activities are not intended for an academic diploma, but for professional enhancement. However, IRPA can cooperate with IOMP and other international and regional organizations to assist the development of excellent education, training and qualification programs in radiation protection, particularly in the developing world. It is important for the continuation and continual improvement of radiation protection practices that we ensure the appropriate education of a new generation of radiation protection professionals and medical physicists.

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RADIATION PROTECTION IN THE HEALTH SECTOR -SOME ISSUES

Robert Corbett

IRPA

The rise of the role of radiation protection is evident in radiation therapy, advanced radiological diagnostic capabilities and use of new radiopharmaceuticals. The IAEA and the major initiatives directed toward radiation protection of patients. If radiation protection and excellent patient care are seen to be common threads in medical advances in all countries and regions, perhaps the societal dividend of excellent education, training and qualifications in radiation protection and medical physics can be understood and measured. The vision is to foster a strong, competent and well-respected radiation safety profession, whether specifically the qualified radiation protection professional or a medical physicist with qualifications as a radiation protection expert, resulting in an overall operational culture of safety, including radiation protection. This will result in a sustained protection of the health and safety of the patient, the medical staff, the public and the environment. An increase in stakeholder confidence and economic development leads to a positive societal dividend. In medicine, radiation protection leads to better diagnosis and treatment of disease. Highly qualified medical physics, medical technology and radiation protection resources result in delivery of diagnosis and therapy services with high quality, efficiency and safety for patients and staff. Building competence comprises training and assessing the qualifications of personnel to develop and maintain appropriate levels of competence, the ability to apply knowledge, skills and attitudes to perform in an effective and efficient manner and to an established standard. Radiation protection professionals and medical physicists are challenged to be aware of developing technologies and new clinical techniques, to analyze the potential radiation risks to patients and staff, to initiate necessary radiation safety training for medical staff, and to be involved in planning, dose measurement and optimization of the procedures to achieve appropriate diagnosis and treatment while maintaining appropriate dose control

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ROLES OF MEDICAL PHYSICISTS AND RADIATION PROTECTION SPECIALISTS

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The International Labor Organization acknowledges the roles medical physicists and radiation protection specialists play in diagnostic and therapeutic radiology departments as health professionals. Although in some facilities the tasks may be performed by the same individual, there are significant differences in functions and responsibilities. Medical physicists are involved in developing and/or reviewing the purchase specifications of medical radiological equipment and physics instrumentation (both hardware and software); they are responsible for their acceptance testing and commissioning, for the calibration of all radiation sources and for the evaluation of medical imaging equipment in terms of performance and image quality. In medical imaging departments, they are also responsible for establishing patient diagnostic reference levels. In radiotherapy departments, they participate in the treatment planning process, performing or supervising the clinical dosimetry, periodically evaluating patient dose distributions and making in vivo dosimetry determinations. Other supervisory functions encompass patient and/or dosimetry accessory construction, applicator/catheter preparation, and maintenance and quality control programs, which include ensuring the interconnectivity and interoperability of networked equipment. Medical physicists collaborate with their clinical colleagues by discussing clinical protocols and promoting/developing/participating in research projects. Radiation protection specialists prepare the license for the regulatory authorities; perform and/or review structural shielding calculations; advise on ancillary shields, survey meters and personnel monitors; verify equipment compliance with IEC safety features and/or equivalent national standards; check radiation warning signs, door interlocks and emergency controls; perform radiation safety surveys; establish dose constraints and operational limits; document staff and consultants' qualifications; develop radiation safety QC programs; chair or participate in the institution's radiation safety committee; impart radiation safety training courses; maintain inventory of radioactive sources and up-to date license-related documents; keep up on staff changes and qualifications, and liaise with the regulatory authorities. Joint functions involve the participation in QA and accreditation programs and the investigation of accidental medical exposures.

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RADIATION SAFETY IN PEDIATRIC RADIOLOGY: WHAT CAN WE DO AS MEDICAL PHYSICISTS?

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Pediatric projection imaging differs from imaging of the adult patient. Children are smaller, more radiosensitive, and less compliant than their adult counterparts. Their characteristics affect the way projection imaging is practiced and how dose is optimized. Computed radiography (CR) and digital radiography (DR) have been embraced by pediatric practitioners in order to reduce dose and improve image quality. Unfortunately, dose optimization with CR and DR has been hampered by a lack of definition of appropriate exposure levels, a lack of standardization in exposure factor feedback, and a lack of understanding of the fundamentals of CR and DR technology. The potential for over-exposure exists with both CR and DR. Both the Society for Pediatric Radiology and the American Association of Physicists in Medicine (AAPM) recognize the promise and shortcomings of CR and DR technology and have taken steps to join with manufacturers in improving the practice of CR and DR imaging. A new standard for exposure factor feedback has been published by the AAPM and the International Electrotechnical Commission. The Alliance for Radiation Safety in Pediatric Imaging, better known as ImageGentlyTM, hosted a summit of stakeholders to assess the condition of pediatric DR imaging and to initiate improvements. The American College of Radiology will incorporate Pediatric Digital Radiography into its Dose Index Registry to collect data on the state of practice. The US Food and Drug Administration is supporting development of educational training materials on the safe use of DR equipment with children. The International Atomic Energy Agency has published training materials on radiation protection of children. Although the risks inherent in pediatric projection imaging with CR and DR are low, efforts to reduce dose are worthwhile, so long as diagnostic quality is maintained. Long-standing recommendations for limiting radiation dose in pediatric projection imaging are still applicable to CR and DR.

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INNOVATIONS IN MEDICAL PHYSICS EDUCATION

William Hendee; Slavik Tabakov

All medical physicists are educators. Many have specific teaching responsibilities for physicians, technologists, dosimetrists, graduate students and others. But even medical physicists without specific educational responsibilities are teachers – if only by example in the clinic and in group discussions about patients. To fulfill these responsibilities, medical physicists employ various electronic aids along with personal discussions of physics concepts and applications. Electronic aids vary from power-point presentations to sophisticated web-based modules that explain physics at different levels through the use of text, illustrations, animations, pop-ups, questions with answers. Radiologists-in-training must understand physics concepts underlying their profession, but they have little time for, or interest in, attending physics lectures. Further, young people are accustomed to acquiring information from the world-wide web rather than from lectures and books. In recognition of this manner of learning, approximately 50 web-based modules have been developed on the physics of medical imaging. The modules represent a collaborative effort of the American Association of Physicists in Medicine (AAPM) and the Radiological Society of North America. The modules follow the new curriculum for teaching radiologists developed by the AAPM and are accessible at no cost to radiologists and radiology residents. They also are very useful as an introduction to medical imaging for medical physics graduate students. Each module requires about an hour to review, including a self-test at the end to assess the degree of assimilation of the material. The modules have been very well-received, and have stimulated interest in developing similar modules for radiation oncologists-in-training and for graduate students and residents in medical physics. They also have served as a model for web-based modules on ethics and professionalism being prepared as learning aids for radiologists, radiation oncologists and medical physicists.

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EMITEL e-ENCYCLOPAEDIA OF MEDICAL PHYSICS AND DICTIONARY OF TERMS

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EMITEL - the e-Encyclopaedia of Medical Physics and its Multilingual Translator (Dictionary) has been launched at WC2009 (www.emitel2.eu). This international project attracted more than 300 specialists from 36 countries and grew to be the largest international project in the profession. The paper describes the development of EMITEL and its effective use, plus its planned future development.

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PROFESSIONAL STATUS OF THE MEDICAL PHYSICISTS IN LATIN AMERICA AND THE CARIBBEAN

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In Latin America and the Caribbean, the application of radiation in medical practice has increased exponentially in the different modalities. New technologies have been implemented in many institutions in the region not all with appropriate preparation. However, despite the fact that of the importance of the medical physicist in the hospitals, there is a lack of professionals with adequate academic formation and training. In most countries, the medical physicist is not yet legally recognized by the Ministry of Health and/or Ministry of Labour as a professional. Also, many centers still fail to recognize the importance of the physicist in the service. In some medical fields, the national laws do not require a physicist as a staff of the hospital. The education programs are very different from country to country and as result the quality of the professionals are diverse and, consequently, the quality of the whole process involving diagnostic, treatment, the safe use of the radiation for the patient and for the professional occupationally exposed, is not the optimum. This session will present the professional status of medical physicists in LAC countries. It also will review some requirements for a qualified medical physicist, the possibility to standardize the education programs, to verify all educational tools that could be shared in the region, to create an accreditation process that could enable the professional to work in any country of the region. Also to establish an action plan in order to reduce the differences among the professionals in LAC countries. It will be also discussed a more effective involvement of the ALFIM member societies, including responsibilities and activities of each society in order to optimize this process. For ALFIM projects it is essential to strengthen the support of IOMP, WHO, PAHO and IAEA.

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MEDICAL PHYSICS EDUCATION AND TRAINING IN ARGENTINA

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Argentina has one of the largest traditions in training medical physicists in the field of radiation therapy within Latin America. However, only recently our country has faced the requirements of adequate academic background and formal training programs in this matter. As Mexico, Brazil or Colombia, Argentina is one of the host countries eligible for training in physical aspects of radiation therapy. During the past four decades, national authorities worried on safe use of radiation, (CNEA and ARN) have established by law, the requirement of hiring “specialists” in radiotherapy physics for all radiotherapy centers in the country. To strengthen this measure, the authorities implemented the issuance of a special course, 6 month long, very popular till today in all LatAm region. The situation for other areas of Medical Physics is quite different. Nowadays, in a country like Argentina, with 40 million inhabitants, the number of medical physicists involved in clinical practice in RT is about 90, while those involved in NM are no more than 5 and worse is the field of radio diagnostic with just 1 or 2 trained clinical MP professionals. No legal recognition of our profession from health authorities, or some kind of disrespect among peers at University, lack of legal framework and absence of appropriate strategies to establish a professional certification process contribute to make MP an unattractive profession. Measures to revert this situation have begun to be implemented, and nowadays Argentina has 2 established Master degrees programs in Medical Physics and 3 formal training sites for clinical practices. Unfortunately, needs were faster and some undergraduates programs have arrived since 7 or 10 years ago to fulfill the necessity of the market. We are now facing the challenges to raise the legal recognition of Medical Physics as health profession and working together with other countries or international societies would help a lot to reach the goal.

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QUALITY AND SAFETY IN STEREOTACTIC RADIOSURGERY AND STEREOTACTIC BODY RADIATION THERAPY: MORE CAN BE DONE

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Stereotactic radiosurgery (SRS) has been an effective modality for the treatment of benign and malignant cranial disease for 50 years. Increasingly, the stereotactic approach, ablative doses of radiation delivered in a highly focused manner to a target of interest, is being applied in a number of extracranial disease sites. Stereotactic body radiation therapy (SBRT) holds significant potential for improving tumor control rates across a range of locations and histologies. Both SRS and SBRT require specialized technology, meticulous procedures, and dedicated personnel. Several recent high-profile medical radiation events have generated considerable attention within the media, and serve to remind the profession that close attention to ongoing quality improvement is a fundamental responsibility. These include: a calibration error on a radiosurgery linac that affected 77 patients in the U.S. in 2004-2005; identical errors in measurement of output factors affecting 145 patients in France between April 2006 and April 2007, and 152 patients in the U.S. between late 2004 and late 2009; a single incident in France in which the backup jaws for an AVM treatment with a small circular collimator were set to 40 cm x 40 cm; an error in a cranial localization accessory that affected seven centers in France, Spain and the U.S.; and regular treatment planning and targeting errors (e.g., right-left transposition) on both linac and gamma devices. The purpose of this abstract is to: 1) Discuss radiation error prevention efforts undertaken by the World Health Organization (WHO), the International Commission on Radiological Protection (ICRP), the National Health Service (NHS) and other organizations, 2) Review reported errors in SRS/SBRT commissioning, dosimetry and delivery, 3) Provide broad ranging recommendations (staffing, training, credentialing, resource identification, patient-specific quality assurance) for SRS/SBRT processes and procedures that may be beneficial in understanding and reducing risks inherent to the modalities.

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RESULTS OF THE DOSE INTERCOMPRATION AT THE RCP PHANTOM OF PELVIS AND HEAD AN NECK USED FOR THE VALIDATION OF IMRT TECHNIQUE AT THE CENTRO CONTROL DE CANCER

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Abstract: The clinical implementation of a Intensity Modulated Radiation Therapy (IMRT) technique is a hard work to physics group, however due to complexity and high quantity of parameter that must be taken into account, there are a good chance to introduce a systematic error at the chain of measurement which can be difficult to found by the same team that made the measurement as show by the results of the Radiological Physics Center (RCP), this make clear the need for an independent check allowing the validation of a chain of measurement, the test consist in the same processes to irradiate a patient, is required to do a CT of phantom, to define the target volume and the organ at risk, making the plan following a protocol with doses limits, perform the quality control, and finally delivery the plan in the phantom, we obtained satisfactory result with deviation at the absolute dose lower than 3% in all target and organ at risk, and a geometric match lower than 2mm. With these results we can conclude than our chain of measurements including the quality control system ensure the optimal performance of the IMRT technique for our clinical implementation

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ABSOLUTE ABSORBED DOSE RATE IN WATER MEASURED IN SMALL RADIOTHERAPY FIELDS

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This work presents results of the absorbed dose rate in water measured with Gafchromic film (MD-V2-55), thermoluminescent (TLD-100) and alanine dosimeters for small radiation fields (4 to 50 mm diameters) used in stereotactic radiosurgery (SR) and intensity modulated radiotherapy (IMRT). All dosimeters were vacuum sealed using food saver packets, mounted in a spring loaded jig and supported in the water phantom at 5 cm depth perpendicular to the radiation beam. Firstly, all detectors were calibrated in terms of absorbed dose to water in a ⁶⁰Co gamma-ray and a 6 MV X-ray reference radiation fields (10 cm x10 cm) using a NIST calibrated ionization chamber. For the small fields, the measurements were performed in a Gammaknife unit, two linear accelerators; one for SR and one for IMRT treatments. The results suggest that, if a strict protocol is followed, the new radiochromic film, MD-V2-55, can be used to measure the absorbed dose rate to water in the small radiation fields within an combined uncertainty of less than 1.5%, besides the low cost of the system. While the TLD-100 and alanine dosimeters, similar to the most ionization chambers available, are too large to measure the absorbed dose rate in a very small radiation field. Comparing to the MD-V2-55 measurements, the international code of practice, AAPM and IAEA protocols, subestimate the absorbed dose rate of up to 11% for the smallest fields. We thank Marc Desrosiers and James Puhl for the alanine dosimetry measurements. We also acknowledge Ana Elena Buenfil Burgos and Flor Herrera for technical support. This work was partially supported by DGAPA-UNAM grant IN102610 and Conacyt grant 127409

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IMPLEMENTATION OF A 3D QUALITY CONTROL SYSTEM WITH ANATOMICAL CORRELATION TO INTENSITY MODULATED RADIATION THERAPY (IMRT)

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Abstract: The quantity and correlation of the information using a traditional 2D method to quality control in IMRT is poor and not specifically to determine the clinical quality of a treatment plan. The development of matrix array with better algorithms and the use of a single standard of images DICOM have allowed the implementation of news tools; we present the procedure to implement the Compass system using chamber array into a daily routine to quality control in IMRT plan, The compass has several solutions in one package, first allows the pre verification of Monitor Units (MU) and the absolute dose calculation in our TPS, second we can check the dose distribution at the organs at risks (OAR) and targets defined in the plan using a independent algorithm, next using the detector system allows to evaluate the clinical impact at the dose distribution due to delivery of the planned treatment by the machine but in the geometry of the patient not in a phantom, finally the implementation of Compass reduce the time and optimize the quantity and correlation of the information with the quality of dose clinical delivery in the patients.

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IMAGE QUALITY METRICS FOR COMPUTED TOMOGRAPHY

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Computed Tomography (CT) is entering its fifth decade as a clinical modality, however the methods by which medical physicists assess image quality on CT images remain identical to those established in the first decade of CT. Prior to the Digital Imaging Communication in Medicine (DICOM) standard and the widespread use of Picture Archiving and Communication Systems (PACS), subjective visual evaluation was necessary because the only output of the CT system was a film image. Current access to digital CT images suggests a necessary change. The International Commission on Radiological Units and Measurement (ICRU) will be publishing new recommendations for quantitative assessment of image quality in CT soon. The Modulation Transfer Function (MTF) in both the x-y and z dimensions is recommended for the assessment of spatial resolution, consistent with modern image science practice. The three dimensional Noise Power Spectrum (NPS) is recommended for the assessment of image noise. A cylindrical polyethylene phantom is specified in which dose to the center of the phantom is adjusted to a standard level (10 mGy), and the NPS is then computed at this standard dose setting. These methods will allow medical physicists to make quantitative image quality comparisons between CT scanner types and models, and also optimize CT protocols for a number of imaging procedures. The use of mathematically-rigorous quantitative techniques will reduce the subjectivity associated with visual assessment methods and allow higher precision in image quality measurement. In addition, the complexity and cost of the hybrid image quality-dosimetry phantom will be considerably less than traditional phantoms, providing better accessibility. Software for the evaluation of MTF and NPS will also be provided. Overall, the transition from historically qualitatively CT image assessment to quantitative metrics, grounded in state-of-the-art image science techniques, should enable more meaningful CT scanner comparisons at the local, regional, and international levels.

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OPTIMIZATION OF THE SCAN PROTOCOL IN THE MEASUREMENTS OF CORONARY ARTERY CALCIUM

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The aim of this study was to evaluate the influence of the tube current applied for studies of calcium score. The research was carried out in a private clinic of Rio de Janeiro, using a 64-slice MDCT scanner and an anthropomorphic cardiac CT phantom. In all images, the Agatston score, the volume and mass of the calcifications, and the noise for each current tube was determined. The average CT attenuation number obtained for all tube currents was 261.6 ± 3.2 HU for the CaHA density insert and $-0.2 \text{ HU} \pm 2.0$ for the water insert. The images obtained at lower tube currents were noisier and grainier than those obtained at higher tube currents. However no significant differences were found in the calcium measurements, which suggest a high potential of patient dose reduction, around 50%, without compromising diagnostic information.

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EVALUATION OF THE IMAGE QUALITY IN COMPUTED TOMOGRAPHY: DIFFERENT PHANTOMS

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The aim of this work was to compare the simulators provided by the computed tomography manufactures with ACR CT Phantom. Also, the results of Catphan Phantom was compared with ACR Phantom. The image evaluation followed the protocol established by the manufacture of the phantoms. Test of Accuracy of CT number of water showed a very large discrepancy for all simulators. For uniformity and noise test, the phantoms of GE and Siemens presented results with a very large disagreement in relation to ACR phantom. The results indicated that the simulator ACR was the most comprehensive and flexible for used in various scanners model. Also was verified that some simulator did not present sufficient data to perform a completely image evaluation.

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OPTIMIZATION OF PEDIATRIC CT PROTOCOLS: ABDOMEN AND CHEST

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The aim of this work was to optimize pediatric CT protocols for abdomen and chest in a public hospital of Rio de Janeiro. The relationship between image noise and radiation dose was investigated in computed tomography images using a water phantom and the Alderson Randon phantom. The CT dose index was estimated using a CT ionization chamber. Comparing the results obtained in this study with the values of CTDI_{100,air} of the original protocol, it was verified a reduction of 17% and 23%, for abdomen and chest respectively maintaining the diagnostic image quality.

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FRONTIERS IN BIOMEDICAL IMAGING WITH ULTRAHIGH MAGNETIC FIELDS

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In the last decade and a half, imaging of cellular processes in vivo has been identified as an indispensable capability for biomedical research. Today, numerous different technologies are employed in pursuit of imaging processes such as organ function, intracellular chemistry, tissue perfusion, oxygen utilization, gene expression, and enzyme activity in intact animals and humans. In this effort, magnetic resonance imaging (MRI) has evolved as a powerful tool. MRI has proven to be rich in information content but inherently poor detection sensitivity, which impose a fundamental limitation on this methodology. In the last two decades, we have pursued ever increasing magnetic fields for use in MRI magnetic resonance spectroscopy (MRS) to alleviate this limitation and also for extracting unique physiological information in humans, going first to 4 Tesla, and subsequently to 7 and 9.4T. A plethora of early experiments, particularly at 7T, demonstrated superior sensitivity and accuracy of functional brain imaging (fMRI) signals, detection of increased number of metabolites in spectroscopy, and improvements in several contrast mechanisms for anatomical imaging. In fMRI, these gains have ultimately resulted in unique applications such as robust functional mapping of elementary computational units in the human brain. Similarly, ultrahigh fields have proven to be rich in anatomical detail. These applications had to deal with complexities arising from damped traveling wave behavior of 300 MHz RF, the 7T proton frequency, in the human body. These were managed through multichannel transmit capability on the transmit side while, on the receive side, they lead to significant gains in spatial encoding using parallel imaging. With these engineering and methodological solutions, human imaging at 7T and higher fields has been feasible not only in the human head but also in the human torso, where the challenges have been considered insurmountable until our recent work, leading to accomplishments such as coronary and kidney angiography without contrast agents and morphological imaging of the torso in high resolution and contrast.

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EFFECT OF THE SCANNER BACKGROUND NOISE ON THE RESTING BRAIN NETWORKS DETECTED BY fMRI

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Resting state studies by fMRI are carried out in order to identify the brain networks responsible for the basal functioning of the brain, known as resting state networks (RSN). Although considered to be in rest, subjects are unavoidably under a massive charge of environmental acoustic noise produced by the MRI equipment. Our aim was to verify if the massive auditory information input can mask the 'real' RSNs. The functional volumes were acquired when 7 naive subjects (4 women) had their eyes opened under default EPI sequences or during soft-tone sequences (slew-rate reduction), as allowed by a Philips Achieva 3T MRI scanner. The sound pressure level difference between the default and soft sequences reached 12 dB. Experimental sessions consisted of two runs of 7 minutes each under two different levels of noise. The sequence of conditions was counter-balanced between subjects. The functional volumes were preprocessed in BrainVoyager and submitted to self-organizing group Independent Component Analysis (sogICA). The influence of the higher noise level was evaluated by identifying the BOLD components and comparing the functional volumes of the five representative resting state networks under each condition (random effects ICA). The results show that a lower level of noise may uncover functionally wider components. A t test showed that the high noise condition induced significantly higher BOLD signal in the posterior cingulate cortex only. On the other way, lower noise levels induced higher BOLD activity in the bilateral parietal lobule, bilateral superior frontal gyrus and insula. Yet, the motor resting state network seems to be wider under low noise, reaching auditory areas in the temporal cortices and a oscillatory component on the thalamus was identified in the low noise condition. The results indicate that a compromise should be taken into account when studying rest, balancing between noise reduction and speed of acquisition.

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STUDY OF MDX MOUSE BY NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY (MRS)

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ABSTRACT: The *mdx* mice are used as animal model to investigate the pathogenesis of Duchenne Muscular Dystrophy (DMD) and frequently provide some important information about the dysfunctions on mutant metabolism. This paper combines High Resolution ¹H nuclear Magnetic Resonance Spectroscopy (MRS) and statistical analysis to study the metabolic profile of samples from quadriceps of *mdx* and control mice at different ages. In the spectra there are 24 distinct chemical shift regions associated with several metabolites. The areas under each region were calculated and used in our analysis. The *statistical distances* and *correlation matrix* were analyzed in order to identify the key biomarkers metabolites that characterize the dystrophy progression in *mdx* muscle and effects of natural aging in control ones. For instance, carnosine, taurine and creatine were consistently decreased in *mdx* when compared to the control ones.

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A TOOL FOR CONVERTING & CORRECTION OF MRSI IMAGES IN TO DICOM FORMAT

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Mostafa Robotjazi

Different magnetic resonance imaging (MRI) techniques is used for diagnosis of various diseases. Magnetic resonance spectroscopic imaging (MRSI) is a method to provide biochemical, functional as well as anatomical information. Use of this technique to determine clinical target volume is encouraging in radiotherapy. Treatment planning and different volumes delineation in radiotherapy is based on the CT images and for more accurate contouring CT images are fused with MR images. For using MRS images in treatment volume definition they have to be converted to DICOM files in order to fuse them with MRI images. In this work a software tool is introduced to convert MRSI non-DICOM images into DICOM file which can be used for fusion in various software and standard diagnostic-therapeutic tools.

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THE ROLE OF ANTHROPOMORPHIC PHANTOMS IN CLINICAL TRIAL QUALITY ASSURANCE: THE RADIOLOGICAL PHYSICS CENTER'S (RPC) EXPERIENCE

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Purpose: Describe the RPC's anthropomorphic phantoms, how they are used to credential institutions to use advanced technologies in the National Cancer Institute's clinical trials and results of the credentialing process. **Material/methods:** The RPC has 4 QA phantoms, H&N, pelvic, spine and thorax phantoms, to credential institutions, i.e. demonstrate the ability to deliver a specific radiotherapy treatment from imaging to delivery. The phantoms are water-filled plastic shells with imageable targets, avoidance structures, and heterogeneities. They contain TLD and radiochromic film dosimeters. The institution must treat the phantom like a patient; perform CT simulation, develop a treatment plan, and deliver the treatment. The phantoms are returned to the RPC; the dosimeters are analyzed and compared to the institution's digital treatment plan. Any discrepancies are pursued to help institutions identify the origin and methods of resolution. **Results:** As of 2010, the H&N, pelvic, spine and thorax phantoms were irradiated 950, 230, 58 and 272 times, respectively. The failure rates were 20%(H&N), 22%(thorax), 17%(pelvis) and 38%(spine) using 7%/4mm (H&N and pelvis), 5%/5mm (thorax) and 5%/3mm (spine) criteria. The failure rate has decreased, except for the spine phantom, from >30% to ~20%. Acceptance criteria were established from a sampling of phantom results such that 90% of irradiations were expected to pass. The spine and thorax phantom also use 5%/3mm and 5%/5mm gamma index analysis, respectively. Analyses of results show that if the criteria were universally $\pm 5\%/3\text{mm}$, the failure rate would double (40%-60%). Numerous reasons contribute to phantom failures from incorrect beam modeling to poor heterogeneity correction algorithms to large institutional QA criteria. **Conclusions:** Using the RPC's phantoms to credential institutions for clinical trials have identified numerous dosimetry discrepancies, when resolved, have improved the quality of care for patients. Work supported by PHS CA010953 and CA081647 awarded by NCI, DHHS.

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ACCEPTANCE AND COMMISSIONING OF THE XVI SYSTEM AT ICESP, SAO PAULO

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This work describes the acceptance and commissioning of the first XVI system of the Elekta Synergy Full installed at Instituto do Cancer do Estado de Sao Paulo (ICESP). This linear accelerator is provided with two high-energy photon beams and six high-energy electron beams, namely 6 and 15 MV and 4, 6, 9, 12, 15 and 18 MeV respectively. The CBCT system is composed by a retractable X-ray source and amorphous silicon panel detector, which is mounted orthogonally to the megavoltage beam line of the linear accelerator. The acceptance and commissioning tests cover the following topics: the system mechanical safety; the geometric accuracy; the image quality; registration and correction accuracy. All safety checks (system interlocks and system touch guards) have been thus performed according to the document provided by the manufacturer and a perfect compliance has been found. In order to verify the agreement of MV and kV beam isocenters, a ball-bearing phantom was used: it consists of a steel ball located at the tip of a long PMMA tube which is coupled to a base plate locked at the end of the couch with a series of vernier adjustments that take into account the position of the steel ball in 0,01 mm increments in all three directions. For the image quality tests, a Catphan phantom was used and was scanned in the CBCT high-resolution mode. Some selected and appropriate section for spatial resolution and low-contrast objects were then evaluated in the XVI viewing software. An agreement of 0,3 mm was found between the MV and kV isocenters. The registration and correction accuracy was also evaluated by using the Catphan phantom in conjunction with the software provided by the manufacturer. The deviations found in all 3 directions for the couch position were less than 0,5 mm when the accepted limit ranges within 2 mm. In conclusion, these tests will provide guidelines for the quality assurance program to be implemented into the IGRT systems at ICESP.

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TOMOTHERAPY DOSE RATE ANALYSIS AND CONSIDERATIONS FOR ABSOLUTE CALIBRATION

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In this study, dose rate variations have been analyzed for a period of five months for two tomotherapy HiART (Tomotherapy, Madison, WI) system. Helical tomotherapy output is mainly characterized by a rotational dose rate variation and a drift with treatment time. It also frequently presents cyclic or random dropped pulses. Its dose rate can change with magnetron wear to an irregular drift with sometimes higher amplitude rotational variation. The purpose of this study is to evaluate the dose rate patterns impact for absolute calibration. A homemade application has been developed to analyze and store linac monitor chamber count readings during a morning output QA with one of the recommended calibration plans. Since the absolute dose is measured with an ionisation chamber in a phantom, monitor chamber readings are calibrated with this measurement. Two parameters are evaluated for this data, the drift of the output and the standard deviation of the gantry rotation output variations (2σ). The absolute dose measurement obtained during an output calibration with this calibration plan was found to be mainly integrated in the central 65 seconds of a 220 seconds plan. It has been observed that the output sometimes drops when the ionisation chamber is exposed to the main beam, so it can bring forth calibration error. Dose rate considerations during a calibration or a QA were found important to understand what is going on and to take proper decisions when we obtain different calibration factors. It has also been found during this monitoring over a five months period that the percentage of drift and 2σ parameters are sensitive to tomotherapy units instabilities.

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A RISK MANAGEMENT APPROACH TO CREDENTIALING OF RADIOTHERAPY CENTERS FOR CLINICAL

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Background: Multicentre clinical trials rely on participating centers for quality assurance and compliance with the treatment protocol. If this is in question, not only the patient treatment but also the scientific question of the trial can be jeopardized as was recently reported by L Peters (JCO 2010, 28:2996). In order to ensure protocol compliance, credentialing of centers participating in clinical trials is commonly performed by clinical trials organizations. Methods: The TransTasman Radiation Oncology Group (TROG) has used a risk management approach for the design of the credentialing procedures for some of the more recent radiotherapy trials that involve complex technology. The process aims to identify risk areas that could affect the trial outcome. They are analyzed in terms of likelihood of occurrence, severity of impact on the trial question and detectability. A matrix is then put together for the key issues to ensure that each is addressed in at least one of the elements of the credentialing process: facility questionnaire, contouring studies, test plans, set-up studies, dose verification in a phantom, and site visits/observation. This leads to a final subset of credentialing elements which are proposed to the trial management committee for implementation for a particular trial. Results: Two recent trials where this process was followed are a study of adaptive radiotherapy for bladder cancer (TROG 10.01) and a trial of hypofractionated image guided radiotherapy for early stage lung cancer (TROG 09.02). The credentialing process for both trials includes site visits and an assessment of image guidance as key elements. Conclusion: A modified risk management approach was found to be an effective way to design a credentialing program for a particular clinical radiotherapy trial.

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STATISTICAL PROCESS CONTROL: QUALITY CONTROL OF ACCELERATOR BEAM STEERING

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Objective: This study investigates the utility of statistical process control (SPC) methodology to detect changes in linear accelerator beam steering parameters prior to equipment failure (interlocks actuated). **Methods:** Steering coil currents (SCC) for the transverse and radial planes are set such that a reproducibly useful photon or electron beam is available. SCC are sampled and stored in the control console computer each day during the morning warm-up. The transverse and radial - positioning and angle SCC for photon beam energies were evaluated using individual and moving range process control charts (PCC). Data from Oct-2009 (annual calibration) until two weeks following a beam steering failure on June 28th was evaluated. Appropriate action limits were developed using conventional SPC guidelines and experience. **Results:** PCC high alarm action limit was set at six standard deviations from the mean. Low alarm indicators were: (1) nine points in a row on either side of the mean, and (2) two out of three points in a row greater than two standard deviations from the mean. Transverse angle SCC for 15X and 6X indicated a high alarm on March 13th and April 14th respectively. A downward trend in this parameter continued, with high alarm, until failure. Transverse position and radial angle SCC for both energies indicated a high or low alarm starting in March or April. **Conclusions:** Quality control using SPC may have reduced machine down time by providing an early warning of changes in the beam steering process. **Keywords-** Quality control, quality assurance, statistical process control

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QUANTITATIVE EMISSION TOMOGRAPHY

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Most medical diagnostic and some therapeutic procedures rely greatly on visual interpretation of images acquired with different techniques that show anatomical and/or functional information of the patient. One of these imaging modalities, emission tomography, which includes both PET and SPECT, is capable in producing quantitative physiological and metabolic information of specific organic systems or physiopathological processes. This is possible by extracting the radiopharmaceutical concentrations in the volumes of interest and inserting them in appropriate model of a particular process. However, this operation is hampered by factors related to the imaging system, to the patient's characteristics and the moving organs, to the radiopharmaceutical path inside the body, to the interactions of radiation with the tissues and to the reconstruction and processing methods. Efforts had been dedicated by several research groups to overcome some of these degrading factors, in order to produce figures with accuracy that may result in more efficient therapeutic conduct and benefit to the patients. Hybrid system, as PET/CT and SPECT/CT, is one solution that contributed immensely in the photon attenuation correction and the precise localization of lesions or abnormalities, apart from the advantage of producing a combined anatomical and functional image. Detecting systems with more sensitive and faster response and corrective processors enhanced the geometric resolution and counting capacity of modern equipments. Inherent motions effects, as respiratory and cardiac motions, can be reduced greatly by gating systems. Reconstruction algorithms that include resolution recovery, attenuation and scatter corrections, as well as statistical considerations resulted in more reliable images for extraction of activities present in the regions being examined. Development of radiopharmaceuticals with specific targets improves the modeling process and, consequently, the accuracy of the functional parameter. In this presentation, these problems related to quantification and some methods developed for their solution will be addressed.

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THE EFFECT OF BARIUM SULFATE IN REDUCTION OF SUB DIAPHRAGMATIC ACTIVITY IN MYOCARDIAL PERFUSION IMAGING

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Background: The aim of this study was to investigate the effect of barium sulfate in reduction of sub-diaphragmatic activity in technetium 99m sestamibi myocardial perfusion scan. **Methods:** This study included 15 patients (6 male, 9 female) randomly selected from whom referred for 2 days rest-stress Tc-99m myocardial perfusion scan. All patients underwent stress phase of scan, after stress phase a planar static scan (for 5 min) from abdominal area of patients obtained, after that all patients were given 80 gr of barium sulfate, solved in 200 cc water, with 100 cc room temperature water and second planar static scan (for 5 min) obtained from them. The effect of barium sulfate on sub cardiac activity was evaluated both visually and quantitatively. After obtaining two planar static images, an area of about 1404 pixels (mean 1404.06 pixels) in left upper quadrant of abdomen, adjacent to inferior wall of heart in gastric area was selected in both images in same area of selection. **Results** There was a significant reduction in the sub cardiac count per pixel in barium group compared to control group (p value < 0.001). **Conclusion:** The findings indicate that filling of the stomach with barium sulfate, as a low price, safe and worldwide available oral contrast, resulted in an improvement in the image quality by decreasing the adjacent gut activity.

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A SIMPLE SEGMENTATION ALGORITHM TO MEASURE GASTRIC CONTRACTION ON SCINTIGRAPHIES

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The scintigraphy is the gold standard for human gastric motility due its functional characteristics. In all quantification methodologies described for these purposes is evident that the segmentation of the image parts where the radioactive tracer is distributed is the main task. Usually this segmentation process is executed manually and, consequently, depends on user experience as technician, physician or researcher that make the quantification protocols low precision or even irreproducible. In this way, our aim was to develop a image processing algorithm for automatic quantification of gastric contraction. For the initial tests, scintigraphic images of a healthy volunteer that received 60 ml of ^{99m}Tc-labeled meal where processed to quantify the gastric contraction. All the images where processed on MatLab as follows: first we applied power transformation and threshold enhancement followed by low-pass Fourier filter, which smoothed the image and reduced the background noise. This image was segmented by the application of Canny's edge detector and thus dilated, eroded (to avoid truncated edges) and had its interior filled, respectively, resulting on a binary image of the tracer distribution used to determine the perimeter and compute inner area. Considering that as stomach contracts it modifies the meal distribution and consequently its area, we recorded the image area as a function of time and could access the gastric contraction profile with the same level of confidence of manual segmentation described on literature. When we computed the Fourier transform spectra to determine the main frequencies that predominated on the contraction signal it was also coincident with the specialized literature. Although it was only a preliminary study we could determinate the contraction profile and its frequency composition, which can be applied on several physiological studies, such as dyspeptic patients or to evaluate drug effects on the gastrointestinal tract, for example.

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ESTABLISHMENT OF A BRAZILIAN DATABASE FOR ASSESSMENT OF NEURODEGENERATIVE DISORDERS

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1-Mutimagem PET/CT; 2-CDPI - Clínica de Diagnóstico Por imagem

Neuropsychiatry diseases have been studied in many different modalities of medical imaging. New quantitative tools are discoveries and applied every year to support clinical diagnosis. Recent advances in voxelwise statistical analysis have promoted early diagnosis easier and more objective than visual inspection. The aim of this study was to develop a normal brain database from individuals of various ages, in order to define a pattern of glycolytic metabolism in the Brazilian's brain to be used on MATLAB/SPM8. 20 individuals, 10 women aged from 40 to 71 years and 10 men aged between 40 and 68 years were selected. These individuals had no history of neurological and neuropsychiatric disorders. Neurological PET image acquisition was performed 45 minutes after administration of fluorodeoxyglucose (FDG). All DICOM images were converted to the SPM (Statistical Parametric Mapping) analyze mode and underwent five major steps of image post-processing. 1) Realignment - to eliminate possible movement artifacts during the image acquisition, 2) Space Standardization - linear and nonlinear deformation to a standard anatomical space, 3) Binary Mask - to remove external signals from the brain caused by scattering, 4) Smoothing - calculated the punctual averages with neighborhood and 5) Evaluation and comparison of individuals (groups or individually). Two patients with metabolic changes identified by two nuclear medicine physicians were compared with the database. The regions with high and less uptake could be identified by SPM. This database is constantly growing and can be used to compare the brain FDG uptake of patients undergoing neurodegenerative diseases. In a near future, we will be able to quantify alterations in uptake of neurodegenerative disorder in the Brazilian population aided by a Brazilian database.

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EVALUATION OF PHYSIOLOGICAL TIME SERIES WITH NONADDITIVE APPROXIMATE ENTROPY RATE

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This work describes generalizations of entropy-based complexity measures for complex physiological time series analysis that is consistent with Tsallis nonadditive statistics. Nonadditive statistics has proven to be suitable for modeling systems with long term memory, nonlinear and multifractal phase space. Most of the physiological systems present these features while ruled by weakly chaotic dynamics. Chaotic dynamics complexity is traditionally measured by entropy rate metric such as Kolmogorov-Sinai entropy. While dealing with real time series, approximate entropy (AppEn) metric family showed to be appropriate to estimate complexity. Surrogate data is a widely used technique to test null hypothesis in nonlinear model dynamical system. In this work, generalized nonadditive entropy rate is evaluated with respect to parametric entropy through surrogate data technique. This model was applied to heart rate variability (HRV) dynamics analysis. HRV is one of the most traditionally available physiological data that is known to be low dimensional dynamics. Here we calculated differences in AppEn from HRV to surrogate data as a function of q entropic exponent. These analyses have shown a more detailed description when compared to classic entropic analysis. This method was evaluated in three datasets: normal individuals, patients with atrium fibrillation and patients with heart failure. Results shown that, when we consider q entropic parameter in AppEn, it is easier to distinguish between different dynamics. The results indicate that this parametric analysis has potential in describing nonadditive entropy rates in short term time series.

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NSECT APPLIED TO THE ASSESSMENT OF CALCIUM DEPOSITION DUE TO THE PRESENCE OF MICROCALCIFICATIONS ASSOCIATED WITH BREAST CANCER

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In this paper we presented an application of the Neutron Stimulated Emission Computed Tomography (NSECT) which uses a thin beam of fast neutrons to stimulate stable nuclei in a sample, emitting characteristic gamma radiation. The photon energy is unique and is used to identify the emitting nuclei. This technique was applied in evaluating the calcium isotopic composition changing due to the development of breast microcalcifications. A particular situation was simulated in which clustered microcalcifications were modeled with diameters less than 1.40 mm. In this case neutron beam breast spectroscopy was successful in detecting the counting changes in the photon emission spectra for energies which are characteristics of ⁴⁰Ca isotope in a low deposited dose rate.

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BRADYKININ B2 RECEPTOR IS NOT REQUIRED FOR TUMOR GROWTH REGRESSION BY RADIOTHERAPY

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Recent progress in tumor immunology suggests that tumor cell killing by radiotherapy leads to the generation of anti-tumoral immunity. Mechanistic studies suggest that tumor cell death induced by irradiation favor engulfment, processing and antigen presentation by dendritic cells, ultimately favoring development of a tumor-specific T cell immune response that is critically required for tumor regression. A poorly explored corner of radiotherapy research is the relationship between tumor cell death, extravascular proteolysis and immunity. We chose to focus our attention on the kallikrein-kinin-system (KKS) based on evidences that kinins generated in sites of microbial infection activate dendritic cells via bradykinin B2 receptors (BK2R), thereby linking extravascular proteolysis to the cytokine circuits that steer CD8+ T effector cell development. Here we tested whether activation of the KKS could influence host resistance to melanoma in C57BL/6 mice subjected to local radiation therapy. To this end, we injected naive mice (n=5-8) into the thigh with B16 melanoma cells. After 7-10 days of tumor growth, the mice were submitted to local radiotherapy (8-15 Gy), shortly after receiving a single-dose injection of (i) the B2 receptor antagonist HOE-140 (ii) captopril, inhibitor of angiotensin converting enzyme (ACE/kininase II). Our results confirmed that radiation therapy has a pronounced beneficial effect, attenuating tumor growth and increasing survival as compared to non-irradiated groups. However, we did not detect significant differences in host resistance in irradiated mice pre-treated with either HOE-140 or captopril. Given the difficulties to predict the time-window leading to extravascular proteolysis in irradiated mice, we repeated these experiments in mice genetically deficient in bradykinin B2 receptor (B2KR). Consistent with the pharmacological studies, we found that irradiation therapy decreased tumor growth and increased host survival. Collectively, our results do not support the hypothesis that activation of B2KR is required for tumor regression induced by local radiotherapy.

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IMRT COMMISSIONING: HOW CLOSE IS CLOSE ENOUGH?

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Intensity Modulated Radiation Therapy (IMRT) has become an important treatment modality in modern radiation therapy facilities. IMRT treatments involve a high degree of complexity in planning and delivery, therefore the quality of the patient's treatment is highly dependent on local implementation and QA. It is generally acknowledged that IMRT commissioning involves careful evaluation of the total RT chain including treatment planning, data transfer and delivery. This is different from patient-specific IMRT QA procedures which are intentionally kept as simple as possible but comprehensive enough to enable detection of gross errors before treatment begins. Typically, commissioning involves a progression from simple tests, which reveal easily identifiable errors or inadequacies, to more complex tests representative of what might be expected in clinical situations. Independent dose evaluation involving supplied phantoms containing dosimeters have also provided valuable feedback to institutions attempting to validate IMRT planning and delivery, however dose discrepancies have been significant. Currently, there is no common consensus regarding the level or nature of testing that must be performed to properly commission an IMRT system or what overall level of accuracy is acceptable or might be expected. There have been attempts to establish uniform guidelines for validation of IMRT techniques based on analysis of QA results from multiple institutions (e.g. QUASIMODO project in Europe and AAPM TG-191 Report). This multi-institutional approach assumes that the fundament underlying validation of the treatment planning and delivery systems at the participating institutions has been rigorous but not necessarily optimal. In this presentation we will look at available recommendations for IMRT commissioning. Examples will be provided where suboptimal IMRT commissioning may result in patient specific QA results that appear reasonable. Finally, a process is proposed to evaluate commissioning based on establishing the best parameters for specific combinations of planning and delivery systems.

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GEOMETRIC ACCURACY EVALUATION OF STEREOTACTIC BODY RADIATION THERAPY THROUGH AN END-TO-END TEST

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The high dose delivery and the use of small margin around the tumor in stereotactic body radiation therapy (SBRT) require a high level of accuracy. The purpose of this study was to evaluate through an end-to-end test the total geometric accuracy of the SBRT technique used at Hospital Sírio-Libanês. For this, a cubic plastic phantom with a radiopaque sphere embedded was imaged with a computed tomography scanner. These images were transferred to a treatment planning system for delineation of the sphere, used as a target, and definition of an isocenter with twelve beams, with different combinations of gantry and couch angles. A megavoltage cone beam computed tomography was used for positioning the phantom at the isocenter of a Primus-Siemens linear accelerator where the planned fields were run and electronic portal images were simultaneously acquired. The overall process deviation was assessed by measuring, for each portal image, the misalignment between the central mark (the center of the sphere) and the beam central axis. The mean error measured was 0.67 ± 0.28 mm showing sufficient geometric accuracy of the SBRT approach employed at our institution.

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FEASIBILITY OF STEREOTACTIC TREATMENT PLANNING THROUGH INDICES OF CONFORMITY

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Conformity is an important quality for a good radiotherapy plan. Some indices published in the literature designed to quantify conformity of plans were reviewed here. Intended to compare stereotactic radiotherapy (SRT) techniques, we choose four cases with plenty different characteristics and re-planned them on the iPlan RT Dose using static conformal fields (SCF), dynamic conformal arcs (DCA) and intensity modulated stereotactic radiotherapy (IMRT). Utilizing the van't Riet index, conformity number (CN), we calculated and plotted the index against isodose levels, enabling to compare dose coverage and conformity to the targets. DCA proved to be the most conformal option on three of four cases, by the other hand IMRT cases have lower high dose and SCF was most often an intermediate option. Conformity number is in general a very good parameter to analyze qualitatively multiple plans but still presenting some issues.

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EFFECT OF NOISE REDUCTION ALGORITHMS ON PATIENT DOSE

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Recent radiation overexposures in computed tomography (CT) head perfusion examinations and subsequent attention by the world media and press outlets have brought significant public attention to radiation dose for medical imaging procedures. Users of imaging equipment (technologists, radiologists, physicists) as well as manufacturers and government regulators have also been sensitized to these issues. Consequently, there is a significant effort being undertaken to reduce the patient radiation dose in several ways such as enhancing detector efficiency, optimizing acquisition factors (kV, mAs, beam filtration), using technical capabilities such as pulsed fluoroscopy and last-frame-hold, and/or implementing noise reduction algorithms during acquisition or post-processing of the acquired data. This presentation describes noise reduction algorithms for all modalities, with a major focus on CT. Major methods for reducing CT dose include automatic exposure control (AEC) to account for differing attenuation tissues (e.g. lung vs. soft tissue) and differing pathlengths (elliptical body shapes with longer lateral vs. anterior-posterior projections), and post-processing using statistical iterative reconstruction techniques to reduce the impact of noisy projections on the final reconstructed tomographic images. Significantly decreased patient dose can be achieved with these methods, in some cases by a factor of two to three times, with images that are diagnostically similar to higher dose acquisitions. However, technology can be misused as in CT brain perfusion cases in which the “noise index” for AEC was improperly set too low with an unintended high radiation dose. Continued dose reduction and improvements in patient safety are achievable, but there are limits on how low a dose can be used to achieve an optimal result. Appropriate and thorough training on the use and outcome of noise reduction algorithms is essential, and learning when to apply or to not apply them are keys to their safe and effective use for the optimal imaging of the patient.

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STUDY OF THE CT DOSE PROFILES IN A CHEST PHANTOM

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For optimizing patient doses in computed tomography (CT), the Brazilian legislation has only established diagnostic reference levels (DRLs) in terms of Multiple Scan Average Dose (MSAD) in a typical adult as a quality control parameter for CT scanners. Compliance with the DRLs can be verified by measuring the Computed Tomography Air Kerma Index with a calibrated pencil ionization chamber or by obtaining the dose distribution in CT scans. An analysis of the quality of five CT scanners in Belo Horizonte was done in terms of dose profile of chest scans. Measurements were done with rod shape lithium fluoride thermoluminescent dosimeters (TLD-100) distributed in cylinders positioned in peripheral and central regions of a polymethylmethacrylate chest phantom. The peripheral regions presented higher dose values. The results contribute to disseminate the proper procedure and optimize the dosimetry and the tests of quality control in CT.

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DOSIMETRY IN COMPUTED TOMOGRAPHY USING A SMART ELECTRONIC DETECTOR

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Computed tomography (CT) examinations bring high doses to the patients due to the accumulated dose from the adjacent scan. A CT dose descriptor which allows for the multiple-scan series is named multiple scan average dose (MSAD). In general, the MSAD is determined by submitting a film or an array of thermoluminescent dosimeters (TLDs) to the irradiation from a multiple-scan series, however reading the dose information can take a long time because these methods are indirect. Another approach to estimate the MSAD can be accomplished with a single scan by measuring the CT dose index (CTDI) using a pencil ion chamber. Nowadays electronic semiconductor devices have been used as radiation detector because they have some advantages for dosimetry (e.g. high sensitivity, small size, and real time measurements). In this work a smart electronic detector is proposed to measure the CTDI and MSAD: an array of high sensitivity photodetector type plus its electronic system embedded in an encapsulation like a pencil. The whole dosimetry system consists of an electrometer, the detector and a computer used to acquire the data. A CT scanner was used for all irradiation assessments. The proposed detector was evaluated free in air and in a head phantom undergoing CT examination in axial mode. For measuring the CTDI, the detector was positioned to take a single slice dose profile at the middle of its longitudinal axis. On the other hand, to obtain the MSAD, the measurement was taken by scanning all the smart detector length. The results present two innovations: 1) the dose profile is directly plotted from the data of the smart detector indicating a more accurate method; 2) and consequently, both CTDI and MSAD are measured in real time and in a more accurate, simple and fast way.

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ESTIMATION OF PATIENT DOSE IN CT: AN EXTENSION OF IAEA PROJECT IN BRAZIL

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The aim of this work was to estimate the patient dose in routine procedures in Brazil and identify the potential of optimization in adults and pediatric procedures. The sample included ten hospitals distributed in different states of the country. In each hospital, the routine protocols of head, chest, high resolution chest, abdomen and pelvis were recorded. The values of C_w , C_{vol} and PKI were estimated based on the nC_w values provided by Impact. For the same procedure, significant differences in patient doses were verified between the hospitals and, as well, in the same de-partment. In some cases, the technical factors are so low that suggest a rigorous evaluation of the image quality. Problems also were observed regarding to the procedures records, the information about the procedure is insufficient. This study indicated the necessity of an implementation of an action plan that includes training program to operate the scanner in an optimized mode, to carry out the dosimetry and to evaluate the image quality. The large range of patient doses indicated that there are an expressive potential of patient dose reduction and optimization maintaining the diagnostic information.

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PRELIMINARY RESULTS OF QUANUM IMPLEMENTATION IN CUBAN NUCLEAR MEDICINE SERVICES

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Setting up quality management systems in Nuclear Medicine services has been, for years, an aim for medical physicists in Cuba. In the last decade, we have walked with steady steps towards that direction, by setting up national standards and regulations by regulatory authorities. Several research projects, involving both national and international institutions, have been carried out with the objective of developing the necessary infrastructure as well as qualifying staff members, in order to ensure the improvement of quality assurance and management programs. Since last year, the IAEA's QUANUM document has been incorporated to the methodology for quality management audits in Nuclear Medicine services in Cuba, together with the existing national guidelines and regulations. Five audits, carried out in the first half-year, have shown that most of class A requirements included in QUANUM are fulfilled in all Nuclear Medicine Services. The previous could be explained by the fact that all those requirements were already included in the national standards. However, class B requirements referred to quality management systems are not followed well enough, and so much work is still needed in this area.

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MISALIGNMENT EVALUATION FOR PET/CT

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The combination of functional imaging of positron emission tomography (PET) and computed tomography (CT) in the PET/CT scanner provides accurate anatomical localization of metabolic abnormalities improving the tumor assessment and opening new exciting possibilities for target volume definition in radiation oncology. This image registration by hardware fusion became essential in cancer management but rarely validated or controlled. The aim of this work is to propose a procedure to misalignment evaluation as a part of quality assurance program. Methods: Registration images of the PET/CT PhantomTM were obtained in four gantry conditions simulating different clinical situations. Eight axial points and five sagittal and coronal points were elected on CT and PET attenuated corrected images (CTAC) to compute the target registration error (TRE) in all axes. The mean TRE (TRE_{mean}) and mean vector length (TRE_{length}) were obtained. Results: The maximum TRE offset was 3,1mm. The TRE_{mean} results obtained were under specification limits and TRE_{length} did not demonstrate significant errors between all gantry configurations. Assessment results may be limited by the use of attenuation corrected images and visual localization of points for evaluation. Conclusion: The procedure proposed can be easily done and results were obtained to different clinical situations with mean errors £3mm. All offset results were less than PET/CT spatial resolution and inside manufacturer specifications.

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PARAMETRIC CHARACTERIZATION OF NON-IMAGING INTRAOPERATIVE GAMMA PROBES

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In this work the NEMA NU 3-2004 protocol is applied with the aim to test two gamma probes (SIG) that are use in Cuba, by devices designed for such purpose. These are SIG-0502 with detectors S1, S2, S3 and SIG-0202 with S4 detector. Results of eleven performance tests are shown, which are between normal ranges previously reported in literature and manufacturer manual. Sensitivity and shielding effectiveness values, obtained in air were above 5cps/kBq and 99% respectively for all measured detectors. Spatial resolution was better due to the extra collimator effect (15mm less at small detector). The recommended activity for each test is shown to all probes. The probe SIG-0202 (NAVIGATOR) from one of institution tested resulted unfit for surgical procedures exceeding length of one hour, because battery must be replaced.

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MOLECULAR PET-CT IMAGING-GUIDED RADIATION THERAPY TREATMENT PLANNING

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PET is currently one of the most advanced molecular imaging modalities used in clinical diagnosis, staging, assessment of tumor response to treatment, and radiation therapy (RX) planning. The foundation of molecular imaging-guided RX lies in the use of advanced imaging technology for improved definition of tumor target volumes, thus relating the absorbed dose information to image-based patient representations. Historically, anatomical CT and MRI images were used to delineate the gross tumour volumes for radiotherapy treatment planning. The capabilities offered by modern RX units and the widespread availability of hybrid PET/CT scanners stimulated the development of biological PET imaging-guided RX treatment planning with the aim to produce highly conformal radiation dose distribution to the tumour. One of the most difficult issues facing PET-based RX is the accurate delineation of target regions from typical blurred and noisy functional images. The major problems encountered are image segmentation and imperfect system response function. Image segmentation is defined as the process of classifying the voxels of an image into a set of distinct classes. The difficulty in PET image segmentation is compounded by the low spatial resolution and high noise characteristics of PET images. Despite the difficulties and known limitations, several image segmentation approaches have been proposed and used in clinical setting including thresholding, edge detection, region growing, clustering, stochastic models, deformable models, classifiers, and several other approaches. A detailed description of the various approaches is reviewed. Moreover, we also briefly discuss some important considerations and limitations of the widely used techniques to guide practioners in the field of radiation oncology. The strategies followed for validation and comparative assessment of various PET segmentation approaches are also described. Future opportunities and the current challenges facing the adoption of PET-guided delineation of target volumes and its role in basic and clinical research are also addressed.

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ADAPTIVE RADIATION THERAPY

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Image Guided Radiation Therapy where imaging of clinically relevant structures is used in the treatment room to assist patient set-up intuitively makes sense to improve daily delivery of radiotherapy. However, the availability of high quality images allows more than patient positioning: in adaptive radiotherapy images are used to modify the treatment plan to ensure the treatment objectives are still met for the patient as he/she presents on the treatment day, not as she/he was at time of treatment planning. Adaptive radiotherapy has many challenges, most notably the time constraints at treatment if adaption is to be performed in real time. At present these time restrictions prohibit contouring and replanning of the patient at the time of delivery and either off-line adaptive strategies need to be employed or a simple selection of the best plan for the day can be made from a number of pre-determined treatment plans. At Peter MacCallum Cancer Centre we have developed a protocol for on-line adaptive radiation therapy for bladder cancer where the volume and location of the target can vary significantly from day to day. Based on the planning CT and five Cone Beam CT (CBCT) image sets acquired in the first week of the patient's treatment, plans are developed for a small, a medium and a large bladder as observed for the individual patient. The most appropriate plan is then chosen daily by the radiation therapy staff based on CBCTs acquired directly prior to treatment. The program requires considerable logistic support and additional training for treatment staff and it is currently being tested if adaptive radiotherapy for bladder cancer is feasible in a multicentre clinical trial. The presentation will also review off-line adaptive strategies in particular in the case of lung cancer where functional imaging may have a role to play in the future.

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PATIENT RADIATION EXPOSURE TRACKING

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It is now a fact that some individual patients are receiving radiation doses in excess of 100 mSv from repeated diagnostic CT examinations. It is also a fact that hair loss and erythema have been reported in the last 3 years in patients undergoing CT scans. In the past, many countries laid emphasis on the establishment and use of diagnostic reference levels (DRLs) that have contributed immensely to the optimization process. DRLs cannot help handling the problem of multiple and unjustified exposures which in some situations account for as much as 50% of all examinations. The approaches utilized have been awareness and use of appropriateness criteria developed by professional societies. Obviously, the current situation with high unjustified examinations indicates that this alone is insufficient. A compelling answer is to track lifetime radiation exposure (radiation history) of patients. The IAEA had launched a project called Smart Card/SmartRadTrack few years ago. Technology is advancing at a fast pace and some countries have recently reached the stage of tracking radiation exposure of patients instantaneously when the procedure is conducted in several dozen hospitals in the country connected by picture archiving and communication system (PACS), and through slightly increased effort where conducted in another part of the country from where data can be transferred through PACS. A large number of countries have this possibility restricted only to individual hospitals. Some countries are advancing to a nationwide system. The image data transfer standards now involve radiation exposure indices with which major vendors are now complying. It is envisaged that existing bottlenecks will be taken care of in the coming years. While sub-national systems are a reality, and national systems a possibility achievable within a few years, the international systems are something that require political agenda. The call for action role that the IAEA is playing, besides being initiator and facilitator, is visionary towards achieving radiation protection of the patients in future.

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PROGRAM OF RADIATION PROTECTION OF PATIENTS (ARGENTINA)

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After an initial period of conviction during 2004 and 2005 for installing an active discussion on Radiation Protection of Patients inside the medical community, there were organized “working groups” in Radiodiagnosis, Radiotherapy, Nuclear Medicine and on radiation protection of pregnant women. These groups began systematic activities, which received a strong institutional support of the Argentine Society of Radiology, toward the implementation of a “Program of RPP “ that is being put nowadays into practice. The rapid advances which are present in Medicine today, both in equipment and work protocol, determine that _norms and regulations never arrive on time_ which is why it is paramount that health services have _systems of dynamic quality and continual improvement_ that can be adapted quickly to changes. The program has six main aims and targets to be fulfilled in successive stages: 1) To guarantee the Justification. Target: Development of the “Prescription Guide “ (achieved in 2006) 2) To optimize the radioprotection: Target: Development of a “ Manual of Procedures “ (In process of review) 3) To prevent potential exposures. Target: Design of a “Basic Quality System” for Health services (achieved for radiotherapy and nuclear medicine) 4) To achieve a qualification of the professionals by means of a process of certification and recertification (In process) 5) To spread PRP’s criteria by means of chats, meetings and the use of the media and graphical means. (successfully fulfilled) 6) To achieve a control system to encourage good practice and correct deviations. Target: To regulate the systematic control of medical equipment and the presence of specialists in radiation protection in health services. Strategies to cope with different interests, main problems, failures and difficulties are described. The effective participation of the professional associations is a key aspect for the success of the national programme.

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ASSESSMENT OF SAFETY CULTURE IN MEDICAL PRACTICES UTILIZING IONIZING RADIATION I

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Radioactive materials or radiation generators are used throughout the world for a wide range of peaceful purposes in areas such as the industry, medicine, agriculture, research, education, and others. Radiation protection programme should be implemented through an effective infrastructure, which includes adequate laws and regulations as well as structured complex of experts and operational provisions and more importantly a safety culture shared by all those involved with protection and safety responsibilities from the workers up through to the management levels. A good safety culture can lead to a more effective conduct of work and a sense of accountability among managers and employees who should be given the opportunity to expand their skills by training. Safety culture is important in the sense that it has an influence on behaviour, attitudes and values, which are important factors in achieving good safety performance. The safety culture in medical practices utilising ionizing radiation sources has been assessed using a performance indicator. A questionnaire was prepared using the established safety assessment protocols for conducting safety assessment for the various practices as a guide. The questionnaire covered the following areas: general safety considerations, safety policy at the facility level, safety practices at facility level, definition of responsibility, staff training, safety of the physical structure of the facility and the emergency plans. The analysis showed that the percentage levels of commitment to safety for the respective practices are as follows: radiotherapy, 52-85%; linear accelerator, 78%; brachytherapy facility, 76%; X-ray diagnostic facilities, 25-86%; dental X-ray facilities, 20-68%; and nuclear medicine practices, 45-88%. None of the practices was able to satisfy all the requirements that will ensure a 100% level of safety culture. Necessary recommendations have been made to enhance the level of safety culture in the relevant medical practices.

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SENSITOMETRIC CURVES AS A TOOL FOR EVALUATION OF THE OFF-AXIS SOFTENING EFFECT I

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Purpose - In photon beams produced by linear accelerators, the quality of the beam changes along the beam axis due to different attenuation of the photons in the variable thickness of the flattening filter. Methods such as HVL and narrow beam measurements have been suggested to evaluate this softening effect; also Monte Carlo calculations were performed. In this work sensitometric curves have been used to evaluate the change of the beam quality at off-axis positions. The sensitometric curve method relies on the radiographic film's response to low energy photons; this energy dependence is expressed as a shift ratio of the sensitometric curves obtained with the EC-L film cassette combination for different beam qualities. The shift is expressed by the increase in optical density as a result of the beam softening. **Methods and Materials** - The work was performed in a Varian Clinac 600c linear accelerator (6MV x-ray) and in a Varian Clinac 2100 (6MV x-ray). A Kodak EC-L cassette screen film combination was used. Due to the low number of monitor units that are required to obtain the sensitometric curves with the EC-L cassette screen film combination, the stability of the linac was checked for low MU irradiations. The readings of 10 irradiations at each of the following 1, 2, 3, 5 and 10 MU were recorded. The sensitometric curves were obtained by irradiating the EC-L cassette screen film combination to a series of exposures. The cassette was placed in the path of the beam at the central axis and in three positions off the central axis. First, a full sensitometric curve was created in order to determine the linear range of the curve. Afterwards, short sensitometric curves in the linear range were measured. On each position along the beam axis the amount of radiation deposited in the cassette screen film combination is different due to different attenuation at the variable thickness of the flattening filter. This was taken into account by measurements of the dose ratio between the central axis and each position off axis. The change of the beam quality was evaluated by the ratio of the exposure to the film, expressed as Log (MU), at the off-axis position and at the central axis for an optical density of 1.8. **Results** -For the stability check of the linear accelerators, the deviation between ten repetitions for all measured MUs was less than 0.5% and therefore it can be assumed that the linear accelerators is stable at low MUs. The shifts of the sensitometric curves were clearly shown as a function of the distance from the central axis. As the distance from the central axis increases, the shift of the sensitometric curve is greater. The softening of the beam is evaluated by the ratio of the exposure units of the off axis curve and the central axis curve at optical density 1.8. As the distance from the central axis increases the exposure units ratio decreased and reached a maximum change of 4.4%. **Conclusion** - The sensitometric curve method is more sensitive to spectral changes than the $TPR_{20,10}$ method and it follow the trend of the $TPR_{20,10}$.

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SENSITIVITY OF FILM MEASURED OFF-AXIS RATIOS TO FILM CALIBRATION CURVE USING RADIOCHROMIC FILM

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OAR of conical beams generated with a SRS-dedicated linac were measured with EBT2 film and stereotactic diode. The sensitivity of the FWHM and penumbras 80-20% and 90-10% with respect to the characteristics of the film calibration curve fit was investigated. In all the cases, penumbras resulted to be more sensitive than FWHM. However, these differences were, in general, smaller than the differences found between EBT2 reference values and the stereotactic diode measurements. The larger variation in OAR parameters was found to depend on whether the fit intersected or not the origin. A 1D gamma-index analysis showed this difference can be important in all measured conical beams.

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SURFACE AND PERIPHERAL DOSE MEASUREMENTS WITH WEDGE FILTERS FOR PHOTON BEAMS

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The wedge fields are often used in various clinical situations to obtain homogeneous dose distribution around target volume. The aim of this study is to measure and compare surface and peripheral dose in Enhanced dynamic wedge (EDW) and upper Physical wedge (PW) using Thermoluminescent dosimeter (TLD) and Gafchromic EBT film. To measure surface and peripheral doses, measurements were performed using 6 and 18 MV X-rays from Linac. Following exposure parameters were applied: Source to surface distance (SSD) 100 cm, 5'5cm², 10'10cm² and 20'20cm² field sizes for 15° and 30° wedge angles and 5'5cm², 10'10cm² and 15'15 cm² for 60° wedge angle. All measurements were carried out and repeated by Advanced Markus Plane-Parallel chamber (PTW-Freiburg). Measurement of peripheral doses was performed at the distance of 5cm and 10cm outside the fields. Surface doses on the central axis under dynamic wedge are more than that of the physical wedge and open field using the same exposure condition. The maximum surface dose produced by the physical wedge is nearly 24.5cGy and by the dynamic wedge is around 27cGy for 30° wedge in 20_20cm² field size. Peripheral doses of dynamic and upper wedges are similar. Surface and peripheral doses for 18MV beams are less than that for 6MV. GafChromic EBT film provides precise measurements for surface dose in the high energy photons. Agreement between film and plane-parallel chamber measurements was found to be within ±1% for doses in depth of maximum dose. There was 4% overestimate on the surface doses when compared with the plane-parallel chamber measurements for all field sizes in photon beams. The two wedge systems produce significantly different surface and peripheral doses that should be considered when choosing a wedge system for clinical use.

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MAGNETIC NANOPARTICLES CONTRAST AGENTS IN MRI

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Recent technical advances have enabled the design and synthesis of many types of nanoparticles with a wide range of applications in biomedicine, such as target drug delivery, hyperthermia, and molecular imaging. In Magnetic Resonance Imaging (MRI) magnetic nanoparticles (MNP) and in particular superparamagnetic particles (SPM) based on iron oxides have been used as effective contrast agents (CA) that enhance relaxation processes. The synthesis processes must produce monodisperse population of particles of predictable and reproducible size and physiochemical composition. The particle size and size distribution play critical role in defining the MNP ability to reduce relaxation times. The chemical composition and physical structure (e.g. the surface chemistry) will define the magnetization of the particle and therefore the strength of the interaction between the MNP and surrounding spins. We have concentrated in using MNP as both MRI-CA and Hyperthermia Agent. For this multifunctional application the particles have to be stable and soluble in water at natural pH and physiological salinity, non-toxic, and with targeting ability. We use polymer coating to prevent the formation of large aggregates and also to aid in controlling the contrast ability. The latter is effectively done through varying the distance of closest approach of the diffusing spin from the magnetized core by varying the thickness of the coating layer. The hyperthermia ability is controlled by adding various elements such as Gd, Mn, and Zn to iron oxide with optimized concentrations. We present results for MNP synthesized using chemical co-precipitation with both longitudinal and transverse (T1 and T2) relaxation times quantified at different magnetic fields of 1.5, 3, and 7T. Experimental data will be compared to theoretical models of relaxation and the role of different parameters such as diffusion coefficient, magnetic moment, coating layer, and particle size will be fully explained. We will also present computer simulated (Monte Carlo technique) relaxation data.

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INFLUENCE OF BRAIN ROI LOCATION FOR ADC MAPS CALCULATION FOR REFERENCE VALUES TO BE USED IN THE IN VIVO CHARACTERIZATION OF BRAIN TUMORS MRI IMAGES

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In diffusion-weighted magnetic resonance imaging (DWI), the contrast is determined by the random microscopic motion of water protons. In general, pathologic processes, such as neoplastic cell changes, tend to alter the magnitude of structural organization by destruction or reorganization of membranous elements or by a change in cellularity. These changes will also have an impact on proton mobility, which can be followed up by DWI. From DWI is obtained the ADC (Apparent Diffusion Coefficient) map, which is a representation of the magnitude of water diffusion at the points of a given region of interest (ROI). The purpose of this study was to assess the variation of ADC values in different brain ROIs of normal subjects, using a computer tool previously developed. The aim of this assessment was to verify whether ADC values could be used to differentiate between normal subjects and patients with multiform glioblastoma (a high-grade glioma) and meningioma. ADC maps were calculated for 10 controls, 10 patients with glioblastoma and 10 with meningioma. For controls, mean ADC values were calculated for 10 different ROIs, located in the same places where the tumors were present in the patients. These values were then averaged over ROIs and over subjects, giving a mean ADC value of $(8.65_{-0.98}) \times 10^{-4}$ mm²/s. The mean ADC values found for brain tumors were $(5.03_{-0.67}) \times 10^{-4}$ mm²/s for meningioma and $(2.83_{-0.45}) \times 10^{-4}$ mm²/s for glioblastoma. We concluded that the ROIs used for computing brain ADC values for controls were not essential for the estimation of normal reference ADC values to be used in the differentiation between these types of tumors and healthy brain tissue.

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HIPPOCAMPAL ASYMMETRY IN SUBJECTS: A STRUCTURAL CONNECTIVITY STUDY USING DTI

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Magnetic Resonance with Diffusion tensor imaging(DTI) can provide a quantitative analysis of the magnitude and directionality of water molecules in a three-dimensional space reflecting the micro-structure of brain tissues. Bundles of fiber tracts in white matter provoke an anisotropic water diffusion allowing the tracing of nerve fibers using DTI what can be used for the calculation of a connectivity map and brain network analysis. The brain is considered a complex network with evidences of small-world attributes. The vulnerability indicates the importance of an individual node to network efficiency, thus is a very relevant parameter in the study of focal diseases. The aim of this work is to estimate the vulnerability of several brain structures in healthy individuals from Magnetic Resonance data in order to define a control pattern. We evaluated 30 controls (18-65 years old), right-handed, without symptoms or history of neurological diseases in a Philips Achieva 3T machine with standard MRI protocol and a whole brain high resolution DTI sequence. Six brain structures were chosen for ROI analysis due to their importance in temporal lobe epilepsy: hippocampus(H), temporal pole superior(TPS), medial pole temporal(MPT), superior temporal gyrus(STG), middle temporal gyrus(MTG), and inferior temporal gyrus(ITG). The tractography and the individual connectivity matrix were calculated from DTI data and registrated with 3D-T1 images. The vulnerability of each subject was estimate from the local and global efficiency definitions. A lateralization index (LI) was used for asymmetry quantification of brain hemispheres. The mean vulnerability for each left (right) region was: H 3,3%(2,7%), STG 5,9%(5,8%), TPS 2,7%(2,6%), MTG 1,7%(1,6%), MPT 0,9%(0,9%), ITG 2,3%(2,3%). The highest LI value was 11,3% in H. This finding suggests a normal asymmetry connection pattern probably due to hemispherical dominance what is relevant for analysis of temporal lobe epilepsy patient connectivity.

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INTERNATIONAL TRACEABILITY FOR RADIATION DOSIMETRY

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Ever since the International Commission on Radiation Units and Measurements (ICRU) encouraged the International Committee for Weights and Measures (CIPM) to establish reference standards for radiation dosimetry in 1958, the International Bureau of Weights and Measures (BIPM) – also founded by the Metre Convention in 1875 - has been running international comparisons to enable each Member State to compare their dosimetry, verifying that their results are compatible and traceable to the International System of Units (SI). The CIPM's Consultative Committee for Ionizing Radiation (CCRI) meets biennially to ensure that the comparisons are consistent with this aim and to make recommendations about collaborative projects and particularly the work of the Ionizing Radiation Department at the BIPM. All relevant international bodies are either Members or Observers of the CCRI, which has three Sections concentrating on x-ray, gamma-ray and electron dosimetry, radionuclide activity and dosimetry, and neutron fluence and dosimetry, respectively. The BIPM comparisons are held on an ongoing basis so that any national laboratory with primary standards can take part at any time to suit their own schedule, there being about 22 such laboratories. National laboratories holding secondary standards (about 30) can have their national standards characterized by the BIPM, as indeed can the IAEA, to facilitate the dissemination of dosimetry or activity measurements with appropriately small uncertainties. Most recently, the BIPM has established mammography dosimetry facilities for comparisons and calibrations; a travelling instrument for the measurement on-site of short-lived radionuclides relative to the International Reference System (SIR) for gamma-emitting radionuclides; and a travelling calorimetry for accelerator dosimetry as used in radiotherapy. In addition, a brachytherapy dosimetry transfer system is presently being trialed. However, the BIPM, having limited finances, closed its neutron facilities in 1996 as there are only six national laboratories with neutron facilities, which could conduct appropriate comparisons amongst themselves.

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INITIAL EXPERIENCE OF PATIENT SPECIFIC QUALITY ASSURANCE FOR RAPIDARC USING ARC CHECK AT HOPE AT GUATEMALA

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RapidArc is a radiotherapy modality that optimizes more parameters than intensity modulated radiotherapy (IMRT), therefore it is necessary to have a higher level of quality control of equipment and specific treatment plans for patients. The aim of this paper is to report the quality control made prior to treatment initiation at the first radiation therapy center with RapidArc in Latin America. Measurements were taken with a 4D phantom ArcCheck and MapCheck software together with the IMRT phantom from IBA. The treatment plans were generated on Varian's RapidArc optimizer, and delivered with a Clinac 2300CD linear accelerator, also from Varian. The readings on the detector array are compared with the doses reconstructed to 1 mm grid on ArcCheck geometry based on the exported dose from the Eclipse. Basic tests were carried out: linearity, consistency and ghost effect. And in the IMRT phantom the dose delivered was compared to that predicted by Eclipse with an ionization chamber PTW Pinpoint. The reported treatments are brain (Glioblastoma) and prostate with seminal vesicles and pelvic lymph nodes, which were compared using the Gamma index criteria and DTA with 5% dose threshold. The gamma evaluation result is 97.9% for prostate and 98.9% for the brain, by adopting the criterion of 3% and 3mm. Similarly, the DTA 3mm evaluation was 95.0% and 97.3% respectively. And the ionization chamber readings had a difference of 1.1% and 0.5% for prostate and cranial respectively than the results predicted by Eclipse. The evaluations show the great overlap between the predicted doses with those obtained in the phantom, so that assessments of treatment they give us great certainty. Although the results are positive, it is advisable to restrict the quality assurance evaluations of treatment plans, rigorous methods should be applied to the daily quality control for accelerator parameters for reliability

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COMPARISON OF RAPIDARC AND INTENSITY MODULATED RADIOTHERAPY TREATMENT PLANS

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The purpose of this study is to examine the plan quality and monitor unit with sliding window Intensity Modulated Radiotherapy (IMRT) and RapidArc (RA) treatment plans using American Association Physicists in Medicine TG119 test suites. The structure set includes multi-target (superior, inferior, center), prostate, head and neck and C-shape. Plans were performed with Eclipse planning system with the plan goals specified in TG119. The plan results for multitarget shows that the D_{99} is greater than the plan goal for all the targets. The D_{10} is less than the plan goal for superior and inferior targets in both IMRT and RA plans. The plan results for prostate shows that D_{95} is greater than the plan goal for both IMRT and RA plans. The D_5 is less than the plan goal for IMRT plan and almost equal to plan goal for RA plan. The D_{30} is less than the plan goal for bladder and rectum in both the plans. The plan results for head and neck shows that the D_{99} and D_{90} were greater than the plan goal for Planning Target Volume (PTV). The spinal cord and parotid doses were less than the plan goal in both the plans. The plan results for C-shape shows that the D_{95} was greater than the plan goal and D_{10} was less than the plan goal for PTV. The dose to center core was less than the plan goal in both IMRT and RA plans. Both the IMRT and RA plans were met the plan goal for all the target and normal structures. RapidArc optimization and treatment planning requires more time than the IMRT plan. The monitor unit calculated by the RapidArc plan is less compared to IMRT plan, which reduces the treatment error caused by patient motion during treatment and integral dose.

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DEVELOPMENT OF THE DEDICATED PHANTOM SYSTEM WITH ROLLED RADIOCHROMIC FILMS FOR VMAT QA

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To achieve easy and practical quality assurance (QA) for volumetric modulated arc therapy (VMAT), the new verification system using wrapped radiochromic films (Gafchromic EBT2, ISP, NJ, USA) around cylindrical surface and ionization chamber was developed; the phantom allows to insert the rolled and the square films to measure the delivered doses along the arc trajectory and the axial planes, respectively. The central cylindrical body covered with films was inserted into another enveloping acrylic body of 5 cm thickness. The phantom structure can secure the enough effective measurement region providing the stable measurement and set-up condition. The analysis software geared toward the verification for arc therapy facilitates dose comparison between the delivered doses to film in rolled-out plane with the reconstructed dose matrix of calculated doses in ERGO++ (version 1.7.6, Elekta Ltd., Crawley, UK). The amount of dose disagreement can be distinguished in polar coordinates by the gamma index (3 mm/3%) differentiating between over- and under-estimated doses. The film characteristics of flexibility, high spatial resolution, and dose integration led to sophisticated dose verification at each corresponding position. The verification system guided to notice what gantry angle principally causes the significant dose error in cylindrical coordinates. More significant dose error around critical organs was also estimated in patient anatomical geometry. As the modulated fields (dose calculation using the grid size of 2 mm and angular increment of 5°) of VMAT (Elekta Synergy, Elekta Ltd., Crawley, UK) was delivered for prostate cancer, the specific positions not satisfying the gamma criteria were detected using our developed VMAT QA system. Rolled-up and -out films on cylindrical phantom with the elaborate dose analysis enables adapted QA for VMAT to detect critical dose error by the various dynamic factors.

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FUTURE TRENDS OF EPR IN MEDICAL APPLICATIONS

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Electron Paramagnetic Resonance (EPR), also known as Electron Spin Resonance (ESR) or Electron Magnetic Resonance (EMR) is a technique for measuring unpaired electrons whose basis is similar in nature to that of Magnetic Resonance Imaging (MRI), but usually operates at a higher frequency range, typically in the microwave region of the electromagnetic spectra (1 GHz to 9 GHz). ESR was discovered in Russia in 1945 and since then it is evolving in many areas of science. Medical applications of this spectroscopy include: free radical detection; oximetry; follow up of healing processes, as in bone and other tissues; detection and quantification of paramagnetic transition ions such as copper, iron and manganese in different tissues; radiation dosimetry, both in vivo and ex vivo using biological tissues, and with dosimeters that can be prepared for this purpose or can be fortuitous materials found in a radiological accident scene. The possibility of performing in vivo measurements presents a great challenge due to the characteristics of the interaction of the microwaves with biological tissues. A review of examples and future trends in each of these areas will be given with special emphasis in dosimetry of ionizing radiation.

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LONG-LASTING PHOSPHORESCENCE SCINTILLATORS FOR USE IN RADIOLOGICAL PROTECTION

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This work reports the development and characterization of a novel class of long-lasting phosphors, named cadmium silicate (CdSiO_3). The long-lasting phosphorescence (LLP) phenomenon, i.e., the persistent emission of light by a material after it has been exposed to ultraviolet light or ionizing radiation, is a useful property for applications in X-ray imaging detectors (image plate) and system for preventive detection of radiation. The material was produced by solid state reaction and characterized by X-ray diffraction (XRD), X-ray absorption (XAS), X-ray excited optical luminescence (XEOL), thermal stimulated luminescence (TSL), optical absorption (OA) and time-resolved photoluminescence (PL). This set of techniques allowed the determination of the crystalline structure, valence of the dopands, emission spectra, light output, lifetime and the possible role of the dopands (transition metals and rare earth ions) in the luminescence process. CdSiO_3 presents monoclinic crystalline structure, belonging to the space group P21/c, which is not modified due to the presence of dopands in a concentration up to 2mol%. The dopands tend to occupy the Cd^{2+} site, with valences of 2+ or 3+. The change of valence gives rise to different kind of defects that affect the possible luminescence channels and, consequently, the emission lifetime. CdSiO_3 presents intrinsic blue emission at 480 nm and a lower intense red emission at 590 nm, with LLP of about 3 h in the visible region. For the doped and co-doped samples, the relative intensity of the bands and LLP lifetime are changed, so it is possible to tailor this material at specific color and lifetimes, according to the application desired. The colors obtained were blue, green, pink, red and white, with lifetimes varying from minutes to hours. The use of this material as coating of ceramic tiles for use in radiodiagnostic rooms are being currently tested for large scale production in a ceramic industry of Sergipe/Brazil. Acknowledgements: CAPES, CNPq, FAPITEC-SE

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RADIATION DETECTORS BASED ON SELF-SUSTAINABLE FILMS OF SCINTILLATOR AND POLYMER

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In the present work, free-standing composite films made of scintillator materials dispersed in an optically transparent polymer matrix were prepared by casting method for the first time and characterized using radioluminescence (RL) and photoluminescence (PL) techniques. The scintillators used were $\text{Bi}_4\text{Ge}_3\text{O}_{12}$ and CdWO_4 (BGO and CWO, respectively), which present high efficiency for β particles, X- and γ -rays. Their characteristic emissions with maximums in the blue region, as well as radiation resistances, make them suitable materials for application as radiation detectors in high energy physics and medical imaging. BGO powders were synthesized via SHS method whereas CWO was produced via solid state reaction. Composite films were prepared by casting the scintillators and polystyrene (PS) in chloroform under continuous magnetic stirring. Samples with different weight percent (wt%) were prepared by fixing the mass of PS used and varying the mass of the scintillator. RL (using β particles and X-rays as excitation sources) and PL measurements were performed at room temperature and in all cases the intrinsic luminescence was present, peaking at 510 nm and 500 nm for BGO and CWO, respectively. It was observed that the higher the wt%, the greater the light yield. The efficiency of the CWO films was twice higher than that of the BGO single crystal used as reference, even with some attenuation of the radiation by the PS. These results show that radiation detectors with large areas can be produced at low costs, which can be an attractive for the production of signaling and security devices. Acknowledgements: CAPES, CNPq, FAPITEC-SE

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NANOPARTICLE INCREASES DOSIMETRY SENSITIVITY OF MAGIC-*f* TO RADIATION THERAPY

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Purposes: Evaluate dosimetric sensitivity enhancement of MAGIC-*f* gel with incorporated silver nanoparticles. Material and Methods: Silver nanoparticles (AgNP) with 150nm average size were synthesized in polyvinyl-alcohol solution and incorporated to MAGIC-*f* gel by rehydrating process. Silver mass-fraction of 0.5% was considered. Control samples with non-modified gel were also manufactured. Gel was stored in 5mL glass tubes. Dosimetric sensitivity of gel with and without nanoparticles was evaluated to 250kV orthovoltage beam. Field size of 10x10cm², source-to-surface distance of 40cm and 10cm of acrylic below the gel samples were used. Doses in a range between 0-10Gy were delivered to the gel samples. MRI relaxometry was used to perform dosimetry in a 3T clinical scanner relating the transversal relaxation rate (R2) of gel to doses. Time-to-echo of 20ms, number of echoes equal 5, time-to-repetition of 3000 and pixel size of 0.5x0.5mm² were used. Results and discussions: The signal of non-irradiated samples with and without AgNP were $(0.41 \pm 0.02)s^{-1}$ and $(0.40 \pm 0.01)s^{-1}$ respectively, showing chemical and magnetic passivity of the AgNPs before irradiation. A linear relation was observed between R2 and doses to both gel groups (with and without AgNP), revealing no chemical interferences of AgNP in polymer chains formed after radiation induced hydrolysis. However, gel sensitivity was increased in 42% when 0.5% mass-fraction of silver nanoparticles is embedded. Sensitivity enhancement indicates that the number of long polymer chains is higher in gel containing AgNP than in normal gel to same doses delivered. Conclusions: Silver nanoparticles increase dosimetry sensitivity of MAGIC-*f* polymer gel due to raise of low energy electrons that are locally absorbed enlarging polymer chains.

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ULTRASOUND IMAGING FOR DIAGNOSIS AND GUIDANCE OF TREATMENT EMPHASIZING BREAST CANCER

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Traditional, new and investigational ultrasound imaging modes and processing will be mentioned briefly to aid selection and use of systems. Included will be B mode and harmonic imaging, speckle reduction, compound imaging, 3D imaging, flow imaging and quantification, contrast imaging, elasticity imaging and interventional guidance with fusion to other modalities. Illustrations will be given of automated 3D ultrasound, with and without registration to mammography, 3D mammography, MRI, and/or optical imaging, for semi-automation for screening, diagnosis and treatment assessment. Arguments will be given as to why good, coregistered ultrasound screening should be able to improve the sensitivity of mammographic screening while mitigating the usual increase in callbacks, why ultrasonic CT should reduce callbacks from MRI screening, and why coregistered 3D mammography, ultrasound and optical imaging might provide similar screening effectiveness as the combination of mammography and MRI.

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A COMPARATIVE STUDY USING BOTH CODED EXCITATION AND CONVENTIONAL PULSES IN THE EVALUATION OF SNR SENSITIVITY AND AXIAL RESOLUTION IN ULTRASONIC A-MODE SCAN

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In this work we have made a comparative study of backscattering of ultrasound conventional and chirp codified pulses. We simulate the interaction of these two different pulses with a computational phantom constructed with variable amplitude and phase scatterers following a Gamma distribution. We use the echo signal-to-noise ratio (eSNR) metric of the backscattered signals from both coded excitation pulse (CEP) and conventional pulse (CP) for various scenarios, as well as the evaluation of the axial resolution (AR) of the system using both pulses. The computational phantoms were created with regular and variable scatterers spacing with amplitude and phase variation for three transducers: 2.25 MHz, 5.0 MHz and 7.5 MHz center frequencies. The duration of the excitation CEP was 18 μ s with chirp frequency bandwidth varying from a multiplying factor of 3.7, 2.0 and 1.2 times the transducer bandwidth, respectively. The pulse compression was performed using matched (MF) and mismatched (MMF) filters. The results for different transducers and phantoms are in accordance to the literature and have given an improvement of the SNR for coded pulse above 20 dB (in average) over conventional pulse excitation. In addition, the axial resolution for both codified and conventional pulses are in the same range. For a 2.25 MHz transducer, ARs were 1.33 λ , 1.18 λ and 1.38 λ for CP, CEP/MF and CEP/MMF filters. Similarly, ARs for 5 MHz for all above three conditions were 1.34 λ , 1.14 λ and 1.29 λ , and for the 7.5MHz transducer 1.31 λ , 1.23 λ and 1.38 λ . Our results have confirmed the increase in gain and very close agreement of the axial resolution. Further research and development should be carried out in order to use the potentialities of CEP techniques in medical ultrasound imaging equipment.

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SIMILARITY METRICS COMPARISON IN NONRIGID REGISTRATION IN CONTRAST ULTRASOUND IMAGES

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Contrast enhanced echocardiography is a noninvasive and low cost method for cardiovascular diagnosis, as the myocardial perfusion evaluation. The injection of a nontoxic contrast in the patient blood enhances the image contrast, resolution and makes it also possible to trace the blood tissue, unlike usual ultrasound images. To evaluate this perfusion, which is related to image intensity variation, a sequence of frames must be aligned to assure points correspondence over the images sequence. The registration allows also evaluating a displacement field, which conveys information about the heart mechanics. In this paper six similarity metrics for echocardiography images non rigid registration using block matching algorithm approach has been studied. The similarity metric provides a quantitative way to measure how much registering images regions are similar and its choice has shown fundamental influences in registration results. It becomes, therefore, an important issue to verify how it responds to intensity variation, as uniform or non uniform bright fluctuations, contrast changing, rotations and some block matching parameter choice, as searching window and region of searching size as well maximum image grey level. The metrics chosen for evaluation are: Normalize Cross Correlation (NCC), Mutual Information (MI), Difference entropy (DE), Difference Variance (DV), Energy (E) and Sum of Square Differences (SSD). Results show that MI and NCC metrics are almost invariant to brightness variations, however, the MI is more dependent on number of bins in histogram than the other metrics. All metric fail when a rotation greater ten 10 degrees is present due to block matching algorithm. MI and NCC showed more robustness to contrast variations. Although MI has shown good performance in evaluations, it has a higher dependence on number of bins in histogram. This study indicates MI and NCC as best similarity metric for nonrigid registration of contrast enhanced heart ultrasound images.

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ANALYSIS OF DIFFERENT FLUIDS BY ULTRASOUND RADIATION FORCE

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Acoustic radiation force has been used to examine the physical properties of materials in several areas. This force is used as a piston to promote non-contact mechanical perturbation to the medium. Vibroacoustography, for example, is a technique that uses two focused ultrasound beams, with slightly different frequencies, to create a low-frequency modulated force over a small region of interest. The sound emitted by this vibrating region is detected by a hydrophone. In this work, we present a new technique based on this kind of non-contact and modulated ultrasound radiation force to vibrate a magnetic target. The amplitude of vibration of the target is measured using a magnetic transducer. This technique was named as vibromagnetoacoustography (VMAG) by Carneiro (2009). The aim of this work is to evaluate the viscoelastic properties of fluids. Two confocal piezoelectric elements, with focus at 7 cm, were used to create concentric ultrasound beams. The interaction of these ultrasonic waves creates a modulated acoustic force on the target. This modulated force has a high frequency Δf ($f_1 + f_2$) component that promotes a static displacement to the target and a low frequency Δf ($f_1 - f_2$) component that vibrates the target. The low frequency used on this experiment was between 0 and 1000 Hz. The magnetic transducer was built using a magnetoresistive sensor with resolution of 10 nT. The modulated acoustic radiation force was applied over a magnetic sphere target, of NdFeB with a radius of 1.36 mm, immersed in the fluid. This procedure allow to measure static and dynamic displacements of the magnetic target (ball) simultaneously. The apparatus was evaluated through measurements in water and oil. The results were within the expected and we can identify with this system the different fluids as well the viscoelastic parameters which were estimated fitting the response of the magnetic transducer using a special function that describes the vibration of a spherical target immersed.

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VIRTUAL COLLABORATIVE ENVIRONMENT FOR NUCLEAR MEDICINE TRAINING: A PILOT STUDY

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FAMED - PUCRS, FAFIS – PUCRS and FACIN - PUCRS

Purpose: This article presents the validation of a virtual collaborative environment design for personnel training in nuclear medicine. **Method and Materials:** The development started with the identification of technological premises and organizational constraints in nuclear medicine services. The prototype was developed using Moodle platform. In order to improve Moodle basic configuration, a set of interaction functionalities to support the social constructivist methodological approach was developed. A pilot study was conducted with a sample of fifteen volunteers, all nuclear medicine professionals. Quantitative and qualitative data analysis obtained from a semi-structured questionnaire was conducted. **Results:** The collaborative environment was validated and considered relevant for personnel training by a community of professionals engaged in nuclear medicine. The database materials, available in the virtual environment can be increased continuously according to the virtual community professional interests. Suggestions for improvements and new features were proposed and will be included in further version. The prototype website is available online at <http://marfim.lad.pucrs.br:58080/moodle/>. **Conclusion:** The results showed that the virtual collaborative environment created into Moodle platform, based on social constructivist methodology, has pedagogical potential. We believe that the learning process improves when professionals interact and discuss about their experiences, using supporting materials and communication tools in a secure and access restricted environment. A training program to improve moderators actions is necessary, because the motivation skills needed in this kind of environment are different from those used on face-to-face classes in traditional teaching. More studies are needed in order to analyze the effectiveness of this environment in continuing education.

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MEDICAL PHYSICS EDUCATION IN SERGIPE: HISTORY, CHALLENGES AND PERSPECTIVES

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The undergraduate course in medical physics at Federal University of Sergipe (UFS) was created in 2000, as a bachelor degree, and the first class started in 2001. At the first years, the main challenge was to attract students that knew what a medical physics professional is. Nowadays, after 10 years of permanent divulgation activities, this is not a problem anymore, although we still have _misplaced_ students for other reasons. Since 2004, 72 students were graduated, which represents 36% of the students that initiated the course. This number is far from ideal, although it is a lot better than conventional physics bachelor's degrees (at UFS, only 12% of entering students finish the course). To improve it, it is necessary to motivate the students during the course and the challenge is to meet student_s expectation with course possibilities. The course is design to be a physics course with disciplines from other branch of knowledge, allowing a multidisciplinary professional actuation. However, the non-physics part of the course is small, limited for the course length and the necessity of a solid foundation in physics. Therefore, the medical physics course is an academic course that needs to be associated to on-the-job trainings or post-graduate studies. Other important challenge at the moment is to increase the job space for the medical physicists. For that, it is necessary to convince the health professional of the importance of medical physics activities for quality improvement. Even though there are challenges ahead, the medical physics area in Sergipe changed greatly in the last 10 years because of the UFS course. The numbers of medical physicists working increased from two to more than twenty, including seven university professors. So, the medical physics course is continuously changing local situation and increasing the number of students interested in physics and working with it.

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DEVELOPMENT OF A RESIDENCY PROGRAM IN RADIATION ONCOLOGY PHYSICS: AN INVERSE PLANNING APPROACH

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Over the last two decades, there has been a concerted effort in North America to organize medical physicists' clinical training programs along more structured and formal lines. This effort has been recognized by the accreditation of around three dozen training programs by the Commission on Accreditation of Medical Physics Education Programs (CAMPEP). Although accreditation has led to more standardized and high quality clinical training the development of rounded professionals who can function at a high level in a multidisciplinary environment has not necessarily been recognized as a priority of a radiation oncology physics residency. In this report we identify, and discuss the implementation of, the essential components of a radiation oncology physics residency designed to produce professional clinical physicists. Our approach is that of inverse planning, by now familiar to all radiation oncology physicists, in which objectives and constraints are identified prior to the design of the program. Inverse planning objectives go beyond those traditionally associated with residencies, i.e. clinical physics knowledge and critical clinical skills to encompass those other attributes essential for success in a modern radiation therapy clinic. These additional attributes include management skills and leadership, ethical behavior and professionalism, teaching and communication skills, and knowledge of error management techniques and patient safety. The constraints in our optimization exercise are associated with the limited duration of a residency and the training resources available. Without compromising the knowledge and skills needed for clinical tasks, we have successfully applied the model to the Tom Baker Cancer Centre's two year residency program. The program requires 3800 hours of overall commitment from the trainee, of which 6-10% is spent in learning and practicing non-technical "soft skills".

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PATIENT RESPONSES IN A PHASE 1 CLINICAL TRIAL OF TARGETED ALPHA THERAPY FOR METASTATIC MELANOMA

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Targeted alpha therapy is based on the cytotoxic properties of the high linear energy transfer (~ 100 keV/μm) and low range (20-80 μm) of alpha particles. Monoclonal antibodies are labeled with an alpha emitting radioisotope to form the alpha-immunoconjugate. Our phase 1 melanoma trial with intravenous injections of up to 25 mCi of the ²¹³Bi-cDTPA-9.2.27 demonstrated that alpha therapy could regress solid tumours without any adverse events¹. The effect of key parameters such as melanoma inhibitory activity protein, age, sex, injected dose, lactate dehydrogenase, disease stage and treatment dose were examined. Thirty nine patients with stage IV melanoma or in transit metastasis were treated with activities of 55-1035 MBq. No adverse events of any type or level were observed, so the maximum tolerance dose was not achieved. An objective partial response rate of 10% was observed for partial response, with 40% stable disease for 8 weeks and a median survival of 8.9 months. Survival analysis showed MIA, disease stage, LDH and treatment effect to be significant prognostic indicators for survival. The lack of dose response is indicative of the importance of the tumour capillary permeability, without which alpha therapy cannot function². References: (1) Raja C, Graham P, Rizvi SMA, Song E, Goldsmith H, Thompson J, Bosserhoff A, Morgenstern A, Apostolidis C, Kearsley JH, Reisfeld R, Allen BJ. Interim analysis of toxicity and response in Phase 1 trial of systemic targeted alpha therapy for metastatic melanoma. *Cancer Biology & Therapy*. 2007 6:6, 846-52; (2) Allen BJ, Raja C, Rizvi SMA, Song EY, Graham P. Tumour anti-vascular alpha therapy: a mechanism for the regression of solid tumours in metastatic cancer. *Phys. Med. Biol.* 52 (2007) L15-L19.

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CURRENT CHALLENGES IN PROTON AND LIGHT ION THERAPY

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The interest in proton therapy and Carbon ion therapy has increased significantly over the last few years. The rationale for using these beams instead of photon beams is the feasibility of maintaining the target dose while reducing the total dose to critical structures. Alternatively, these modalities allow delivering higher doses to the tumor, while maintaining the total dose to critical structures. Proton and light ion therapy are being used on more and more patients. In order to fully utilize heavy charged particles in radiation therapy one needs to understand not only the benefits of precise dose painting but also the challenges that come with increasing dose delivery accuracy. In addition, the underlying biology differs from conventional therapy making dose no longer the only parameter to be considered in treatment planning. This presentation will give a short introduction into proton and light ion radiation therapy. The basic physics and delivery modes will be introduced. The clinical rationale for using heavy charged particles will be outlined based on a few clinical examples. Next, we will discuss the uncertainties and limitations of precisely shaped dose distributions. The finite range of heavy charged particle beams in tissue affects the consequences of uncertainties in dose calculation and delivery. We will demonstrate the clinical significance of beam range uncertainties for static as well as moving targets. Current research projects to reduce uncertainties and to understand their magnitude will be summarized. Heavy charged particle therapy requires radiobiological modeling because the dose-response relationship differs from traditional photon therapy. We will present how the biological effectiveness depends on treatment modality, beam configuration and dose and how this information is used in treatment planning.

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A BEAMLINE FOR MEDICAL IMAGING AND THERAPY AT SESAME SYNCHROTRON

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Whether for diagnosis or therapeutic purposes, X-rays have many applications in medicine. Synchrotron Radiation sources open new perspectives. This has already been the case for a number of years in molecular and cellular biology where the scope of absorption and diffraction work has been greatly extended. This could also be the case for medical imaging and radiotherapy where the characteristics of the beam (collimation, stability, flux) allow new approaches in the energy range of radiological X-rays. Such a source is built today in Jordan; known as SESAME synchrotron facility. The design of the SESAME light source is based on an electron storage ring with maximum energy of 2.5 GeV and a beam current of 400 mA. A beamline dedicated to medical imaging and therapy is proposed to be built at SESAME facility. This beamline will cover medical imaging (angiography, tomodensitometry, microtomography, X-ray microscopy) as well as radiotherapy. One of the most important factors for the design is the high photon flux required for the various medical applications. This can be achieved through the combination of the storage ring and a superconducting multipole wiggler. Special windows and apertures, mirrors and monochromators are also required to produce beam with high cross-sectional uniformity. This talk includes a description of the design features of the beamline as well as the insertion device. Some applications that can be performed at this beamline will be discussed. Experimental techniques proposed to be used in these applications will be also introduced in more detail and some recent results will be presented. Moreover the talk will show the efforts done by the Jordanian Association of the Medical Physics (JAMP) and the Jordanian medical physicists to support building-up this beamline. All the aforementioned points make clear that the medical Imaging and therapy beamline at SESAME synchrotron facility will be of great use to the medical sciences and will lead to valuable advances in medical imaging and therapy technologies. Furthermore the beamline will give a major boost to Jordanian's medical physics science community.

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ASSESSMENT OF NEW TECHNOLOGIES IN RADIATION MEDICINE: DIAGNOSTIC AND THERAPY

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In the United States and in many other countries, new technologies must be proven to be safe and effective before they can be marketed and used with patients. For pharmaceuticals, this process is very time-consuming and expensive, and involves clinical trials under carefully-controlled conditions. For a medical device, the process is more complicated because the device and its clinical applications may change over the course of a clinical trial. When this happens, data collected earlier in the clinical trial may be invalidated, necessitating the extension of the clinical trial beyond its anticipated completion date. Also, a clinical outcome is often difficult to measure for a medical device because, unlike pharmaceuticals, many factors other than the device influence the outcome. A better way to assess the safety and effectiveness of medical devices is needed. Among the devices needing an improved assessment method are new or improved technologies for medical imaging and radiation therapy. Recently the American Association of Physicists in Medicine joined forces with the Morgridge Institute for Research to form the Institute for the Assessment of Medical Devices (IAMD). The IAMD intends to use an engineering paradigm for assessment of new technologies principally in medical imaging and radiation therapy. In this paradigm, a new technology, or an improvement in an existing technology, is analyzed from a physics and engineering perspective to identify and validate the potential advantages and disadvantages of the new technology compared with those of the displaced technology. If the paradigm suggests and measurements verify that the advantages significantly outweigh the disadvantages, the technology is translated into the clinic under carefully-controlled conditions that are far less laborious than a randomized controlled clinical trial.

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WILL DR REPLACE CR?

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During the past two decades, digital imaging has supplanted screen-film (analog) radiography in many radiology departments. Today, manufacturers provide a variety of digital imaging solutions based on various detector and readout technologies. Both computed radiography (CR) and digital radiography (DR) output a digital x-ray image rather than traditional analog film. As of today the DR technology gives it a slight edge over CR. DR couples a flat-panel, thin-film transistor (TFT) array or a charge-coupled device (CCD) array with an x-ray detector to capture the image on a built-in phosphor or photoconductor plate. The captured image is then converted to digital signal and distributed to a workstation for subsequent reviewing and reporting. CR works in a similar manner, except that the capture plate is not built in. It is contained within a cassette that the operator removes and transports to a reader for image readout and distribution to a workstation. CR has been enjoying the advantage of lower cost and flexibility especially in portable imaging, however it still suffers labour-intensive workflow problem like the analog system. DR, though has a much higher start-up cost, enjoys an increase in productivity and better image management. The prediction a decade ago of the demise of CR has not come true, rather the distinctions between CR and DR are blurring. Some innovation include wireless, portable DR units. Meanwhile, some CR systems come with single-exposure, cassetteless dual-energy imaging through the use of automated plate handling, built-in metal filters, and software that speeds up image processing. The merging of these two technologies is compelling us to rethink our usage of terminology and also the need to think in terms of indirect digital capture versus direct digital. Advances in both DR and CR may ultimately render the debate whether DR will replace CR irrelevant.

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RADIOPROTECTION IN INTERVENTIONAL RADIOLOGY

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The problem of interventional radiology is that every day there are more specialists non-radiologists that use different technologies without having a suitable preparation and training in radiological protection. This determines an increase in the damages that are produced in the patient from erythema or radiodermatitis up to ulcers that need surgery. The situation is more risky even for the patient and the operator when there are used equipments that are not designed neither prepared for interventional radiology. There was done a systematic work of control of the doses received by the patient and the operators during different practices of interventional radiology in the Service of Radio Diagnosis of the Hospital Italiano of the City of Buenos Aires. The target of the work was to establish guidelines, reference levels and protocols of work for the radiological protection of the patient that they could be applied in other services, especially for those services led by specialists non-radiologists. The results were also used for designing the questionnaires of the program of re-certification. There was done the follow-up of different conditions of work in order to optimize the operative parameters minimizing the risks of radiation, reducing the doses of the patient and simultaneously that of the operators. The measurements of dose in the patient and the operators were done using ionization chambers and TLD. The Program of work is part of the joint program of Radiological Protection of the Patient coordinate by the Argentine Society of Radiology and the Argentine Society of Radioprotection.

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CHARACTERIZATION OF DIGITAL IMAGES GENERATED BY X-RADIATION EQUIPMENT USING DIFFERENT TRANSDUCERS: COMPUTED RADIOGRAPHY VS DIGITAL RADIOGRAPHY

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The aim of this work is to characterize the CR and DR systems in Porto Alegre city and surroundings areas. That way the data acquisition was performed in four different steps: (a) homogeneity and speed determination and heel effect, (b) image characterization, (c) signal-dose curve characterization and (d) effect of thickness and time regarding the IP exposure and the reading process on image resolution. Was presented a group of tests, easy to apply, for characterize a digital system. The DR system presented generally better image quality indexes than CR systems. All the evaluated systems presented differences on evaluated indexes.

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SIMULATED INTENSITY PROFILES FOR CYLINDRICAL OBJECTS IN MAGNIFICATION MAMMOGRAPHY

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We present a user-friendly Matlab simulation interface tool to predict intensity profiles for magnified x-ray images of weakly attenuating cylindrical objects including phase contrast effects. Based on a previous monoenergetic formalism, we now consider polyenergetic x-ray beams to study the effect of the spectral description on the predicted phase contrast effects. We have found that, for weakly attenuating objects with diameters $< \approx 1$ mm, detailed resolution in the spectrum description is not necessary. Simulations are compared with images of cylindrical objects obtained under conditions found in a commercial digital mammography system. The magnification images of phantom fibers show weak but visible edge enhancement due to phase contrast. The polyenergetic simulations give an improved description of the data with respect to the effective energy monoenergetic assumption.

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IMAGE PROCESSING TECHNIQUES TO EVALUATE MAMMOGRAPHY SCREENING QUALITY

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CONICET - FaMAF

Mammography imaging proved to be the best non invasive method for breast cancer diagnosis but it requires that irradiation parameters to be set within Protocols recommendations (minimal dose delivering). This work presents a whole investigation about mammography image formation by means of validated Monte Carlo simulations along with further image analysis and mathematical processing. Several image processing methods have been suitably introduced and investigated according to their capability for micro-calcification detection and quality evaluation. The obtained results suggest the feasibility of all the proposed methods. Furthermore, it was possible to characterize the reliability of each one and to infer the corresponding advantages/disadvantages even obtaining an image quality evaluation as a function of several parameters configurations.

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DOSIMETRIC QUANTITIES AND METHODS IN DIAGNOSTIC AND THERAPEUTIC NUCLEAR MEDICINE

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Methods for diagnostic internal dose calculations in nuclear medicine are well established and standardized, however, anthropomorphic models have undergone a significant change, with the introduction of image-based, realistic standardized models of human adults, children, and pregnant women, and models for some animal species as well. Methods for therapeutic dose calculations are still developing significantly, as more patient-specific methods are applied, and as observations about calculated dose quantities and observed biological effects are being challenged by new experimental findings. This talk will review the state of the art in diagnostic and therapeutic nuclear medicine, showing how measurements are made and applied to the best models to provide clinically relevant dosimetry information. Current challenges and theories of radiobiology will be discussed, to demonstrate what has been learned recently, and where future research will likely be focused.

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INFLUENCE OF MORPHOLOGY ON NUCLEAR MEDICINE DOSIMETRY BASED ON PATIENTS IMAGES

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In nuclear medicine, the absorbed doses currently available are based on standard mathematical models. These models have recently been replaced by the ICRP by computational phantoms, more detailed and realistic representations of human anatomy. However, both mathematical and computational models represent a fixed geometry. The objective of this work was to study the effect of patient morphology on absorbed doses using patient whole body CT images. Patient-based absorbed doses were calculated for 17 organs for 8 radiopharmaceuticals using the OEDIPE software associated with the Monte Carlo code MCNPX. The results were then compared to the standard doses based on reference mathematical and the new recently published reference computational phantoms. In a second step, mass corrections were applied to the reference computational and mathematical phantoms and the differences with patient-based absorbed doses were evaluated and analyzed according to the percentages of self-absorption. Dose differences among patients can reach a factor of 3.4 due to differences in organ masses and topology. The maximum discrepancies between patients and reference phantoms are of the order of 400% and 100% for the mathematical and computational phantom respectively due to the anatomical differences and to the approximations previously used for electrons. The application of mass correction reduces significantly the differences only for organs with a percentage of self-absorption higher than 80%. Finally, the ICRP biokinetic models for different radiopharmaceuticals were integrated into OEDIPE software to allow an automatic assessment of absorbed doses for patients with various morphologies. The assessment of a specific dosimetry was therefore performed in a reasonable time, taking into account the changes in morphology of nuclear medicine patients. The results give an estimate of the variation in absorbed dose that may occur when standard phantoms are used to perform patient dosimetry.

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PRIMARY AND SCATTERING CONTRIBUTIONS TO BETA SCALED DOSE POINT KERNELS BY MEANS OF MONTE CARLO SIMULATIONS

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Beta nuclides have proved to be appropriate for radioimmunotherapy. Dosimetric performance of each radionuclide has to be carefully investigated and characterized. One usual and practical dosimetric approach is the calculation of dose distribution about a unit point source of any radionuclide of interest, which is known as dose point kernel. Absorbed dose distribution results from the contribution of primary and scattering radiation. This work presents a method capable of performing dose distributions for nuclear medicine dosimetry by means of Monte Carlo methods. Dedicated subroutines have been developed in order to compute separately primary and scattering contributions to the total absorbed dose performing particles transport up to 1keV or least. The suitability of the calculation method has been preliminary tested with monoenergetic sources and further applied to the characterization of different beta-minus radionuclides of nuclear medicine interests for radioimmunotherapy.

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ESTIMATION OF HUMAN EFFECTIVE ABSORBED DOSE OF ⁶⁷GA- DTPA-GONADORELIN BASED ON BIODISTRIBUTION RAT DATA

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Background: In this investigation, we estimated the effective absorbed dose to human organs, following i.v. administration of ⁶⁷Ga-labeled gonadorelin -one of the gonadotropin releasing hormone (GnRH) agonists- using biodistribution data from injected normal rats. Methods: Four rats were sacrificed at exact time intervals (0.25, 0.5, 1, 2, 4, 24 and 48 hour post injections) and the percentage of injected dose per gram of each organ was measured by direct counting from rat data. The Medical Internal Radiation Dose (MIRD) formulation was applied to extrapolate from rat to human and to project the absorbed radiation dose for various organs in the human. Results: From rat data we estimate that a 185-MBq injection of ⁶⁷Ga-cDTPA-GnRH into the human might resulted in an estimated absorbed dose of 5.26 mGy to the whole body and the highest effective absorbed dose was in lung with 2.73 mSv and the organs received the next highest doses were the bladder wall 1.59 mSv, liver 0.80 mSv and Bone marrow 0.52 mSv. Conclusion: The biodistribution of ⁶⁷Ga-cDTPA-GnRH in rats showed high breast uptake and low muscle and blood uptake. These results suggest that it should be possible to perform early imaging of the breast anomalies and GnRH receptors indicating potential malignant lesions.

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DETERMINATION OF HUMAN ABSORBED DOSE OF ²⁰¹Tl(III)-DTPA-HlgG BASED ON BIODISTRIBUTION DATA IN RATS

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Introduction: We to estimate the absorbed dose in normal organs and inflamed tissue following i.v. administration of [²⁰¹Tl](III)-DTPA-HlgG by using biodistribution data in inflammation-bearing rats. **Method:** The percentages of injected dose per gram of each organ were calculated. The Medical Internal Radiation Dose (MIRD) formulation was applied to calculate the absorbed dose for various organs. **Result:** The inflamed tissue to blood activity concentration ratios were about 19 and 23.3 at 24 and 28 hours post injection, respectively. A 185-MBq injection of ²⁰¹Tl-DTPA-HlgG into the human body, might result in an estimated absorbed dose of 14.4 mGy for total body and the highest absorbed dose was in the kidney with 1195 (mGy) and the second to the Spleen were the liver, the lungs and adrenal which received 250.5(mGy), 58.64(mGy), 56.44(mGy) and 36.4(mGy), respectively. **Conclusion:** biodistribution of [²⁰¹Tl](III)-DTPA-HlgG demonstrated significant inflamed tissue uptake and low muscle and blood uptake, allowing for imaging of inflamed tissues. **Keywords:** MIRD, Internal Dosimetry, Absorbed Dose, ²⁰¹Tl, Biodistribution

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LASERS IN MEDICINE

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Since the discovery of the LASER, various applications were developed in health sciences. Probably the best known and widely used is the LASER surgery, which employs high power LASER beams. However there are other important applications in various medical specialties, which will be covered in this talk. We will focus on the use of low intensity laser beams applied to therapy, due to the anti-inflammatory and analgesic actions and to the promotion of tissue regeneration. The mechanisms involved in these processes are not completely known, and we'll present and discuss various hypotheses on the laser action, based on experimental and clinical studies.

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LIGHT DISTRIBUTION IN PHANTOMS

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One of difficulties in doing dosimetry of Low Level Laser Therapy (LLLT) is to know the light distribution inside the illuminated tissue. This knowledge can be obtained with the use of materials that simulate the optical properties of tissues. The aim of this work is to evaluate materials to build solid phantoms. The phantoms were made of resin or paraffin. Nanoparticles of alpha and gamma Al₂O₃ and glass microspheres were added to the transparent resin to generate scattering. The light distribution is altered with the variation of scatterer concentration in the resin samples and with the sample thickness in the paraffin ones. The samples were illuminated with an He-Ne laser (632.8 nm) and the transmitted light was detected with a CCD camera centered with the laser beam. The scattered light was measured with the same camera positioned perpendicularly to the laser beam. The images were analyzed with the software ImageJ. To analyze transmitted light we trace a profile perpendicular to the beam crossing the point of maximum intensity. This profile looks like a Gaussian curve. The maximum of transmitted intensity decreases and the width of the profile tend to increase when the concentration of scatterers or the thickness of the sample increase. The scattered light profile was analyzed through a line parallel to the beam traced in the image. In this profile the light intensity initially increases steeply, until reaching a maximum, and, far from the edges, it decreases exponentially. The maximum intensity of the perpendicularly scattered light and the corresponding position are dependent on scatterer concentration or on the quantity of paraffin between the laser and the point of observation. These simulators help to understand the light distribution, and can be used in clinical practice in order to optimize LLLT and PDT treatments.

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REPRODUCIBILITY OF RADIANT ENERGY MEASUREMENTS INSIDE LIGHT SCATTERING LIQUIDS

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The aim of this project is to evaluate the uncertainty associated with measurements performed with laser beams in scattering liquids with optical fibers. Two lasers with different wavelengths were used, 632.8 nm and 820 nm, to illuminate a cuvette containing Lipovenos PLR, the scattering liquid. A mask at the top of the cuvette was used to control the positioning of a 250 μm optical fiber and the laser entrance point. The light energy was measured with an optical power meter; the integration time was 60 s, measured with a chronometer. There were no systematic errors associated with the integration time. Two tests were done to evaluate the uncertainty associated with the positioning of the components of the experimental arrangement. To evaluate the uncertainty of the positioning of the cuvette, seven series of measurements with the optical fiber 5 mm far from the beam were performed. Between two series, the cuvette was removed from the holder, the liquid was mixed and the cuvette was put back in the same position. A second test was done to evaluate the reproducibility of fiber positioning and the relative positioning of mask and cuvette. Three distances between the beam and the fiber were used: 4 mm, 5 mm and 6 mm, through the positioning of the fiber at three different holes in the mask. Six series of measurements were performed; between two series the cuvette was removed from the holder, the liquid was mixed and the cuvette was put back in the same position. Each series was done in a different order, permuting the three positions. The uncertainty associated with the positioning of the experimental elements was of the order of 7%. The variation of incident laser energy was also evaluated, resulting in 6.5% and 4.0% for the red and infrared lasers respectively.

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A PILOT STUDY - ACUTE EXPOSURE TO LOW-INTENSITY, LOW-FREQUENCY OSCILLATING MAGNETIC FIELD: EFFECTS ON CARRAGEENAN-INDUCED PAW EDEMA IN MICE

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The purpose of this work is to evaluate the effects of oscillating magnetic field (MF) on edema evolution in an animal model. Paw edema was induced in 32 female Swiss mice by injection of 50 μ L of 1.0 % carrageenan diluted in saline in the left hind foot pad. Animals were randomly assigned into four experimental groups (exposed to different field frequencies) and two controls. Groups 1 (0 Hz), 2 (3 Hz), 3 (9 Hz) and 4 (15 Hz) were exposed for 60 s to an oscillating MF (300 mT) in the 1st, 2nd and 3rd hour after the injection. Control groups (CGN and DCL) were not exposed to the MF. Diclofenac was administered to DCL group 1 hour after the edema induction. Paw volumes were determined every hour using a water plethysmometer. The results were graphed against time and, to evaluate the edema, the area under the curve (AUC) was measured. All groups receiving some form of intervention (1, 2, 3, 4 and DCL) revealed AUC values that were substantially lower than those of CGN group. DCL had the lowest reduction percentage (25.0 ± 6.1 %) and group 3, the highest (46.9 ± 4.0 %). Compared to DCL_s results, only groups 2 and 3 showed significantly lower AUC values. Also with statistical relevance, group 3 showed lower AUC values than groups 1 and 4. According to this experiment, acute exposure to oscillating MF yields positive results in the regression of carrageenan-induced edema in mice, with indications that such effect depends on the field frequency.

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TREATING THE PROBLEM OF DIAGNOSTICS OF ONCOLOGICAL POST- OPERATIVE CONDITION BY THE METHOD OF CHEMILUMINESCENC

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To treat the problem of diagnostics of oncological diseases, the method of initiated chemiluminescence is proposed. The investigations performed give the reliable results under diagnostics of post-operative condition. Studying three experimental groups: before medical treating; one month after operation; and one year after medical treatment (without relapses) it is established, that the second maximum on the kinetic curve of initiated chemiluminescence can serve as an indication towards an active process of oncogenesis. It is proved, that normally this second maximum is absent. Analyzing the group distribution it is established, that the largest frequency of a given characteristics is connected with the group before medical treatment, rarely it can be found within a group of one year after medical treatment (without relapses). In the group of one month after operation this characteristic is absent or faintly expressed. This reveals a possibility to apply this method under monitoring of the quality of medical operation performed. Since the given analysis is not expensive, it is proposed to implement it into mass investigations of oncological processes and, in particular, of post-operative conditions, to control the quality of medical treatment performed. Also we propose to pay a special attention to a long-term medical examination of patients after operation, since this allows the timely exposure of possible relapses of oncological processes.

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IOMP PROJECT FOR MODEL CURRICULUM AND ASSESSMENT OF MSc-LEVEL COURSES

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Introduction: The IOMP project for Model Curriculum for Medical Physics Education aims to present guidance on the organisation of post-graduate (MSc level) courses. The project presents several models for this: modular, distributed, mixed, topical and e-Learning. The advantages/disadvantages of these models are discussed from the point of view of specificity in the country. The aim of the project is to introduce criteria and method for IOMP Validation of MSc courses in Medical Physics. The paper will also introduce a new book with educational experience from 25+ countries. Results: Based on assessment of many educational programmes from various countries, the project proposes indicative MSc curriculum outline with the following percentage of main modules in the course: (1) Basic modules: Basis of Human Physiology and Anatomy ~10%, Basis of Radiation Physics ~10%, Research Methods ~10%, Radiation Protection and Hospital Safety ~10%; (2) Optional modules: Medical Imaging Physics (non-Ionising) ~10%, Medical Imaging Physics (Ionising) ~10%, Radiotherapy Physics ~15%, MSc project ~ 25%. The indicative content of the modules is presented, forming a total number of contact hours. The latter varies (according to local University requirements) from c. 1200 to c. 350 (in case of high self-reading expectation). The delivery of this education is linked with the Organisation of the MSc courses: staffing (local and external) and host University requirements. These are also linked with the requirement/method of IOMP Validation of the MSc course. Conclusion: The Model curriculum project will allow for a small country with limited expertise in setting a post-graduate course in Medical Physics to go forward. Validating the programme by an experienced body as IOMP ETC will assure the local University that this programme is in line with the international standards. This will result in boost of our professional development.

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BRACHYTHERAPY DOSIMETRY

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The use of Brachytherapy sources has increased for treatment of prostate, breast, gynecological cancers as well as other sites. The sources used are high energy and low energy and high dose rate as well as low dose rate. Each of these types have their own characteristics. Also a new technology using a miniature x-ray source, termed electronic brachytherapy, can be treated in the same manner. The standard worldwide protocol used for dosimetry of Brachytherapy sources is the American Association of Physicists in Medicine Task Group 43. The air-kerma strength, or reference air kerma, for the source should be measured by the clinic, using a traceable calibrated well chamber. There are published consensus values for the other parameters of the source. A description of the primary standard for high energy, low energy, high dose rate, low dose rate and electronic brachytherapy sources will be discussed. Mention will be made of the TLD measurements for the other parameters of the sources and the development of the consensus standard. The process establishing the origins and magnitudes of different uncertainties that can enter into photon brachytherapy treatment planning will be presented. A statement of uncertainty should always accompany the results of the dosimetric measurements and calculations. Finally an awareness of the operation of the treatment planning system is important; an example of how a wrong value can be given will be presented.

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¹⁵³SM-EDTMP ABSORBED DOSE EVALUATION FOR UNDER BONE METASTASIS TREATMENT PATIENT BY MONTE CARLO METHOD

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Objective: Monte Carlo simulation is used to evaluate the radiation absorbed dose in treatment of cancers by using radiation therapy. In this research work to evaluate and assess the radiation absorbed dose in the metastasis bone and its normal surrounding tissues for treating bone metastasis by using ¹⁵³Sm-EDTMP the EGSnrc has been used. This simulation code has some special advantages such as: possibility to use a CT scan image to define the material geometry and source distribution which cause to achieve more precise and actual assessment. **Methods:** In this research, the CT-create subroutine was designed and written to create geometry of the tissues as a three dimensional phantom. Then a desirable volumetric distribution of ¹⁵³Sm-EDTMP was considered inside the bone metastasis. Then the designed simulation program in this research, was executed for 200 million particles of β^- , in 3 different and dominant energies of ¹⁵³Sm means: 640, 710, 810 keV and gamma photons (103 keV) by considering all possible interactions. Finally the 3D absorbed dose in different parts of under treatment tissue and its surrounding tissues were calculated by DOSXYZnrc Code. **Results:** In our study, the amount of absorbed dose in the minimum and maximum range were calculated for a metastasis bone (3.6 - 7.8 Gy), for the bone without metastasis (0.35 - 1.6 Gy) and for the muscle and lungs between the amounts 0.025 - 0.035 and 0.0005 - 0.004 (Gy) respectively. **Conclusion:** Our results showed in treatment the bone metastasis by using ¹⁵³Sm-EDTMP the absorbed dose inside the metastasis bone is about 4-20 times more than the normal bone which justify that, this treatment method is very effective. Furthermore, always we should consider that for treating cancer the amount of effective equivalent dose must be satisfy the conditions of international standards such as ICRP.

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DOSIMETRIC CHARACTERIZATION OF OPTICALLY STIMULATED LUMINESCENCE DOSIMETERS

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In vivo dosimetry is becoming essential, especially for modern techniques and treatments with no standard set-up such as Total Body Irradiation (TBI). We studied OSL dosimeters to verify if their dosimetric characteristics are appropriated for that purpose. Tests showed that OSL response is, in the used range, linear with dose, with linear correlation coefficient of 0.9830 and 0.9995, for 6 MV and 15 MV, and independent of dose rate and energy, with a mean relative difference of 0.4% between 6 and 15 MV. Besides that it has a good reproducibility, mean relative error between the readings of 1.5%, although a signal fade, 2%, was observed in a few days. These dosimeters have a considerable dependence when used to dose measurements at huge distance, 20% of difference when compare measures at 100 cm and 290 cm. When used to measure output factor it presented response similar to other dosimeters, such as ionization chamber, with a mean relative error of 3%. Based on the results, we can conclude that OSL dosimeters are good enough to be used for treatment dose verification since it be calibrated at the same distance.

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DIAGNOSTIC REFERENCE LEVELS IN RADIOLOGY

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The concept encapsulated by diagnostic reference levels (DRLs) has been around for at least two decades. DRLs are a powerful tool in the implementation of optimization of radiation protection in imaging procedures. There is general consensus on the ground rules for DRLs, including: establishment of DRLs should be facilitated at the national or regional level as a result of consultation between the health authority, professional bodies and the radiation protection regulatory body; setting values for DRLs must take into account the need for adequate image quality, and values should be based on wide-scale surveys; and the quantities used should be easily measured. DRLs are specified for “typical patients” for common radiological procedures, with the underlying assumption that if appropriate optimization is occurring for the “typical patient” then it is also happening for other patients, such as larger or smaller patients. Experience has shown that this cannot be assumed, and DRLs are needed for a range of patients. However the practice of radiology has changed markedly in the last two decades, including the advent of CR and DR in radiography, flat panel detectors in fluoroscopy, multi-detector CT, and a rapid increase in the use of image guided interventional procedures. DRLs need to be revised as technology and techniques improve or change. The impact of these developments on DRLs and their use will be discussed. Notwithstanding the issues of keeping DRLs current and relevant, the level of use of DRLs currently varies widely around the world. Many countries have yet to introduce DRLs into their radiation protection framework and, for those that have, the level of utilization across the whole country is often low. The medical physicist has an important role to play to ensure that the use of DRLs as a tool for optimization of radiation protection becomes more wide-spread.

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RADIATION DOSES IN PEDIATRIC INTERVENTIONAL CARDIOLOGY PROCEDURES

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The increased number of interventional cardiology procedures in recent years is often responsible for some of the highest patient and staff radiation doses in medical imaging. The risk of stochastic and deterministic effects in children undergoing diagnostic and therapeutic interventional cardiology procedures is particularly worrisome given their higher radiation sensitivity. The purpose of this work was to estimate radiation doses received by 41 pediatric patients in a public hospital in Recife, Pernambuco, Brazil, using a Phillips Allura-12 fluoroscopic system. Twenty-five of them were less than 1 year old. Of the 41 patients, 23 underwent coronary angiography; the rest were treated for congenital defects such as pulmonary stenosis. Radiation parameters such as tube potential, tube current, pulse width, fluoroscopy time, and air-kerma rate were collected during each procedure. The total number of runs and images per run as well as cumulative reference air-kerma ($K_{a,r}$) values displayed by the system were also documented. The results showed $K_{a,r}$ values ranging from 46.3 mGy to 1079.1 mGy, with a mean value of 295.8 mGy. The distribution of air-kerma values on the patient skin were determined for four diagnostic and six therapeutic interventions, using calibrated radiocromic films and the peak skin values ($K_{a,e,Max}$) were derived, correcting when necessary for geometrical misses. The resulting $K_{a,e,Max}$ values ranged from 214.3 to 486.7 mGy, with a mean value of 318.7 mGy. Air kerma-area products (P_{KA}) were calculated from the recorded data, yielding a range of 2.3 to 80 Gy.cm² with a mean value of 17.1 Gy.cm². No immediate deterministic effects were observed in any of the patients, a fact attributed to the resulting relatively low doses; however, the children's radiation history has been documented, in order to assess future risks, especially if the procedures have to be repeated.

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RADIATION DOSE TO PEDIATRIC PATIENTS IN COMPUTED TOMOGRAPHY IN SUDAN

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The use of pediatric CT has been increasing rapidly with annual growth estimated at about 10% per year. Because of current and growing use of CT and the potential for increased radiation exposure to children undergoing these scans. In Sudan, there has been a remarkable increase in the number of CT examinations being performed. The purposes of this study are to: (i) to measure the radiation dose and estimate the related risks to both pediatrics and adults patients during CT for chest, abdomen and brain and (ii) propose a local diagnostic reference level for abdominal CT. A total of 80 patients were investigated. CT scanners that participated in this study are helical CT scanners (16 slices and dual slices). Organ and surface dose to specific radiosensitive organs was estimated by using software from National Radiological Protection Board (NRPB). For the pediatric group, the age was ranged between 0-10 years while the mean of weight was 13.53 Kg. The DLPs were 320.58 mGy.cm , 79.93 mGy.cm, 66.63mGy.cm for brain, abdomen and chest respectively. The CTDIvol were 25.06, 3.48, 2.46,mGy for brain, abdomen and chest respectively and the effective doses were 2.05, 1.8, 1.08,mSv for brain, abdomen and chest respectively. The study has shown a great need referring criteria, continuous training of staff in radiation protection concepts especially for pediatric. Further studies are required in order to establish a reference level in Sudan.

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INNOVATIONS IN BIOLOGICAL IMAGING AND THE CLINICAL IMPACT ON CANCER DIAGNOSIS AND TREATMENT

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Progress in cancer treatment is mainly influenced by the effectiveness of early cancer detection and the availability of reliable treatment methods. There are sufficient clinical data demonstrating that tumor curability correlates with the size, i.e. number of clonogenic cells at diagnosis. Despite some encouraging results achieved with methods of molecular medicine such as blood analysis early cancer detection is the domain of imaging. Several highly innovative imaging technologies are currently under development with the perspective of single molecule visualization. The light microscopy in the late 19th century already allowed spatial resolutions of ca. 200 nm i.e. close to the light diffraction limits. In contrast to traditional transmission microscopy techniques mostly based on light absorption the application of fluorescence dyes as biomarkers opened the large area of fluorescence microscopy with resolutions down to some 5 nm as achieved with the recently developed Stimulated Emission Depletion (STED) technique. With the availability of the femtosecond lasers another class of optical imaging methods has been introduced into biomedical applications, for instance Raman Scattering including Coherent Anti-Stokes Raman Scattering (CARS). The advantage of RS-imaging is that no contrast media interacts with the probe. First applications demonstrate the potential of RS imaging in the detection of specific tumor associated molecules at the cell surface. Beyond the conventional planar illumination technologies in optical imaging (OI) advanced processing methods and computer modelling allow now for 3D-visualization of objects at the molecular up to the macroscopic level. Multimodality imaging by combining optical tomography imaging with CT, PET and MR is another promising technique. However, what is the impact of that novel optical imaging methods on the clinical translation? Three areas are outlined briefly: (i) the potential of OI in tumor surgery for distinguishing tumor from normal cells; (ii) OI is suitable to investigate in-vivo treatment responses of radiation and drug effects at a molecular level and (iii) imaging of tumor growth and preclinical drug testing by analysis of the biodistribution of tracer molecules (smart probes) in small animal models. In conclusion, optical imaging offers numerous applications in cancer research and is a fascinating field challenging increasing involvement of medical physics.

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X-RAY FLUORESCENCE SCANNING OF HUMAN TEETH AND DEDICATED IMAGE PROCESSING

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Nowadays, X-ray fluorescence constitutes a useful and accurate technique, worldwide established for constituent elementary distribution assessment. Actually, concentration distributions of arbitrary user-selected elements can be achieved along sample surface with the aim of identifying and simultaneously quantifying every constituent element. Visualization of elemental distributions of biological sample is gaining importance in many disciplines of biological, forensic, and medical research. Images are promptly achieved (within few minutes) scanning with a specially designed robotic arm which performs step by step or continuous positioning. The scanning areas considered in this study are for samples up to 100 cm² along with variable spatial resolution capable of reaching 0.2 mm² per pixel. XRF spectra are detected at each position (x,y) in times of up to 1ms. Dedicated image processing programs _MatLab_ supported - have been developed with the aim of performing suitably automatic XRF image analysis. Furthermore, developed programs are integrated by means of dedicated graphic interface for user interaction. The integrated tool allows to process and analyze acquired XRF images by means of different techniques including noise filtration, background subtraction, selective spectrum peak individualization, single/multiple element mapping and even image fusion. After preliminary tests, the whole XRF scanning system has been used for different applications. This work resumes the main characteristics of the new portable XRF scanning system. In addition, system performance is investigated for applications to human tooth obtaining. Dental sample elemental spatial distributions are reported and discussion is presented regarding the use of this information for further correlation with the corresponding pathologies associated.

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IN VIVO XRF SCANNING ANALYSIS OF HUMAN NAIL

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Knowing the elemental composition of human fingernails revealed the presence of certain elements in them, level: major, minor and trace. Depending on their nature and concentration, could mean a contamination process, a metabolic disorder or related to a disease of the individual. Using the technique in vivo EDFRX Scan, for one or more of the detected elements, it is possible to determine different levels of intensity of characteristic X-rays along a longitudinal section of the nail or the entire nail and forming a two dimensional image of distribution that allows us to quantify the level of changes in the concentration of each element point to point. This research presents the results of elemental analysis on samples of human fingernails, identifying its elements and their spatial distribution and forming a 2D image allows us to quantify the level of changes in the concentration of each element point to point. This research presents the results of elemental analysis on samples of human fingernails, identifying its elements and their spatial distribution. For our analysis we used a mini X-ray tube (MTRX), a digital pulse amplifier and MCA (PX4), a solid state detector SDD (Silicon Drift Detector), a robotic arm that positions the detector and the Mini -X on a point (x, y) of the sample. In addition, an electronic control software for mechanical scanning and image acquisition and processing XRF, it allows you to select the step and acquisition time at each point and other related parameters. The elements found are S, Ca, Cu, Fe, Zn, and Pb. And their spatial distributions point to point, vary over time and from individual to individual. The exposure time for a simple scan would not exceed 15 s and the dose delivered to the individual is calculated based on the ALARA criteria, being the order of 0.1mGy/s. The results of this research to conclude that it is possible to determine the elemental composition of human nails in vivo, and its spatial distribution.

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MRI GEL DOSIMETRY: UNCERTAINTIES EVALUATION IN 1.5T, 3T AND 4.5T

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Purpose: Estimate uncertainties in MRI gel dosimetry experiments as a function of pixel-size and the number of averages assumed in the scans. Material and Methods: MAGIC-f gel was used to perform experiments in 1.5T, 3T and 4.5T resonance tomography. Gels were stored in 25mL glass tubes (2cm-diameter; 16cm-length). A paramagnetic ion solution (0.2%NaCl:0.3%MnCl₄) was used around gel tubes in all scans to reduce magnetic susceptibility artifacts. Relaxometry protocol uses time-to-echo of 20ms; time-to-repetition of 3000ms; 16 echoes. Two pixel-sizes were evaluated: 0.5x0.5mm_{xy} and 1x1mm_{xy}. Standard deviations (SD) were evaluated in 12x12mm_{xy} areas centered inside each gel tube. Ratio between SD when no averages are applied and when n averages are considered during image acquisition was defined as RSD(n); n ranged from 1-4 and is proportional to total scan-time. RSD(n)

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EVALUATION OF THE PRE-DOSE INFLUENCE ON RAD-HARD EPITAXIAL SILICON DIODES RESPONSE IN RADIOTHERAPY PHOTON BEAM DOSIMETRY

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In this work, we present the preliminary results about the evaluation of the pre-dose influence on the response of rad-hard epitaxial (EPI) diodes, processed at University of Hamburg, for radiotherapy photon dosimetry using a Siemens Primus Linear Accelerator. Comparative measurements were performed with two diodes: one (#44) non-irradiated and other (#45) which received a gamma pre-dose of 200 kGy from a ⁶⁰Co irradiator. Each device was housed in a PMMA probe and connected in the short-circuit current mode to the input of an integrating electrometer. All data was gathered in a PMMA phantom. The short-term repeatability was measured with photon beams of 6 and 18 MeV energy with dose-rates of 2,11 cGy/s and 3,70 cGy/s, respectively. The current signals induced in both devices are very stable, although it was not observed any improvement on the instantaneous stability of the pre-irradiated diode response. Indeed, the smallest coefficient of variation (CV) of 0.04% was obtained with the non pre-irradiated #44 device. The dose-response curves of the diodes, evaluated from 63 cGy up to 370 cGy, were linear (correlation coefficient ³ 0.99991) with the highest charge sensitivity achieved (5.0 μ C/Gy) for the non-irradiated #44 EPI diode. However, both diodes exhibit a similar energy dependence which might be attributed to the structure and small dimensions of the devices. Some studies are under way to clarify the origin of this effect. The percentage depth dose profile (PDD) and transversal dose profile (TDP) were also measured in PMMA with #45 diode. The results were in excellent agreement with those calculated with Colapse Cone Convolution and Pencil Beam codes using the Oncentra MasterPlan® Treatment Planning System (TPS).

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DOSIMETRY OF CONES FOR RADIOSURGERY SYSTEM

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Dosimetry of small fields, such as cones for radiosurgery, requires a lot of care in its implementation. The acquisition of curves of percentage depth dose (PDD) and profiles for nine circular cones with diameters from 4 to 20 mm for 6 MV photons was performed. Measurements with four types of dosimeters: diode, pinpoint ionization chamber, diamond detector and film, were done. A comparison between the data obtained with the several detectors permitted to conclude that the diode is the detector more reliable. The effect of various methods to “smooth” the curves was studied and showed that there are methods that change very much the measured data. Interpolations were made in PDD curves in order to eliminate the noise of small fields due to low signal in the detectors. The most important conclusion refers to the choice of suitable detector, in this case the diode, and to a careful handling of obtained data to not disturb or modify the results of the measurements.

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SETTING UP A PROGRAMME FOR PATIENT DOSE MANAGEMENT IN RADIOLOGY

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Imaging has become a crucial part of medical diagnosis for a wide range of conditions. The exposure to ionising radiation from X-ray examinations carries an attendant risk, so as the number of imaging procedures rises, the potential number of patients who may develop cancer will increase. An important factor in minimising patient doses is to ensure that the X-ray equipment is optimised and here medical physicists have a key role to play. There are two elements to this service, performance testing of equipment and surveys of doses. Performance tests should be carried out at the time of installation and periodically thereafter. The introduction of digital radiography has allowed high quality images to be obtained with a wide range of exposure factors, and it is difficult for radiographers to recognise when higher doses are given, so establishing agreed exposure factors and ensuring that automatic exposure control systems are set correctly is essential. Confirming the dose and imaging performance of the available options on fluoroscopy and CT equipment is crucial and the information obtained on dose performance should be given to radiologists, so they can make informed choices in developing imaging protocols. Even if X-ray equipment is set up correctly, use may not be optimal in practice. Surveys of patient dose allow equipment that is giving higher doses to be identified, so that imaging protocols can be optimised. Setting of diagnostic reference levels (DRLs) in terms of measured dose quantities against which doses can be compared is important. These should be based on local equipment and practice, but take account of guidance from the IAEA and EC, and DRLs from individual countries. The requirements for equipment performance testing programmes and the training of staff will be discussed. Factors that need to be considered in the organisation of patient dose surveys and setting of diagnostic reference levels will be described.

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DEVELOPMENT OF GONADS PROTECTORS FOR USE IN PEDIATRIC RADIOLOGY

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The use of radiology as a diagnostic tool has become a common practice and its benefits are undeniable. However, standards and techniques for radiation protection are underutilized in the name of increased productivity, convenience or lack of knowledge. Given that children have a longer life expectancy, the risks of stochastic effects compared to the risk in adults increases significantly. Therefore, this study motivated by the recommendations of United Nations Scientific Committee of the Atomic Radiation Effects - UNSCEAR, designed and produced tools for radiological protection for use in pediatric radiology, taking into account anatomy, dimensions and various ages. The raw material used in the study was a damage lead apron, a X-ray machine and an ionization chamber. The results were quite satisfactory and the conclusion reached its goal. Some minor issues were reported at the end of the work for a possible extension of this study to other projects.

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METHOD FOR REDUCING OVARIAN DOSES IN PROCEDURES OF UTERINE ARTERY EMBOLIZATION (UAE)

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The procedure for uterine artery embolization (UAE) is the access and embolization of the uterine artery guided by X-ray. In previous work (CBFM 2009), was presented a methodology for estimating ovarian dose and entrance skin dose (ESD) of patients undergoing UAE procedures. On that occasion, it was shown that the values were above those obtained by other authors in similar works. The calculation of entrance skin dose done separately for fluoroscopy mode and for arteriography mode showed that the arteriographys were responsible for the outcome of high dose. Thus, actions have been proposed for dose reduction, including: change of frame rate/sec from 2 to 1 and efforts to reduce the number of sets of arteriography during the procedure. This paper aims to show the results obtained after these optimization actions. The methodology used was the same as the previous work. Twenty four UAE procedures were accompanied, where the parameters of image acquisition were recorded for the calculation of the ESD from the output of the X-ray tube. The ovarian dose estimation was performed by inserting a vaginal probe containing three TLD chips. The results were compared with the previous work and there was a 57% reduction in ovarian dose and 30% of entrance skin dose. Therefore, it was proven that the new protocol used allows a substantial dose reduction in patients.

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VIRTUAL HUMAN PHANTOMS APPLIED TO RADIATION PROTECTION DOSIMETRY

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For a person after being exposed to ionizing radiation, the risk of suffering from radiation-induced detriments in organs or tissues is first of all dependent on the absorbed dose, which is the amount of radial energy absorbed per unit mass throughout the organ or tissue of interest. Consequently, the determination of organ and tissue absorbed doses in the human body is of primary concern in radiation protection for patients submitted to radiological examinations, for occupationally exposed workers and for members of the public, especially near nuclear installations. However, as human tissue cannot express itself in terms of absorbed dose, exposure models have to be used to determine the distribution of absorbed dose throughout the human body. A computational exposure model consists of a virtual representation of the human body, called phantom, plus a method, usually Monte Carlo, for transporting ionizing radiation through the phantom and for calculating the absorbed dose to organ and tissues of interest. Early virtual phantoms were homogeneous slabs and cylinders representing the human torso. Then, mathematical or stylized phantoms based on simple geometrical bodies like cylinders, ellipsoids, cones, tori, etc. were developed exhibiting already all important organs and a skeleton, but representing the human body still in a rather crude manner. Improved anatomical representation was achieved with the introduction of tomographic or voxel phantoms. Based on tomographic images of real persons, voxel phantoms are true to nature representations at least of the scanned individual. Stylized phantoms are easily changeable but are poor representations of the human body, while voxel phantoms are excellent representations of the human body but difficult to change. The answer to the problem are so-called BREP (boundary representation) phantoms, which preserve the advantages of stylized and voxel phantoms and have recently been designed using 3D modeling software developed in the area of computer graphics and animated film.

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ADULT HUMAN PHANTOMS AS A FUNCTION OF BODY MASS AND HEIGHT

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Today, human phantoms used for absorbed dose calculations in radiation protection, radiology and nuclear medicine are constructed with an unprecedented degree of anatomical realism. This became possible by using software tools developed in the area of computer graphics, like Non-Uniform Rational B-Spline (NURBS) or polygon mesh surfaces which even allow introducing movements into the phantoms. Applying these phantoms to real persons, patients in a radiodiagnostic department, for example, requests the body mass and the body height to be taken into account because these and other anthropometric parameters can have a strong effect on the organ and tissue absorbed doses. Based on anthropometric survey data for Caucasian populations, 36 adult human mesh phantoms, 18 in standing and 18 in supine posture with 9 phantoms for each sex and posture, are currently being developed at the Department of Nuclear Energy at the Federal University of Pernambuco in Recife/Brazil. Each group of 9 male or female posture-specific phantoms has body masses and heights based on the 10th, 50th and 90th mass and height percentiles taken from the Caucasian survey data. Other investigations were used to derive methods for organ and tissue scaling. This presentation will report on the standing phantoms for adult males and females. Preliminary dosimetric results indicate that organ and tissue absorbed doses change more or less linearly with body mass or height, which is of great advantage for the calculation of organ and tissue absorbed doses in X-ray diagnosis, for example, because data can be interpolated linearly for the patient's body mass and/or height. The phantoms will be used in a future version of the popular software package CALDose_X, which is currently used by more than 1000 users in ca. 35 countries worldwide.

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A COMPARISON BETWEEN MCNPX AND GEANT4 CODES FOR α -PARTICLE MICRODOSIMETRY

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Microdosimetry using Monte Carlo simulation is a suitable technique to describe the stochastic nature of energy deposition by alpha particle at cellular level. Because of its short range, the energy imparted by this particle to the tissue is highly non-uniform. Uranium uptake represents an occupational risk workers involved in uranium industry. The objectives of the present study were: (1) to study the effect of uranium localization over the specific energy imparted to the cell nucleus using MCNPX and geant4 codes for a simple cell model and (2) to assess the effect of voxel dimension to validate the use of a complex 3D voxelised geometry. To do that, the specific energy (z) deposited in the cell nucleus, the single-hit density of specific energy $f_1(z)$, the mean specific energy $\langle z_1 \rangle$, and the frequency of hits received by the nucleus were calculated. Our results shows that, when an alpha particle generated outside the cell, $\langle z_1 \rangle$ is higher by a factor 1.2 than when generated in cytoplasm localisation. This factor is about 2.3 higher than outside cell localisation. However, the hit frequency decreases rapidly from nuclear localisation to cytoplasm localisation (about 7 times lower). This interaction becomes low for the outside cell localisation (about 370 times lower). The study of the voxel size highlighted that the shape of the curve $f_1(z)$ obtained with MCNPX for less than 1 μm voxel-size present a significant difference from the shape of non-voxelized geometry. When using Geant4, little differences are observed whatever the voxel size is. When a 3D voxelised phantom of cell is used, the error in deposited energy is about 12.4% using 1 μm voxel. This error decrease with decreasing voxel-size to reaches 1% using 0.1 μm voxel. However, the calculation time using Geant4 code is more than 10 times higher than MCNPX code in the same condition.

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CONTAMINATION MAPPING WITH IN VIVO MEASUREMENTS AND MONTE CARLO CALCULATIONS

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In the case of an internal contamination, in vivo counting is a very useful method that enables a precise measurement of the incorporated activity and its distribution in the body. However, when a complex contamination occurs, with very few information on the nature and activity of the radionuclides, it is difficult to establish a posteriori the activity distribution only by using spectrometry measurements. In this work, a new method has been implemented using both in vivo measurements and Monte Carlo (MC) calculations to optimize the contamination mapping. The method consists in separating the contribution of each potentially contaminated organ in the experimental counting rate. The contribution of each organ to the count is accounted through the MC simulation of the detectors_ counting efficiency by loading each contaminated organ alone. Using experimental counting rates and simulated counting efficiencies, the activity estimation in each potentially contaminated organ is feasible. To validate the method, a series of measurements was performed in collaboration with the KIT (Karlsruhe) and the CIEMAT (Madrid). For these experiments, punctual sources (241Am, 152Eu) and the Livermore physical phantom were used with different sets of radioactive lungs (238U, 235U, 241Am, 152Eu). The first results demonstrate the feasibility of the method and its efficiency in determining the activity distribution. The use of MC simulations proved to be very successful in separating the contribution of each organ. However, the activity estimate showed significant differences from the real values (up to 16%) and these call into question the modelling of the detectors and their positioning. Future steps will focus on taking into account perturbation sources (old contaminations, new retention organs etc.) and on looking for the optimal positioning of the detectors to improve the estimation of the contamination and its distribution.

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FLTC LABELLED, MAGNETIC NANOPARTICLES CONJUGATED D-PENICILLAMINE-ANTI-METADHERIN

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In this study, silane modified magnetic nanoparticles were prepared after capped with silica generated from the hydrolyzation of tetraethyl orthosilicate (TEOS). Amino silane (SG-Si900) was added to this solution for surface modification of silica coated magnetic particles. Finally, D-penicillamine (D-PA)-anti-Metadherin (anti-MTDH) was covalently linked to the amine group using glutaraldehyde as cross-linker. Magnetic nanoparticles were characterized by scanning electron microscopy (SEM), X-Ray diffraction (XRD), vibrating sample magnometry (VSM), and atomic force microscopy (AFM). AFM results showed that the particles are nearly monodisperse and average size of the particles was 40-50 nm. An aminoacid derivative D-penicillamine was conjugated anti-metadherin (Anti-MTDH) which results the increase of uptaking potential of a conjugated agent, labelled fluorescein isothiocyanate (FITC) and then conjugated to the magnetic nanoparticles. In vitro evaluation of the conjugated D-PA-anti-MTDH-FITC to magnetic nanoparticle was studied on MCF-7 breast cancer cell lines. Fluorescence microscopy images of cells after incubation of the sample were obtained to monitor the interaction of the sample with the cancerous cells. Incorporation on cells of FITC labeled and magnetic nanoparticles conjugated D-PA-anti-MTDH was found higher than FITC labeled D-PA-anti-MTDH. The results show that magnetic properties and applying magnetic field increased incorporation rates. The obtained D-PA-anti-MTDH-magnetic nanoparticles-FITC complex have been used for in vitro imaging of breast cancer cells. FITC labeled and magnetic nanoparticles conjugated D-PA-anti-MTDH may be useful as a new class of scintigraphic agents. Results of this study are sufficiently encouraging to bring about further evaluation of this and related compounds for fluorescent-MR dual imaging.

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ATTENUATION OF GOLD NANOPARTICLE IN RADIATION THERAPY ASSESSED BY TLD DOSIMETRY

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Purposes: Quantify attenuation fractions (Fatt) due to gold nanoparticles in x-ray radiation therapy beams using thermoluminescent dosimeters (TLD). **Material and Methods:** Gold nanoparticles (AuNP) of 45nm average diameter were used in this study. Seven groups of Lithium Fluoride TLDs, each one containing 3 tablets of 3x3x0.9mm, were pre-calibrated in a Cs-137 source and in 200kV clinical x-ray beam. Different gold mass-fractions (0%, 0.08%, 0.17%, 0.25%, 0.33%, 0.42% and 0.5%) were casted in one surface of the tablets of each TLD group. The dosimeters were positioned in an acrylic plate with small recess properly designed to fit 3 tablets each time and a 10cm-height acrylic block was positioned underneath the TLDs to guarantee backscattering conditions. Radiation fields of 10x10cm and source-to-surface distance of 40cm were set to delivery 2Gy to all groups. During irradiations, the surface of TLD that contained AuNPs was positioned towards the beam incidence. The Fatt was calculated as the ratio between doses measured with TLD tablets with and without AuNP. PENELOPE Monte Carlo simulations were performed to determine Fatt resultant from equivalent thin gold layers containing the same number of atoms of the experimental concentrations. **Results:** Experimental Fatt varies between 1 and 0.87 in the range of AuNP concentrations considered. To concentrations 0%, 0.08%, 0.17%, 0.25%, 0.33%, 0.42% and 0.5% the experimental Fatt found were 1, 0.99, 0.98, 0.98, 0.94, 0.91 and 0.87 respectively. An exponential behavior of Fatt with concentration of AuNP was revealed in experiments when low concentrations of gold nanoparticles are considered. The Fatt obtained by Monte Carlo simulations linearly varies from 1 to 0.92. **Conclusions:** Attenuation measurements of AuNPs in x-ray beam using TLDs shows exponential behavior to gold concentration in contrast with Monte Carlo results to atoms evenly distributed at the surface. Both curves tend to agree excluding low concentrations.

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PHOTOACTIVE MAGNETIC NANOSPHERES FOR NANOMEDICINE

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Benedito José de Castro and Benedita Dalva Fortes de Castro

The purpose of this study was to explore the physics and biologic properties of polymer nanospheres carrying YFeAl-ZnS nanoparticles. Magnetic and fluorescent polymer nanospheres containing the photoactive and superparamagnetic YFeAl-ZnS nanoparticles were prepared by inter-facial polymerization of epoxidic polymer based on the ether diglycidic of bisphenol A (DGEBA). The microstructure and size distribution of the polymer nanospheres were determined by transmission electron microscopy (TEM) and atomic force microscopy (AFM). The fluorescence of the polymer nanospheres was observed using the epifluorescence microscopy. In-vitro experiments about the biocompatible properties of polymer nanospheres carrying the hybrid YFeAl-ZnS nanoparticles were accessed in mammalian cells (CHO). It was observed that the polymer nanospheres did not affect the viability of mammalian cells or the growth rate of cell culture. The biophysical properties of the polymer nanospheres carrying the hybrid YFeAl-ZnS ceramic indicated that this can be a highly versatile nanobiomaterial for therapeutic and cancer diagnosis. Keywords_ Quantum dots, ZnS, Magneto fluid hyperthermy.

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SIZE-CONTROLLED $Y_2O_3:EU^{3+}$ NANOPARTICLES FOR LUMINESCENT PROBES

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In the present work, Eu^{3+} doped Y_2O_3 nanoparticles were produced through proteic sol-gel technique and the adjustment of pH was tested in order to control the particle size of the powders. A strong correlation between the initial pH and the temperature of crystallization was observed, allowing the production of particles with controlled diameter from 4 nm to 50 nm. The samples were characterized by X-ray diffraction, high-resolution transmission electron microscopy, optical microscopy and photoluminescence spectroscopy in both absorption and emission modes. A blue-shift of the excitation peak corresponding to energy transfer from Y_2O_3 host to Eu^{3+} ions was observed as the particle size was reduced from 50 to 4 nm. The suppression of a charge transfer band also resulted from the reduction of the particle size. The emission spectrum of the $Y_2O_3:Eu^{3+}$ with particles of 50 nm was found to be similar to that of bulk material, whereas 4 nm particles presented broadened emission peaks with lower intensities. Acknowledgements: CAPES, CNPq, FAPITEC-SE

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CHALLENGES OF TREATMENT PLANNING WITH NEW TECHNOLOGIES AND TREATMENT TECHNIQUES

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The introduction of new technologies in radiation therapy is principally aimed at improving the treatment outcome, by means of a dose distribution which more strictly conforms to the tumor (clinical target) volume. A highly conformal dose distribution allows for a dose escalation to the target volume without an increase in the radiation dose to normal tissues, or for a decrease in normal tissue dose without reducing tumor dose, or a combination of both. Such refinement of the dose distribution actually delivered to the patient may be obtained through the following: (1) providing technical solutions on the irradiation equipment to improve the dose distribution conformity to the target (beam intensity modulation combined or not with gantry rotation, multibeam approaches and hadrontherapy for example); (2) providing treatment planning tools to optimize the dose distribution for each of these new technical solutions (inverse planning approach), with in addition solutions able to consider biology into the treatment planning process; (3) providing the means to apply them accurately to individual patients (image guided radiotherapy). The normal process when introducing a new or upgraded piece of equipment or software component in a radiation therapy department starts with planning. For instance, dose distributions obtained from intensity modulation radiation therapy (IMRT) may exhibit a less uniform dose distribution in the target than conventional approaches. Therefore, ways of prescribing, dose reporting, normalizing have to change and move parallel with new treatment techniques. Thus, new international radiotherapy recommendations or guidelines were more than welcome. Increased Treatment Planning Systems (TPS) complexity poses a challenge and requires understanding of its multiple functionalities, understanding of its limitations in anatomical modeling, adherence to the instructions for use of the system (avoiding changes in the way the TPS is used without proper testing and validation). The design and testing for software warnings and interlocks is becoming increasingly important.

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LÉVY METRIC AND THE DESIGN OF TCP BASED CONSTRAINTS FOR PLAN OPTIMIZATION

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Modern Radiation Therapy techniques require novel methods for the computation and evaluation of plans. In this work, we develop the concept of Lévy distances between Dose Volume Histograms for the same volume of interest. It will be shown that Lévy distance is a global property, with a clear geometric interpretation, and rigorous mathematical foundations. A direct application to tumor control probability variation is provided.

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INFLUENCE OF HIGH-DENSITY INHOMOGENEITIES IN STEREOTACTIC RADIOSURGERY WITH 6 MV LINEAR ACCELERATOR

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The influence of high-density tissue inhomogeneity in small-diameter X-rays beam used in stereotactic radiosurgery with 6 MV linear accelerator has been investigated. We show the difference between dose calculated with an inhomogeneity correction factor and dose calculated without this correction in intracranial tumors. The correction dose magnitude depends on intracranial tumors locations. Several planning systems neglect the disturbance on distribution of depth dose produced by the bone electron density; this produced systematic subdoses on the target. Therefore, the Monitor Units must be corrected by independent calculations.

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IMPLEMENTATION OF INTRAOPERATIVE RADIOTHERAPY (IORT) ON A VARIAN

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The aim of this paper is to present the experience of the reference center from the network of radiotherapy of Chile in intraoperative radiotherapy. Is detailed the application system construction having a coupling easy on collimator linear accelerator. It also details the cost and the set up for measurements with corresponding PDD curves and isodose curves. This technique was implemented in a Varian Clinac 21EX for beams with 6, 9 and 12 MeV electron energy. The coupling system provides a good dose distribution both laterally and in depth for each energy. This provides a good coverage of treatment planning volume.

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IMPLEMENTATION OF INTRAOPERATIVE RADIATION THERAPY TECHNIQUE: A PEDIATRIC CASE

Graciela Alejandra Brito Roco; Gabriel Zelada Silva; Marcia García Arencibia; Karen Goset Poblete; Francisco Ossandón; Andrés Córdova Bernhart; Alejandro Berlín Rosenblut

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In this work we present the process followed for the re-implementation of the Intraoperative Radiation Therapy (IORT) Program in the new Linear Accelerator Elekta Synergy Platform, recently installed in the Radiotherapy Unit of the Clinica Alemana Santiago, Chile. Being the first institution in the country, since 2003 with clinical cases of IORT reported(1). The technique was implemented for a critical case of a pediatric patient with no other suitable therapeutic approaches. In order to ensure that the treatment machine is approved for clinical use, in different clinical scenarios for this specific case, the following commissioning procedures were done: a dosimetric database for two electron energies (9 and 12 MeV) was constructed by measurements that characterized the electron beam. Both, Percentages of Dose in Depth (PDD) and field profiles, were used to generate isodoses curves, at variable Source Surface Distances (SSD). The measurements were made using Hard Docking system, with beveled (30°) acrylic cones of 6 and 8 cm width, and a range of SSD between 120 and 135 cm. Subsequently, absolute doses were obtained on the central axis for each energy and SSD combination. Finally, with all the data, we developed a software using MATLAB (v7.10.0.499), for rapidly obtain the desired monitor units of the treatment parameters (cone size, dose, energy and prescription isodose) defined intraoperative. (1) Goset K., Rossi R., Camacho J., Córdova A. and Sánchez-Nieto B.(2004), Radioterapia Intraoperatoria: Primer Caso de Chile , LXXVII Congreso Chileno e Internacional de Cirugía.

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APPLICATIONS OF THE IAEA DOSIMETRY IN DIAGNOSTIC RADIOLOGY CODE OF PRACTICE

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The IAEA published its International Code of Practice for Diagnostic Radiology (TRS457) in 2007. This document is a complementary document to ICRU 74 and endeavors to bring a harmonizing approach to diagnostic radiology dosimetry using air kerma as the basic measurement quantity. The application of the document is seen both in the clinical and calibration work places and it is also an aim of the IAEA to bring these fields into a closer understanding of each other. Recently a coordinated research project (CRP) at the IAEA reviewed the application of TRS457 examining amongst other things, instrumentation, calibration, and clinical dosimetry protocols. Of greatest interest were the applications to CT and fluoroscopy dose estimation and their associated usage of pencil ionization chambers and kerma area product meters and their calibrations. It was found there is a wide range of calibration methods for both instruments, which have a direct impact on the clinical measurement and its uncertainty. There were also identified a number of areas in dosimetry that require ongoing investigation in diagnostic radiology and these included the areas of paediatric dosimetry, tissue and organ dosimetry, measurements of skin dose and dosimetric formalism for emerging technologies such as mammographic tomosynthesis as well as the impact of DICOM structures on dosimetric collection and accuracy. Many of these issues are currently being addressed through a new CRP. The preliminary results of this work reinforce the need of a harmonized basis for dosimetry that includes a sound knowledge of the capabilities of dosimetric instrumentation and calibration. This then builds a platform for meaningful assessment of patient dose and provides the tools needed for optimization processes in diagnostic radiology.

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CALIBRATION OF PKA METERS AGAINST ION CHAMBERS OF TWO GEOMETRIES

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Kerma-area product (KAP or P_{KA}) is a quantity proposed to be independent of the distance to the X-ray tube focal spot and that can be used in radiological exams to assess the effective dose in patients. Clinical P_{KA} meters are generally fixed in the tube output and usually calibrated on-site by measuring the air kerma with an ion chamber and evaluating the irradiated area by means of a radiographic image. Recently, a device was marketed (PDC, Patient Dose Calibrator, Radcal Co.), which is designed for direct P_{KA} readings and easier calibration of clinical P_{KA} meters with traceability to a standard laboratory. This work presents a metrological evaluation of two methods that can be used in standard laboratories for the calibration of this device, namely, against a reference 30 cc ionization chamber or a reference parallel plates monitor chamber. Lower energy dependence was obtained when the PDC calibration was made with the monitor chamber. Results are also shown of applying the PDC in hospital environment to the cross calibration of a clinical P_{KA} meter from a radiology equipment. These results confirm lower energy dependence of the PDC relatively to the tested clinical meter.

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DEVELOPMENT OF A PARALLEL PLATE ION CHAMBER FOR RADIATION PROTECTION LEVEL

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A new parallel plate vented ion chamber is proposed in this work. The application of this chamber was primarily intended to the measurement of stray radiation in interventional procedures, but the energy dependence of only 2.6 % obtained with the first prototype, in the range of 40 kV to 150 kV, allows its employment in other radiation protection applications. Electric field calculations permitted the development of an optimized chamber model regarding effective volume and saturation voltage level, which conferred also a dual entrance window capability. Monte Carlo calculations were employed to match the required effective volume with the chamber dimensions. The Monte Carlo results revealed also that the influence of the conductive layers composition, which was neglected at the beginning due to its very small thickness of about 35 μm , has important contribution on the chamber response.

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ESTIMATION OF ABSORBED DOSE OF HUMAN TISSUES DURING BMD SCAN BY TLD CHIPS AND MONTE CARLO METHOD

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Osteoporosis is a disease that characterized by low bone mass and structural deterioration of bone tissue. Dual energy x-ray absorptiometry (DEXA) is the standard technique for diagnosis of osteoporosis. To evaluate the osteoporosis, BMD study is done usually on femur and or spine regions. The purpose of this research work is to evaluate patients' organs doses during performance of dual x-ray absorptiometry by TLDs chips and Monte Carlo method. The surface dose of cervix, kidney, abdomen region, thyroid and background were measured by placing 59 (TLD-GR 200) at various organs locations. In addition, the Hologic Explorer system (QDR series), the patient body, x-ray source and radiosensitive tissues such as cervix, kidney, abdomen and thyroid were simulated by Monte Carlo method. Then absorbed dose of the mentioned organs were assessed. For spine (femur) BMD scan in simulation, the absorbed dose of the cervix, kidney, abdomen and thyroid were 4.19 (5.88), 175 (3.68), 8.71(3.27) and 1.8 (μ Gy) respectively. For spine (femur) BMD scan by using TLDs, the absorbed dose of the cervix, kidney, abdomen and thyroid were 4.5 (5.64), 162.17 (3.99), 8.45 (3.55) and 1.95 (μ Gy) respectively. The relative difference between our simulation results and experimental data was less the 8%. Therefore simulation study can be used instead of the experimental method for assessment the radiation absorbed dose especially for internal organs and inside the organs which is not easy available in experiment. Furthermore our results showed, to reduce the danger probability during BMD scans, these scans should prescribe with more precision and sensitivity.

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A NEW MAMMOGRAPHY DOSIMETRIC PHANTOM

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Breast phantoms produced with tissue-equivalent materials are used in an attempt to simulate, in terms of attenuation and density, the glandular and adipose tissues. In this work, a set of breast tissue-equivalent phantoms (BTE phantoms) with semi-circular shapes of different thicknesses and tissue compositions were produced aiming to simulate fractions of glandular tissue (glandularities) in the range of 0 to 100 %. Such phantoms may be used to measure incident air kerma (Ki) and the glandular dose (Dg) delivered to the patients undergoing mammography. Aiming a characterization of the materials used to produce the phantoms, measurements of the attenuation coefficients to X rays at 17 keV were performed. The carbon-hydrogen-nitrogen (CNH) elemental composition and densities of the tissue equivalent materials were also determined so that the mass-attenuation coefficients could be calculated. Measured values of attenuation coefficients and densities of the breast tissue equivalent materials (BTE), as well as CNH composition, were compared with values available in the literature. Linear attenuation coefficients of adipose BTE materials for this photon energy agree with data presented in the literature but these coefficients for glandular BTE material are up to 22% lower than data presented by other authors. This indicates that ongoing actions are needed to improve the glandular BTE material composition. Finally, it is suggested the use of BTE phantoms in the place of polymethylmethacrylate (PMMA) phantoms to select exposure parameters (kV, mAs and target/filter combination) specific for each breast glandularity from 0% to 100 % in the optimization of doses in mammography.

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THE ROLE OF TOMOSYNTHESIS IN ROUTINE CLINICAL APPLICATIONS

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Tomosynthesis is a novel diagnostic method offering a quasi three-dimensional representation of an object. A number of low-dose projection images of the object are acquired from different angles. These images are reconstructed into a three-dimensional volume, from which individual thin slices can be studied. The influence of the overlapping tissue is suppressed and detection of lesions in the focus plane is enhanced. Over the last decade, a number of scientific papers have been published to explore the possibilities of this new technique. Even though the majority of scientific papers on tomosynthesis have focused on breast, the commercial introduction of dedicated breast tomosynthesis units has been slow, and it has only been available for purchase outside the US for approximately a year. Tomosynthesis has been available for general radiography for a few years, and especially for chest and skeletal imaging it is used in clinical routine in Swedish hospitals. Tomosynthesis has potential to significantly improve sensitivity and specificity in breast cancer screening compared to mammography. However, there are only a small number of clinical studies published which compare the performance of tomosynthesis and mammography in controlled settings. There are a few research groups that have started studies of tomosynthesis in a screening setting, but hitherto there are no papers published in scientific journals. A study comparing the sensitivity and specificity of breast tomosynthesis and conventional 2D digital mammography is running at Skåne University Hospital Malmö, Sweden. Based on expected differences in cancer detection with the two modalities, it is estimated that 15 000 women have to be examined, for obtaining statistically significant results. Currently, over 1300 women have been examined, and seven confirmed cancers have been detected. Experiences from the ongoing study will be presented, together with results from supplementary studies.

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IMAGE QUALITY ANALYSIS IN DENTAL CONE-BEAM COMPUTED TOMOGRAPHY

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Office-based cone-beam computed tomography (CBCT) has been used in oral and maxillofacial radiology practice. This article presents the limitations and potentialities in the development of QC protocols adjustable to different dental CBCT models. This assessment was based on the analysis of image quality parameters in different equipments, using standard procedures and maximum values provided by Brazilian regulations for multi-slice detector computed tomography (MDCT). CT number uniformity, noise level, high and low contrast spatial resolution were analyzed qualitatively and quantitatively in two equipments: i-CAT (Imaging Sciences International Inc., USA) and Planmeca 3D s (Romexis, Finland). Different attenuating objects were developed through rapid prototyping using ABSplus deposition for data acquisition. Uniformity was measured in 5 regions (central, left lateral, right lateral, anterior, and posterior). Lateral regions showed better results (5 HU) than posterior and anterior (15 HU), compared to 5 HU, maximum difference between CT numbers. Measured noise in a water phantom was lower for i-CAT (6.3%), than Planmeca 3D s (11.9%), exceeding 10% maximum noise. Low and high contrast, and spatial resolution were qualitatively analyzed using variable diameter holes and internal pattern visibility, produced by deposition. Image analysis showed that higher noise prejudiced low contrast resolution. Both equipments showed acceptable high contrast spatial resolution (1 mm). The main limitations for adapting MDCT procedures for CBCT quality control are: variety of gantry geometries; kVp and mAs limited range regulation; FOV differences; difficulties for using standard CT phantoms; lack of QC specific regulation for office-based CBCT. The study showed the high potentiality of ABSplus deposition for phantoms prototyping with variable and complex geometries and different densities, representing a flexible tool for the development of QC models for image quality analysis.

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SUBTRACTION OF MAMMOGRAPHIC IMAGES USING A CONTRAST MEDIUM

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The subtraction of radiological images acquired with different x-ray spectra (dual-energy) permits the emphasized visualization of an element of interest in the object of study. The technique is based on the non-linear dependence of the x-ray attenuation coefficients with energy and atomic number. On the other hand, the administration of a contrast medium CM -generally iodine-based- to the patient during some of the images to be subtracted offers the possibility of differential emphasis of the highly attenuating medium. Factors (other than biological conditions) that determine the image contrast are the x-ray spectra, the time when images are acquired and the subtraction procedure. This presentation reports results from a clinical protocol, carried out at the Mexican National Institute of Cancerology, aimed at optimizing the contrast of the CM in subtracted mammographic images of BIRADS 4 and 5 patients. We present the subtraction of series of images, obtained under a single compression with a GE Senographe DS digital unit. Mean glandular doses were kept below 6 mGy. The procedure requires “mask” images obtained at two energies (called low and high), the injection of CM and the acquisition of series of images with the high x-ray energy. During the offline analysis, images are subtracted either in dual- or single-energy temporal schemes. Subtracted images display the CM in vasculature and interstitial space near the lesion. The temporal series permits to obtain kinetic contrast curves. Preliminary results indicate different temporal patterns of CM uptake depending on the lesion being benign or malignant, and on the type of breast cancer. The optimization of the image subtraction technique will be discussed.

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ENHANCEMENT DETECTION OF MICROCALCIFICATIONS IN MAMMOGRAPHIC FILM IMAGES BY DENOISING AND IMAGE PROCESSING TECHNIQUES

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Purpose: Breast cancer is one of the most prevalent cancers among women. Mammographic radiology, as one of the primary studies, is used for diagnosis of breast tumors and defects. Mammographic images have some instinctive limitations like weak distinction in splitting cyst from tumor, over- dependence on film development and print stages, a relatively high dependence on proficiency of specialist physician, etc. For this reason, improvement the quality of mammographic images is very important. **Materials and Methods:** The suggested plans in this study are design and implementation of two software packages where their input includes high- quality, intermediate and or even very low quality mammographic images based on specialist physician's study while its output is composed of reduced noise and processed images that show the input images with higher quality and more details. In this study, mammographic images were initially converted into digital images and then to increase spatial resolution, reduce the noise, edge detection and consequently improvement of their contrast, two methods, means spatial and frequency domain methods were used. **Results:** In this research work, 120 mammographic images have been used. The purposed algorithms, search for a defect such as pile or calcification in abnormal zones so it could be deemed as an index for cancer diagnosis. The designed plans in this study characterize the areas with pile and or defects so that specialist physician could explore these zones more accurately and sensitively. A number of successful experiments validated our suggested algorithm. **Conclusions:** Through this research work, it is concluded that the frequency domain analysis is easier to implement as compared to spatial domain and also it is concluded that medical doctor diagnosis would improve and would be more accurate.

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DETECTION AND CLASSIFICATION OF BENIGN AND MALIGNANT MICROCALCIFICATION CLUSTERS WITH CELLULAR AUTOMATA IN MAMMOGRAPHY IMAGES

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Digital mammography is one of the most suitable methods for early detection of breast cancer. Existence of microcalcification clusters (MCCs) in mammograms is one of the earliest signs of breast cancer. 60-80% of breast carcinomas reveal MCCs upon histological examinations. The high correlation between the appearance of the microcalcification clusters and the diseases show that the computer aided diagnosis (CAD) systems for automated detection/classification of MCCs will be very useful and helpful for breast cancer control. Therefore, an intelligent classifier is required which can help radiologists to classify the suspicious areas and diagnose the breast cancer. This research work presents a new approach for classifying benign or malignant micro-calcification by using a high speed and low cost pattern classifier. The proposed classifier was built around a special class of sparse network referred to as Cellular Automata (CA). In the first step, the mammograms were de-noised. Then, the mammograms contrast was enhanced by using wavelet-transformation. To select the suspicious areas, Morphological operations and Threshold techniques were employed. Finally, to classify benign and malignant micro-calcifications on binary images the CA method was implemented. The suggested algorithm was tested on 47 mammograms, which were taken from Digital Database for Screening Mammography (DDSM). The performance analysis of the CAD algorithm was done by receiver operating characteristics (ROC) plot. Also, the validations of results by visual inspection were done by expert radiologist. The output results of the suggested algorithm were compared with the reports of medical radiologist physicians and demonstrated the accuracy of about 94%. Therefore, the suggested classifier was able to classify benign or malignant microcalcifications with a high accuracy amount and high speed. So, the suggested algorithm in this research work could be used for early detection of breast cancer.

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INVERSE PLANNING IN BRACHYTHERAPY

Victor Bourel

Optimization in Brachytherapy is used since early 30s when the first rules were imposed to obtain best results with this technique. Several decades later, with the arrival of Computerized Treatment Planning, optimization possibilities had great development, particularly in treatments with HDR Brachytherapy equipments. Until 2000 approximately all Treatment Planning for these equipments used only Forward Optimization, which consists in determining dwell times for dwell positions necessary to give the required dose in some dose points; frequently this points are defined from catheters or applicators independently of patient anatomy. Incorporation of 3D images in Brachytherapy lead in last years the development of Inverse Planning. Inverse optimization is an anatomy-based dose optimization, this means the construction of objective functions and penalty functions from target volume and organs at risk. The main benefit of the Inverse Planning approach is that all dosimetric requirements (dose coverage, dose homogeneity, organs at risk protection, etc.) are simultaneously and automatically taken into account in the planning process. This is different from forward planning where the dose distribution is iteratively adjusted by modifying the dwell times or the source positions until an acceptable dose distribution is produced. Different mathematical methods (deterministic and stochastic) have been used to solve the Inverse Planning problem in Brachytherapy. We can find in recent publications several systems (IPSA, HIPO, ARM, IPIP, etc.), some of them have been commercially implemented. Publications comparing results between Forward Planning and inverse Planning (specially in prostate and cervix) show a clear advantage for inverse planning in target dose coverage and organ at risk protection.

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IMPACT OF PHYSICAL DOSE RATE EFFECT ON THE LONG TERM RESULTS OF THE Cf-252 BRACHYTHERAPY OF CERVIX CARCINOMA

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Purpose : Evaluate effect of dose rate on the long term results after combined radiation therapy for stage IIB and IIIB of cervix uteri carcinoma. Materials and methods : In the period of 1994-1999 375 pts with cancer of cervix uteri stage IIB and IIIB received combined radiation therapy: Co-60 external beam therapy and gamma-neutron Cf-252 brachytherapy. During this period Cf-252 sources physical dose rate have reduced more than 4 fold. For isoeffect calculation the Riabuchin formulae was used. Results : Obtained data shows that Cf-252 gamma-neutron brachytherapy provides excellent results: 5 and 10 year survival was 75% and 68% for stage IIB and 56,6% and 50% for stage IIIB respectively. There was no statistically significant differences between overall survival for and 56,6% and 50% groups of patients treated in period 1994-1996 vs 1997-1999. Conclusions : Clinical results looks like confirmed the rightness of Riabuchin formulae.

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DOSE COMPUTATION FOR A ^{103}Pd STENT SOURCE USED IN INTRAVASCULAR BRACHYTHERAPY BY MONTE CARLO CODE

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Purpose: This study was designed to assess the suitability of a ^{103}Pd -implanted stent for use in intravascular brachytherapy. **Materials and Methods:** The doses given to the intima, media, and adventitia are very crucial quantities in IVBT. The Monte Carlo method was used to determine the dose rate distribution, using MCNP5 code. The stent source was modeled by a hollow cylinder of 1.7 cm length (2 mm diameter). Scoring voxels consisted of contiguous annular disk shells with 0.1 mm spacing in the radial direction and 0.2 mm spacing in the longitudinal direction. **Results:** In the plane containing the source axis, the Monte Carlo-generated doses in rectilinear coordinates are converted to polar coordinates. The dose rate constant $[D_0(r_0, \theta_0)]$, and radial dose function $[g_L(r)]$ were generated from these values and listed in tabular format. **Conclusions:** These parameters can be used in future treatment planning system for IVBT. **Keywords:** Intravascular • brachytherapy • Restenosis • Stent • ^{103}Pd • MCNP5

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EVALUATION CRITICAL DOSE OF RECTUM DURING HDR BRACHYTHERAPY IN TREATMENT OF CERVICAL CARCINOMA

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Purpose: The aim of this study was to assessment of actual dose delivered to rectum and compare with the calculation of treatment planning system (TPS). **Materials and methods:** We measured the dose delivered to the rectum by semiconductor diode detector (PTW/Germany) .The factors that influence diode response were investigated as well. Calibration factors of diodes vary with time weekly calibration was compared to investigate the influence of time on the accuracy of calibration. Then 40 applications of patients with cervix carcinoma were evaluated. Dose in rectum was measured by means of rectal dosimeter and compared to the calculated doses. **Results:** We investigated the differences between measurement and calculation of dose in this research. The mean difference between the TPS _calculated dose and the measured dose was 6.5% (range -22 to +39) for rectum. The TPS-calculated maximum dose was typically higher than measured dose. **Conclusion:** The study showed that main reason for difference was due to patients movement and applicators shift in the time lapse between imaging and treatment .It is recommended that in vivo dosimetry should be performed in addition to computation. In vivo dosimetry is a reliable solution to compare planned and actual dose delivered to organs at risk (OAR). **Keywords:** brachytherapy, in vivo dosimetry ,cervix carcinoma

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DOSES TO PATIENTS IN INTERVENTIONAL CARDIOLOGY

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There is growing concern about doses delivered to patients in interventional cardiology and more effort should be put in limiting the probability of radiation injuries and stochastic effects, with particular attention paid to children. In particular, repeated procedures on the same patient, might be in the range of deterministic effect. The aim of this study is to analyze doses, in order to increase awareness and discuss ways for optimization of the procedures and, when possible, limiting the fluoroscopy time (FT). The Catheterization Laboratory (Cath Lab) of the Heart Center at the University Hospital, Rigshospitalet, in Copenhagen, is equipped with seven angiography units, of most recent Philips and Siemens models. Each angiography unit has a dose area product (DAP) meter. A computerized clinical database of procedures is active as from 1998, including DAP values and FT. The Cath LAB is well equipped with personal dosimeters, lead aprons, lead eye wears and lead glass shields, for the workers. Data from more than 50.000 diagnostic coronary angiography procedures, more than 20.000 percutaneous coronary intervention (PCI) procedures, and more than 800 congenital heart disease procedures are available in the clinical database. Data related to the diagnostic procedures and the PCIs are analyzed separately, taking into account: patients' average age and gender, BMI, FT, DAP value, operator (level of experience) and the number of lesions in case of PCI. Doses to patients during PCI were statistically significantly related to body mass index (BMI) of patients and number of PCI lesions (PCI-complexity), as expected, but also to the different operators, and their experience levels. In addition, more than 800 congenital heart disease procedures; (circa 200 patients with more than one intervention) have been analyzed, dividing the patients into four age groups (1-364 days, 1-5 years, 6-11 years and 12-18 years). In conclusions doses to patients during cardiac interventional procedures seem to be within the "expected" dose range. However, a few percent of patients receive relatively high doses. Patients' BMI, procedures' complexity and operators' way-of-work are important factors; this last one, in particular, shows that there is room for improvement in the optimization of procedures and reduction of doses to patients and staff. Anyhow, doses should always be evaluated in relation to the clinical results, but in this case the clinical evaluation criteria are not easy to define. Doses to staff are monitored regularly without any major problem, due to the appropriate use of protection devices.

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EVALUATION OF PATIENTS-SKIN DOSE UNDERGOING INTERVENTIONAL CARDIOLOGY PROCEDURE

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In interventional cardiology (IC) the coronary angiography (CA) and percutaneous transluminal coronary angioplasty (PTCA) procedures are the most frequent procedures. Since the 1990s, the number of IC procedures has increased rapidly; it is also known that these procedures are associated with high radiation doses due to long fluoroscopy time (FT), large number of cine-frames (CF) acquired to document the procedure. Mapping skin doses in interventional cardiology is useful to find the probability of any skin injury, to detect areas of overlapping field and get a permanent record of the most exposed areas of skin. The purpose of this study was to estimate the maximum skin dose (MSD) in patients undergoing CA and PTCA, and comparing these with the reference levels proposed in the literature. Patients' dose measurements were carried out on a group of 38 patients at the hemodynamic department in four local hospitals in Rio de Janeiro, Brazil, using Gafchromic_ XR-RV2 films. In PTCA procedures, the median and third quartile values of MSD were estimated at 2.5 and 5.3Gy, respectively. For the CA procedures, the median and third quartile values of MSD were estimated at 0.5 and 0.7Gy, respectively. In this work we used the Pearson's correlation coefficient (r), and we found a fairly strong correlation between FT and MSD ($r = 0.8334$, $p < 0.0001$), for CA procedures. The 1Gy threshold for deterministic effects was exceeded in nine patients. The use of Gafchromic_ XR-RV2 films was shown to be an effective method for measuring MSD and the distribution map of the dose. The method is effective to identify the distribution of radiation fields, thus allowing the follow up of the patient in order to investigate the appearance of skin injuries.

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INVESTIGATION OF DOSES TO CARDIOLOGISTS IN HEMODYNAMIC INTERVENTIONAL PROCEDURES

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In cardiac X-ray procedures, exposure levels of the involved staff are higher than in conventional radiology due to the use of long fluoroscopy times and high dose rates, among other factors. Interventional radiology requires the operator and assisting personal to remain close to the patient, and thus close to the primary beam of radiation. The purpose of this study was to quantify the levels of radiation doses of physicians who performed cardiac catheterization procedures, angioplasty and electrophysiological studies. Staff radiation doses were estimated during cardiac interventional therapeutic or diagnostic procedures performed in Departments of Hemodynamic of three Hospitals in Rio de Janeiro, Brazil. To assess the physicians's exposure, thermoluminescent dosimeters LiF:Mg, Ti (TLD 100) were used. Personal equivalent doses, $H_p(d)$, at the physician's right and left wrists and left knee were estimated. $H_p(d)$ at the level of the chest and forehead were also estimated. In total, staff radiation dose was estimated for 59 coronary angiographies, 16 angioplasties and 6 electrophysiological studies. The average values of personal dose equivalent ($H_p(d)$), in mSv, for main cardiologist in coronary angioplasty procedures are 0.43 (chest), 0.16 (forehead), 0.66 (left wrist), 0.34 (right wrist) and 1.33 (left knee). For percutaneous transluminal coronary, are 0.37 (chest), 0.13 (forehead), 0.48 (left wrist), 0.23 (right wrist) and 1.13 (left knee). One way to optimize the protection of staff is the implementation of basic and continuing training in radiological protection.

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EVALUATION OF STAFF RADIATION DOSE IN CARDIAC CATHETERIZATION

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The objective of this study was to determine the patient and staff doses during cardiac catheterization procedures and to estimate the risks associated with this exposure in Ahmed Gasim Hospital in Khartoum Bahry- Sudan. The measurements involved 50 operations. The dose received by the medical staff was measured using TLD chips (LiF: Mg, Cu, P). Dose Area Product (DAP) was used to calculate the patients radiation dose. The main operator and the rest of the staff received 0.14 and 0.01 mSv per procedure, giving rise to an estimated annual effective dose of 17.67, 6.3 mSv per year, respectively. Occupational dose to the cardiologists was much lower than the relevant statutory dose limits. The monitoring of radiation workers is not established properly. It is obvious that high patient and staff exposure is due to the lack of experience and protective equipments.

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MAGNETIC MONITORING OF CARDIAC VALVES PROSTHESIS

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This work has the purpose of developing an experimental model for monitoring the behavior of cardiac valves prosthesis. Our main goal is to detected failures before it compromises the patient that already has a prosthetic heart valve manufactured with a magnetic material attached in its leaflets, using an un-invasive method.

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IMAGING REGULAR PHANTOMS THROUGH ACB TOMOGRAPHY

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During the last decades much research effort has been done to produce a tomography system capable of detecting the electromagnetic properties of matter using non-invasively and contactless resources. AC Biosuseptometry, that developed originally to evaluate animals and humans gastrointestinal tract functional aspects, is now proposed to act as a tomography system based to measure the response of high susceptibility regular shaped phantoms. We employed a 13-channel AC Biosusceptometer coupled to a compensation coil and a driving system to dislocate the sample while its response to the excitation magnetic field was digitalized and stored on a computer. Finishing the scanning task the signal was processed, resulting on sinograms that allowed us to reconstruct images using filtered backprojection on MatLab (Mathworks Inc.). For simplest geometries (one and two bars), it was necessary only one channel to reconstruct an acceptable image but we needed to employ multiple channels to reconstruct more complicated geometries (triangle and square). For all cases, the final image presented good signal-to-noise resolution and allowed us to determine the position and shape of the phantom, despite some distortions due the divergent behavior of magnetic field. In the future, these preliminary results can be expanded to more elaborated in vitro situations (irregular phantoms) or small animals.

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NEURONAVIGATION SOFTWARE FOR TRANSCRANIAL MAGNETIC STIMULATION

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Transcranial magnetic stimulation (TMS) is a non-invasive technique used for cortex mapping, psychiatric diseases treatment and general brain studies. For TMS application it's necessary to hold the stimulation coil on the subject scalp above the cortex region of interest. To avoid the subjective positioning and operator dependences, neuronavigation software have been used to precisely localize structures in the brain relative to the coil. These systems are composed by spatial tracker devices and algorithms that co-register the subject's real position with his or her tomographic images. However, due to its cost and other issues, this technology is not widely accessible. In order to overcome these difficulties, we have adapted InVesalius medical imaging software so it could be used as a neuronavigator system, all the work being open-source, multiplatform and freeware. After these modifications, the software has become capable of communicating with three different tracking systems, two electromagnetic from Polhemus, ISOTRAK II and PATRIOT, and one optical from Claron Tech., model MicronTracker MTC 3.5. InVesalius does the co-registration by capturing the fiducial points with a spatial localizer and the respective coordinates in the tomography images. The user interface is composed by four visualization windows: sagittal, coronal and axial slices, and a volumetric reconstruction, despite the control panel used to manage configurations. The software also allows the user to add markers above the image to support the coil positioning. These markers may assume several colors and sizes in the volumetric window to represent different operations. Their coordinates can be saved and reloaded, and the data can be exported in ASCII format, making possible to work with other programs and create functional brain maps. Thus, the objective to assist TMS applications with the InVesalius Neuronavigator was achieved.

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ANALYSIS OF THE BOLD RESPONSES ON EEG-FMRI ACQUISITION IN PATIENTS WITH EPILEPSY

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The technique of magnetic resonance imaging (MRI), characterized by high spatial resolution, associated with electroencephalography (EEG), characterized by high temporal resolution, can be a powerful tool to study neurological disorders, including epilepsy. Electroencephalography is a mechanism to record electrical brain activity, using principles of electronics, physics and physiology. Functional MRI (fMRI) relies on the different magnetic properties of blood depending on its oxygen content. The goal of functional imaging is to obtain images that are sensitive to brain function. To this end, we aim to understand the mechanisms of neural activity and the processes related to it. This paper describes the methodology of the combined EEG-fMRI method in a tertiary hospital, and assesses the results of 16 exams regarding their concordance with the clinical history, and clinical applicability of the technique. The results of the exams were analyzed statistically with the software SPM8. BOLD responses were analyzed considering the clinical history of each volunteer. The studies that showed statistically significant activation areas consistent with clinical history were considered compatible (seven exams) while the studies with results not consistent were considered incompatible (one exam). Six compatible exams were considered clinically relevant because they add information regarding the definition of the epileptogenic zone or epileptic syndrome. The studies with absence of epileptiform activity on EEG (three exams) or significant BOLD activations (three exams) were considered null. Two exams were excluded due to excessive head motion. EEG-fMRI is a promising technique that can be important to improve the understanding of neurological disorders, including epilepsy. The method may be used in the future as an important diagnostic tool for refractory epileptic patients as it may add information about the localization of epileptogenic zone or definition of epileptic syndrome.

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INTERICTAL SPIKES LOCALIZATION USING EEG DISTRIBUTED SOURCE LOCALIZATION AND SIMULTANEOUS EEG-fMRI

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Different reports have showed concordance between EEG source localization and EEG-fMRI in order to analyze where the interictal epileptiform discharges (IED) are generated. This agreement is partial because both techniques show limitations and measure different physiological phenomena. Several methods have been tested looking for a more accurate approach since this information could be important in the pre-operative evaluation of epilepsy. In this work we investigated the concordance between EEG source localization using distributed source model (DSM) and simultaneous EEG-fMRI of IEDs. Three patients with temporal lobe epilepsy (TLE) and different video-EEG lateralization (left, right and bi-temporal) were selected. The scalp EEG was recorded in a 32-channel system and fMRI acquisitions were in 1.5 and 3.0T MR-scanners. In order to evaluate the wide spreading of the spikes, 3 time positions were chosen in the averaged spike using the maximum root-mean-square across channels. The Bayesian Model Averaging was used for solving the EEG inverse problem in the time domain, reporting the primary current density. Conventional event-related fMRI analysis was performed from the timing of spikes defined by a neurophysiologist resulting in t-score maps. A lobar agreement was observed between both techniques in all cases. The fMRI activation shows more extensive area, except in the right TLE case that was more restrict. The inverse solutions in different times illustrated certain propagation patterns of temporal spikes. The Euclidean distance (E_d) between the maximum values of primary current density and t-score were 42mm (left-TLE), 29mm (right-TLE), 20mm (left, bi-TLE) and 24mm (right, bi-TLE). Previous studies using equivalent current dipoles (ECD) have reported average E_d greater than 30mm between ECD location and the nearest fMRI voxel suggesting that DSM could be more appropriated. Indeed, the results indicate better EEG-fMRI concordance and suggest the use of both techniques as complementary tools in the pre-operative evaluation of TLE.

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NUCLEAR TRANSVERSE RELAXATION TIMES OF WATER AND FAT IN NON-ALCOHOLIC FATTY LIVER

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Non-alcoholic fatty liver disease (NAFLD) is one of the most common causes of chronic liver disease. NAFLD is characterized by intracellular accumulation of triglycerides in hepatocytes, i.e. hepatic steatosis. Magnetic resonance spectroscopy (MRS) is very precise and non-invasive method for lipid quantification in tissues. Several studies has been used this technique for fat quantification in patient with liver diseases, but few works had estimated the nuclear transverse relaxation time (T_2) of fat and water components. In this study we estimated these T_2 values and fat content in the liver of patients with hepatic steatosis. Magnetic Resonance Imaging was performed with a 3.0-T scanner (Achieva, Philips) in 23 patients (46 10 years, 9 females) with NAFLD in different stages. The MRS data from a single voxel ($3 \times 3 \times 3 \text{ cm}^3$), positioned in a homogeneous region of the liver, were acquired using PRESS sequence ($TR = 1600 \text{ ms}$, 2048 points, 1.5 kHz bandwidth, 16 averages) with multiple TE (32, 45, 60, 80, 135 ms). The AMARES algorithm in jMRUI software was used to determine the peak areas (water and CH_2 -fat). The data was fitted to single exponential decay curves in order to calculate the T_2 values. The T_2 values of water (27.3 5.4 ms) showed little variation between patients, suggesting not influence of the disease in the magnetic micro-environment of the water molecules. These values are not noticeably decreased indicating no iron deposition. The T_2 values of lipid (68.4 14.1 ms) showed a wide variation among individuals as expected from the patient diversity. However no correlation ($r^2 = 0.25$) was found between T_2 and fat content. Only a tendency was observed indicative of that a high fat content helps to a more efficient relaxation mechanism. No correlation between both T_2 values was founded.

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METABOLIC CHANGES IN HUMAN VISUAL CORTEX CAUSED BY PHOTIC STIMULI USING ³¹P-MRS

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The present work is a pilot study, where we attempted to assess variations of the main resonances present in a brain ³¹P-MR spectrum (GPCh, PCh, β -ATP, α -ATP, γ -ATP, PCr, Pi, PE, NAD+NADH and GPE) with two different paradigms using visual stimulation. MRS data were obtained with two identical 3.0T scanners (Achieva, Philips, The Netherlands), situated in the two institutions involved in the study. A surface-coil was used to acquire the signals from the occipital cortex. A non-localized sequence with an excitation adiabatic pulse, a NOE pulse and decoupling was used. Two paradigms were tested: Short protocol - 3 blocks off and 2 blocks on (off-on-off-on-off) of 1.5 min each (3 spectra/block), tested on 7 healthy subjects; Long protocol - same as the short one, but with each block lasting 5 min (10 spectra/block), tested on 7 healthy subjects. The visual stimulus consisted of a radial black-white checkerboard flickering at 8Hz. Spectra were processed using the jMRUI software. In both protocols there was an increase of GPCh and decrease of NAD+NADH in on blocks compared to off blocks. The calculated PCr/Pi ratio was smaller in on blocks in comparison to off blocks (78% for the short protocol and 93% for the long protocol), indicating the PCr fast response to stimulation as an ATP source for short periods. The other metabolites analyzed showed no significant variations between blocks. Higher fields and more sensitive coils would be necessary to improve temporal resolution and detection of lower metabolic variations.

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MATERIAL CHARACTERIZATION AND VALIDATION TO USE AS NON- ANTHROPOMORPHIC BREAST PHANTOM ON MRI ACQUISITIONS

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The main objective of this work is to define a simulator for mimic breast tissues on signal intensity and/or contrast for magnetic resonance images that can be easily manipulated. The purposed materials for simulator were characterized on T1 and T2 and the images generated were segmented. The T1 and T2, calculated by Osirix and Imaj software, were averaged and its values were compared to the T1 and T2 published and validated. The fat pork and silicone has good results for the phantom. The segmentation was performed by two different persons and the variation on the volumes was calculated.

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LOW CURRENT DETECTED BY MRI: A DISCUSSION ABOUT THE SIMULATED AND EXPERIMENTAL RESULTS

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Several groups have been detected variations of Magnetic Resonance (MR) signal in vitro and in vivo experiments due to the existence of low electric currents. Two main approaches have been used based on different effects: Ampère's Law (magnetic effect) and Lorentz Force (mechanical effect). Both effects have been discussed separately in each methodology but they are present together in this kind of experiments. In this work we evaluated the influence of mechanical effect in a magnetic field sensitive experiment with low current phantoms. We carry out a comparison of MR signal obtained in current phantoms formed by copper wires and filled with solutions of equal magnetic permeability, nevertheless different viscosities (liquid and gelatin). By the wire was passed a squared wave pulse with 60 μA intensity in a 250 mHz frequency (2s off /on cycle). We acquired 400 dynamics single-shot EPI scans (TR/TE =100/33 ms, resolution 0.9x0.9x4 mm) for each condition in a 3T scanner (Achieva, Philips). Theoretical simulation of magnetic field distribution on the magnitude and phase signal was made considering the wire position inside the voxel and the susceptibility effects. The minimum values calculated in simulation for different wire's positions were 1% for magnitude and 5° for phase images, and the maximum values were 2% and 9°, for liquid phantom. These values cannot explain the signal loss detected in magnitude and phase images that were: 18 % and 11° (liquid); 2% and 8° (gelatin), respectively. We also simulated a condition that the wire had a displacement into the voxel when the current was turn on, obtaining 8% and 8° for magnitude and phase signals, respectively. The results suggest a small wire displacement due to Lorentz force in magnetic field sensitive experiments. We conclude that the mechanical effect could be dominant in very low current and low viscosity phantoms.

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REPRODUCIBILITY OF FRACTIONAL ANISOTROPY IN A 3T MR SCANNER

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The reproducibility of Fractional Anisotropy (FA) was estimated between two immediate acquisitions and between two acquisitions separated by 19 days in average in a sample of nine healthy volunteers. The Variation Coefficient (VC), Repeatability Coefficient (RC) and Intraclass Correlation Coefficient (ICC) were calculated in a voxel-wise fashion for both short and long terms, and then averaged for white matter skeleton, whole brain and for the tracts defined by the John Hopkins University Tractography Atlas. In white matter skeleton, for short term procedure: VC = 0.121, RC = 0.109, ICC = 0.750; long term procedure: VC = 0.144, RC = 0.128, ICC = 0.732. In whole brain, for short term procedure: VC = 0.088, RC = 0.100, ICC = 0.997; long term procedure: VC = 0.196, RC = 0.117, ICC = 0.760. The CV value for left and right corticospinal tract was the minor value obtained for all tracts studied (in both short and long term procedure) and its ICC value was the major value obtained for all tracts, for short term procedure: VC (left, right) = 0.053, 0.061, ICC (left, right) = 0.998, 0.998, and for long term procedure: VC (left, right) = 0.115, 0.136 and ICC (left, right) = 0.729, 0.724. The values obtained for the different coefficients show a good reproducibility for the FA in short and long terms. Reproducibility in long term is slightly smaller than in short term procedures, evidencing the variability of biological effects.

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EVALUATION OF BONE REGENERATION THROUGH ELECTRON SPIN RESONANCE SPECTROSCOPY - EXPERIMENTAL STUDY IN RABBITS

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Electron spin resonance (ESR) is a spectroscopic technique that detects unpaired electrons, such as the ones present in free radicals. Some of them are not naturally present in bone tissue, but can be induced by ionizing radiation. When a calcified tissue is irradiated, free radicals are generated, among them, the CO_2^- . This radical is stable and is present in the inorganic matrix of calcified tissues, Hydroxyapatite. This paper presents the application of this spectroscopic technique for monitoring bone mineralization processes during the bone repair in animal model, induced by polyurethane Poliquil® in two forms, as an occlusive membrane and as a bone grafting. In the first experiment of Guided Bone Regeneration (GBR), 18 rabbits underwent surgical procedure of craniotomy to create a defect 15 x 5mm in the skull. In the treated group (N = 9), two membranes were adapted, one in contact with the dura mater and the other, in the surface defect. In the control group (N = 9) the defect remained filled with clot. In the second experiment, 9 animals underwent the same surgical procedure and the defect was treated with 50mg of polyurethane pellets in association with clot. After 30, 60 and 120 days post surgery, three animals from each group were euthanized and specimens containing bone defect prepared for analysis by microscopy and ESR. In the first experiment of GBR, the ESR and microscopic results demonstrate centripetal bone growth and advanced stage of bone regeneration in the treated group. In the second experiment, the ESR spectrum of collected bone pieces presents the superposition of the spectrum of the biomaterial and the radical CO_2^- . The separation of the components was made using spectral simulation and the percentage of mature bone tissue in the defect region was determined through the comparison with the spectrum of the native bone.

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MAXIMUM LIKELIHOOD EXPECTATION MAXIMIZATION RECONSTRUCTION USING SELECTED PROJECTIONS IMPROVES IMAGE QUALITY IN MYOCARDIAL SPECT

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Description of purpose; In Tc-99m tetrofosmin/MIBI myocardial SPECT, the tracer is actively taken up by the liver and the gallbladder, and that causes artifacts in the apex and the infero-posterior wall of the heart. Maximum likelihood expectation maximization (ML-EM) reconstruction that excludes projections with high liver and gallbladder counts may reduce these artifacts. To validate this approach, we performed phantom and clinical studies. Materials and methods; The ML-EM method can reconstruct SPECT images from imperfect projection data. We modified the usual ML-EM method to exclude projections with high liver and gallbladder accumulation that overlaps myocardial uptake. In the phantom study, the Tc-99m concentration in the myocardium, the liver, and the gallbladder was set in the proportion of 1:1:2. As a control, all projection data were used and there was activity only in the myocardium. We compared pixel count ratios of infero-posterior (IP) and anterior (A) regions using images generated under the various conditions. In the clinical study, Quantitative Gated SPECT with Tc-99m tetrofosmin was investigated. The IP/A ratios of both methods were compared in 20 cases. Results; For the phantom study, the IP/A ratio of the reference image was 87.9%. In the case of radioactivity in the myocardium and the liver, the IP/A ratio with all projection data was 90.7% but 87.5% using only the selected projection data. In the clinical study, the IP/A ratio of the improved average were 18.7%. In the one patient, overlapped high accumulation was observed in the projection data from RAO30° to RPO60°, and from LAO30° to LPO72°. The IP/A ratio with all projection data was 130.5% but only 113.6% using only the selected projection data. Conclusions; The ML-EM reconstruction from selected projections reduces myocardial artifacts caused by high accumulations in the liver and the gallbladder of Tc-99m tetrofosmin.

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PRIMARY STUDY TO COMPARE RECONSTRUCTED CARDIAC SPECT IMAGES WITH RESOLUTION RECOVERY ALGORITHM TO CONVENTIONAL ITERATIVE ALGORITHM

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Abstract— The aim of this primary study is to compare the diagnostic quality of cardiac SPECT images acquired with both standard acquisition time and half acquisition time, reconstructed with conventional iterative algorithm and resolution recovery algorithm, respectively. 10 myocardial perfusion images were acquired in a CardioMD gama camera (Philips): 32 projections, 25 sec/projection, 64x64 matrix size, for standard time acquisition. The same patients were imaged with half acquisition time (12 sec/projection). The images acquired with standard acquisition time were reconstructed with the iterative filter Maximum Likelihood Expectation Maximization (MLEM) with 8 iterations, while those acquired with half acquisition time were reconstructed with a resolution recovery system developed by Philips (Astonish). The images were evaluated by 4 expert physicians from the cardiovascular nuclear medicine facility of *Fundação Bahiana de Cardiologia*. The images were delivered to each physician as if they were from 20 different patients in order to make their perfusion diagnoses. The comparison between the images reconstructed by both methods showed a concordance of 82,5% ($k=0,63$). Key words: — Astonish, reconstruction method, half acquisition time, resolution recovery.

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DEVELOPMENT OF ANTHROPOMORPHIC CIRRHOTIC LIVER PHANTOMS FOR NUCLEAR MEDICINE

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Nuclear medicine is a specialty that uses tools and procedures for radiopharmaceuticals and physiological study of invasive and noninvasive. In quality control tests generally used radioactive material inside the phantom for the evaluation and optimization of scintillation camera parameters for calibration of equipment for health professionals training with regard to the analysis of parameters and image reconstruction the capability of displaying images obtained through the injury. Some of these phantoms, like the one Jaszczak, for example, are effective for use in procedures for quality control systems the SPECT and PET. In this study, we sought to develop three phantoms for use in quality control and professionals training, and could serve for analysis of liver cirrhosis scintigraphic obtained in SPECT and PET systems. The first anthropomorphic phantom developed represents a liver with advanced cirrhosis, which consists of three hemangiomas, the second has not signify a hemangioma and liver cirrhosis intermediate grade and the third one represents the lowest degree of liver cirrhosis in which is included three hemangiomas. For analysis, the image acquisitions were performed with matrix 64 x 64, 128 x 128, 256 x 256 and 512 x 512, a distance of 5, 10, 15 and 20 cm between the surface of the phantom and detector energy window of 5, 10, 15 and 20% and count statistical of 100, 250, 500 and 1000 cpm. The results showed that the images obtained are similar to those with equivalent degrees of liver cirrhosis when such images were acquired with a distance of 15 cm from phantom-detector matrix and 256 x 256. It is noteworthy that even with restrictions on choice of matrix, distance, energy window and count statistics, the images are satisfactory for the optimization of quality control and professionals training in nuclear medicine.

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PHYSICS QUALITY ASSURANCE WITHIN AN ISO 9001:2008 NUCLEAR MEDICINE QUALITY FRAME

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Quality assurance in nuclear medicine departments is described in several international protocols, and should ideally be part of an integrated strategy of global departmental search of excellence. The Nuclear Medicine department in Hospital General Universitario Gregorio Marañón is running an ISO 9001:2008 quality system comprising every aspect of its activities. Imaging quality assurance activities are one of several integrated processes. This work develops the results of this approach and the reasons for its advisability.

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PERFORMANCE OF THE PHILIPS GEMINI TF LYSO SYSTEM ACCORDING NEMA NU 2 2001

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The performance measurements results for Gemini TF non-time-of-flight LYSO PET/CT scanner are presented according National Electrical Manufactures Association (NEMA) NU 2-2001 standards and compared with the NEMA NU 2-2001 factory results. All performance values measured except the timing resolution (as expected due time-of-light capabilities) were similar for GEMINI TF time-of-flight scanners although the data from low-activity acquisitions were not corrected for the LYSO background events because the reference values provided by manufacturer were based on NEMA NU-2001. The maximum values of NEC rates were achieved at clinical range. The results indicate that the scanner has very good overall performance and within manufacture specifications.

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DEVELOPMENT AND EVALUATION OF STANDARD OPERATING PROCEDURES (SOPS) FOR QUALITY CONTROL TESTS AND RADIOLOGICAL PROTECTION ACTIVITIES IN A NUCLEAR MEDICINE SERVICE

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The quality management in nuclear medicine services is a requirement of national and international standards. The Brazilian regulatory agency in health surveillance, the *Agência Nacional de Vigilância Sanitária*, in its *Resolução de Diretoria Colegiada Nº 38*, requires the elaboration of documents describing the technical and clinical routine activities. This study aimed to elaborate, implement and evaluate Standard Operating Procedures (SOPs) for quality control tests and radiological protection activities in the nuclear medicine service of a university hospital. Were developed 18 SOPs involving tasks related to dose calibrator, gamma camera, Geiger-Müller detectors and radiological protection activities. The performance of its application was evaluated for a period of 6 months. Was observed reduction in 75% of reported operational errors and 42% of the number of reported incidents with contamination by radioactive material. The SOPs were adequate and successful in its application. New procedures involving clinical activities will also be developed and evaluated. Keywords— quality management, nuclear medicine, standard operating procedure.

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LEVEL OF OCCUPATIONAL EXPOSURE DURING DAILY WORK IN A NUCLEAR MEDICINE DEPARTMENT

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Workers in Nuclear Medicine Department have a exposition geometry very complex. The source of irradiation is not collimated and irradiated for all direction, interaction with many structural tissue inside the body before could be detected outside. The professional who work in a nuclear medicine department this is exposure for all this condition and different energies. This work proposes a good approach to estimate the mensal dose level according the dose rate during our daily routine. To measurement the dose rate we used an ionization chamber Babyline 81 and choose the most frequent exams using ^{99m}Tc . A previous study was conduct to determine the most frequency exams made in the nuclear medicine department at central army hospital in Rio de Janeiro and previous ambient monitory do determine place with higher exposure could be interfere in the measurement of this work. The Renal Scintigraphy with DTPA an average dose rate was $(2.50 \pm 0.25) \mu\text{Sv/h}$, for Renal Scintigraphy with DMSA was $(1.20 \pm 0.25) \mu\text{Sv/h}$, for Bone Scintigraphy using two different protocols was $(2.63 \pm 0.30) \mu\text{Sv/h}$ and $(3.09 \pm 0.30) \mu\text{Sv/h}$. Exposition during elution, dose preparing and clinical procedure was considering a critical moment in the daily routine of the employee. The dose rate obtained in this study demonstrated the professional cannot exceed the public dose limit in one day of our work routine and for the radioprotection department this is a good approach to make a radioprotection plan the nuclear medicine department.

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MEASUREMENTS OF RADIATION DOSE TO PATIENTS AND STAFF DURING THYROID SCAN

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Nuclear medicine staff members may receive a significant radiation dose during nuclear medicine procedures. The objectives of the current study are to (i) quantify and to evaluate both patient and staff entrance surface doses associated to selected organs by direct thermoluminescent dosimetry (TLD) during thyroid scan procedure (ii) identify the dose delivered to the parotid, lenses and salivary glands during the thyroid scan. A total of 45 patients with thyroid goiter and the staff (Technologist) were considered in this study. The mean patient's surface doses for forehead was 0.10 mGy, salivary gland was 0.09 mGy and thyroid surface dose was 0.10 mGy per procedure. The staff radiation dose was 0.20 for hand, 0.08 mGy for the chest, and 0.07 mGy for the forehead. These results revealed that staff radiation doses were higher than those published in the literature. This may be attributed due to the high activity administered to the patient compared to the international protocols.

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PROJECT OF AN APPLICATION TO ASSIST PRESCRIPTION AND DISPENSING OF ¹⁸F-FDG DOSES

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Introduction: PET/CT (Positron Emission Tomography/ Computed Tomography) uses radiotracers of short half-life, and the Fluorine-18, whose half-life is 110 minutes, is the most used in the form of ¹⁸F-FDG (Fluorine-18-Fluoro-deoxy-glucose). Moreover, in Brazil, most of the PET/CT centers purchase radiotracers produced in a different location from where it is used. Due to the rapid decay of ¹⁸F-FDG and high costs from its acquisition and transport, it is helpful introducing a computer-based application that implements the logistics of using the radiotracer, making the prescription and fractionation of doses more quickly and efficiently. Methods: Via Excel software (Microsoft®), was developed a spreadsheet, where the user enters activity, time and volume of the ¹⁸F-FDG multiple-dose vial received by the nuclear medicine department, as well as the mass of each patient, the factor activity/mass for a weight-based injected activity and the time set for each injection. The spreadsheet calculates the activity and volume to be prepared for each patient and the activity and volume available after each injection. The tool is being tested for three months in a PET/CT department in Ribeirão Preto-SP. As this work is still in progress, the next step is to validate the tool and make it available to other PET/CT centers. Results: Experience with the implantation of the tool showed optimization of the use of ¹⁸F-FDG by planning ahead the fractionation of administered doses. The users opined that it improves the utilization of the radiotracer, may decrease the cost with acquisition of unnecessary additional doses, and potentially reduce the time spent with handling the radioactive material. Conclusions: Implementation of a system for calculation of doses involves optimization of: 1) costs to doses purchased; 2) amount of radiotracer administered to each patient; 3) exposure of the staff to Fluorine-18 radiation while handling ¹⁸F-FDG.

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EVALUATION OF EFFECTIVE HALF LIFE OF IODINE 131 IN PATIENTS UNDERGOING RADIOIODINE THERAPY

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The main therapy performed in nuclear medicine is the radioiodine, which uses iodine-131 for treatment of patients with thyroid cancer, in order to end all remaining thyroid tissue possible that there were surgically removed and still treat the metastatic potential in existing other body organs. Administration occurs through ingestion by the patient's iodine-131 in liquid or capsule form. From this, the radioactive material will be distributed by the patient's body, located mainly in the residual thyroid tissue. According to the standard CNEN - National Commission of Nuclear Energy, NN 3.5 - Requirements for Radiation Protection and Safety for Nuclear Medicine Services, with activities in excess of 30 mCi is administered, the patient must stay in isolation for radiation protection. In this study, we sought to determine the mean effective half life of patients undergoing radioiodine therapy. We analyzed 20 patients during treatment, which measures the rate of exposure to one meter in height of the patient's cervical region, were collected. It was also used a screen with a thickness of two mm of lead, where fees were collected with screen display (display only the cervical region) and without the screen (whole body exposure) in front of the patient. For this, we used a radiation detector Geiger Muller, brand MIR 7026, calibrated at DEN - UFPE, and considered the patient's body as a point source. Through the exposure rates were calculated activity accumulated in the body and neck of the patient. From the data, was drawn a curve showing the decay of activity in the patient's body over time in both parameters measured. Thus it was possible to find the contribution of the concentration of iodine-131 in the patient's body, besides the contribution of the cervical region to find the effective half life. With the average decay curve of activity versus time, it was possible to calculate the effective half life of iodine 131 patients, yielding (13.2 ± 0.2) h.

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DOSIMETRIC EVALUATION DUE TO RADIATION IN THYROID ISSUED BY Tc^{99m} AND I^{131}

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Using the scheme MIRD and the representation Cristy-Eckerman for the thyroid of an adult, one determines his dosimetric contributions of the emissions of the Tc^{99m} and of the I^{131} . The results show: (1) The absorbed dose to the gland due to emissions of Tc^{99m} (pertechnetate) is $2,34 \times 10^{-2}$ mGy/MBq, where 92,3% of the dose corresponding to the local energy deposition due to electrons conversion (70,4%), Auger electrons (4,2%) and 17,7% corresponds to self-dose due to gamma photons (15,6%) and characteristics radiation (2,1%). Dosimetric contribution due to source organs of the biokinetics, except the thyroid, is 7,6% significant value to be ignored. (2) The absorbed dose to the gland due to emissions of I^{131} (iodide) is $3,41 \times 10^2$ mGy / MBq, where 99,74% of this dose corresponding to the local energy deposition due to beta emissions (90,12%), the conversion electrons (3,87%) and Auger electrons (0,02%), and the remaining (5,73%) corresponds to autodosis due to gamma photons (5,53%) and characteristics radiation (0,2%). The contribution dosimetric organ biokinetics remaining source is negligible. Conclusion: There are significant differences in the estimated doses, due to local energy deposit of Tc^{99m} (pertechnetate) in the thyroid, with respect to the tax organ dosimetry biokinetics sources (except the thyroid) to ignore; While the contribution dosimetric organ biokinetics source for the gland is not significant when you use the I^{131} (iodide). So, depending on the radiopharmaceutical used and its biokinetics shall significance of their contributions.

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3D DOSE VERIFICATION OF I-131 DISTRIBUTION USING POLYMER GEL MAGIC-F AND NMR

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The polymer gel dosimetry is an efficient dosimeter for three-dimensional verification, in radiotherapy is useful for verification of complex fields and quality control of linear accelerators. In nuclear medicine this tool is little known, some factors that contribute for this complexity of gel manufacturing and reading the information, but the gel is the only dosimeter capable to study a three-dimensional distribution of dose with higher resolution. This information is very important in the new nuclear medicine where the possibility of incorporate nanoparticle with radiopharmacy to increase the local dose. In this study we used a MAGIC-f polymer gel. The gel was irradiated using a 100.0 mCi source of an Iodine-131. To obtain the internal dose distribution around the source we made a phantom of gel where the source was positioned in the center and was irradiated during 3 hours and to verification the dependence of MAGIC-f to the dose rate, we expose the gel in a geometry where variation the distance tube-source during a 12 hours of exposure. The gel exposure during 3 hours, the absorbed dose near source was 17.0 Gy and for external exposure the higher dose was 7.8 Gy and the gel no sensitized for low rate dose under 0.27 Gy/h. This study demonstrated the versatility to polymeric gel dosimeter using MAGIC-f to study the internal dose distribution and enabling of theory dosimeter calculation due Monte Carlo simulation or MIRD tables. This study demonstrated the versatility of polymer gel dosimetry using MAGIC-f as a detector to check the internal dose distribution and a new possibility of experimental verification for theoretical dosimetry using iodine-131.

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PATIENT'S RETAINED ACTIVITY IN NEUROENDOCRINE TUMORS TREATMENT WITH [¹⁷⁷LU, TYR³] OCTREOTATE

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Cancer treatment is one of the main focus in medicine where nuclear medicine specialty has a important role using unsealed radioactive sources, projecting new perspectives of palliative treatment and even full healing. Workers involved in different procedures during handling are being exposed to radiation as anyone surrounding the patient. The treatment of neuroendocrine tumors using ¹⁷⁷Lu DOTATATE still does not have standard rules or procedures in Brazil and has being used in an experimental manner. This present work was performed to estimate the retained activities and to provide guidelines and rules aiming the radiological protection of the workers, caregivers and general public. The procedures were followed by using two types of radiation detectors, a Geiger-Müller and a NaI scintillator, at different distances from the source. The measurements were taken in a public hospital at Rio de Janeiro. The patients retained activity after 24 hours reaches high values up to 70% of administrated activity and the hospitalization is recommended until the dose rate falls, at 1m distances, to 20µSv/h, corresponding to approximately 1850MBq (50mCi). If the patient is not hospitalized the dose constrain for the total treatment will be crossed and hit 6.8mSv, above the brazilian limit of 5mSv.

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INFLUENCE OF ELEMENTAL WEIGHT OF HUMAN TISSUES ESTIMATED BY ICCT SOFTWARE IN ABSORBED DOSE CALCULATION

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Therapeutic use of radiopharmaceuticals in Nuclear Medicine has been well established and presented good success rates against many forms of cancer. The biologic effects of radionuclide therapy are measured via a physical quantity, the absorbed dose, which is defined as per unit mass of tissue. Therefore, is of great important an accurate dosimetry to assess the potential effects of treatment and to confirm or contradict the treatment predictions. The most common method used to estimate the absorbed dose at organ level was developed by Medical Internal Radiation Dose (MIRD) Committee, called MIRD system. However, this method does not have adequate patient data to obtain a dose estimate accurate in therapy. In recent years, internal radionuclide radiation dosimetry system evaluated spatial dose distribution. This system is based in Monte Carlo radiation transport codes together with anatomical and functional information of the patient. The high accuracy is, at least in part, due the Monte Carlo method to allow human tissues to be characterized by elemental composition and mass density. Thus, a reliable estimating of human tissues (elemental composition and mass density) must be obtained. According to Schneider, Bortfield and Schlegel the tissue parameters (mass densities (ρ) and elemental weights (ω_i)) can be obtained using Hounsfield units provided from CT images. Based on this, the Nuclear Engineer Center of IPEN developed the ICCT software (Image Converter Computed Tomography). It converts CT images in tissue parameters (mass densities (ρ) and elemental weights (ω_i)). This work was intended to verify if the estimate values by software ICCT of the tissue parameter, elemental weights (ω_i), are plausible to estimate the absorbed dose with reasonable accuracy.

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THE CENTER OF ACTIVITY OF GASTRIC NUCLEAR MEDICINE IMAGES FOR EVALUATING FOOD DISTRIBUTION DURING GASTRIC FILLING AND EMPTYING

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The food accommodation on stomach after ingestion is the aim of study in some gastric diseases; the gold standard food distribution parameter is the proximal and total counts ratio on gastric nuclear medicine image. This ratio showed correlation with the center of activity localization on health and disease on gastric emptying cintilographic image. In this work were acquired 10 minutes dynamic images during and after ingestion of a milk shake like liquid meal of 437 kcal, followed by 10-12 30s static image, in each 5 and 10 min to evaluate gastric emptying. The center of activity is equivalent to the center of mass on classical mechanics, with the pixel value corresponding to the mass value. The center of activity position was quantified between 0 and 1 by its position in a virtual image skeleton, obtained by image thinning. The lower value means that the food is concentrated at proximal stomach area. The milk shake was labeled whit 72 MBq of Technetium, bounded on phytate avoiding absorption by gastric mucous. 9 dynamic and static images of young volunteers were analyzed, age ranging from 21 to 33 and average of 27 years old. In 7 dynamic records were possible recognize a center of mass localization minimum value region into the first 2 minutes after milk shake ingestion, while 6 static records showed lower value on first two 30s accumulated images, accomplishing 0 and 5 minutes after ingestion, those images were recovered from the dynamic image. The higher proximal food concentration after ingestion is expected in normal subjects. The center of activity position has shown usefulness on food distribution on nuclear medicine image, even though its necessary increase the robustness for obtaining a more reliable quantitative parameter for food distribution, as food dispersion around the center of activity.

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DEVELOPMENT OF CARDIAC SIMULATOR FOR USE IN NUCLEAR MEDICINE

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A program of quality control in nuclear medicine services includes checking the efficiency of all equipment used for diagnosis and for therapy, as well as the scintillation camera. In this work we develop and evaluate the performance of two phantoms heart, an anthropomorphic static and another dynamic for quality control in scintillation cameras. The anthropomorphic static phantom was used to characterize and evaluate tomographic images of the heart at 180° from right anterior oblique (RAO - 45°), and the response of the processing system to different volumes of the left ventricle. The dynamic heart phantom allowed evaluating the ejection fraction of left ventricle of 30 %, 50 % and 70 % through tomographic images of the heart at 180° from RAO - 45°. The movement of the dynamic simulator was generated by a motor connected to a piston; the beating of the heart phantom is synchronized through an electrocardiogram simulator.. Moreover, the dynamic heart phantom was evaluated the influence of the heartbeat in the measurement of left ventricular ejection fraction (LVEF). It was also possible to assess LVEF by different arrays of image acquisition. Additionally, it was established and held an intercomparison of LVEF in different scintillation cameras. The results of quality control tests were satisfactory and can be used as parameters in future assessments. The new anthropomorphic static phantom was efficient to use in measurements of variations of left ventricular volume. Likewise, the new dynamic heart phantom is efficient for use in measurements of left ventricular ejection fraction. Therefore, the two new simulators heart showed effective for use in quality control of scintillation camera.

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LACK OF CORRELATION BETWEEN FREQUENCY AND AMPLITUDE OF POSTPRANDIAL CONTRACTIONS

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Meal ingestion induces peristaltic contractions in the human gastric antrum, which grind solids and propel contents to the duodenum (gastric emptying). Abnormal antral contractions are found in disease, but the relationships between their frequency and amplitude in healthy people have not been much studied. We aimed at determining whether amplitude of antral contractions during gastric emptying in asymptomatic volunteers depend on frequency variations. Eight fasted volunteers ingested a liquid meal (320 mL/437 kCal) labeled with Technetium-phytate. Dynamic images (one frame/s) from the stomach were periodically acquired for 4 min using the high sensitivity collimator of a gamma camera. Frames were summed in a composite gastric image, over which a region of interest was delineated perpendicularly to the antrum. The *_activity versus time_* curve from counts in this region was normalized and filtered digitally. Dominant frequency of contractions was obtained by spectral analysis using the Fast Fourier Transform. Amplitude of contractions was obtained manually by measuring the differences between counts corresponding to peaks and valleys of 3-5 consecutive contractions. Average values for contraction frequency ranged 2.1_4.0 cycles per min (median: 2.9 cpm). Values for contraction amplitude ranged 36-70 % (median: 41%). There was no significant correlation between frequency and amplitude values (coefficient of correlation: 0.04; $p>0.50$). Also, contraction amplitude in subjects with lower (< median) frequencies were similar to that for the remaining volunteers (50% versus 49%; $p>0.50$). We concluded that frequency and amplitude of postprandial contractions of the human stomach are physiologically regulated by independent mechanisms.

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SPATIAL RESOLUTION LIMITATIONS DUE TO DIFFERENCES BETWEEN POSITRON EMISSION POSITION AND ANNIHILATION DETECTION LOCALIZATION

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Since its successful implementation for clinical diagnostic, positron emission tomography represents the most promising medical imaging techniques. The recent great growth of PET imaging is mainly due to its capability to trace the biologic pathways of different compounds within patient, assuming patient can be radio labeled with some PET isotope. Disregarding the isotope type, the PET imaging method is based on the detection of two 511keV gamma photons being emitted at almost 180 degrees to each other as consequence of electron-positron annihilation. Therefore, this imaging method is intrinsically limited by random uncertainties in spatial resolution related with differences between positron emission actual position an detected annihilation localization. This work presents a Monte Carlo approach for the study of the influence of this effect for different isotopes of the potential implementation in PET.

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PET IMAGING PERFORMANCE OF LONG-LIVED POSITRON EMITTERS: Zr-89 AND I-124 COMPARED TO F-18 USING GATE MONTE CARLO SIMULATIONS

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The long-lived positron emitters such as zirconium-89 (89Zr) and Iodine-124 (124I) have recently drawn significant interest in using immuno-Positron Emission Tomography (immuno-PET) in the detection of lymph node metastases in head and neck cancer and monoclonal Antibody (mAb) quantification. This study aims to evaluate PET imaging characteristics of 89Zr and 124I in comparison to 18F-deoxyglucose (18F-FDG) using GATE Monte Carlo simulations. Monte Carlo simulations are increasingly used in nuclear medicine imaging to develop and optimise medical imaging systems and acquisitions. GEANT4 application for tomographic emission (GATE; version 4.0.0) as used in this study is a relatively new Monte Carlo simulation package based on GEANT4 dedicated to nuclear imaging applications. For this study, the Siemens Biograph 6 PET scanner geometry, which consists of 24,336 LSO crystals, was modelled using GATE. The scatter fraction (SF) and noise equivalent count rate (NECR) measurements were simulated by modelling the NEMA NU-2001 scatter phantom uniformly filled with a solution of water and 89Zr, 124I or 18F. Results, so far, have suggested that the 89Zr isotope seems to be a promising isotope for immuno-PET imaging as its physical characteristics fulfil immuno-PET imaging requirements in comparison to 124I isotope where SF and NECR figures are degraded due to prolonged positron range and the presence of prompt-gamma photons with an energy near 511 keV.

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NEUTRON ACTIVATION OF MICROSPHERES CONTAINING ^{165}Ho : PRELIMINARY RESULTS

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Microspheres labeled with therapeutic radionuclides are widely used for treatment of many tumors in several countries. The internal radionuclide therapy can use a biodegradable device that provides structural support for the radionuclide of choice and causes the tumor reduction. The aim of this work is to assess the activation of polymeric microspheres which encapsulate ^{165}Ho , manufactured at the Biotechnology Center-IPEN/CNEN-SP. After activation, beta minus emission of ^{166}Ho ($T_{1/2}=26.8\text{h}$, $E_{\text{max}}=1.84\text{ MeV}$) can be used for therapeutic purposes. This study used microspheres samples (about 10 mg) with size ranging between 20 to 50 μm . The polymeric matrix used comprised of: PDLA, poly(D,L,lactic) containing holmium acetylacetonate (HoAcAc) prepared at 1000 rpm; PLLA, poli(L,lactic) containing HoAcAc prepared at 500 rpm, with viscosity of 1 dl.g^{-1} and another sample of 2 dl.g^{-1} ; ultrahigh holmium microspheres prepared by a solvent evaporation process. The samples were irradiated with a neutron flux in a range of 0.9 to $1.1 \times 10^{13} \text{ n.cm}^{-2}\text{s}^{-1}$ for 1 hour at the IEA-R1 nuclear reactor located at IPEN/CNEN-SP. After the irradiation the samples were analyzed by Gamma Spectrometry using an HPGe detector from Canberra in order to measure the ^{166}Ho activity and also the level of radionuclidic impurities. The highest specific activities of ^{166}Ho obtained were: 21.3 MBq.g^{-1} for the ultrahigh holmium sample, 11.5 MBq.g^{-1} for PDLA polymer, and 5.8 MBq.g^{-1} for PLLA polymer (the same for both viscosities employed). Some undesirable contaminants were found in some samples, such as ^{24}Na . New studies must be performed to assess the possible change in structural and chemical properties of these compounds due to the irradiation for potential future clinical use.

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Code: 385 – Session: PO-M0-IB-01

GROWTH OF TUMOR SPHEROIDS IN SUSPENSION: A PHYSICAL APPROACH

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In this paper we investigate the growth of spheroids in suspension, especially the cell line EMT6-Ro. We apply the dynamical Monte Carlo method formalism in a lattice-based cellular automaton and find good agreement with experimental data by means of growth curves, obtained from the literature. We also show singular characteristics of this approach, which are the distribution of waiting times and conformation of the cellular aggregate.

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ANALYSIS OF PARTIAL CORRELATIONS BETWEEN LINEAR AND NONLINEAR MEASURES OF HRV

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This study aims to investigate partial correlations between linear and nonlinear measures of heart rate variability (HRV) time series. HRV is an important carrier of autonomic nervous system (ANS) physiological status and provides a sensitive estimation of physiologic conditions and early indicator for some diseases. Although there are fundamental paradigmatic differences on linear and nonlinear models, both interpret HRV representing the same observable physiological dynamics, and therefore is expected to have partial relationships among their results. In linear model scope, a set of statistical measurements are considered in time domain, such as square differences in normal beats (SDNN), SDNN index, root mean square of successive differences in beat intervals (RMSSD), number of pairs of successive beat intervals differing in more than 50 ms (NN50), NN50 proportion (pNN50) and HRV triangular index. Measurements in frequency domain allows quantification of HRV physiology in dynamic components, namely very low (VLF), low (LF), high (HF) frequency band and their ratio (LF / HF). Nonlinear models are based on the assumption that the behavior of a system is consequence of nonlinear combinations of autonomic nervous system parts, when responding to various physiological variables. We have evaluated Detrended Fluctuation Analysis (DFA), Hurst exponent, Poincaré Plots measurements, Symbolic Dynamics and Entropy measures. Correlations are investigated in pairs of linear and nonlinear measurements verifying numerical range and physiological conditions of existing statistical correlation. HRV time series obtained from electrocardiograms of healthy individuals, hypertensive patients and patients with Chagas disease were selected in this study to investigate existence of correlations between the various measurements and the validity domain ranges for such correlations. Results obtained can help to elucidate the existing relationship in different HRV models, and suggest some physiological and clinical validity domain range for correlations.

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MONTE CARLO SIMULATION FOR TUMOR GROWTH BY USING EXTERNAL IMAGES

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The tumor growth is a problem of great interest currently. From the standpoint of Physics it can be described as a stochastic process far from equilibrium. To examine this question is used analytical methods and also simulations. Several studies have been carried out to better understand the process of tumor growth. However, a few works has been successful in bringing this knowledge for the clinical therapies. In this work, we tested a technique to integrate the results of Monte Carlo simulations with images collected externally to the computer program. Such images can be obtained from medical examinations as X-rays, mammograms, etc. The procedure is performed as follows: a digital or scanned image of a tumor (in the early stages) is handled by the software that converts it into an array. This matrix, is read by the main program, and operates as the starting point for the Monte Carlo simulation. Using the dynamical Monte Carlo method with the initial condition supplied we can make forecasts with regard to the rate of growth that tumor and morphological data expected for the particular situation. A stochastic version of the classical Gompertz mathematical model was used to provide the dynamics of the system we analyzed. The procedure was successfully tested for two-dimensional images. In cases where the images could be read, without noise, by the technique is software applicable directly. However, when the initial imaging is compromised spots or composed of other structures beyond the tumor, we must to withdraw the undesirable parties with the help of the software for the treatment of images, before use in simulation.

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EFFECT OF CONSTANT PHYSICAL ACTIVITY ON INDIVIDUALS LIVING WITH TYPE 2 DIABETES

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This paper evaluate the effect of exercise assistant on physical activity and resultant physiological and biochemical changes within 6 months in individuals with type 2 diabetes. A total of 50 inactive patients with type 2 diabetes were given proper exercise canceling and were randomly given an exercise assistant (n = 25) or not (n = 25). Exercise assistant, based on the trans-theoretical model, in additions to motivational theory and cognitive behavioral strategies into an individualized intervention to promote physical activity. Changes from baseline to 6 months were assessed in 1) physical activity (5-day recall, accelerometer, cardio-respiratory fitness, stage, and processes of change), 2) physiological changes (blood pressure and BMI), and 3) biochemical variables (HbA1c, lipid profile, and fibrinogen). At the end, group variances were recorded for the change in minutes of adequate activity ($P < 0.001$) and 5-days activity counts ($P < 0.001$). Experimental participants indicates an increase in 5-days activity counts and 5-days minutes of moderate activity ($P < 0.001$); the control group indicates no significant changes. subsequent experimental participants increased stage of change ($F = 22.6$, $P < 0.001$) and in the grouping, differences were recorded for the changes in total exercise duration and peak gradient ($P < 0.005$), HbA1c ($P = 0.02$), systolic BP ($P = 0.02$), and fibrinogen ($P = 0.03$). Hence, exercise assistance enhance increased on physical activity and thereby improved glycemic control and cardiovascular risk factors in people with type 2 diabetes. Hence, exercise assistance enhance increased on physical activity and thereby improved glycemic control and cardiovascular risk factors in people with type 2 diabetes. Physiological, Biochemical, type 2 diabetes, trans-theoretical model, motivational theory, cognitive behavioral strategies, accelerometer, cardio-respiratory, peak gradient, systolic BP, fibrinogen, glycemic, cardiovascular

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DENSITY VARIATION ANALYSIS OF BONE TISSUE IN THE RADIUS REGION OF MONGREL DOGS

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The dog is among the animal most commonly used for studies of bone metabolism, evaluating treatments to prevent bone loss or restore bone mass. The dog bone is an excellent model for bone changes study related to age in humans. The adult skeleton of both species contain a similar fraction of compact bone tissue (80%), and has similar microscopic features, displays bone loss more rapid in females and show similar responses to factors that affect bone metabolism, such as hormones and immobilization. This study aims to determine the density variation in the longitudinal direction of the radius bone of mongrel dogs at different ages, masses and genres. For this study, were used samples of forelimbs of mongrel dogs obtained after death. The density determination was performed by immersion in water that is to determine the volume using the buoyancy of the sample. Buoyancy is defined as the force exerted by fluid on an object which is immersed and is equal in modulus, the mass of the displaced fluid. By immersing of the object in the liquid measuring the mass of the fluid displaced in the balance, which is the buoyancy. The displaced volume is numerically equal to the buoyancy. With the data of mass and volume can get the result of density. Due to the longitudinal dimension of the bone assessed was expected that there would be some variation in bone density over the same. The presence in the bones of two different types of bone tissue, spongy and compact, and the variation in concentration of these along the bone are factors causing the difference in density.

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SURFACE WAVE INSPECTION OF GEL DOSIMETERS

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Ultrasound radiation force vibrometry has been used to study the dispersive nature of surface wave velocity of the MAGIC polymer gel dosimeter. Surface waves were created using pulsed radiation force. Surface waves propagating outwards from the vibration center were monitored by an ultrasound transducer operating in pulse-echo mode at two locations along the propagation path. The propagation speed of the shear wave at each frequency was estimated by tracking the phase change of the wave over the distance it propagates. From the phase data of the surface wave, group velocity was estimated for the gel. The experiments were performed using two gel dosimeter phantoms of different absorbed doses varying from 10 and 20 Gy, while a non-irradiated phantom was kept as a control. To obtain knowledge about the irradiated volume, magnetic resonance spin-spin relaxation rate ($1/T_2$) images were acquired and converted to absorbed dose distributions. The dose maps were compared, in a qualitative way, with dose distributions measured using ultrasound B-scan imaging. The results shown that surface wave ultrasound vibrometry can detect changes of group surface velocity in polymer gel dosimeter. It was also found that ultrasound B-mode imaging has potential to display absorbed doses distribution.

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A NEW ULTRASOUND CONTRAST FOR DOPPLER ULTRASOUND MEASUREMENT FROM STATIC AND DYNAMIC FLUID

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Doppler ultrasound is a very powerful tool to evaluate velocity and flux volume of dynamic fluid. Its principle of working is based on the detection of shifted frequency of the ultrasound echo reflected from structure in movement. The ultrasound beam should be continuous or pulsed. For clinical application, for example, the use of Doppler ultrasound is very useful to evaluate the velocity and flux volume of blood. In this case the Doppler signal is generated by the movement of blood cells into the flux. In this work, we present a new approach to generated ultrasound Doppler image just from portion of volume labeled with magnetic particles. To verify this idea, continuous ultrasound Doppler was evaluate in two different flux: one labeled with non magnetic microparticles (Glass beads) and the second one with ferromagnetic microparticles, of same size. An alternated gradient of magnetic field (200 Hz, and 0.2 mT/cm) was applied to magnetized the sample. The Doppler signal was acquired based on lock-in amplifier using the second harmonic as reference. The sample consisted of yogurt mixed with 2 % of microparticles as ultrasound spread and the flux was generated pumping this fluid into a silicone tube of 1 cm of diameter with speed of 10 cm/s. The amplitude of the Doppler ultrasound signal from the flux with magnetic particles was much bigger than from the flux with non magnetic particles.

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GASTRIC ASSESSMENT BY DIGITAL IMAGES PROCESSING OF ULTRASOUND IN LABVIEW PLATFORM: PRELIMINARY RESULTS

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Spite ionization radiation dose undergoing per the patient's, to date, the gold technique in gastric evaluations still is Scintigraphy. Gastro images with ultrasound technique is controversial because of the stomach is a hollow cavity filled with gas in basal conditions or in fast state. Fortunately, a stomach with food is recommended in gastric motility and gastric emptying assessment. Such, a lack of air in stomach contributes in this kind of studies and in recordings of excellent images by ultrasound. In this study, a digital image processing of ultrasound gastric is presented. A whole automated routine and filters implemented are described in order to use this procedure in gastric peristalsis and gastric emptying evaluations. To date, 10 volunteer have been measured about dominant frequency which one there are values lest that 3 cpm, although the behavior stomach activity is observed in dynamic graph, an analysis in frequency space is performed.

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OPTIMIZATION OF PEDIATRIC CHEST RADIOGRAPHIC IMAGES USING OPTICAL DENSITIESRATIO

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The aim of this study is the optimization of radiographic images for the pediatric patients in the age range between 0 and 5 year of life, through Optical Density Ratio (ODR), considering that pediatric patients are over-exposed to radiation in the repeated attempts to obtain radiographic images considered of good quality. The optimization of radiographic techniques was carried out with the RAP-PEPP (Realistic Analytical Phantom coupled to homogeneous Phantom Equivalent to Pediatric Patient) phantom in two incubators and one cradle. The data show that the clinical routine radiographic techniques generate low-quality images at up to 18.8% when evaluated by the ODRs, and increases in doses up to 60% when compared to the optimized techniques doses.

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EVALUATION OF RADIATION DOSE AND IMAGE QUALITY IN COMPUTED TOMOGRAPHY IN RIO DE JANEIRO

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The aim of this work was to evaluate the dose index and the image quality in seventeen computed tomography scanners installed in radiology departments at the city of Rio de Janeiro in order to analyze protocols and to evaluate the possibility of a patient dose reduction in routine procedures. The age of the scanners varied between 2 and 14 years old.

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ENHANCEMENT OF CONTOURS IN DIGITAL IMAGES RADIOLOGICAL

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The central theme of this work is to improve the quality and enhance the edges in digital images obtained from radiographs of the lungs. To effect these actions will be necessary to know the techniques of digital image processing and apply them on the digitized radiographs. The images obtained from equipment using X-rays can be distorted and obscure important parts that may be necessary for a more specific diagnosis. In an endeavor to improve the identification of areas hidden behind the ribs and highlight the edge of the pulmonary region, and strange shapes on X-ray normal, without the need to employ advanced techniques in artificial intelligence. Will apply this analysis techniques such as digital filtering, convolution, linear algebra and statistics, mainly in order to get the desired improvements, tests and discarding alternatives that we may not generate the expected results for each particular step. The final presentation will be the main external forms highlighted on the original image and a series of intermediate steps with specific improvements that could be used for other applications.

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DETECTION OF THE SMALLEST MICROCALCIFICATIONS FOR EARLY DIAGNOSTIC OF MAMMARY CANCER

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Even though breast cancer is a cancer with relatively easy early diagnostic and has an appropriate treatment, it has high mortality rates in Brazil. This is in part because the disease is diagnosed only in advanced stages, but also because the whole information contained in the mammograms is not used by physicians and radiologists. There are many parameters to be considered in assessing the quality of a mammogram image. Among these parameters are contrast, spatial resolution, the signal to noise ratio, and the efficiency of the applied dose. Even with the improvement of the quality of radiographs, many structures, such as small microcalcifications, are not always identified by radiologists in the images. To determine the lowest detectable structures in digital mammograms, we made a numerical analysis of a few digital mammography using simulators, determining the spatial and intensity resolutions and studying the noise and its distribution. With this, we could determine the detection levels, quantifying the probability that any point is due to statistical noise or a real change in breast density. This is the first step towards early detection of microcalcifications. In our work it was possible to detect even the smallest microcalcifications of the simulator, 0.18 mm in diameter, with false alarm probability smaller than 1/1000.

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DETECTION OF SPHERICAL PATHOLOGY SIGNS IN CHEST RADIOLOGICAL IMAGES

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Nodules and calcifications in the lungs can be symptom of several diseases. Therefore, chest images should allow the visualisation of these pathology signs, even when they are very small. This study aimed to evaluate the detection threshold of spherical pathology signs in chest images. For that, it was used an anthropomorphic chest phantom made of epoxy resin, chest human bones and human heart, which has gone through a preservation process called Glycerination. To simulate the lung, an artificial organ was made of foamed polyurethane with the insertion of the spherical objects made of aluminum and epoxy resin. The epoxy resin objects (diameters of 0.1, 0.3, 0.5, 0.8, 1.0, 1.5, 2.0 and 2.5 cm) were used for simulating nodules and were placed in the pulmonary hilum of the right lung. The aluminum spheres (diameters 0.1, 0.2, 0.3, 0.5, 0.6, 1.0 and 1.5 cm) were used for simulating microcalcifications and were placed in the left lung apex. Images were obtained using conventional X-ray and computed tomography equipment. For evaluate the detection of pathology signs, different radiological parameters were utilized (45kV-76kV, 80-6mAs, in conventional X-ray equipment, for example). Besides, the entrance and exit doses were determinate, for allowing dose analysis together with image quality. The images, in almost all kVs, allow the visualization of nodules larger than 0.5 cm and all microcalcifications. The dose evaluation showed the procedure optimization at higher kVs, as expected. The results found prove the efficacy of the developed artificial lung for quantify the detection of pathology signs in radiological images. Besides, they call attention to the importance of performing quantitative quality image tests in routine quality control programs. The developed lung, associated with the anthropomorphic chest phantom, can be useful also for professional training.

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EXPOSITION TECHNIQUES OPTIMIZATION IN COMPUTED RADIOGRAPHY AND COMPARATIVE ANALYSIS WITH THE SCREEN-FILM TECHNIQUE

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After the introduction of computed radiography systems in the radiodiagnosis services, in substitution to the screen-film system, it was noticed that this migration, despite the innumerable advantages, implied in the increase of radiation dosage to obtain images by the new system. This study aimed to optimize the exposition techniques in computed radiography systems and to evaluate the dosage increase percentage of skin entrance in relation to the previous system. The X-ray equipment used has single-phase generator, with a maximum voltage of 125 kV and maximum current of 500 mA. The scanner image is the Philips brand, model Eleva Corado and the imaging plates are Fuji brand. Was taken as reference examinations of the chest, paranasal sinuses, spine, knee and hand. For each technique, the tube voltage was increased to the maximum, without compromising the image contrast, so using and enjoying the lowest possible current-time product. After obtaining the exposure techniques that would allow images of good diagnostic pattern, ie with a minimum level of quantum noise and the lowest possible of radiation dose to the computed radiography system, we compared the levels of dose measurements with those that were practiced in the screen-film system. It was found that the percentage of high dose found even optimizing the techniques of exposure to the computed radiography system was significantly high, with percentage increases ranging from 50% (chest) to 150% (knee). It was concluded that the dosage increase percentage found, even with the exposition techniques optimization to the computed radiography system were significantly high, even exceeding the reference values recommended by the legislation.

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OPTIMIZATION STUDY OF DIGITAL PEDIATRIC CHEST RADIOGRAPHY PERFORMED

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Radiation protection is a concern in pediatric radiology since there is a greater chance for radiation induced effects for children. Chest radiography is the most frequent radiographic exam performed in the radiological centers and the pulmonary region is one of the more difficult to image when high quality is essential. This study aims to evaluate different operation conditions to promote the optimization of digital pediatric chest radiography performed with computed radiography (CR) system, using an anthropomorphic pediatric phantom, quality phantom and termoluminescent dosimeters to measure the entrance skin dose (ESD). The results suggest that the tube potentials between 60 kV and 70 kV with current-time product around 5 mAs are optimal for imaging the range of attenuation in the phantom, for pediatric chest radiography. The ESD in this condition is 0.28 mGy.

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RADIATION DOSE REDUCTION IN A NEONATAL INTENSIVE CARE UNIT IN COMPUTED RADIOGRAP

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The present study examines the prospect of dose reduction through optimization of radiographic parameters in relation to image quality. In order to practice radiation protection in neonates, determination of the Entrance Surface Doses with thermoluminescent dosimetry (TLD) for different preterm infants of 28 to 34 weeks were developed. The sample consisted of 208 neonatal chest radiographic examinations of 12 neonates admitted and treated in the Care Intensive Neonatal Unit. TL results of the EDS were compared with those dose values reported by Diagnostic Radiology Levels (DRLs). Radiographs were evaluated for satisfactory image quality. Chest and abdomen radiography to born children prematurely were covered in this study. Entrance surface doses values measured for neonates in routine practice examination were higher than the DRL of 50 μ Gy proposed by the National Radiological Protection Board (NRPB) as the reference values. Results obtained suggest to radiation dose reduction in neonates could be possible if the high tube voltage techniques is applied. Diagnostic reference levels for hospital have been proposed with optimized radiological techniques in relation to image quality and the proposed values are lower than the DRL of 50 μ Gy. Key Words: Entrance surface dose, preterm infants, TLD, intensive care

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A DIGITAL SUBTRACTION RADIOGRAPHY BASED TOOL FOR PERIODONTAL BONE RESORPTION ANALYSIS

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The aim of this paper is to describe an aided diagnosis scheme for periodontal bone resorption so that the dentist can make an early diagnosis of the periodontal disease and establish the best treatment plan to increase the success of healing. Three ways of displaying the results are provided: qualitative, simple quantitative and colored-percentage quantitative views. A total of 72 pairs of in vitro radiographic images were used. The main procedure registers the images perspective projection aimed to align them in rotation and translation, followed by the application of a contrast correction technique. The results from the subtraction were evaluated firstly by the comparison between the actual and the digital sizes corresponding to the holes made by drills in phantoms. The mean error was 4.2%. The method was also applied to actual tooth radiographic images and it could detect clearly the effect of treatment of periodontal diseases. It is dependent on the reproducibility of the process of radiographs acquisition and digitization, but the calculated mean error allows to conclude by its better efficacy compared to usual procedures in this field.

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QUALITY ASSURANCE OF CT IMAGE FROM THE SOFTWARES IMAGEJ AND EXCEL

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The objective is to automate the quality assurance of CT image acquired (Philips Brilliance CT Big Bore) using a public domain program, ImageJ, jointly with the Microsoft Excel program. For this, we used a phantom that is divided into two parts: a PVC pipe filled with water with a diameter of 200 mm to simulate the head and a nylon cylinder of 300 mm diameter to simulate the body. In ImageJ, we developed macros that define the regions of interest (ROI) and measure the average number of CT and their standard deviation and also a macro to determine the diameter of the acrylic pin phantom head. The results are exported to Microsoft Excel where they are automatically analyzed and compared with acceptance limits proposed by the equipment manual (Volume Brilliance CT-1).

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METHODOLOGY FOR QUALITY CONTROL OF INTRAORAL IMAGE

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This study aimed to develop a methodology for quality control of intraoral radiographic image by building a calibration curve obtained from the contrast with the image of a dental simulator which has four regions of X-ray attenuation. For that were performed different exposures and processing radiographic using Ektaspeed radiographic films and Kodak and Agfa processing solutions. From densitometric analysis was determined the standard technique of exposure and image processing. By this standard technique was constructed the calibration curve of the simulator to check the influence of deterioration of processing solutions in the quality of radiographic images. The results showed that for radiographic processing using Kodak solutions at temperatures of 20°C and development time of 2.5min shows optical density levels similar to those obtained using Agfa solutions with development time of 5 min at the same temperature. The calibration curve of the simulation showed a slope of 3.20, which corresponds to the value of standardized contrast to this study. The Kodak chemical solutions showed a loss of activity after a period of two weeks after being prepared. The Ektaspeed film showed a 60% decrease in the contrast when processed in overused Kodak chemical solutions. For radiographic processing methodology applied the value of 1,68mGy of air kerma skin entrance proved to be effective for the visualization of anatomical parts of the simulator, and this value is below the reference levels of entrance skin dose in periapical examinations established in Brazil.

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USING A DEDICATED SOFTWARE FOR THE ANALYSIS OF THE HOMOGENEITY OF CR DIGITAL IMAGE RECEPTORS

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The homogeneity of the receptors response of digital imaging systems is an important parameter to be evaluated regularly in a digital mammographic system, since many of the problems encountered in digital images are caused either by incorrect calibration as well as defects of the image receptors. The evaluation of this parameter is one of the procedures for quality control of digital imaging systems proposed by the European Guidelines for Quality Assurance in Breast Cancer Screening and Diagnosis. Aiming at improving the sensitivity of the tests of receptor homogeneity, it has been developed software for DICOM image processing that allows the user to analyze an image of a plain receptor, with the possibility of using a variable size Region of Interest (ROI). The software performs an automatic scan of the whole image and calculates the mean pixel value (MPV) of the whole image and MPV, standard deviation (SD) and signal to noise ratio (SNR) for each ROI. These data may be shown graphically allowing full view of the receptor response and identification of affected areas.

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COMPARISON AMONG PRINTED ON PAPER, SCREEN-FILM AND DISPLAYED IMAGES UNDER QUALIT

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Laser paper print rather than laser film would be a significantly more cost-effective option production when it is used in radiology, but is necessary guarantee an acceptable diagnostic quality that guaranty the clinical image information and the longevity of the medical image data. In Brazilian radiological protection regulations there are any recommendations established for digital systems image registration. Due to the a transition from analog to digital radiographies at Hospital São Paulo (HSP), Federal University of Sao Paulo (UNIFESP), this study evaluated the clinical quality image to chest, lumbar spine, and abdomen radiographies based on the quality criteria recommended by the International Atomic Energy Agency (IAEA), when these images are shown in a display and in a paper sheet. These results were compared with similar images assessment in SF system and between paper print and display image viewer. In all kinds radiographies studied the image printed presented degradation in terms of clinical quality when compared with analogic film used in SF system and when compared with display image at medical grade monitor.

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ASSESSMENT OF A COMPUTED RADIOGRAPHY SYSTEM IN THE NATIONAL CANCER INSTITUTE

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According to the Brazilian national regulations is required to perform periodic tests for quality control (QC) in medical and dental radiology, in order to improve or maintain the level of use of tests, decreasing the frequency of false positives and/or negative for the diagnosis and improve the security point of view of radiation protection for staff and patients. With the inclusion of digital technology for imaging acquisition systems in radiology, it is necessary to establish QC protocols to evaluate these new systems to ensure its good performance. Those new technologies have been implemented in the Brazilian National Cancer Institute (INCA) a computed radiography (CR) system and digital displays. The first eliminates the need for the use of film and processing chemicals radiographic, slowing the rate of repeat examinations due to problems in processing, and the second, allows the evaluation of images digitally, eliminating the use of negatoscopes, enabling the optimization of the radiographic image varying parameters such as contrast and digital image processing. Aiming for maximum performance integrating these two technologies were adapted from two papers in the literature, procedures for an adequate measurement of both systems. This study aimed to establish a QC protocol for CR and digital displays to be used for routine quality assurance in the three Hospital units of the INCA. The established protocol was tested and adjusted where necessary to address the feasibility of QC within the reality of the Medical Physics Department of the INCA.

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DAILY QUALITY CONTROL IN COMPUTED RADIOGRAPHY MAMMOGRAPHY USING THE MANUFACTURER PHANTOM

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The quality control (QC) in mammography system involves a large amount in test tools, which imply in a big space for storage and a high number of exposure. This work describes a QC system using a phantom, Fuji Computed Radiography (FCR) One Shot Phantom M Plus, that evaluates several parameters with just one exposure. The software offers tests with annual, semi-annual, quarterly, weekly and daily periodicity, and analyze the conformities of the mammography equipment, image plate and cassettes. Because of the high number of tests it was evaluated the daily test only for seven months in two mammography equipments. The test, through the software and its image, allows the analysis of ten parameters in QC. The evaluation of these parameters was realized by the average of the values provided by the software. Only one of the evaluated items showed not conformity, but this was observed and the necessary corrections were realized. The monitoring of use of FCR Mammography QC software with the FCR One Shot Phantom M Plus was realized and through this we can investigate that the quality program provided by the system is appropriate for the radiology services that has the Fuji Computed Radiography system

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SECONDARY CALIBRATION TO REALIZE LUMINANCE MEASUREMENTS ON VIEWBOX USING LUXIMETER, BASED ON A CALIBRATED PHOTOMETER

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Viewbox is an important device the help doctors to diagnostic medical image based on film as transducer. The luminance and illuminance conditions (intensity and homogeneity) may guaranty the best environment contribution to reduce errors on diagnostic. Many regulations around the world define constancy parameters different characteristics of viewbox luminance and illuminance that requires specific measurement equipment. However to realize the constancy tests you can use a luximeter submitted to secondary calibration. This work shows how to do the calibration and how to adapt this methodology to be used on these tests.

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CHARACTERIZATION OF AN EPOXY MIXTURE TO BE USED AS MAMMOGRAPHIC PHANTOM

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This is a work under development. The purpose of this work is to execute the benchmarking of an epoxy mixture to be used on mammographic application. To do that, we perform measurement of dosimetric quantities and evaluation of the optical density on different configuration. The entrance and exit KERMA were measured with and without the phantom to define characteristic the transmission and the backscattering for the new material. That characterization is needed to confirm the use of this material for dosimetry measurements. We performed measurements of optical density, and contrast, and homogeneity study to evaluate its possibility to use this epoxy for image quality control. The preliminary data was collected in a screen-film system and all the quality control tests for the mammographic unit and processing equipment presented an acceptable quality and constancy indexes. Some compositions were evaluated, for 100% fat tissue, for 100% glandular tissue, for 50/50%, for 25/75% and for 75/25% glandular and fat tissue respectively. The characterization shows that the epoxy developed on this work can be used for dosimetry (based on KERMA, transmission and backscattering data), presenting similarities to the epoxy BR12, Phantom Mama (a Brazilian phantom) and/or CIRS mammographic phantom, when the 50%/50% fat/glandular tissue composition was simulated by mixing slabs of each material in the same proportion. However to image quality studies the material presents non-homogeneities, as was expected for epoxies. But it had good results in contrast and optical density results. We are planning make measurements on different mammographic equipments to have a complete dosimetric characterization and the observation of the image in different systems (including CR and DR). We are planning to define the equivalence for simulates the mean breast as well verify the possibility to increase the homogeneity of the material.

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PHANTOM DEVELOPMENT FOR QUALITY CONTROL IN AUTOMATIC EXPOSURE CONTROL IN COMPUTED TOMOGRAPHY SYSTEMS

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The technologies of computed tomography (CT) are changing fast and clinical applications of this modality are increasing alarmingly, following concerns about individual and population doses. In this evolution, some devices were developed in order to reduce the dose received by the patient when submitted to a CT scan, one of the most important was the automatic exposure control (AEC), which automatically adjusts the current in X-ray tube considering the attenuation of radiation in each anatomical region being irradiated. Currently, the AEC systems on CT equipment are not tested on Quality Control test, so the development of a dedicated phantom was necessary. Based on the Report 05016 from Keat (2005), an elliptical phantom for tests in the AEC systems was developed. This phantom was manufactured in acrylic and is 300 mm long, 61 mm in the lowest diameter and 439 mm in the largest diameter at end, and a holder to position it in a box over the CT bed which allow this phantom be irradiated without interference of the attenuation by the material of the examination bed. Tests on the developed phantom were conducted in a GE PET / CT 690 CT scanner. Either the CTDI presented by the equipment as well as the X-ray tube current when decreasing thickness of the phantom has shown reduction, similar to Keat (2005). Each manufacturer uses the AEC systems in a different manner to indicate the correction of the X-ray tube current with respect to image noise, thus, Quality Control testing methodology must be developed for each manufacturer. The tests realized at GE, has shown that the phantom respond adequately to the AEC system and proved being a good resource which can be used in Quality Control of computed tomography regarding optimization dose studies.

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MONTE CARLO SIMULATION OF X-RAY SCATTERING PATTERNS PRODUCED BY WATER

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This work presents first steps in a feasibility study that aims at taking advantage of the material-related information contained in the coherently scattered radiation, particularly in connection to mammographic studies. At diagnostic energies, the coherent scattering of X rays by biological materials depends on the molecular structure due to interference effects. Consequently, there are significant differences among scattering patterns produced by different biomedical materials, although they have similar electronic densities. When a scattering pattern is measured, both single and multiple scattering are detected; in addition, the single scatter component can be separated in single coherent and single incoherent scattering. In this work all these components were studied as part of the total scattering pattern produced by water. The study was performed on the basis of Monte Carlo simulations, varying the beam energy (from 12 to 75 keV) and the water phantom thickness (from 0.5 to 10 cm). Experimental form factor data were used for modeling the coherent-scatter cross sections. Each photon history was analyzed and total detected scatter ratio, fraction of single scatter, and the ratio coherent to total scattering were calculated. Spatial distribution for each contribution was analyzed from radial histograms.

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DENOISING OF LOW-DOSE X-RAY IMAGES WITH A WAVELET TRANSFORM

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It is very important to reduce the x-ray dose to decrease the patient risk in radiographic imaging. But the x-ray dose is one of the major factors that determine the quality of images. Low-dose images increase statistical noise, making it difficult to discriminate small lesions from the noisy background. To achieve a high quality image from low-dose x-ray images, we previously proposed a method. In it we used a wavelet shrinkage method that consisted of the following components: (1) pre-processing of an original image with a gamma correction, (2) translation-invariant wavelet de-noising method, (3) filtering of wavelet coefficients by a modified BayesShrink method that is applicable to Poisson noise. In this paper we evaluated the validity of our proposed method in terms of a dose limit with a phantom photographed with the clinical conditions. The results of experiments showed that images acquired with 1/10 of the standard photographic dose represented the lower limit to our denoising method, and the quality of images processed with our method was higher than that with the conventional methods by 2~3 dB of the peak signal to noise ratio.

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X-RAY TUBE OUTPUT MEASUREMENTS: AN EVALUATION BASED ON STUDY OF CASES

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Brazilian regulation (Portaria 453) defines periodic Quality Control tests to guaranty the constancy for radiological procedures. One of them is the measurement of the constancy on tube output. They give upper and lower limits for different wave rectification. This work proposes a discussion about the these limits defined for tube output measurement, each contradict the ALARA principle, and show the tube output measurements realized on x-ray equipment using different wave rectification, and high frequency. The experimental results presents equipment that generates tube output under the lower limit each means this equipment gives minor dose by mAs, maintaining the image quality. This work discusses the necessity of a limit for tube output and suggests an evaluation of a group of testes (including image quality) to be analyzed together to this test. Alone, it is just a reference of constancy for define the dose by mAs (non-related to constancy of image quality) and an indicative of the useful life of the tube.

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RECONSTRUCTION OF MATERIALS INSIDE A DUCT USING X RAY TRANSFORM

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This work presents a methodology for reconstruction of constants by parts functions. The paper focus in one application of this methodology for identify the different materials in a duct. The principle physics is based in attenuation of X ray when this through the duct. Each element of the composed has a specific cross-section contributing with the loss of the intensity of X ray. In this study, was used the parallel and divergent beam for the cases of two dimension. In this case we need to know the source position in order to back project the rays accordingly in a divergent way. In three dimensions, the projections discontinuity determination problem is study by the projections images contour determination. Each ray generates one algebraic equation. The experiment shows that with a single view it is not possible to obtain information of the materials, however, it is possible reconstruct the materials. When is used two views, there are enough information to reconstruct the materials inside the duct.

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ISODOSE CURVE DETERMINATION OF PROSTATE FOR THE BRACHYTHERAPY TREATMENT USING MCNPX CODE

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This paper presents a methodology for the determination of the isodose curves from a 2D array of data, post processed with MATLAB program, from a computer simulation using the MCNPX code and the MAX06 phantom in permanent implants therapeutic procedures performed with brachytherapy low dose rate. With these results was possible to obtain the isodose curves for the four selected slices of the MAX06 phantom using the countour function of the graphical interface of the MatLab program.

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USING MCNP5 CODE FOR SIMULATION OF BETATHERAPY PROCEDURES FOR THE PTERYGIUM PREVENTION

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Pterygium is the triangular growth of the fibrovascular tissue of the bulbar conjunctiva. Its initial treatment is surgical with a recurrence rate around 20-40% of operated cases. In order to prevent their recurrence, betatherapy with ⁹⁰Sr+⁹⁰Y applicators is the one that has shown better results, decreasing the recurrence rate to 20% or less. These applicators have high dose rate so special attention should be payed when planning these applications, always remembering that the lens (the critical region of the eye) must be preserved. Based on the above, we performed a simulation of a betatherapy application considering a ⁹⁰Sr+⁹⁰Y applicator in the treatment of pterygium prevention using the MCNP5 code. The human eye has been modeled with all its main structures and characteristics and a plate of ⁹⁰Sr+⁹⁰Y was attached to the eye in the place where the pterygium was removed. The purpose of this simulation was to calculate the amount of dose that each region of the eye receive during an application of betatherapy. The results are plausible: the regions closer to the plate received greater doses than the farther ones. Another important point observed is that the lens was preserved during the procedure receiving about 0.015% of the maximum dose that the sclera receives. With the results of this simulation has an effective and practical guide that may be inserted into the routine of medical physicists in order to facilitate and streamline their work.

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IMPLEMENTATION OF A THERMOLUMINESCENCE DOSIMETRIC LABORATORY FOR BRAZILIAN BRACHYTHERAPY SOURCES

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This work describes the main characteristics of the dosimetric laboratory setup for experimental brachytherapy sources dosimetry to be implemented by the Nuclear and Energy Research Institute - National Nuclear Energy Commission São Paulo (IPEN-CNEN/SP) and a TLD-100 dosimeters selection from a batch is also described. For the experimental dosimetric analysis, the thermoluminescence (TL) dosimetry technique was selected. It was applied TLD-100 microcube shapes dosimeters and Solid Water™ phantoms water simulators to the measurements. The absorbed dose data acquisition was conducted by a Harshaw 3500 TLD and a special oven for the dosimeters thermal treatment was projected. TLD-100 batch selection was performed with a panoramic Cobalt-60 irradiator. Dosimeters batch selection was performed after irradiations in a panoramic Cobalt-60 irradiator, establishing 5.25% as the lowest standard deviation for the reproducibility of TL responses. The TL response (arbitrary units) of the all selected dosimeters was lower than 8%. The TLD-100 dosimeters reproducibility and others dosimetric processes and devices to acquire the source's dose distributions data were considered suitable for dosimetric studies with low dose rate brachytherapy sources.

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HDR BRACHYTHERAPY SALVAGE FOR LOCAL PROSTATE CANCER RECURRENCE AFTER RT

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Purpose: The aim of this study was to evaluate the feasibility and safety of salvage high-dose-rate (HDR) brachytherapy for locally recurrent prostate cancer after external beam radiotherapy. **Materials and Methods:** We analyzed 10 patients between april and october 2010. After pathologic confirmation of locally recurrent disease, all patients were treated with 36 Gy in six fractions using two transrectal ultrasound-guided HDR prostate implants, separated by 1 week (three fractions each implant and at least six hours interval between the fractions). Using dose volume histograms, in all cases, the following dosimetric constraints were evaluated: prostate ($V_{150}/V_{100} \leq 0,5$ and $V_{100} \geq 95\%$), rectum ($V_{75} < 1\text{cc}$) and urethra ($D_{10} < 150\%$, $D_{30} < 130\%$ and $V_{125} < 1\text{cc}$). The number of needles implanted and prostate volumes were also registered. **Results:** The mean values and respective deviations from the dosimetric parameters cited were: prostate ($V_{150}/V_{100} = 0,5 \pm 0,1$ and $V_{100} = 99,5 \pm 0,8\%$), rectum ($V_{75} = 0,9 \pm 0,3\text{cc}$) and urethra ($D_{10} = 137 \pm 0,1\%$, $D_{30} = 128 \pm 0,1\%$ and $V_{125} = 0,2 \pm 0,1\text{cc}$). The patients, considering short-term outcomes, had not demonstrated genitourinary or gastrointestinal complaints and all of them exhibited PSA fall after the treatment. **Conclusions:** Salvage HDR prostate brachytherapy after external beam radiotherapy appears to be a feasible and effective technique. Clinical results, considering long-term outcomes, will be published in further papers.

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PRELIMINARY PROPOSAL FOR SOLID RADIOACTIVE WASTE MANAGEMENT

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The Brazilian National Cancer Institute estimate 489,270 new cancer cases will occur in the country in 2010. The highest incidence will be, for masculine sex, of prostate cancer (about 52 thousand cases) and lung cancer (except for non-melanoma skin cancer). A multi-disciplinary team was created at Instituto de Pesquisas Energéticas e Nucleares - Centro de Tecnologia das Radiações (IPEN-CTR / SP) to develop a national ¹²⁵-iodine source and start the installation for local manufacture. The seeds production in Brazil will enable to lower the treatment cost and make it feasible for more patients. ¹²⁵-iodine is deposited onto a silver thread, which is positioned in the interior of a titanium capsule. To set up routine production it is necessary to make a radiological protection plan, specifying the radioactive waste management procedures. The purpose of this work is to offer an initial proposal to help the team administrate the solid radioactive waste generated from the production process. Management of radioactive waste generated by the ¹²⁵-iodine sources production should be done in the own laboratory physical space, since it has enough room for this. The solid waste will be handle weekly, in bags weighing 1.1kg/week. The collection system will be done with a resistant bag that will be handled by a member of the radiological protection team. The process will still include a sealing machine. The remaining activity in the bag is under discharge limits resulting in a simpler and safer planning. It should be clear that a policy of reduction and recycling during the process is vital, so that costs and unnecessary waste generation may be achieved.

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DEVELOPMENT OF AN IRIIDIUM-192 SEED FOR OCULAR TUMORS TREATMENT

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The Institute for Energy and Nuclear Research, in partnership with the School of Medicine, created a project that aims to develop and implement an ophthalmic therapeutic treatment for cancer with iridium-192 seeds. The School of Medicine treats many cancer cases in the SUS, and brachytherapy group of IPEN has extensive experience in prototype sources. The seed to be manufactured will perform as follows: a core of iridium-192 is packaged inside small cylindrical seeds consist of a titanium capsule of 0.8 mm outer diameter, 0.05 mm wall thickness and 4.5 mm in length. The core is an alloy of platinum-iridium (20/80) of 3.0 mm in length and 0.3 mm in diameter. The proposed method for making seeds provide chemical data The composition of the core and the coating of iridium-platinum alloy, the irradiation parameters of wire in the IEA-R1 Nuclear Reactor (IPEN), the sealing of the seeds by laser welding with pulsed sources YAG, the source of the leak tests in accordance with ISO 9978, metallographic testing that will ensure the absence of cracks and / or porosity in the weld region, so that no radiation leak from seed, and to measure the activity of the source . After fabrication of the prototype of the seed, the evaluation will be conducted for use in cancer treatment in eyes. It is expected that treatment is available to serve a larger number of patients at costs commensurate with the Brazilian reality.

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RESPONSE-PROBABILITY CHARTS AND RESPONSE-PROBABILITY VOLUME HISTOGRAMS FOR RT

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A new method for treatment plan evaluation and comparison based on the radiobiological response of individual voxels is proposed. A head and neck tumor case was selected to demonstrate the benefits of the method using Conformal Radiation Therapy (CRT) and Intensity Modulated Radiation Therapy (IMRT). Response-probability distributions were obtained by calculating the response probability in every voxel using the Linear-Quadratic-Poisson model. Total probability of tissue response was calculated using the Poisson and the relative seriality models. The 3D physical and the 2 Gy converted dose distributions and the BED distribution are shown and compared with the proposed methodology. Response-probability volume histograms (RVH) were also derived and compared with common dose volume histograms (DVH). 3D response-probability distributions are very useful for plan evaluation since their visual information focuses on the doses that are likely to have a larger clinical effect in a particular structure. The graphical display becomes independent of the prescription dose highlighting the local radiation therapy effect in each voxel without the loss of important spatial information. RVH are advantageous since by incorporating the radiobiological properties of each voxel they summarize the 3D distribution into 2D without the loss of information on the structure radiobiological heterogeneity. Thus more clinically relevant radiobiological constraints could be defined and used in treatment planning optimization. The proposed method aims to complement quantifiers like the probability of tissue response. Response-probability charts and RVH can differentiate more clearly different treatment plans than conventional dosimetric analysis. These measures become increasingly important when dose distributions need to be designed according to the microscopic radiobiological properties of tumors and normal tissues.

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EVALUATION OF RBE FOR IMRT FIELD USING MICRODOSIMETRIC METHOD

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Microdosimetry has been developed for the evaluation of radiation quality, and single-event dose-mean lineal energy y_D is well-used to represent the radiation quality. In the cell irradiation experiments reported in the previous study, the RBE values of the Human Salivary Gland tumor cells for 200 kV X-rays, ^{60}Co gamma-rays, and 6 MV X-rays were 1.000, 0.903, and 0.872, respectively, and it was found that Relative Biological Effectiveness depended on the photon energy. To investigate the radiation quality of the three photon beams, the y_D values were measured with the Tissue-Equivalent Proportional Counter (TEPC), and the Microdosimetric Kinetic model was implemented to derive the RBE values from only the measurements of the y_D values instead of performing the cell irradiations. By using this model, it was found that the RBE outside the field increased because of the low energy scattering photons. In IMRT fields, however, the TEPC measurements are impracticable, because a monitor unit, which controls a Multi-Leaf Collimator (MLC), doesn't work at such an extremely low dose rate. To solve this problem, the pencil beam method of deriving the y_D values by an analytical approach was proposed in this study. This model requires a scatter dose kernel and a kernel of the y_D value. The two kernels were derived from the experiments, and verified by comparing with the film dose and the TEPC measurements. By using these kernels, the changes of the RBE for the IMRT fields were evaluated. Consequently, the RBE in the high dose region was almost constant and unity. However, the RBE in the low dose region was approximately 2% higher, and the RBE outside the field was approximately 5% higher than that in the high dose region.

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INITIAL EXPERIENCE OF PATIENT SPECIFIC QUALITY ASSURANCE FOR RAPIDARC USING ARCCheck at hope at guatemala

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Medical Physics

RapidArc is a radiotherapy modality that optimizes more parameters than intensity modulated radiotherapy (IMRT), there for it is necessary to have a higher level of quality control of equipment and specific treatment plans for patients. The aim of this paper is to report the quality control made prior plans initiate treatment at the first radiation therapy center with RapidArc in LatinAmerica. Measurements were taken with a 4D phantom ArcCheck and MapCheck software together with the IMRT phantom from IBA. The treatment plans were generated on Varian's RapidArc optimizer, and delivered with a Clinac 2300CD linear accelerator, also from Varian. The readings on the detector array are compared with the doses reconstructed to 1 mm grid on ArcCheck geometry based on the exported dose from the Eclipse. Basic tests were carried out: linearity, consistency and ghost effect. And in the IMRT phantom the dose delivered was compared to that predicted by Eclipse with an ionization chamber PTW Pinpoint. The reported treatments are brain (Glioblastoma) and prostate with seminal vesicles and pelvic lymph nodes, which were compared using the Gamma index criteria and DTA with 5% dose threshold. The gamma evaluation result is 97.9% for prostate and 98.9% for the brain, by adopting the criterion of 3% and 3mm. Similarly, the DTA 3mm evaluation was 95.0% and 97.3% respectively. And the ionization chamber readings had a difference of 1.1% and 0.5% for prostate and cranial respectively than the results predicted by Eclipse. The evaluations show the great overlap between the predicted doses with those obtained in the phantom, so that assessments of treatment they give us great certainty. Although the results are positive, it is advisable to restrict the quality assurance evaluations of treatment plans, rigorous methods should be applied to the daily quality control for accelerator parameters for reliability

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DEVELOPMENT OF THE DEDICATED PHANTOM SYSTEM WITH ROLLED RADIOCHROMIC FILMS FOR VMAT QA

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To achieve easy and practical quality assurance (QA) for volumetric modulated arc therapy (VMAT), the new verification system using wrapped radiochromic films (Gafchromic EBT2, ISP, NJ, USA) around cylindrical surface and ionization chamber was developed; the phantom allows to insert the rolled and the square films to measure the delivered doses along the arc trajectory and the axial planes, respectively. The central cylindrical body covered with films was inserted into another enveloping acrylic body of 5 cm thickness. The phantom structure can secure the enough effective measurement region providing the stable measurement and set-up condition. The analysis software geared toward the verification for arc therapy facilitates dose comparison between the delivered doses to film in rolled-out plane with the reconstructed dose matrix of calculated doses in ERGO++ (version 1.7.6, Elekta Ltd., Crawley, UK). The amount of dose disagreement can be distinguished in polar coordinates by the gamma index (3 mm/3%) differentiating between over- and under-estimated doses. The film characteristics of flexibility, high spatial resolution, and dose integration led to sophisticated dose verification at each corresponding position. The verification system guided to notice what gantry angle principally causes the significant dose error in cylindrical coordinates. More significant dose error around critical organs was also estimated in patient anatomical geometry. As the modulated fields (dose calculation using the grid size of 2 mm and angular increment of 5°) of VMAT (Elekta Synergy, Elekta Ltd., Crawley, UK) was delivered for prostate cancer, the specific positions not satisfying the gamma criteria were detected using our developed VMAT QA system. Rolled-up and -out films on cylindrical phantom with the elaborate dose analysis enables adapted QA for VMAT to detect critical dose error by the various dynamic factors.

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EVALUATION OF COLLIMATED 6 MEV ELECTRON BEAM PROFILES THROUGH XIO AND PENELOPE M

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Dose distributions determined by treatment planning systems and Monte Carlo simulation codes can differ significantly due mainly to differences in the calculation algorithms employed. Beam profiles for collimated electron fields were evaluated using XiO treatment planning system (TPS) and PENELOPE Monte Carlo simulation code and were compared to the profiles obtained with ionization chamber (0.1 cc/IBA). Standard applicators were used for electrons fields of 10x10 and 15x15 cm² and the comparison of the dose profiles inside the radiation field found maximum differences of 1.5% and 2.0%, between PENELOPE and ionization chamber and of 2.2% and 1.8% between TPS and ionization values, for each field size respectively. Maximum differences of 3.0% and 3.2% were found for the comparison of the beam profiles from PENELOPE and TPS values for each applicator respectively. For all comparison, the differences increased up to 10% for regions outside the radiation field (isodoses lower than 50%). To obtain collimated fields, the standard 10 x 10 cm² applicator was used with additional blocks of cerrobend to produce fields of 1x1, 2x2, 3x3, 5x5, 7x7 and 9x9 cm². The comparison of the beam profiles obtained using PENELOPE and TPS for regions inside the radiation beams showed maximum difference of 5.0 %, 4.3 %, 4.8 %, 4.0 %, 3.4 % and 3.0%, respectively for each studied field. These differences increased up to 12% for regions with isodoses lower than 50%. Decreasing the field size produces beam profiles with a Gaussian shape due to the lack of lateral equilibrium. The TPS curves did not showed a continuum behavior, presenting breaks in the profile curve due to the interpolation of data for the collimated fields. The results confirm the differences from simulated profiles with PENELOPE and TPS profiles. Even tough these differences, the beam profiles showed similar behavior.

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RADIOCHROMIC FILM RESPONSE TO CLINICAL ELECTRON BEAMS

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The characteristics of radiochromic films responding to 9 MeV therapeutic electron beams were determined. The analysis was performed with Gafchromic EBT films and Microtek ScanMaker 9800 XL scanner. The film dose response shows a nonlinear behavior and is expected to follow a polynomial of five degree. Conflicting with other works, the sensitivity of radiochromic film is bigger in the region of 100 to 200 cGy. The response over the scan field is not uniform. The variations due the film location in scanner bed are within 14%. The film response energy dependence, field size dependence and dose rate dependence are not important.

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SKYSHINE PHOTON DOSES FROM 6 AND 10 MV MEDICAL LINEAR ACCELERATORS

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The skyshine radiation is the phenomenon that occurs when primary photon beams are scattered in the atmosphere above the roof of a medical linear accelerator facility, generating an additional dose at ground level in the vicinity of the treatment room. With respect to the radioprotection this situation assumes an important role when the ceiling is designed with little or no shielding and there are buildings constructed adjacent to the radiotherapy treatment room. In literature there are few reported skyshine measured doses and with poor agreement with empirical calculations. In this work we carried out measurements of skyshine photon dose rates produced from several 6 and 10 MV medical linear accelerators. Each measurement was performed outside the room facility, with the beam positioned in the upward direction, at an horizontal distance d from the target and for a 40 cm x 40 cm maximum photon field size at the accelerator isocenter. Measured dose-equivalent rates results were compared with calculations obtained by an empirical expression, and differences between them deviated from one or more order of magnitude.

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QUALITY CONTROL IN RADIO THERAPY: METROLOGICAL EVALUATION OF THE CONGRUENCE OF LIGHT AND RADIATION FIELD IN LINEAR ACCELERATORS

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The objective of this work is to evaluate the metrological reliability of the light/radiation field size congruence parameter in linear accelerators at State of Rio de Janeiro. This parameter assessment is a dosimetric quality assurance requirement. In this study, three different procedures were carried out in order to measure the irradiated field size on radiochromic films: (A) measurement of irradiated field size in RTQA and EBT QD+ radiochromic films using a calibrated ruler with traceable accuracy; (B) measurement of irradiated field size in EBT QD+ radiochromic films, using the calibrated ruler and an optical densitometer; (C) measurement of irradiated field size in RTQA and EBT QD+ radiochromic films by means of a transmission scanner. The impact of the measurement uncertainty on the congruence parameter conformity, according to tolerance levels advised by the IAEA/TEDOC – 1151, was investigated. Despite the requirement recently published by the Brazilian National Health Surveillance Agency, regarding the compulsory use of optical densitometer on the quality control tests, here represented by procedure (B), the RTQA film properties did not allow its optical density reading. The highest levels of measurement uncertainty were observed when congruence parameter were evaluated by procedure A, and the lowest levels were obtained with procedure C, with the best results using EBT radiochromic films. When the measurement uncertainty was considered for conformity assessment, only one of the linear accelerators (7.7% of the units evaluated) presented results in accordance to the acceptance limits by means of all the three procedures. Keywords: 1. Metrology. 2. Linear Accelerator. 3. Radiotherapy. 4. Quality Assurance

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ANALYSIS OF DATA QUALITY ASSURANCE OF THE THREE LINEAR ACCELERATORS AT HC-FMUSP

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Most radiotherapy treatments are nowadays carried out by using external photon beams produced by linear accelerators. The maintenance of good quality treatments depends essentially on the stability of the accelerators and on the ability of local quality assurance (QA) to monitor drifts in the beam parameters. One of the most crucial parameters is the output of an accelerator, defined as the absorbed dose per monitor unit (MU) at a given depth of a reference beam, measured in a water phantom. The aim of this work consists to evaluate and analyze the short and long-term stability of output factors as well as the other dosimetric parameters normally included in a quality assurance program in Radiotherapy. The results of calibration factors of all accelerators were satisfactory and mostly within the limits established by TG-142. All output factor measurements were taken in reference conditions, i.e., field size of 10 x 10 cm² with a source-surface distance (SSD) of 100 cm. The average calibration factors for the period of almost 3 years for the Clinac 600C and Clinac 6 EX was (0,995±0,006) and (0,993±0,008) respectively. For the Clinac 2100CD for 6 MV and 15 MV was (1,005±0,008) and (1,003±0,009) respectively in a period of almost 5 years. The values of $TPR_{20,10}$ of three accelerators are almost constant, within acceptable limits. The $TPR_{20,10}$ values were obtained according TRS-398 protocol. The average values of $TPR_{20,10}$ for Clinac 600C was (0,666±0,006), for the Clinac 2100CD for 6 MV and 15 MV was (0,666±0,003) and (0,646±0,0004) respectively and for Clinac 6 EX was (0,664±0,001). It can be concluded that a detailed study of output data and $TPR_{20,10}$ from a quantitative point of view is extremely useful into a quality assurance program.

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USE OF TLDS IN QUALITY CONTROL FOR EVALUATION OF EDWF IN RADIOTHERAPY

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The aim of this work was to determine whether the Enhanced Dynamic Wedge Factor (EDWF) could be evaluated using thermoluminescent dosimeters (LiF:MgTi, TLD-100) and, if so, incorporate it to the postal system created by the Quality Program in Radiotherapy _ PQRT of the National Cancer Institute _ INCA/MS in Brazil. We performed two sets of measurements to determine the EDWF in the central axis of the radiation beam: one set with ionization chamber (farmer PTW 30013 0,6 cc) and electrometer (PTW Unidos E), the reference set, and the other set with TLDs. The measurements were performed for four field sizes (5 cm x 10 cm, 10 cm x 10 cm, 15 cm x 10 cm and 20 cm x 10 cm) and for five dynamic wedge angles (10°, 15°, 30°, 45° and 60°). The beam energy used were the energies available for photons beams (6 MV and 15 MV) from the Varian Clinac 2300 C/D linear accelerator at the Hospital of Cancer I, INCA. After data acquisition, the results with TLDs were compared with the EDWF values obtained with ionization chamber and with a reference work (Souza, R.S.; October/2005). Due to the low percentual deviation (amongst $\pm 3\%$) between the measurements performed with them and those with ionization chamber, we concluded that the assessment of the EDWF is possible with TLDs and could be used as a remote quality assurance system.

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EVALUATION OF A CR SYSTEM FOR LINAC WEDGE FILTER QUALITY CONTROL

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The use of computed radiograph (CR) system to physical wedge quality control (QC) has been investigated. The purposed QC consists in compare periodic with a reference wedged field profile measurement performed with Fuji FCR Capsula CR System. To test its suitability, repeatability and reproducibility of CR dose response was investigated. Ten measurements were carried out for each wedge (15, 30, 45 and 60°). This procedure was repeated one and two months later. Previous calibration was performed against ionization chamber (IC). In order to monitor the variations on wedged field profiles, measurements on three points (central axis, +8 cm and - 8 cm) were carried out with Daily QA 3 (Sun Nuclear Corporation) device before CR exposures using 100 MU and 100 cm SSD. Further on, the method sensibility was tested simulating errors on wedge positioning. The cassettes were irradiated with 5 and 10° collimator rotations for comparison with reference measurement. These CR profiles deviations were compared with the profiles deviations obtained with a 0.15 cc Scanditronix/Wellhofer IC. All CR irradiations were performed with 1 MU and 100 cm SSD. The imaging plate reading were performed right after irradiation and normalized on central axis. The CR images (16 bits, DICOM form) were exported to ImageJ 4.3 software, which was used for dose evaluation. It was used a 6 MV photon beam (Primus Linac; Siemens) and field size 20x20 cm² for all measurements. Repeatability and reproducibility occurred on CR measurements (standard deviations less than 0.8%). Furthermore, the CR system is similar to IC in the capacity to detect wedged field dosimetric changes. All the differences of distances to agreement found with CR and IC were less than 1 mm and the relative dose differences were less than 1.5%. Therefore, the Fuji FCR Capsula CR System can be used for physical wedge QC.

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VALIDATION OF A CYLINDRICAL PHANTOM FOR VERIFICATION OF RADIOTHERAPY TREATMENTS IN HEAD AND NECK WITH SPECIAL TECHNIQUES

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Verification of radiotherapy treatments in head and neck require, among other things, small-volume chambers and a phantom as to reproduce the geometry and density of the anatomical structure. In new documents from the ICRU, report No. 83, establishing the need for quality control in radiotherapy with special techniques such as IMRT. This paper builds a cylindrical acrylic phantom with standing water, containing seven measuring points in the transverse plane and free location (0-20 cm) in the longitudinal plane. These measurement points are constituted by cavities for the accommodation of the ionization chamber of 7 mm of mayor diameter (Semiflex, Pin Poin with Build cup). The results of the validation of the phantom yielded percentage differences less than 1% in fixed beams and less than 2.2% in arc-therapy for TPS Eclipse calculation. The preparation of this phantom, made particularly to verify the head and neck treatments, was simple and reliable for checking the dose in radiotherapy with fixed beams and/or special techniques such as arc therapy or IMRT, so that will be sent to various radiotherapy centers in the country for dosimetric verification in such treatments.

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DESIGN AND EVALUATION OF AN IGRT SOFTWARE FOR DAILY TARGET ALIGNMENT

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Purpose: To design and evaluate an IGRT software for organ motions estimation during the course of radiotherapy. **Method and Materials:** A fiducial marker technique, originally developed in the pre-conformal radiotherapy era, has been used with our homemade software. Fiducial markers are implanted in the organs and orthogonal portals are performed daily before the treatment. The software does 2D-2D matching based on the fiducial markers for these orthogonal portals and calculates shifts (mm) in the superior-inferior (SI), left-right (LR) & anterior-posterior (AP) dimensions in comparison to the reference digitally reconstructed radiographs (DRR). The interfraction motion in any direction is then calculated by using shifts in any dimension. QA of this software has been performed using seed embedded Styrofoam phantom. About 20 known shifts in different dimensions were stated for imaging and compared with the results calculated from software. **Results:** An average difference of about ≈ 0.1 mm has been calculated regarding the precision of this software. Shifts optimization obtained from this simplified IGRT software has been used to rescale/shift the treatment position which allows minimizing the variation interfraction organ motion. **Conclusion:** Assessment of this new software tool has been successfully tested for delivering IGRT to reduce the interfraction motion.

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IMPORTANCE OF CUTOUT FACTOR IN RECEIVED DOSE IN TREATMENT OF KELOID

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The most effective treatment for keloid is a beam of radiation with electrons. In this case there is a need to bring the metal shield preventing scar with the most healthy tissues that are irradiated. These screens are specific to each patient. The non-use of a correction factor of protections (cutout factor) can lead to significant variation in dose received by patients. Besides the determining of cutout factor, is made in this work a comparison between the prescribed dose of 400 cGy to the patient [2] and the actual dose that the patient was to be spent with the protection. There is a region of criticality for treatments that combine low energy (less than 12 MeV), small size of field (smaller than 15x15 cm₂) and SSD different of 100 cm. For treatments that combine energies greater than 9 MeV, field sizes larger than 10x10 cm₂, especially for the cone 15x15 cm₂ and SSD of 100 cm, even without the cutout factor, the dose is less than prescribe dose.

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COMPARISON OF RAPIDARC AND INTENSITY MODULATED RADIOTHERAPY TREATMENT PLANS

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The purpose of this study is to examine the plan quality and monitor unit with sliding window Intensity Modulated Radiotherapy (IMRT) and RapidArc (RA) treatment plans using American Association Physicists in Medicine TG119 test suites. The structure set includes multi-target (superior, inferior, center), prostate, head and neck and C-shape. Plans were performed with Eclipse planning system with the plan goals specified in TG119. The plan results for multitarget shows that the D_{99} is greater than the plan goal for all the targets. The D_{10} is less than the plan goal for superior and inferior targets in both IMRT and RA plans. The plan results for prostate shows that D_{95} is greater than the plan goal for both IMRT and RA plans. The D_5 is less than the plan goal for IMRT plan and almost equal to plan goal for RA plan. The D_{30} is less than the plan goal for bladder and rectum in both the plans. The plan results for head and neck shows that the D_{99} and D_{90} were greater than the plan goal for Planning Target Volume (PTV). The spinal cord and parotid doses were less than the plan goal in both the plans. The plan results for C-shape shows that the D_{95} was greater than the plan goal and D_{10} was less than the plan goal for PTV. The dose to center core was less than the plan goal in both IMRT and RA plans. Both the IMRT and RA plans were met the plan goal for all the target and normal structures. RapidArc optimization and treatment planning requires more time than the IMRT plan. The monitor unit calculated by the RapidArc plan is less compared to IMRT plan, which reduces the treatment error caused by patient motion during treatment and integral dose.

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GAMMA INDEX COMPARISON FOR CONFORMAL DOSE DISTRIBUTION OBTAINED THROUGH THREE DO

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Dose distribution for a conformal irradiation technique using small fields was obtained through MAGIC-f dosimeter, PENELOPE-Monte Carlo simulation and XiO treatment planning system (TPS). The gel was stored in a cylindrical phantom of 12 cm diameter, 18 cm height and 0.5 cm thickness. The phantom containing the gel was irradiated with 9 fields of 1 x 1 cm² from a 6 MV clinical beam to a prescribed dose of 16 Gy. Relaxometry from MRI of the irradiated phantom was acquired using a 3 T scanner and head coil, multi spin echo sequences with 16 echo times multiples of 22.5 ms and repetition time of 3000 ms. The transverse relaxation rate R₂ (=1/T₂) was calculated and the R₂ maps were related to absorbed dose using a specific program developed in Matlab_, which provided the dose distributions. PENELOPE and TPS simulations were used faithfully reproducing the irradiation and geometry conditions as the experimental irradiation. The dose distributions obtained with these three tools were compared through Gamma Index using 3% and 3mm criteria. Analyzing a central region of 1 cm diameter in the dose distribution obtained by the gel and PENELOPE code, 100% of the dose values pass the test under Gamma Index conditions, although for regions farther than 1 cm only 57% of the dose values pass this test. Similarly, analyzing a central region of 1 cm diameter from gel and TPS dose distributions, 98 % of the dose values pass the test and 53% for farther regions. From the obtained results it can be concluded that the response of MAGIC-f gel agrees with the simulated and planned values in the central region. To improve gel response some studies are being performed to minimize the difference in region with high dose gradient and low doses so it can be used routinely as a dosimeter in clinical procedures.

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DOSE DELIVERED LINEARITY AT LOW MONITOR UNITS FOR A LINEAR ACCELERATOR

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We present the linearity characterization of the dose delivered by a linear accelerator, model 6EX manufactured by Varian, used at AC Camargo hospital. The measurements were made totalizing 200UM, divided into segments of 1, 2, 5, 10, 20, 50, 100 and 200UM, for dose rates of 100, 400 and 600UM/min, using a Farmer type chamber ionization of 0.65 cm³, Exradin A12, in central axis of a field size 10x10cm² and at 10 cm depth in a water phantom, connected to an electrometer Standard Imaging - CDX 2000B. Each measurement was repeated three times and ionizations average of each segment normalized by the ionization average obtained with 200 MU. We found a deviation between ionizations for a segment of 1MU and 200MU of $+(4.8 \pm 0.1)\%$, $+(4.6 \pm 0.1)\%$ and $+(4.8 \pm 0.1)\%$ for the different dose rates of, respectively, 100, 400 and 600UM/min. For higher UM number in each segment, the results were, respectively for dose rate of 100, 400 and 600UM/min, $+(2.38 \pm 0.05)\%$, $+(2.15 \pm 0.08)\%$ and $+(3.0 \pm 0.3)\%$ for 2UM and $+(1.87 \pm 0.05)\%$, $+(1.59 \pm 0.08)\%$ and $+(1.4 \pm 0.2)\%$ for 5MU, and less than 1.0% for 10UM or more. For these results it is observed that the dose delivered linearity is independent of dose rate clinically used for the linear accelerator Varian 6EX.

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TOTAL BODY PHOTON IRRADIATION (TBI) DOSIMETRY WITH GAFCHROMIC EBT FILM

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INTRODUCTION / PURPOSE AND METHOD: In this work, were evaluated the possibility of the GAFCHROMIC EBT film for the dose measurements with the TBI treatment technique. The film samples were used for in vivo dose measurements on four TBI patients, and the results were compared with ionization chamber and TLD's. These samples had approximately 4.0x4.0 cm², which were cut off from the same batch, and they were wrapped in paper to avoid the effect of ambient light. The irradiated films were measured using an optical densitometer PTW-DensiX. In each strip were performed the analysis of four points to reduce the influence of variations dose in the film. First of all, film was calibrated using a TBI set up (SSD=330cm, dose rate=80UM/min). The relation between absorbed dose and film response was determined, and this relation was plotted as a calibration curve. **RESULTS:** The film presents a good linearity and accuracy in the range of radiation dose 0.75 Gy and 2.0 Gy, and the linear correlation coefficient (R^2) of the calibration curve is 0.996. The measured doses at central axis of the GAFCHROMIC EBT film samples were well, within -6.74% of the prescription dose. In comparisons with ionization chamber doses at central axis, there is a +1.41% maximum deviation. The agreement of measured doses between EBT films and TLD's were within -7.78% to +8.54%. **CONCLUSIONS:** Based on the linear dose response, accuracy and reproducibility of the GAFCHROMIC EBT film, we can conclude that the use of EBT films for TBI dosimetry is very suitable. Furthermore, the film's characteristics make this kind of radiochromic films easier to handle. The GAFCHROMIC EBT film is a practical alternative to TLDs as an in vivo dosimeter in TBI radiotherapy.

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PRELIMINARY STUDY OF THE INFLUENCE OF LOCATION ACCURACY OF THE ISOCENTER IN DOSE VOLUME HISTOGRAMS AND THREE-DIMENSIONAL CONFORMAL RADIOTHERAPY IN PROSTATE

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An important factor of the whole process of treatment is the precision in the location specified in the planning isocenter. The purpose of this study is to conduct a analyze of the influence of accuracy and efficiency in the isocenter localizations using data form dose volume histogram (DVH) in prostate conformal simulating a range of 5.0 mm in the directions IN and OUT, UP and DOWN, LEFT and RIGHT from the center of acquisition- represented . For OR (organ at risk) bladder observed significant influence in the simulations with variations in the directions IN / OUT - 15.6% (11.7 to 22.5) and UP / DOWN - 16.2% (12.5 - 21.3), and the OR rectum showed that the major influences was yourin the direction UP/DOWN - 24.4% (21.9 to 30.3). The dose to the PTV received 95% was 97.8 +/- 4.3% of the prescribed dose. The results show the importance of a protocol in radiotherapy department and use of accessories immobilization in reducing the error of set-up and the consequent possibility of reducing the target volume margins.

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COMPARISON BETWEEN 2D AND 3D PLANNING IN TREATMENT OF ANAL CANAL CARCINOMA

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BACKGROUND: Comparison of different planning techniques of anal canal (2D and 3D). **METHODS:** 2D and 3D radiotherapy planning were performed for 6 patients with anal canal cancer. Prescribed doses ranged from 30,6 to 36 Gy. For each patient dose-volume histograms (DVHs) and isodose distributions were calculated. The analysis covered the evaluation of the minimum and maximum doses in the planning target volume (PTV), the coverage dose in the PTV, maximum dose in the adjacent organs at risk (OAR). **RESULTS:** The analysis of maximum dose in PTV shows that the planning using 2D technique ranged from 40% to 48% of the prescription dose and 3D planning ranged from 16% to 35%. The data of minimum dose had no correlation with the technique. The percentage volume of PTV receiving the prescription dose ranged from 93% to 99% for 2D planning and 58% to 96% for 3D. **CONCLUSION:** The radiotherapy using 3D technique allowed a better preservation of organs of risks, but can provides a decrease in the coverage of PTV.

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CONSTRAINTS AND COMMON TECHNIQUES IN POSTMASTECTOMY RADIOTHERAPY

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Over the past 50 years breast cancer has become a major health problem affecting as many as one in eight women during their lifetime. Mastectomy is one of the main options in the treatment of breast cancer patients in an aim to avoid metastases of the disease. Yet, a successful operation does not eliminate the risks of local recurrence. Postmastectomy radiotherapy can significantly reduce these risks. This study intends to review and evaluate the challenges and complications which are sometimes associated with postmastectomy radiotherapy. Clinical and dosimetric trials are carried out using various techniques to optimize the treatments by maximizing the dose to the tumor and minimizing it to the healthy tissues at proximity. No one technique studied fulfilled these requirements. This is basically because the heterogeneity of the breast cancer means that the response to therapy and a systematic approach to treatment cannot be derived and treatment regions must be determined on a patient-by-patient basis. The accuracy of dose distributions is crucial to the quality of treatment planning and consequently to the doses delivered to patients undergoing radiation therapy. The successful radiation therapy depends on the stage of cancer.

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INFLUENCE OF THE PRESENCE OF TISSUE EXPANDERS IN DOSE DISTRIBUTION IN POST-MASTE

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A growing number of studies have shown that post-mastectomy radiotherapy has benefits associated with the patient's survival. Some models of tissue expander have a magnetic valve on its surface, and that constitutes heterogeneity in the radiation field, and could change dose distribution in the radiotherapy treatment of patients who have this type of prosthesis. In this study we investigated the physical effects of the dose distribution in the vicinity of the metallic heterogeneity, through the determination of the Dose Profile and the Percentage Depth Doses (PDD), for water and in the presence of the heterogeneity, in order to check changes caused by the presence of the metallic artifact. The measure of these quantities was achieved through computer simulations by Monte Carlo, using the code MCNP. Our results show that the presence of the metallic heterogeneity can modify the absorbed dose causing its decrease until 13% in the geometric shadow region of the heterogeneity. This difference isn't acceptable for radiotherapy, as this difference is superior of the limit established by dosimetry protocols that accept under-dosing until 5%. We show also, that the dose profile suffers big changes, what can modify the prescript dose for established locals. These two facts give evidence of the importance of take into account the heterogeneity, in the treatment planning.

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EFFECT OF PHYSIOLOGICAL CONDITION AT THE DOSES TO ORGAN AT RISK (OAR) IN THE PROSTATE CANCER TREATMENT

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Abstract. The Images Guided Radiation Therapy (IGRT) has revealed the importance and impact of the different movement volumes, using the rigid registration implemented in eclipse 8.9 Treatment planning System (TPS) we have made a evaluation of the dose changes at the different volumes and the clinical impact in dependence of daily condition, we selected 5 patients with localized prostate cancer treated with Intensity Modulated Radiation Therapy (IMRT) and IGRT. The initial results show a wide variation that can be up to 50% of the expected doses at the low dose region and 20% at the high dose region to the organ at risk volumes (OAR), but The use of gold seeds implanted into the prostate to IGRT and good margin to expanded the Planning Target Volumes (PTV) used to Clinical Target Volume (CTV) ensure that under different condition the CTV dose is kept in over 95% of the prescribed doses. The dose dependence of the physiological condition put into consideration show the need for Adaptive Radiation Therapy (ART) using on-line correction to guarantees the correct doses to CTV; keeping the dose to OAR within the limit of tolerance, however the current TPS are unable to made deformable registration limiting the interpretation to daily dose variation and unable to do evaluation of cumulative voxel dose.

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EVALUATION OF THE HETEROGENEITY CORRECTIONS IMPACT IN LUNG SBRT

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Stereotactic body radiation therapy (SBRT) refers to an emerging radiotherapy that is highly effective in controlling early primary and oligometastatic cancers at locations throughout the abdominopelvic and thoracic cavities, and at spinal and paraspinal sites. Some protocols have been developed for this kind of procedure. In the special cases of lung, there are protocols in use that considers heterogeneity corrections and others that do not make use of heterogeneity correction. In this work, we recalculated considering the different tissue densities plans initially optimized without heterogeneity corrections to evaluate the dosimetric changes that occurs, like PTV coverage, dose to isocenter, dose to critical structures, and we calculated gamma function between the dose plans originated in the two conditions and performed the superposition between the calculated gamma function with the respective CT slice in order to evaluate in what conditions occurs the major differences between the conditions of calculus considered. The results showed that relevant variations occur between the two situations of calculus. With the superposition of the image relative to γ index and its respective slice CT, we could visualize where the greatest discrepancies occurs. These data allow us to evaluate accurately the doses delivered to the target and organs at risk and compare different protocols, whether or not using the heterogeneity corrections settings.

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OUTPUT ENERGIES OF PROTON BEAMS AFTER PASS THROUGH HETEROGENOUS TARGETS

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In the recent years, the use of proton beams in radiotherapy has been an outstanding progress. Up to now, the CT is a requirement for treatment planning in this kind of therapy because it provides the electron density distribution required for dose and range calculations. However, the use of CT images for proton treatment planning ignores fundamental differences in physical interaction processes between photons and protons and is, therefore, potentially inaccurate. Proton CT (pCT) can in principle directly measure the density distribution needed in a patient for the dose distribution. One important problem that should be solved is the implementation of image reconstruction algorithms. In this sense, it is necessary to know how the presence of materials with different densities and compositions interfere in the energy deposition by ionization and coulomb excitation, during its trajectory, as well as by nuclear non-elastic processes. The calculations were implemented for water targets with slices of other materials inserted in different positions. The study was conducted in two stages, in both SRIM and MCNPX codes were used to perform all simulations of the interaction of proton beams with pencil beam shape, for energies in the range from 100 to 250 MeV.

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DOSIMETRIC CHARACTERIZATION OF IRRADIATION CONES FOR STEREOTACTIC RADIOSURGERY

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In this work, the dosimetric parameters of a set of seven BrainLab cones for stereotactic radiosurgery and radiotherapy (SRS/SRT), varying from 10 mm to 30 mm in diameter, are evaluated. The dosimetric measurements were performed on a Varian Clinac-23EX linear accelerator operating at 6 MV with a CC01 Scanditronix IBA PinPoint waterproof ionization chamber (0.01 cm^3) in a Scaditronix Wellhöfer, Blue Phantom. The chosen setup was 15 mm/s scanning speed and 600 UM/min dose rate with the primary collimator opened at 3.6 cm x 3.6 cm. Measurements were taken from 0 to 25 cm, 100 cm SSD, for the percent depth dose and from 3.6 cm to + 3.6 cm at a depth of 7.5 cm, 92.5 cm SSD, for the beam profile. As expected, the PDP values grew with the diameter of the cone, 3.9 % at 5 cm, and 1.6 % at 20 cm. The $\text{TPR}_{20/10}$ showed an average value of 0.54 with a deviation of 1 %. The best values for flatness and symmetry were found for the 30 mm diameter cone, 1.9 % and 5.1 %, while the worst were found for the 10 mm diameter cone, 13.6 % e 16.3 %, respectively. The average value for the penumbra considering all cones was found as 2.7 mm with a deviation of less than 0.3 mm. Values for field size showed an average deviation of 1.6 % to the real size. These results are in good agreement with the ones reported in the literature and show the challenge of small-field dosimetry, in particular when an ionization chamber is used.

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PDD'S RECONSTRUCTION OF THE LINEAR ACCELERATOR VARIAN 2100C FOR PHOTONS BEAMS OF THE 6MV AND 10MV USING MCNP-4C CODE

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A great challenge in simulations in the area of radiotherapy is to character the source, since the equipment's manufacturers don't provide specifics information about this. This work presents an empiric method for characterization of the ray-X beams of 6.0 MV and 10 MV originating from a linear accelerator of the mark Varian model 2100C. The experimental values of the percentage of deep dose (PDD) were used for reconstruction of the energy spectrum and analysis of the angular distribution of the beam simulated with Monte Carlo's Method, using the code MCNP-4C. The results were shown solid could be used for the space reconstruction of the beam.

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PRESENT STATUS OF BORON NEUTRON CAPTURE THERAPY AT KYOTO UNIVERSITY RESEARCH REACTOR INSTITUTE

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Boron neutron capture therapy at Kyoto University Reactor (KUR) started in 1974. Until the KUR-operation was stopped for the change from the high-enriched uranium fuel to the low-enriched one, two hundreds and fourteen BNCT clinical irradiations were carried out. In May 2010, the BNCT clinical irradiation was restarted simultaneously with the restart of the KUR operation, which was suspended for four years. After the restart, forty clinical irradiations have been already done as of February 2011. Together with developments of BNCT clinical irradiation, the preparation and improvement in the fields of physical engineering and medical physics were also done, for some systems supporting the clinical irradiation, such as irradiation system, dose estimation system, etc. The physical engineering and medical physics supporting BNCT were categorized the following four subjects; (1) the development and improvement of neutron irradiation system, (2) the development and improvement of dose estimation method, (3) the development and improvement of dose planning system, and (4) quality assurance and quality control (QA/QC). In this paper, the current status of BNCT at KURRI is reported, focusing mainly on subject (1).

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PERSONALIZED RADIOTHERAPY TREATMENT FIELD AND PLANNING SYSTEM

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There are many radiosensitive epidermotropics diseases such as mycosis fungoids and the syndrome of S_zary, coetaneous neoplasics originated from type T lymphocytes. Several studies indicate the eradication of the disease when treated with linear accelerators emitting electron beams with energies between 4 to 10 MeV. However, this treatment technique presents innumerable technical challenges since the disease in general reaches all patient's body, becoming necessary not only a very large field size radiation beam, but also deliver superficial doses limited to the skin depth. To reach the uniformity in the dose distribution, many techniques had already been developed. Based on these previous studies and guided by the report n°. 23 of the American Association of Physicists in Medicine (AAPM), the present study developed an energy scattering and degrading plates and made dosimetry (computational and experimental), supplying subsidies for a future installation of Total Skin Electron Therapy (TSET) and develop several scatter plates through MCNP5 numerical simulations. The scatter plates will allow treatments in different Source Surface Distance (SSD) according to the depth, extent of disease and the patient's anatomy. As part of the plates design, first of all, the energy spectrum of the 6 MeV electron beam of the VARIAN 2100C accelerator of Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo was reconstructed through Monte Carlo simulations using the MCNP5 code and based on experimental data. Once the spectrum is built, several materials were analyzed for the plates design based on radial and axial dose distribution, production of X-ray and dose attenuation. Using the repeated structures feature and an auxiliary software, voxels phantoms can be created using Magnetic Resonance Imaging (MRI) and Computed Tomography (CT), simulating the dose distribution in the patient's body including skin, creating personalized treatments.

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DIFFERENCES BETWEEN COMPUTED TOMOGRAPHY EXAMS FOR DIAGNOSIS AND RADIO THERAPY PLA

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This work focuses on the main differences encountered in Computed Tomography procedures undertaken for radiotherapy planning and diagnosis. Furthermore, specific information is given about conventional tomography examinations, focusing on three -dimensional radiotherapy planning for cancer in various locations. It is important to clarify that in order to enable the use of these images in the planning of the treatment, the position of the patient at the moment the examination is undertaken, and during the treatment must always be the same. Therefore adjustments must be made to the conventional tomography equipment and to the protocol of image acquisition control, in order to achieve examinations which focus on radiotherapy planning. As well as clarifying the importance of these adjustments, some of the principal procedures for modifying the equipment are identified, simulating the environmental conditions of the treatment.

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ACCURACY OF THE INHOMOGENEITY CORRECTION IN THE ANALYTICAL ANISOTROPIC ALGORITHM

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The aim of this study was to verify the results of an earlier work where it was concluded that the Analytical Anisotropic Algorithm (AAA) has more accentuated problems in the calculation of the photon attenuation than in the photon scattering by inhomogeneities. Our investigation shows that the AAA accounts more correctly the attenuation along the primary ray path than the scattered radiation in the inhomogeneity. The lowest accuracy was obtained in the points without absorption of the primary radiation by the inhomogeneity, but with the largest contribution of the radiation scattered in it.

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EVALUATING THE USE OF FREE SOFTWARE TO QUANTIFY PATIENT SETUP ERRORS

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In order to verify patient treatment positioning, portal images are compared with digitally reconstructed radiographies (DRRs) acquired in the treatment planning system (TPS). Despite all technologies available, the traditional approach based on physician's eye judgment is still largely used. The purpose of this study is to evaluate the use of ImageJ free software to quantify patient setup errors based on bone anatomy. The method to measure patient displacement tested in this study is based on matching two orthogonal images representing the actual patient positioning with images generated in the treatment planning (used as reference). An algorithm was implemented in an ImageJ macro to match the images and calculate patient displacement. The approach is based on point-to-point registration. Pairs of points, which correspond to the same locations of an anatomical feature, arbitrarily chosen by the user, need to be identified in the portal and reference images. In addition, a manual adjustment can be performed. The images are presented in different colors and segmentations can be made in order to facilitate visual inspection. The algorithm was tested comparing known with measured displacements. A head and neck and pelvic CT scans were used to generate DRRs in the Theraplan Plus TPS. It was acquired reference images (planned patient positioning) and images with conjugated patient displacement of 2, 4, 6, 8, 10, 12, 15 and 20 mm in the S-I, C-C and L-R directions (representing the treatment patient positioning). All the measurements were carried out by 3 observers. The maximum difference between the measured and the known displacements was 1.5 mm. It was not found significant difference among the observer's measurements (maximum difference less than 2 mm). Further study (with real portal images) is necessary before clinical implementation. The results showed that ImageJ free software can be used to patient displacement measurements.

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ONLINE TEACHING RESOURCES FOR HELPING THE LEARNING OF MEDICAL PHYSICS IN BRAZIL

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This work is the result of an undergraduate research project concerning the Group of Medical Physics Teaching Research (GEFIM) from PUC-SP, created in 2004, which objective is to develop and select online didactic resources to help the access and understanding of concepts in the field of medical physics to college students and professionals in Brazil. After the initial background studies about ionizing radiation applied to medical physics, a search were carried out on Internet for Brazilian universities that offer degrees in medical physics, identifying the most frequent specific disciplines in their curricula. There was also a survey of sites and instructional materials available in the Internet that address these topics, which have been selected with criteria based on correctness of information, clarity and appropriateness to the target reader, as well as to facilitate the possible visualization of concepts. A blog related to the project was created entitled “Ensino de Física Médica” (Teaching of Medical Physics), where some search results have been reported. So far, 93 Internet sites were surveyed offering different kinds of online learning materials to address issues related to the area, including: informational texts (37%), videos (18%), simulations and others (45%). In the past year, the blog had 11 posts, which can be classified at least in three modules: (i) What is Medical Physics, addressing the knowledge area and job market; (ii) Radiography, including its history and concepts, and a didactic experiment built by us, and (iii) Interaction of Radiation with Matter, all including theoretical conceptual texts, explanatory videos, simulations, etc.. These features should facilitate learning for those who want to know the area of Medical Physics, adding visualization, interactivity, and applications of knowledge studied in academic disciplines. Another goal of the project is to contribute also to the training of professionals in the Medical Physics field.

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DEVELOPMENT OF DIDACTICAL EXPERIMENTS FOR THE STUDY OF COMPTON SCATTERING AND ELECTRON-POSITRON PAIR ANNIHILATION PHENOMENA

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The present work shows a reviewed approach with phenomenological focus of experiments related to Compton scattering and electron-positron pair annihilation, used for studying the interaction between ionizing radiation with matter. This study intended to develop didactical experiments to be reproduced at Physics or Medical Physics under-graduation laboratory classes. In Compton scattering experiment was possible to determine experimentally the electron rest mass. The result obtained was 0.513(8) MeV. In electron-positron pair annihilation experiment the maximum angular correlation obtained was centered at 180°, as expected, with an angular width of $\pm 2.6^\circ$. The geometrical approach of the phenomena showed it appropriate to better student's comprehension.

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MEDICAL PHYSICS EDUCATION IN MEXICO

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Since 1997, Mexico's formal education in medical physics rests on two programs at the Master of Sciences level (2-year plus thesis). At UNAM, the National University of Mexico in Mexico City, the M.Sc. (Medical Physics) curriculum is part of the Physical Sciences Graduate Program (www.fisica.unam.mx/fismed) and includes academic/training collaborations with national institutes of health and other health services. Thesis research areas span a range of physics applications in medicine and biology, such as radiation therapy and imaging, magnetic resonance, optical physics and radiation biology, among others. The present UNAM academic staff (30) includes researchers, professors and clinical medical physicists who teach courses and direct thesis in collaboration with (15) medical doctors from private and public health centers. A one-semester clinical residency, consisting on rotations through health services in Mexico City, is one of the required activities. At UAEM, the State of Mexico University in Toluca, the M.Sc. program is offered by the Medical School (www.uaemex.mx/pestud/mae_doc/maestrias) and operates in partnership with the National Institute for Nuclear Research ININ. Thesis deal with radiation physics, nuclear medicine and radiobiology. Until March 2011, 73 students have graduated from UNAM and 39 from UAEM programs. Approximately 55% of the graduates have been hired as clinical medical physicists, and they represent about half of the medical physics workforce in the country. 20% of the graduates pursue a doctorate degree in medical physics or related area. These percentages are similar for both programs. About 10% of students come from other Latin American countries. The UNAM program has been recognized by the National Council for Science and Technology (CONACyT) as one of International Competence, the highest level of accreditation for graduate degrees, assuring 2-year fellowships to all registered students.

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CURRENT STATUS OF UNDERGRADUATE MEDICAL PHYSICS COURSES IN BRAZIL

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Medical Physics (MP) teaching in Brazil differs of other countries, since there are a number of undergraduate courses providing this background for bachelor's students. A survey was performed by Brazilian Association of Physicists in Medicine (ABFM) and a Workshop on Medical Physics Education and Training was organized in order to understand the state-of-the-art of the current teaching methods and curricula. During 2009, electronic forms were sent to MP courses coordinators in order to obtain information regarding the status of each University. The requested information included: year of starting the offer of undergraduate MP course, number of openings per year, admissions policy, and others. During the Workshop (February 4-5th, 2010), the current educational methods and ideal profile bachelors in MP were discussed at roundtables and by testimonies of employers, ex-students and postgraduate and residency program supervisors. The survey collected data from 8 out of 13 courses and it showed that MP courses open at least 360 places per year and have duration of 4-5 years. Around 120 students had concluded these undergraduate courses in the last year, totalizing approximately 550 students graduated until 2008. As a result of the Workshop, the need for attention on improving the clinical experience during the undergraduate period appears as the main topic to be reinforced by the institutions. Hospital training after concludes the undergraduate course is an important part of the education-training. The data survey and Workshop showed that undergraduate courses have accelerated the formation of staff for the MP field. Differences on the provided scientific background for the students of different MP courses should be harmonized in order to provide similar information background and resources in each University. It should be done without interference in the main characteristics and natural specialization of each school.

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MEDICAL PHYSICS EDUCATION AND TRAINING IN JAMAICA

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Medical Physics Education and Training in Jamaica Mitko Voutchkov, Emilia Milieva University of the West Indies, Mona, Kingston, Jamaica Medical Physics education at most universities is primarily offered through Masters level programs in Medical Physics or Medical Physics & Bioengineering. Education in Medical Physics was first introduced in Jamaica in 2008 as a Bachelor of Science (BSc) degree at the University of the West Indies (UWI) Mona. The new programme was prepared in response to emerging needs of the country for medical physicists able to work and apply their skills in medical research laboratories, hospitals, regulatory authorities, industry and the private sector. Prior to this medical physicists in Jamaica had to be trained abroad. The Bachelor of Science programme was carefully designed to ensure an adequate foundation in physics, mathematics and anatomy. Specializations are chosen in the second year. Core program courses cover advanced general physics and Medical Physics/Bioengineering, while elective courses focus on computer applications, materials science and electronics. To assure that graduates possess practical problem-solving skills, all BSc students are required to carry out 3 Project-Based Laboratory courses and a Final Year Research Project. Post-graduate education is essentially provided by the university approach, leading to a Masters degree, MPhil and PhD degrees in Medical Physics. Entry requirements for the MSc and MPhil degrees include the BSc degree in medical physics. The MSc degree requires a dissertation based on supervised research (25% of the total degree credits) and coursework. After completing a MSc or MPhil, students may apply to the PhD program. The overall Medical Physics programme is supported by grants from the University of the West Indies, Government of Jamaica and the International Atomic Energy Agency.

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PROFESSIONAL IMPROVEMENT PROGRAM IN MEDICAL PHYSICS APPLIED TO RADIOTHERAPY AT UNICAMP

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The Professional Improvement Program (PAP) in Medical Physics Applied to Radiotherapy at UNICAMP is a program of the Faculty of Medical Sciences (FCM), developed at the Radiotherapy Centers of the Womens Hospital Prof. Dr. José Aristodemo Pinotti - CAISM and the Clinical Hospital _ HC, under the supervision of physicists from the Medical Physics Division (AFM) of the Center for Biomedical Engineering (CEB), both in the State University of Campinas - UNICAMP. The program is similar to a medical residency with students trained in service during 40 hours per week and has a total time of 3840 hours. The main efforts are to transmit knowledge and experience in the routine of Physicists in Radiotherapy. In a Public Institution like UNICAMP, the Radiotherapy Centers present some special characteristics which contribute for a good in job experience, like hundreds of patients a year, resources and professional experience in research, and a Medical Physics Division that have workers with expertise in the fields of Nuclear Medicine, Radiology, Radiation Protection and Radiotherapy. In sixteen years the Program has formed 19 Medical Physicists, all of them were approved to be certified by the National Commission of Nuclear Energy (CNEN) as Supervisor of Radiation Protection in Medical Physics for Radiotherapy and were readily absorbed by the job market. Among them there are 11 specialists in Physics of Radiation Therapy by the Brazilian Association of Physicists in Medicine (ABFM). This article presents the Program's structure, difficulties , main results and prospects.

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MEDICAL PHYSICS EDUCATION AND TRAINING IN ARGENTINA

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Argentina has one of the largest traditions in training medical physicists in the field of radiation therapy within Latin America. However, only recently our country has faced the requirements of adequate academic background and formal training programs in this matter. As Mexico, Brazil or Colombia, Argentina is one of the host countries eligible for training in physical aspects of radiation therapy. During the past four decades, national authorities worried on safe use of radiation, (CNEA and ARN) have established by law, the requirement of hiring “specialists” in radiotherapy physics for all radiotherapy centers in the country. To strengthen this measure, the authorities implemented the issuance of a special course, 6 month long, very popular till today in all LatAm region. The situation for other areas of Medical Physics is quite different. Nowadays, in a country like Argentina, with 40 million inhabitants, the number of medical physicists involved in clinical practice in RT is about 90, while those involved in NM are no more than 5 and worse is the field of radio diagnostic with just 1 or 2 trained clinical MP professionals. No legal recognition of our profession from health authorities, or some kind of disrespect among peers at University, lack of legal framework and absence of appropriate strategies to establish a professional certification process contribute to make MP an unattractive profession. Measures to revert this situation have begun to be implemented, and nowadays Argentina has 2 established Master degrees programs in Medical Physics and 3 formal training sites for clinical practices. Unfortunately, needs were faster and some undergraduates programs have arrived since 7 or 10 years ago to fulfill the necessity of the market. We are now facing the challenges to raise the legal recognition of Medical Physics as health profession and working together with other countries or international societies would help a lot to reach the goal.

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EXPERIENCE IN MEDICAL PHYSICS- BIOMEDICAL ENGINEERING FOR RADIATION IN CUBA

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The present work contains a review about the Cuban Programs for teaching Medical Radiation Physics and Biomedical Engineering in our country. They are described in details. The paper also includes the analysis about the status of the profession in Cuba and some relevant research results obtained in the last 10 years as a consequence of the parallel Medical Physics and Bio-Medical Engineering development in the country. New professional development at present and the future of the profession are also described.

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TEACHING MEDICAL PHYSICS TO HIGH SCHOOL STUDENTS - THE NEW PERSPECTIVE OF PHYSICS

Aline Sá do Espírito Santo

In the last decades, there was an improvement of the development and implementation of medical resources for diagnosis and treatment of several diseases, mainly cancer. One of the protagonists of this scenery is the radiation, applied in Medical Physics – acting directly on the human being. Thus, it is necessary to provide a gradual and sequential education about the intrinsic concepts of the coexistence between human being and the radioactive orb in where he is in. Constructing knowledge columns which underlie an identification of the nature concerning to its essence, phenomena, its relations of cause and effect and its several approaches, people introduced to the Nuclear and Medical Physics will be able to identify facts and myths and, therefore, comprehend the conjunctures and find solutions to future problems. Introductory lessons about Nuclear Physics and Medical Physics were given to high school classes of a particular college at Rio de Janeiro, and topics as the effects of radiation in the human organism, protocols and radiation protection were presented. Using slides during the six lessons, the topics broached allowed the student to form a critique analysis, leaching all information concerning to radiation, enabling a wide overview, which bounds are beyond catastrophes involving nuclear plants and bombings, and reach Medical Physics level. The subject wakened the students' interest, and they suggested that there should be more lessons about topics closer to the surrounding reality, considering them as human beings and citizens. The students praised the business market for Medical Physics professional. The subjective analysis justifies the premise that motivated this work – it is necessary to modify in favor of the students' world perception. This work is valid in its whole, wakening the students' new perspectives of life, everything related to it and the vital importance of Nuclear Physics, essentially Medical Physics.

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ACADEMIC RESEARCH IN MEDICAL PHYSICS IN SERGIPE, BRAZIL

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The essential aspects of a correct diagnosis in radiology and therapy in radiation oncology are related to radiation beam and image quality as well as to the radiological protection of patients and health professionals. In Brazil, in recent years, there has been growing concern about the methods used in these medical specialties with regard to equipment, as evidenced mainly by research conducted in post-graduation programs. The academic research in medical physics in the Federal University of Sergipe (UFS, Brazil) is being developed since the beginning of years 2000, motivated mainly by the implantation undergraduate course in medical physics in this institution, which added research professors and students interested in this area. From 2003, some of the researches have culminated in masters dissertations; in the year of 2010 the first PhD thesis with subjects intrinsically related the medical physics had been published from such research developed at the UFS. The results of these researches have enable publications in national and international journals and in papers presented in conferences. The motivation for some of these works has been the development of phantoms and methodologies to using in beam parameters evaluation of computerized tomography, conventional radiology, mammography, dental radiology and radiation oncology. As might be expected, the results of these studies have contributed to the encourage of adherence to programmes of quality control related to medical imaging and therapies with ionizing radiation in health care institutions, mainly because these surveys are also conducted in collaboration with medical physicists from Sergipe and other states. Moreover, the improvement of national technology it is expected, enabling more affordable materials and equipment used for quality control in medical specialties related with medical physicists.

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THE MEDICAL PHYSICS COURSE IN UNIFEB

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UNIFEB

This paper presents the pedagogical project of the course of Medical Physics of the University Center of the Educational Foundation of the City of Barretos, Brazil. This project follows the rules established by the national curriculum guidelines for courses in physics. Thus, this “case study” appropriately reflects the main features of the courses in Medical Physics in Brazil.

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BSC IN MEDICAL PHYSICS AT THE UNIVERSITY OF CAMPINAS - UNICAMP

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Several medical physics university programs have started in Brazil in the last decade. They are mainly taken at the undergraduate level. At UNICAMP, we combined the teaching expertise of several units, including the Physics Institute, the Institute of Biology, the School of Medical Sciences, and the Center for Biomedical Engineering to create a course that starts with core physics, mathematics, computing and chemistry, then follows with specific courses in Medical Physics intertwined with advanced courses belonging to a strong BSc in Physics, and concludes with a one-year traineeship at the university hospital. The UNICAMP Medical Physics undergraduate course began in 2003, lasts five years and has formed 67 students up to 2010, most of them have got stable working positions as Medical Physicists. This article presents the conception, structure and the first outcomes of this course.

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RESIDENCE PROGRAM ON MEDICAL PHYSICS AT CLINICAS HOSPITAL, SAO PAULO UNIVERSITY

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The main goal of the residence program on Medical Physics at Clinicas Hospital is to provide a specialization course of 24 months. The candidate's selection is made in 2 steps: a general examination with 50 questions of multiple choice; the second step consists of a specific examination which doesn't presuppose the candidates must have certain knowledge in the area. After this second written exam, an interview is promoted in order to evaluate other aspects not covered by the previous exams, including some ethical issues, the ability to deal with patients and the multidisciplinary aspect among other professionals in the hospital. The board committee also evaluates the curriculum's candidates according to rules established by the Residence's Coordination (participation in scientific meetings, trainings performed during graduation in Radiotherapy and scientific publications). The residence is thus directed to students, which concluded bachelor's degree or a degree in physics, aims to train professionals skilled in Radiotherapy area, including obtaining further qualified professional title offered by the Brazilian Association of Medical Physics. The students attend lectures, seminars and the routine of the hospital. They also perform experimental work and develop a monograph to be presented at the end of the residence's period. In the last 5 years, almost 50 candidates have been attending to the selective process for only 2 available positions per year; the candidates come from different parts of the country, including students from the North, North-East, Central-West, South and South-East regions. It should be noticed in the last 5 years that most of the approved candidates are students coming from Graduation on Medical Physics, especially in the Sao Paulo state. For the last 10 residents, 20% were hired by companies in the Radiotherapy area; the remaining residents were hired by hospitals, 20% have found jobs in the North-East region and 60% in Sao Paulo state.

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THE IMPACT OF THE ICTP MEDICAL PHYSICS COLLEGE

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Introduction The Medical Physics College (MPC) at ICTP (the Abdus Salam International Centre for Theoretical Physics) is running in Trieste, Italy since 1988. The College attracts students from approx. 40 countries. For almost a quarter of century the MPC has educated 2500+ colleagues from the developing countries. Many of the participants are medical physics educators and this way many other colleagues benefit from MPC. Results from the Medical Physics College 2010 The main subject of MPC is Medical Imaging. The effectiveness of the 2010 College (with focus on Digital Imaging) was assessed with 3 Questionnaires _ collecting feedback on the College Organisation, syllabus, knowledge transfer and suggestions. The results of these questionnaires showed significant effectiveness in increasing the knowledge of participants. In brief while the student_s estimate of their knowledge prior to the College was with a mean of 45%, after the College it was with a mean of 75%. Based on the feedback the curriculum for the College in 2012 was shaped. This approach to improve the Curriculum with the active participation of the students has been one of the successes of MPC. As in previous years the MPC 2010 initiated new activities - Societies and Educational courses. So far the College has initiated more than 10 MSc courses in various developing countries and countless Short courses. To assist with this each participant receives full set of all teaching materials (incl. EMERALD and EMIT e-Learning and Power Point slides) from the College Directors what has met the high appreciation of all College participants. Conclusion The Medical Physics College at ICTP has introduced successful educational models and has helped many colleagues (and countries) to begin/ stabilise the development of the profession. The feedback from 2010 will be presented together with the outcomes of the educational strategy.

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RADIOTHERAPY QUALITY MANAGER AND MEDICAL PHYSICIST

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The certification system in Japan has a long history, which started from the certification of 70 medical physicists in 1986. Due to the institutional constraint, however, the activities of medical physicist were not performed in clinical site but limited largely to the research and education. As a result, the number of medical physicists in Japan did not increase for a long time. Since 2000, many accidents of radiation therapy have been revealed, many of which were due to inputting errors of parameters for planning system. To meet the societal safety demand for radiotherapy, Japanese Organization of Radiotherapy Quality Management (JORQM) was established in 2004 under the agreement among Japanese Medical Physics Society (JSMP), Japan Radiological Society (JRS), The Japan Association of Radiological Technologies (JART), Japanese Society of Radiological Technology (JSRT), and Japan Society for Therapeutic Radiology and Oncology (JASTRO). JORQM certifies experienced radiology technologists and medical physicists as “Radiotherapy Quality Manager” who is responsible for quality assurance of radiotherapy. Meanwhile, in 2002, the qualifying standards for medical physicist were changed so that radiology technologist can obtain qualification for examine, because they worked for parts of medical physics practice such as QA/QC. Since then, the number of medical physicists has increased steadily. In these surroundings, Japanese Board for Medical Physicist Qualification (JBMP) was established in 2009 under the agreement between JRS and JSMP. In this presentation, the status of both JORQM and JBMP activities and relations between radiotherapy quality manager and medical physicist will be discussed.

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FEEDBACKS IN THE IMPORTANCE OF PHYSICAL SCIENCE IN MEDICINE

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his work came the development and implementation of a course that deals with the physics applied in medicine to make sense of the content of Optics, Electromagnetism, Modern and Contemporary Physics. The course was implemented for future physics teachers in high school. The main objective was to develop alternative materials that develop in students a meaningful learning rather than mechanically. To that end, we implemented and evaluated four times the material in order to seek to improve it, in order to promote more meaningful learning. Were applied pre-tests and post-tests (quantitative and qualitative) that were resolved by the participants in the courses. Such tests were intended to provide indicative of meaningful learning. The course of 40 hours of application, was divided into five parts, each part began with a previous organizer, followed by a problem situation, then he made a brief lecture. These lectures were interspersed with experimental activities of easy and low cost, computer simulations, games, optical illusions, cartoons, exercises, concept maps, diagrams, debates, films, collages, followed by recording the same problem situation, the order to be able to make comparisons. This work is the description of the proposal drawn up and the search for finding indicative, through statistical analysis of feedback from mistakes and successes for the students, greatly influencing the learning of them. The relevance of this scientific and academic work is in the fact that he provide a discussion of new possibilities for teaching applied physics in medicine, using, as well, instructional materials to make lessons more meaningful, creating an interactive and creative learning that encourages, seeking applications Electromagnetism, Optics, Modern and Contemporary Physics in Medicine to improve the teaching of physics, as well as find out if the feedbacks are important for the Teaching of Physics.

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ADULT PATIENT DOSES IN INTERVENTIONAL NEURORADIOLOGY

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Interventional neuroradiological procedures are used to identify or treat neurological vascular problems. In general, these procedures require long fluoroscopic times and a significant number of angiographic images to visualize and evaluate the vascular pathology. This can result in high patient doses. The objective of this paper is to estimate the doses received by adult patients undergoing cerebral angiography and cerebral embolization in a large hospital of Recife, Pernambuco, Brazil. The x-ray imaging system used in this study is a Siemens Artis Zee unit with a flat panel detector; relevant performance characteristics were tested and found to be in compliance with manufacturer's specifications. Data for a cohort of 21 patients, 23 to 63 years old, was collected. The acquisition frame rate ranged between 1 to 3 frames per second with the total number of frames for a given run ranging between 10 and 43 frames. The total number of acquired images per patient undergoing cerebral angiography ranged from 37 to 448, with a mean value of 227 frames. For embolization procedures, the total acquired images ranged from 281 to 777 frames, with a mean value of 450. The total air kerma - area product, generated by the system, was documented for each patient. The results obtained showed that for the angiographic procedures, the mean value is 549.2 mGy.m², with a range between 223.88 and 1057.17mGy.m². For the embolization procedures, the air-kerma area product values ranged from 278.45 to 1576.32 mGy.m² with a mean value of 801.1mGy.m². The dose distribution on the patient's head for a subsequent set of patients was determined using radiocromic film fitted in a rigid device, specifically designed to perform the dosimetry. The results and their clinical significance will be presented and discussed.

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OCCUPATIONALLY DOSIMETRY DURING RADIOLOGY VETERINARY STUDIES

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This paper presents the experimental results of the measurements of the X-ray dose levels during veterinary radiology procedures. The radiation doses levels both primary beam and scattering radiation around of the x-ray source were measured. The dose at the resident's chest over the x-ray shielding apron was from 0.38 up to 0.6 mSv for three residents and was undetectable in 18 occupationally exposed workers. Radiation exposure to the resident's whole body was effectively shielded by the lead apron. The mean dose over the apron of 0.48 mSv was decreased to 0.05 mSv under the apron by a factor of 10. The obtained results indicate that is extremely important the assessment of radiation doses involved in veterinary diagnostic radiology procedures, to protect occupationally exposed workers at the Veterinary Radiology Clinics.

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RADIATION DOSE REDUCTION IN A NEONATAL INTENSIVE CARE UNIT IN COMPUTED RADIOGRAPHY

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The present study examines the prospect of dose reduction through optimization of radiographic parameters in relation to image quality. In order to practice radiation protection in neonates, determination of the Entrance Surface Doses with thermoluminescent dosimetry (TLD) for different preterm infants of 28 to 34 weeks were developed. TL results of the EDS were compared with those dose values reported by Diagnostic Radiology Levels (DRLs). Radiographs were evaluated for satisfactory image quality. Chest and abdomen radiography to born children prematurely were covered in this study. Entrance surface doses values measured for neonates examination were higher than the DRL of 50 μ Gy proposed by the National Radiological Protection Board (NRPB) as the reference values. Results obtained suggest to radiation dose reduction in neonates could be possible if the high tube voltage techniques is applied.

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PATIENT DOSIMETRY DURING TRANSCATHETER EMBOLIZATION PROCEDURES

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The purpose of this study is to evaluate the entrance surface doses and dose distribution using thermoluminescent dosimeters for patients who underwent the transcatheter embolization (TCE) procedures. Interventional fluoroscopy procedures may present deterministic and stochastic risk. Digital angiography system from General Electric (Milwaukee, USA), was used for diagnostic angiography and TCE studies. The radiation doses of the patients were measured with lithium-fluoride thermoluminescent dosimeters (TLDs). A phantom physical was used. The skin dose distribution was measured TLDs. The results of radiation dose measurement with the TLDs during 39 TCE procedures were studied. The mean effective skin dose at the patient's back behind the liver was 973 ± 681 (SD) mSv. The individual dose widely distributed, which generally increased as procedures became more complex with increasing fluoroscopic time and number of DSA acquisition. The maximum skin dose of 3543.2 mSv was recorded in a patient with a small solitary lesion (diameter; 1.5 cm) in the left lateral segment of the liver. TCE was performed with a microcatheter advanced to the second segmental artery. The total fluoroscopic time was 53.4 minutes and 9 series of DSA was obtained in this particular patient. The thermoluminescent dosimeters (DTLs) are easy-to-use for measuring the entrance surface dose and have advantages to provide the dose distribution of skin. This study indicated that the patient doses are in the range of hundreds of mGy, which might cause deterministic effect and further dose reducing techniques are needed.

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OCCUPATIONAL DOSE EVALUATION AT ACCELERATORS CYCLOTRONS FACILITY

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The purpose of this study was to evaluate the individual effective dose and the collective dose received by workers of Accelerators Cyclotrons Facility at the year 2007 to 2009. To carry out this survey it was necessary analyzes the radiological protection records and also reports examinations provided by radiological protection supervisor. It was verified that the highest annual dose received by the target group was 25.80 mSv, by the operation and maintenance group was 9.61 mSv and by the radioprotection group was 11.23 mSv. During the studied period, no workers exceeded the effective dose of 50 mSv, the maximum value for worker in a single year. In 2007 only one worker exceeded 20 mSv, therefore it was observed that the average individual doses are beneath 10 mSv/year, so the established value as generic restriction level of effective dose for the facility is being satisfied. In spite of the 18 MeV cyclotron implantation in 2008, it was verified a reduction of the average individual doses values. The constant training, regular use of dosimeters and implementation of procedures for reducing the doses were measurement that resulted in adequate control of exposure to radiation.

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PERFORMANCE OF DOSE CALIBRATORS IN NUCLEAR MEDICINE SERVICES OF PORTO ALEGRE

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A programme for the comparison of activity measurements of radionuclides administered to patients in Nuclear Medicine Services, for the purpose of either diagnosis or therapy, is being conducted, since 1998, under the coordination of the Radioprotection and Dosimetry Institute of the Brazilian Nuclear Energy Commission, IRD/CNEN. In the present work, measurements of the activity of samples of ^{131}I , $^{99\text{m}}\text{Tc}$, ^{201}Tl and ^{67}Ga were conducted in the dose calibrators of the 11 Nuclear Medicine Services of the city of Porto Alegre, Rio Grande do Sul, from 2004 to 2010. The results were analysed to evaluate the compliance with the Brazilian regulation. The performance of the activity meters in Porto Alegre is shown to be good and improving, which contributes to the radiological protection of patients submitted to diagnosis or therapy with radiopharmaceuticals.

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ASSESSMENT OF PERSONNEL ABSORBED DOSE IN PRODUCTION OF FDG RADIOPHARMACEUTICAL BY CYCLOTRON

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Purpose: The cyclotron accelerators are used for production of medical radioisotopes. One of the most important problems which may encounter is, malfunction of a part of target or beam line which needs the bombardment to be stopped and repaired. In this research work the whole body absorbed dose of cyclotron personnel was assessed in different places of target room by Monte Carlo simulation during the repair after stopping the bombardment. **Methods:** The liquid target room and the maze of cyclotron by inserting 7 ICRU spherical body phantoms inside them were simulated by Monte Carlo method. The production of FDG was simulated by considering, bombardment of an enriched $H_2^{18}O$ by 18 MeV protons at 16 μA beam current via $^{18}O(p, n)^{18}F$ reaction. The activity of target, Aluminum case beam-lines, switching magnet and also the produced neutron spectrums inside the concrete shields and Aluminum cases were calculated to assess the accumulated absorbed dose for specific interval times. **Results:** The accumulated absorbed dose inside the body phantoms which show the accumulated whole body dose, in different places of target room and maze were calculated. These data depend on the duration time of the bombardment and the passed time after the bombardment. According to the calculated dosimetry data, the correlation between the duration time of the bombardment and required time after stopping the bombardment to reach the absorbed dose less than 25 $\mu Sv/h$, was calculated in the two conditions means existence of the target and not existence of it. **Conclusions:** Our results showed the repair can be done immediately after 10 minutes stopping the bombardment if target has been ejected from target room. Also the time sharing between the operators reduce the absorbed dose.

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EVOLUTION OF MAMMOGRAPHY CENTERS THROUGHOUT THE MONTHLY MONITORING PROGRAM OF THE STATE OF MINAS GERAIS

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The monthly monitoring of image quality in mammography is part of a pilot project of the State Program of Quality Control in Mammography (PECQMamo) from Minas Gerais, which aims to maintain a quality standard by evaluating the radiographic image of a breast phantom. For this, the services participating in the program send monthly radiographic image to the Management of Health Surveillance in Health Services (GVSSS). This study lasted 20 months began in May 2009 and included the participation of 24 mammography centers in the region of Belo Horizonte/MG. Images were evaluated according to the manufacturers of simulators, such analysis from the clinics were classified as “according” and “no-according.” Throughout the study, only one service showed the same percentage as 2009 to 2010, being 100% in both years. For others, the average growth rate of compliance was approximately 74%, the lowest value of 5% and more equal to 630%. Thus, the monthly monitoring in mammography proved efficient, because all showed a significant improvement in image quality. But there's much to do, because it's a diagnostic method that requires a high quality image and, therefore, are required: proper equipment, correct radiological technique, knowledge, practice and dedication of the professionals involved.

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RADIATION DOSE MEASUREMENT DURING CONVENTIONAL AND COMPUTED UROGRAPHY

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Radiography has a major role of diagnostic method in medical field. Urography provides the radiologist with useful detailed information. However, it is the responsibility of radiologist and technologist to determine scanning technique factor that provide balance between image quality and radiation dose and share in keeping patient radiation exposure at lowest as possible. The objectives of this study are to: (i) measure and compare patient radiation dose form computed tomography urography (CTU) and (ii) conventional intravenous urography (IVU) and evaluate the protocols used in CTU and IVU imaging procedure. A CT machine (Siemens-Somatom Emotion duo) was used for CTU, while a shimadzu X ray machinewas used for IVU. Patients radiation dose values (DLP) for CTU were 172 ± 61 mGy.cm, CTDIvol 4.75 ± 2 mGy and effective dose 2.58 ± 1 mSv. Cancer probabilities per million were 520.12 for the pancreas and 30.96 for the testicles. Patients entrance surface dose (ESD) values for IVU were 21.62 ± 5 mGy, effective dose 1.79 ± 1 mSv. Radiation dose can vary considerably between scanners and between institutions. In this study the radiation dose is considered low compared with previous studies. A patient radiation risk for particular exam is proportional to the radiation dose delivered during the exam. This dose will depend on the size of patient, the type of scanner and the imaging protocol used. Requests for CT scanning must be generated only by qualified medical practitioners and justified by both the referring doctor and the radiologist.

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RADIATION OUTPUT SPECTRA IN MAMMOGRAPHY: COMPARISON OF A CLINICAL STUDY FROM SIM

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The present study aimed to evaluate the differences between simulation model estimations from experimental measurements. Two simulation models were analyzed: one proposed by report n_ 147 of the National Council on Radiation Protection and Measurements (NCRP 147) [1], and the other presented by Robson [2], called as the parametric method. Both were tube potential dependent functions, whose difference was that parametric method requires a radiation output value to determine the equipment function. When this is possible, parametric method presented the lowest differences from experimental results, ideal to use in dose assessment. Through experimental measurements, it was observed that all digital mammography radiation output values were higher than the analogic systems results, at any tube potential.

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ESTIMATION OF THE RBE OF MAMMOGRAPHY-QUALITY BEAMS USING THE PENELOPE CODE

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Direct DNA strand break yields due to the impact of ^{60}Co and 28 and 30 kVp X-ray beams were determined. A B-DNA geometrical model was used, which accounts for five organizational levels of human genetic material. Direct simple, double and total strand break probabilities were determined in a liquid water homogeneous medium with 1.06 g/cm^3 density. The spectra produced by the X-ray beams at various depths in the phantom were used to study the dependence of the damage yield on depth. The relative biological effectiveness (RBE) was also estimated using the ^{60}Co photons as the reference quality. According to this work, the damage probabilities and thus the RBE are, within the uncertainties, similar for both X-ray qualities and are independent of the depth into the phantom. Furthermore, the total strand break yield is invariant with respect to the energy of the incident photons. The RBE for low energy X-ray beams determined here (1.3 ± 0.1) is lower than previously published results derived from the microdosimetric properties of these radiation qualities. However, our RBE values are similar to those determined by Kühne et al., which used the same biological endpoint and reference quality as our study. In addition, our RBE values and their dependence on depth are consistent with the results obtained by Verhaegen and Reniers.

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MONTE CARLO CONVERSION FACTOR FOR PATIENT DOSES DETERMINATION AT CORONARY ANGIOGRAPHY

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Monte Carlo conversion factor for patient doses determination at coronary angiography examination
Interventional radiology is a set of medical procedures which can be used for to diagnose and treat patients with cardiovascular problems. The doses in patients undergoing these procedures can be high, considering that, in most cases, the examination is long and complex. The aim of this study is to evaluate the doses in patients during coronary angiography examination using conversion coefficients (CCs) obtained by computer simulation using a radiation transport code, Visual Monte Carlo (VMC), and the voxel anthropomorphic phantom, FAX (Female Adult voXel). CCs for Equivalent Dose (H) and Effective Dose (E) were normalized to Kema-Area Product (KAP). Normalized CCs values for H (mSv/Gy.cm) in antero-posterior projection (AP) and postero-anterior (PA) for 6 radiosensitive organs considered were: heart (4.328/0.243); pancreas (6.712/0.002); skin (8.227/8.094), liver (12.671/0.005), colon (8.031/0.028), stomach (21.790/0.005). The normalized CCs for E were 5.210 mSv/Gy.cm and 0.795 mSv/Gy.cm for AP and PA projections, respectively. The results found in this study are important tools to dose and risk estimation in this kind of procedures. Besides, the discrepancy among AP and PA geometries call attention to the necessity to accurately position the patient and to correctly conduct the procedure. The CCs values in AP geometry are consequence of the location of higher radiosensitivity organs close to the entrance surface, without bone shielding, as, for example, colon, stomach and pancreas.

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EVALUATION OF DOSE CONVERSION COEFFICIENT IN THE PHANTOM FAX SITTING AND STANDIN

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UFS

Exposure to ionizing radiation source can lead to serious health problems for workers, patients and even individuals from the public. The protection of individuals against the harmful effects of radiation is a major task in preventing health risks. Order to assess this risk, it is often necessary to know the limits imposed on the dosimetric quantities such as equivalent dose (H) and effective (E). One way to perform a risk assessment to radiation in a patient or worker is through conversion coefficients (CCs) dose. The values of CCs are calculated using anthropomorphic simulators in standing position. However, in this study, these coefficients were estimated using a simulator at which one is standing and the other sit with the aim of evaluating the difference between the dose normalized CCs of E and H for the Air Kerma (Kar). The simulators were exposed to a plane source of unidirectional monoenergetic photons in an anteroposterior (AP) geometry. We used the code VMC (Visual Monte Carlo) and the simulator FAX (Female Adult voXel) in standing and sitting. CCs dose for photons of 100 keV normalized of E by Kar for the simulator standing and sitting were respectively 1.13 Sv/Gy and 0.78 Sv/Gy. The results of CCs of H by Kar (Sv / Gy) for the organs that are critical for the simulator standing were: 1.27 (ovary), 1.40 (bladder); 1,13 (uterus); 1,19 (lung) and 1,28 (liver), and 0.51 (ovary), 0.49 (bladder), 0.48 (uterus), 0.94 (Lung); 1.00 (liver) for the simulator sitting. The calculated results yielded variations of doses statistically significant, showing that for certain situations the use of CCs obtained in the sitting simulator provides smaller doses because in this geometry the irradiation area is smaller and more radiosensitive organs are more distant from the radiation source in relation to the source in standing position.

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THE INVARIANCE OF THE TOTAL DIRECT DNA-STRAND BREAK YIELD

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The Geant4-DNA Monte Carlo simulation toolkit was used to determine direct strand break yields induced by protons and alpha particles impacting on a B-DNA geometrical model, including five organization levels of the human genetic material. The LET of such particles ranges from about 0.4 to 200 keV/mm, at 5.0 mm depth, near the center of the region of interest. Direct total, single and double strand break yields were determined in a liquid water homogeneous medium with a 1.06 g/cm³ density. The energy spectra of single strand breaks (SSB), the number of energy deposition events and the SSB/event ratio were determined. It was found that the target-hit probability is independent of the type and energy of the involved particle, even if this particle is a secondary electron. Such a probability is determined by the geometrical properties of the system. In addition, the total strand break yield and the number of energy deposition events required to reach a certain absorbed dose are nearly independent of the type and energy of the incident ion. On the contrary, the double strand break yield is strongly dependent on the LET of the incident radiation.

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DEVELOPMENT OF A SHIELDING TO PROTECT PATIENTS AGAINST PHOTONEUTRONS PRODUCED BY LINACS IN RADIOTHERAPY TREATMENTS

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This work focus on radiological protection of patients submitted to radiotherapy, using high energy linear accelerators, in which their healthy tissues receive undesirable doses due to fotoneutrons. For that, a shield against the produced fotoneutrons was developed using the computer code Monte Carlo N-Particle version X (MCNP-X). This shield showed be positioned in a simple way, at the outside part of the linear accelerator_s head, reducing the doses. This shield was named External Shielding. The simulation was performed using a computational model of the head of a Varian 2300 C/D linear accelerator, plus the External Shield. In order to verify the effects of this shielding, the values of ambient dose equivalent. These values were compared with the accelerator operating with and without the External Shielding. The results of this study indicated that the External Shielding showed great efficiency in reducing the ambient dose equivalent due to fotoneutron, resulting in an average reduction above 60% for the various simulated configuration, without increasing the ambient dose equivalent due to the photos at the plane of the patient. It was concluded that the implementation of an External Shield at the accelerator_s head increases the protection of the patients against undesirable fotoneutrons doses and may avoid new focus of cancer produced by the radiotherapy.

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PRELIMINARY SHIELDING CALCULATIONS FOR THE CYBERKNIFE ROBOTIC RADIOSURGERY SYSTEM CONSIDERING A STANDARD VAULT AND A TYPICAL GANTRY-BASED LINAC VAULT

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Rem Industria e Comercio Ltda

The CyberKnife Robotic Radiosurgery System utilizes a six-degrees-of-freedom manipulator to position a 6 MV Linac to treat lesions. The vault shielding design has to take into account this six-dimensional capability. This paper presents shielding calculations for a standard vault, with primary walls 200 cm thick, constructed specifically for a CyberKnife System, and for a vault that has originally been designed for a gantry-based linac, with secondary barriers 107 cm thick. After performing the shielding calculations for both vaults, the results showed that the standard vault walls 200 cm thick are adequate for secondary shielding, and for the gantry-based linac vault, of all 6 locations examined, 2 would require an additional shielding, of 9 cm and 4 cm, of concrete of density 2,4 g/cm³. This shows that the CyberKnife System can be installed in a vault originally designed for a gantry-based linac, with limited or no additional shielding, provided that there is no direct incidence of beams on secondary barriers.

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BLACK GRAPE JUICE INTAKE OFFER PROTECTION TO LIVER AGAINST METABOLIC CHANGES FROM ACUTE GAMMA RADIATION EXPOSURE IN RATS

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Exposure to ionizing radiation leads to toxic effects. Research on food or drugs acting as a positive radiomodifier (protective) is of great interest to Public Health and Homeland Defense issues. In this sense, the main focus of this work is to test the black grape juice (BGJ) (*Vitis labrusca*) as a positive radiomodifier against the biological effects from radiation exposure that characterize the Acute Radiation Syndrome (ARS). Therefore, twenty male Wistar rats were divided into four groups, where two were whole body gamma irradiated using the cobalt irradiator facility at the Institute for Energy and Nuclear Research (IPEN), located at USP, São Paulo, Brazil. The animals received 2 ml/body weight of BGJ or placebo twice per day (isocaloric solution of glucose and fructose) by gavage (intra-gastric probe) one week before and four days after irradiation with 6Gy of whole body absorbed dose when they were conducted to euthanasia. The parameters of liver function (albumin, LDH, AST and ALT) were evaluated. Results: Levels of albumin was significantly increased ($p > 0.05$) in treated group compared with controls.. Also it was observed a significant decrease in LDH, ALT and AST enzymatic activities in BGJ treated groups. Conclusions: As elevated levels of albumin and decrease in LDH, ALT and AST activities, can be indicative of liver protection by BGJ against radiation damage with extension to pathophysiological symptoms. Results suggest that BGJ act as a positive radiomodifier supplement exerting some level of protection on liver function against whole body acute gamma radiation exposure. This evaluation based on liver-related enzymes can be added to such hematological analysis following radiation poisoning in order to improve the clinical protocol for on-site operations and mass casualties.

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CHARACTERIZATION OF INDIVIDUAL PROTECTION EQUIPMENT AGAINST IONIZING RADIATION USED ON RADIOLOGICAL AREA OF PORTO ALEGRE CITY

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This work presents the integrity evaluation and transmission calculation of individual protection equipment - IPE (aprons, thyroid and gonads protectors, glasses and gloves). All the IPE has the integrity evaluated. Considering the 64 aprons, in use on the hospital, 60% presented tears and holes on the area of protection and were considered non-conform. They were immediately withdrawn from use and replacing with new. All the other was 100% conform for use. The IPE was assessed for transmission conformity through samples. The different types presented different mean value for the transmission data and different standard deviation.

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COMPARATIVE STUDY OF TWO METHODOLOGIES FOR STRUCTURAL SHIELDING DESIGN OF IMAGIN

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The present study aimed to show which implications can be found in structural radiation shielding design depending on the calculation method adopted. Two methods were analyzed: one that consider the sum of thickness contributions, and other that consider the sum of unshielded air kerma contributions. To compare the results a case analysis was done. A hypothetical radiographic room which contains an exam_s table and a chest bucky was considered. The thickness contribution method presented the highest results, reaching a maximum relative difference of 85% from NCRP 147_s results, and 57% from the unshielded air kerma contributions method.

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INTERNAL EXPOSURE BY I-123 AND Zn-65 IN A RADIOPHARMACEUTICAL PRODUCTION PLANT

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Iodine-123 is used worldwide in nuclear medicine for diagnostic imaging of endocrinal diseases in adult and paediatric patients. It is produced at the Institute for Nuclear Energy (IEN-CNEN) since 1998 and supplied to various nuclear medicine centres located in the State of Rio de Janeiro, Brazil. The IEN has increased its production in about 500% in the first five years in order to respond to the increasing demand from the clinics for the radiopharmaceutical Meta-iodine-benzyl-guanidine (MIBG). The production of MIBG as well as the annual maintenance of the cyclotron can lead to internal exposures of the workers by I-123 and Zn-65. Such workers are routinely monitored at the IRD Whole Body Counter through in vivo measurements for the identification and quantification of such radionuclides respectively in the thyroid and in the whole body. The measurements are based on the detection of the photons of 159 and 1115 keV, emitted by I-123 and Zn-65. This work presents and discusses the analytical techniques and procedures applied at the IRD whole body counter as well as the methodology adopted for the interpretation of the measurements to estimate the committed effective equivalent doses. It is also presented a general evaluation of the results obtained in the monitoring programme of the Production Plant. It is concluded that (i) the measurement techniques are suitable for routine monitoring of this specific group of occupationally exposed workers and (ii) the radiopharmaceutical production plant is safe in terms of radiation protection conditions since all incorporations detected so far represent only a small fraction of the annual dose limits established by the Brazilian Regulatory Board.

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ESTIMATION OF IODINE-131 EXCRETED BY PATIENTS DURING THERAPY

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Iodine-131 is used for ablative dose in differentiated thyroid carcinomas. For the treatment planning, urine bioassay may be used to estimate the effective half-life of Iodine-131 for an individual patient. It has been studied four female patients (13.3±1.5 years old, 50±11 kg corporal weight) who received 107±15 MBq for tracer dose and 5.5±0.3 GBq for thyroid ablation. Urine excreted after Iodine-131 administration was collected for each excretion in the hospital and patient residences in individual recipients. The volume and schedule of excretions were registered in the patient file. The urine samples were measured by an sodium iodide cintillator well counter Genesys Gamma-1 calibrated with a reference source. After reading, the samples were discharged according to the Waste Management Regulation in the country. Urine samples were collected until 95±46 h in tracer phase and 108±50 h in ablative phase, with volumes varying between 7.0±4.8 L and 7.8±5.1 L, respectively. Urine excretion rate ranged between 67±28 mL/h in tracer phase and 64±21 mL/h in ablative phase. Iodine-131 activities discharged in hospitals were 4.19±0.45 GBq and below 0.5 GBq in patient residences. The analysis of urine activities of Iodine-131 excreted by the patients may contribute for more realistic modeling and management of radioactive waste regulations for nuclear medicine in the country, both in hospitals and patients residences.

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GENERIC USE OF A TECHNETIUM GENERATOR IN A NUCLEAR MEDICINE SERVICE

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The Center of Isotopes of the Cuban Republic manufactures a new technetium generator with more shielding than those belong to other producers. This paper has as purpose to evaluate the exposure to workers in a generic nuclear medicine service due to the use of this generator. Maximum conditions of exposure are considered like the use of the biggest activity by generator, a worker alone performances all the operations, 5 kinds of radiopharmaceutical reagent kits are labelled and 55 patients are attended by week. It is assumed the use of a shielding area for sitting the generator, a container with lead for generator eluate and syringe shields during the labelling and administration of patient doses. Effective dose (E) and dose equivalent to hands (Hp(0.07)) are calculated with the code Microshield version 5.03 by operation and 50 weeks by year, except when generator eluates are obtained. For this operation is applied a lineal correlation of the dose rate measured with an area dosimeter EBERLINE, model FH40F2, which was verified in the Cuban Calibration Laboratory. It is demonstrated the use of a technetium generator from CENTIS involves an acceptable low occupational exposure and lower than 3 mSv of the effective dose and 8 mSv as Hp(0.07). The administration to patient doses implies the 90 % of the E. There is an adequate correspondence between our results and the internationally reported data.

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DEVELOPMENT OF TISSUE EQUIVALENT POLYMERIC COMPOSITES: PRELIMINARY RESULTS

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The methods used for determining the tissue equivalent chemical composition are based on the correct determination of the effective atomic number or the mass attenuation coefficient of the simulating material. The present work shows preliminary results of attenuation properties of six polymeric materials developed as tissue equivalent materials. These materials were developed using mass attenuation coefficient method and the preliminary evaluation of their properties were done by measuring transmission curves and transmitted x-ray spectra. The resulting transmission curves show that the material M1 is less attenuating than the other evaluated materials. The other five materials presented very similar behaviors

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EXPERIENCE OF AN INTERNATIONAL GROUP IN RADIATION PROTECTION

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On March 15th 2002 the international group RADIOPROTECCION is created, with 11 people from 11 countries, with the purpose of exchanging information about different topics on radiation protection. This group has been growing significantly. At the end of 2002 it had 179 members and now there are 1700 people from 32 different countries are registered, mainly from Latin America. The group or list of interest is a system of exchange of e-mail where people share issues of common interest. The purpose is to get several people involved in discussions on specific issues and to achieve the distribution of information to the whole group. In this case, the common interests are the issues of radiation protection. The group is mostly integrated by specialists in radiation protection who work in regulatory bodies, nuclear commissions, universities and entities where radiation is used in the industry, medicine, and scientific research. This group is opened for all the specialists in radiation protection that need to have a channel of permanent communication to improve the exchange of experiences and topics of interest in order to help technical problems and to be updated. The messages are in Spanish but also can send messages in Portuguese or English. More than 3400 messages about congress advertisements, courses, workshops and national and international activities on radiation protection and related topics have been sent from this group. In addition, technical articles and news on the specialty have been spread. Technical opinions and feedback have also been exchanged, promoting in this way the communication and cooperation among its members. Today, the information on these issues is complemented by the personal blog about radiation protection. In this group many issues have been discussed, for example: Pregnancy and medical radiation, emergency response, occupational exposure, radiation protection responsibilities, lessons learned from accidental exposures, safety culture,...

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INVENTORY OF USED, DISUSED, WASTE & DISPOSED SOURCES IN KENYA

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Abstract. Kenya is committed to the peaceful applications of sealed and unsealed radioactive sources in medicine, industry, agriculture and training and research in order to achieve socioeconomic development. There are 4 nuclear medicine centers, 3 industrial radiotherapy facilities, 2 gamma irradiator facilities, one linear accelerator, 2 high dose radiation (HDR) Brachytherapy units, 5 industrial radiography units and many training and research facilities in the country that possess radioactive sources. The Kenya Radiation Protection Board is a Regulatory body established under Cap 243 of the Laws of Kenya cited as the Radiation Protection Act which provides for the protection of the public and radiation workers from dangers arising from materials capable of producing ionizing radiation. The mission of the Board is to accelerate, regulate and expand the contribution of nuclear and irradiation technology to the Kenyan economy through promotion of nuclear and radiation safety culture. The use of radioactive material requires an adequate established inventory. The objective of this project is to establish and maintain a national inventory of sealed and unsealed radioactive sources in Kenya. A national inventory was done by sending a questionnaire and personal communication as well thorough countrywide inspection surveys by Radiation Protection Officers from the regulatory body where lead pot containers were carried in case of disposal of a disused source or spent source. Advanced survey meters and automes radiation meters were used for radiation safety work, alarm meters were used to detect the threshold and source identifiers were used to identify unknown sources and their activities. A total of 130 radioactive sources (34 used, 20 disused, 39 waste and 37 disposed) including their JPEG images were identified and a national inventory established. Co-60 recorded the highest activity of 11,000 Ci followed by Cs-137 with 400 Ci and Ir-192 with 40 Ci. An updated inventory for the next 5 years is recommended.

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CALCULATION OF REACTOR PERSONNEL ABSORBED DOSE BY USING TLD-100H AND COMPARISON THE RESULTS WITH TLDs-700

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In this research, the experimental dosimetry simulation of 5MW research reactor personnel was examined. The absorbed dose of workers in the usual work conditions was measured by using the Rando phantom and thermoluminescent dosimeters (TLDs). For this purpose TLDs-100H were placed inside some high risks organs of phantom such as thyroid, gonads,... due to measurement of the absorbed dose value of some sensitive tissues separately, and also put on the left breast (the place of pocket dosimeters) for whole body dosimetry. Also TLDs-700 were used for comparison the absorbed dose value of eyes and whole body with TLD-100H results. The Rando phantom was located 8 hours (daily work) in three areas, the control room that is a common area for workers and two other places, near the reactor pool and near the extracting samples place, that workers should be there for restricted times. The effective dose values of examined organs have been calculated by considering of tissues weighting factors(W_T) either based on ICRP-103 or ICRP-60. The absorbed dose of the different organs are compared either with each other or whole body, based on each mentioned ICRPs, and also results based on both mentioned ICRPs compared either with each other or allowable dose threshold. The final TLDs-100H result based on ICRP-103 are varied ($\mu\text{Sv/hr}$) as: Whole-body:30.6375-6.4375, thyroid:1.2232-0.2306, prostate:0.0850-0.0454, gonads:1.0009-0.5109, breast:3.6765-0.7725, eyes:33.7382-7.0075. The variation of TLDs-700 measured dose ($\mu\text{Sv/hr}$) of eyes and whole body were:53.4625-24.5 and 48.8375-23.4375 respectively. Comparison of ICRP-103 and ICRP-60 reports showed different W_T for a specific organ. Although variation of W_T increases 2.5 times for remainders and breast, or decreases for some others, the results based on both of ICRPs are lower than allowable dose threshold. It is obvious that at the events like trapping of control rod or extracting sample, these values would increase.

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ESTIMATED INCREASE IN INCIDENCE OF LEUKEMIA DUE TO A TERRORIST ATTACK USING A RADIOLOGICAL DISPERSAL DEVICE (RDD)

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Over the last decade, probably due to events at September 11th, 2001, the prospect of a terrorist attack using a radiological dispersal device (RDD - “dirty bomb”) and other forms of radiological use to force is cited as among of one the most serious terrorist threats. The causes of leukemia are not yet well-defined, but an association among additive factors seems to increase the risk of such morbidity. Specific factors can be listed: (a) smoking; (b) ionizing radiation; (c) benzene and, (d) chemotherapy. Results on a scenario-based simulation allow to infer that leukemia occurrence is more likely to occur earlier in younger people and this information can be useful for triage and mass casualty management. Emergency response actions are sorely needed in cases of RDD. Detecting, recognizing and locating radioactive material is of fundamental importance for solving the scenario. Additionally, evacuation and remediation of contaminated areas must be included on the duty which equally must include future concerns about health and safety conditions not only to general public but for the responders. We conclude that the consequences of such an attack can be minimized by an appropriated response flow-chart regarding future concerns such as leukemia induction.

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RADIOACTIVE MATERIAL TRANSPORT: DEALING WITH PROBLEMS OF DENIALS AND DELAYS OF SHIPMENT OF RADIOACTIVE MATERIAL

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The Transport of Radioactive Material is an activity well regulated for all modes of transportation on land, water and air, and, in Brazil, it is the primary responsibility of the Nuclear Energy National Commission (CNEN). This kind of transport is necessary since the Radioactive Material produced at a site is used on another site, being, thus, a mandatory activity that precedes every use of radioactive material in medicine, industry, agriculture, and so on. Mainly because of the lack of knowledge by some individuals involved on the transport activities, some shipments are denied or delayed. Worldwide actions have been taken in order to identify the main causes of the denials and delays problem, and national Focal Points have been established under the International Atomic Energy's Steering Committee on Denials of Shipment responsibility. A process for reporting a denial of shipment of radioactive material has been organized for the stakeholders to use, and an action plan has been implemented by the International Steering Committee, which made evident that encouraging communication between Nations and sharing experiences is the key instrument to ensure a decrease on the denial and delay problem, which has a goal of reaching an insignificant number until 2013.

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DETERMINATION OF AIR KERMA FROM THE TECHNICAL FACTORS OF A RADIOGRAPHIC TUBE

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The poor quality of radiographic imaging produced in radiology services causes a high rate of incident repetitions. Among other reasons, this occurs because operators do not know the correct employment of technical factors and their consequences on the x-ray beam. The adjustment in x-ray beam production, according to patient characteristics and the requested study, usually occurs empirically. Therefore, it is necessary to establish mathematical equations which relate technical factors for quality and intensity of radiation produced. Simulations of different radiation spectra were taken from the variation of some technical parameters. In this first research, the anode angle, the voltage and its ripple were varied individually and calculated the expected values of air kerma for every situation. These data were generated using Report 78 Spectrum Processor software from IPEM - United Kingdom. Individual equations were obtained to relate the air kerma to each of these variables, and an error minor than 2% was achieved. Later, a general equation then was adjusted in order to obtain the air kerma from the voltage and its ripple. Another equation has also been adjusted for angle and anode voltage. The error found between the result calculated by the 2 variables equations and the simulated data is below 5%. The use of these equations allows more precisely estimation of factors influence in the radiation production. The same strategy can be used to find other variables correlation.

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EVALUATION OF DOSE AND EFFECTS OF IONIZING RADIATION ON THE SKIN

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This paper presents a study concerning the evaluation of radiation dose received in biological tissues and their consequent effects with respect to changing parameters of the skin. This study is important to identify the influence of ionizing radiations, since they are employed in large-scale on medical examinations, in contrast with the little available literature covering research on effects to the skin, both for professionals and patients that are constantly exposed. For this, pig ears were acquired as a model membrane, which were properly prepared in the laboratory after being exposed to different types of ionizing radiation, having undergone assessment of parameters before and after dermal exposures with different types of radiation. The parameters analyzed were pH, amount of water and oil in the stratum corneum, transepidermal water loss and amount of sebum present on each sample. What we have learned throughout this work is that all radiation exposure proved to be harmful to the skin, altering the analyzed parameters. However, it is expected that in future, a new study might be made, this time *in vivo*, in an attempt to found that the changes are even more significant, since changes in certain parameters are observed only after a certain interval time in living cells have been modified, which was not possible with the use of samples *in vitro*. Therefore, it is evident the importance of continuing this study with respect to exposure time and dose applied, as well as the use of Individual Protection Equipments - IPE.

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METHODOLOGY TO TLD SELECTION FOR IMRT IN VIVO DOSIMETRY

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Thermoluminescent dosimeters mostly known as TLDs are widely used for dosimetry in several areas of research and in radiotherapy quality assurance (QA). In radiotherapy, a recent treatment method named Intensity Modulated Radiotherapy (IMRT), stands out for bringing a more accurate dose delivered to the tumor volume while preserving the surrounding healthy tissues. The introduction of clinical practices more sophisticated requires a verification of dose distributions provided by the treatment planning system and uncertainties may arise during different phases of the treatment process. The ICRU has established that the total uncertainty of the process of radiotherapy should be less than 5%. This paper describes a methodology for selecting TLD chips from new batch of unsorted detectors which will be used in a study of in vivo dosimetry for IMRT QA. It was based on estimates of the average combined uncertainty desired for this purpose after all possible corrections (3%) and a statistical criteria for outliers exclusion. This commissioning process is necessary in order to reduce the uncertainties and obtain more accurated results. The 501 TLDs Harshaw LiF-100 used in this study were submitted to five cycles consisting of annealing, irradiation and reading under the same conditions. The TLDs were irradiated in the Theratron 780C Co-60 unit (Theratronics) at INCA. The uncertainties of the readings and the individual chip sensitivity were considered and estimated. In according to the criteria established in this work, nearly 66 % of the batch were considered reproducible for use in IMRT QA with in vivo dosimetry.

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STUDY ON THERMAL NEUTRON DETECTION METHOD USING IMAGING PLATE AND ACTIVATION

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At Kyoto University Research Reactor Institute, over three hundred clinical trials of Boron Neutron Capture Therapy (BNCT) have been performed using research reactor. On the other hand, we have been developed cyclotron based epithermal neutron source. To improve the quality of treatment, it is necessary to perform the detection of thermal neutron distribution in water phantom before treatment as quality control. Generally, the method of activation using gold foil/wire and germanium semiconductor detector is applied to detection of thermal neutron flux at several positions. However, the activation method using semiconductor detector takes some time to decide the thermal neutron flux. Therefore, we propose the method using imaging plate and activation materials for easy detection of thermal neutron distribution in water phantom. To evaluate this method, the irradiation test was performed using cyclotron based neutron source. The output of imaging plate exposed by beta ray emitted from activated gold wire was good agreement with the results of activation method using germanium semiconductor detector.

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INFLUENCE OF THE PRE-DOSE ON THE DOSIMETRIC RESPONSE OF RAD-HARD EPITAXIAL SILICON DIODES FOR CLINICAL ELECTRON BEAMS

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In this work the influence of the pre-irradiation on the dosimetric response of epitaxial (EPI) silicon diodes for clinical electron beams was studied using a Siemens Primus Linear Accelerator from Sírio-Libanês Hospital. Three samples of EPI diodes were investigated: #44 - non-irradiated, #45 - received a pre-dose of 200 kGy from a ⁶⁰Co irradiator and #35 – pre-irradiated with 200 kGy from a 1.5 MeV electron beam. All measurements were performed with the diodes unbiased and operating in the direct current mode and inserted into a PMMA phantom. The dynamic current response of the diodes under irradiation with electron beams within the energy range of 6 MeV up to 21 MeV was measured. For all energies, data showed good instantaneous repeatability of the diodes, the non-pre-irradiated one exhibiting a more stable behavior, characterized by coefficients of variation better than 2.8%. Furthermore, the diodes exhibited a quite linear response, given by the charge versus absorbed dose, with charge sensitivities higher than 0.21 mC/Gy. As expected, the highest sensitivity was achieved with the non-irradiated #44 EPI diode. Additionally, with the exception of the #35 sample, it was not observed a significant energy dependence of the devices. The percentage depth dose profile (PDD) and transversal dose profile (TDP) were also measured in PMMA with all diodes. The results were in excellent agreement with those calculated with Monte Carlo code using the Oncentra MasterPlan® Treatment Planning System (TPS). The TDP was also evaluated with a commercialized array of 2D pixel ionization chambers MatriXX from IBA Dosimetry®. The results obtained with the ionization chambers were in a good accordance with those acquired with the EPI diodes.

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SILVER NANOPARTICLES COMPLEXED TO ALANINE FOR IONIZING RADIATION DOSIMETRY

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Alanine has been largely used as a dosimeter in radiotherapy treatments, because it is able to measure doses ranging from 1 Gy up to kGy with the advantages of linearity, ESR signal stability with time, and tissue equivalence to the ionizing radiation. However, alanine has poor sensitivity to low doses and photons with low energy (below 150 keV). In this context, many efforts have been made in order to increase the sensitivity of alanine, by mixing it with compounds of high atomic number. One way to overcome this hindrance would be the use of metallic nanoparticles since they can be positioned very close to the alanine molecule. This in turn would produce more free radicals in the alanine with the photoelectrons emitted by the metal nanoparticle. Moreover, the use of nanostructures would improve the homogeneity of the material, enabling the construction of low-size dosimeters for radiosurgery dosimetry. In this sense several samples of a hybrid nanostructured material containing different concentrations of silver nanoparticles complexed to DL-Alanine were synthesized. UV-Vis spectroscopy, X-Ray diffraction and electron transmission microscopy were used to characterize. Results suggested an interaction of the amino radicals from alanine molecules with the Ag⁺ ions onto the surface of the nanoparticles. This gives rise to changes in the structure and morphology of the nanoparticles as well as in the crystalline structure of the Alanine. When used as a dosimeter, the Alanine complexed with silver nanoparticles presented an increased sensitivity to low energy ionizing radiation. The gain in sensitivity depends on the concentration of silver nanoparticles in a non-linear regime. The linear dose dependence characteristic of pure Alanine was kept.

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STUDY OF SENSITIVITY AND LOWER DETECTION LIMIT (LDL) OF TLD IN 4 MEV AND 9 MEV CLINICAL ELECTRON BEAMS USING LIQUID WATER PHANTOM

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The major purpose of clinical dosimetry is to establish a quality control of the radiation beam in order to obtain an improvement in the quality of radiotherapy. This paper aimed to evaluate the sensitivity of thermoluminescent (TL) dosimeters comparing the performance of detectors produced by IPEN, CaSO₄:Dy, with dosimeters already used in radiotherapy dosimetry, LiF:Mg,Ti (TLD-100) and micro LiF:Mg,Ti (TLD-100) produced by Harshaw. The dosimeters were previously separated in groups, each with 5 detectors, according to their TL individual sensitivities to ⁶⁰Co gamma-radiation in air and electronic equilibrium conditions. The selected dosimeters were irradiated with 4 MeV and 9 MeV clinical electron beams, positioned at depth of maximum dose: 4 MeV - 1.0 cm and 9 MeV - 2.0 cm, with absorbed doses of 0.5, 1.0 and 5 Gy using a linear accelerator Clinac 2100C Varian. The field size used was 10x10 cm² with 100 cm of source-phantom surface distance according to recommended by the Technical Reports Series n° 398 (TRS 398) of IAEA (International Atomic Energy Agency). The CaSO₄:Dy dosimeters are approximately 26 and 318 times more sensitive than LiF:Mg,Ti and microLiF:Mg,Ti for 4 MeV and 24 and 259 times more sensitive than LiF:Mg,Ti and microLiF:Mg,Ti for 9 MeV electrons beams respectively. For both energies studied the dose-response of CaSO₄:Dy, LiF:Mg,Ti and microLiF:Mg,Ti dosimeters presented linear behavior on the electron dose range from 0.5 to 5 Gy and the LDL of the CaSO₄:Dy dosimeter is 20 and 25 times lower than LiF:Mg,Ti and microLiF:Mg,Ti for 4 MeV and 18 and 20 times lower than LiF:Mg,Ti and microLiF:Mg,Ti for 9 MeV electrons beams respectively. CaSO₄:Dy presents similar TL response behavior than LiF:Mg,Ti and microLiF:Mg,Ti dosimeters with higher sensitivity and lower LDL. This result indicates that CaSO₄:Dy can be used successfully in radiotherapy dosimetry.

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THERMOLUMINESCENT RESPONSE OF CASO₄:CD

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In the health sector, where ionizing radiation is its largest employment and therefore provides considerable amounts of exposure in terms of collective dose, is also where more research is conducted in order to enable the greatest benefit in using this type of radiation the lowest possible risk. This study evaluated the performance of a new dosimetric material, CaSO₄:Cd, in powder form, produced by crystal growth. This dosimeter is being tested for possible use for measuring exposure to beta radiation. The evaluations are performing at the Physics Department of the UFS for use as a thermoluminescent detector (TLD). The detectors were developed as follows: the material, after the process of crystal growth, it was granulated to obtain particle sizes between 75 and 150 microns; after that, it was heated to a temperature of 900° C for 6 uninterrupted hours in order to obtain better characteristics thermoluminescent; following, the whole compound was exposed to radiation from a beta source with absorbed doses between 0.5 and 50 Gy, then the material was separated into three batch, with the aim of measuring their ability to save information (absorbed dose). The first batch had measurement of the TL emission performed within minutes after exposure to radiation; the second batch was measured after one week and one month after the three weeks. The results showed, through graphics (TL x temperature), the dosimeter's ability to accurately measure absorbed dose from beta radiation and the capacity to store information related to the radiation absorbed during these times intervals. Now, the dosimetric characteristics are being produced for use in monitors with a badge and wristband.

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CHARACTERIZATION OF CaSO₄:Dy TO GAMMA RADIATION DOSIMETRY

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This paper reports the synthesis and thermoluminescent (TL) characterization of CaSO₄:Dy obtained by the precipitation method. Thermoluminescent CaSO₄:Dy powder and Teflon (PTFE) were mixed in order obtain pellets with size f 4mm x 1mm and approximate weight of 23± 2 mg. Samples of CaSO₄:Dy were irradiated to a radiotherapy source of ⁶⁰Co using a conventional technique for therapy. TL response of CaSO₄:Dy showed a glow curve with two peaks centered at around 164 and 302 °C. TL phosphor showed a good linearity in the range of 0.5 to 30 Gy. Fading of the TL information was 5.19 % in 37 days and presented a standard deviation of 4% for reproducibility.

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STUDY FOR DEVELOPMENT OF DOSIMETER USING STRUCTURED POLYMER

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Polymetallaynes are well known for broad applicability in electronic and electro-optical devices [1] sensors [2] and biosensors [3], electroluminescence [4,5] and photovoltaic behavior [6]. In this communication the property of gamma rays detection for a Pt containing polymetallayne, Pt-DEBP, with a defined chain length is reported. The samples were irradiated with ⁶⁰Co gamma radiation at room temperature with radiation doses ranging from 0 to 90 Gy induced changes in the UV-Vis spectrum and in the fluorescence of Pt-DEBP. The approach adopted was to dilute the polymer in the CHCl₃ and toluene solvents in order to compare them in four different concentrations (0.05, 0.0375, 0.0200 and 0.01125mg/ml) to examine it before and after irradiation with SIEMENS GAMATRON device therapy equipped with ⁶⁰Co source (~1.25 MeV). The irradiation cause a modification in the HOMO-LUMO energy gaps, which is probably connected to morphological changes. Also can observe the formation of a new band at low wavelengths, which for non-irradiated samples do not appear. Then the sample will be tested in the Pt dimer in order to understand whether he is forming polymers minors. The procedure was realized with toluene for confirmation that is no modification in structured. In toluene was not observed a shift in test UV-Vis. These results indicate that the effect is associated to radical formation. Radicals, which result from the solvent radiolysis, attack the polymeric chain, leading to structural alterations and absorption spectrum blue-shift. The number and reactivity of these radicals are dependent on the solvent type. Larger shifts are observed for solutions with halogenated aliphatic solvents. So this effect is not observed with toluene, where halogen atoms are absent. Such observations are relevant to obtain low-dose dosimetric systems, where the target sensitivity depends on the adequate choice of solvent and concentration.

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THE ANGULAR DEPENDENCE OF TL RESPONSE IN SENSITIZED NATURAL QUARTZ OF SOLONÓPOLE

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This work is part of a study on dosimetric properties of Sensitized Solonópole Quartz, called QSS-100, used as a TL dosimeter for conventional radiological examinations. QSS-100 has a sensitivity 5 times greater than TLD-100 with respect to X-ray beams with mean energies of 40 keV. The aim of this work was to analyze experimentally and computationally the angular dependence of QSS-100. At the Metrological Laboratory of Ionizing Radiation of DEN-UFPE, the angular dependence was measured by irradiating QSS-100 dosimeters with a HF 420 Pantak tube, using RQR 5 X-ray beam quality and the results were compared with corresponding data calculate with the EGSnrc Monte Carlo code. Good agreement between calculated and measured responses was observed. The QSS-100 results showed no dependence for angles between -45° and 45° . Additionally, the angular dependence was also calculated for radiation qualities RQR3, RQ7 and RQR9 and again, the QSS-100 showed no dependence for angles between -45° and 45° .

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EVALUATION AND DETERMINATION OF QUALITIES FOR MAMMOGRAPHY

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The development of studies concerning the quantity air kerma involved in mammography is being stimulated by the Advisory Committee on Ionizing Radiation _ CCRI/BIPM. By this mean, it is necessary the identification of the entrance quantities for the experimental proceedings. These quantities are substantiated on the radiation qualities, from which the quantities of practical use in radiological diagnosis, such as air kerma on the skin surface, air-water kerma product, CT air kerma index and dose index for CT, arise. The establishment of each quality is based on Brazilian and international norms and protocols, which provides reference values. To define the traceability conditions of clinical exams equipments, the qualities that must be defined includes the X-ray energy, the radioisotopes targets and the voltage to generate the X-rays. The work took place at the Brazilian Laboratory of Ionizing Radiation _ LNMRI, at the Institute for Radioprotection and Dosimetry _ IRD. To accomplish the study, a X-ray system, with maximum voltage of 60kV, 80mA current and 3.5kW power; X-ray wide beams and specific for mammography, the voltage supplied - which contributes for the X-ray energy _ of maximum value of 40kV for mammography; the Penelope software to generate the spectra and for simulation, based on Fortran language, and the associated quantities _ Rh45, Mo42 and 184W used as targets. This work aims to describe the technological progress that plays an important role on the air kerma determination in mammography beams. For such task, it is necessary to know the involved criterion for the standards definition and the establishment of the radiation conditions. This work fosters the establishment of analytical criteria concerning to the calibration conditions to homologate the entrance quantities and to assure that the used equipments are proper and safe. These criteria are crucial for the maintenance of life quality and for the researches development.

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OSL DOSIMETRY FOR QUALITY CONTROL OF RADIOTHERAPY CLINICAL BEAMS

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Purpose: Dosimetry using optically stimulated luminescence (OSL) has potential application for quality control in radiotherapy. The objective of this work is to compare the dosimetric response of alumina (Al_2O_3) doped with silver nanoparticles and alumina doped with carbon in order to verify its possible application on in vivo dosimetry in radiotherapy procedures. Method and Materials: Dosimeters with 0.5 cm diameter and 0.3 cm high were produced using pure alumina and alumina doped with 0.1% Ag nanoparticles and with 1% carbon. The dosimeters were irradiated using a $10 \times 10 \text{ cm}^2$ field from a 200 kV beam using a Siemens Stabilipan II radiotherapy clinical unit. A dose of 8 Gy was used on all the experiments. The response of the doped dosimeters was compared to the response of pure-alumina dosimeters. Results: OSL signal curves revealed that the presence of a dopant material increases both the sensitivity and the signal-to-noise ratio of the dosimeter. Percent difference of the signal of the carbon tablet with respect to carbon-free tablets was found as 38%. The comparison of the tablets with Ag nanoparticles with the tablets with and without carbon 8% and 46% differences were found respectively. The dopant acts increasing the number of traps in the luminescence process and the nanoparticles act increasing the radiation interaction probability. Conclusions: The analysis of intensity response curves of the dosimeters studied showed suitable characteristics for the application of these materials in radiotherapy. The prospects of this work are to study the doping process of the material to assess sensitivity and reproducibility in the dosimetric features of the dosimeters for its application on in vivo dosimetry.

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NANOPARTICLES AND NANOTECHNOLOGY IN PEDIATRICS INFECTIOUS AND OTHER DISEASES

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BACKGROUND: The smallest particles contain tens or hundreds of atoms, with dimensions at the scale of nanometers, hence nanoparticles. Nanoparticles plays an important role in their toxicity and morbidity , it is useful to classify them based on their number of dimensions. Nanoparticles present possible dangers, both medically and environmentally for children. **METHODS:** Molecular nanotechnology is a proposed approach which involves manipulating single molecules in finely controlled, deterministic ways. Current problems for nanomedicine and application in pediatrics involve understanding the issues related to toxicity and environmental impact of nanoscale materials. **RESULTS:** Among diseases caused by nanoparticles are leukemia (caused by viruses from the retrovirus and herpesvirus families), liver cancer (hepatitis virus), gastric ulcer (*Helicobacter pylori*), nasopharyngeal cancer (Epstein-Barr virus), kidney stones (nanobacteria), severe acquired respiratory syndrome (Corona virus), heart disease (*Chlamydia pneumonia*), juvenile diabetes (Coxsackie virus), pediatric obsessive-compulsive disorder (streptococcal bacteria), psychotic disorders (Borna virus), and prion diseases such as mad cow disease. **DISCUSSION:** The approaches to nanomedicine range from the medical use of nanomaterials, to nanoelectronic biosensors, and even possible future applications of molecular nanotechnology. **CONCLUSIONS:** Very small particles, so-called nanoparticles, have the ability to enter, translocate within, and damage living organisms. Complex drug delivery mechanisms are being developed, including the ability to get drugs through cell membranes and into cell cytoplasm. Efficiency is important because many diseases depend upon processes within the cell and can only be impeded by drugs that make their way into the cell.

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X-RAY SPECTROSCOPY APPLIED TO THE STUDY OF X-RAY TRANSMISSION THROUGH NANOMATERIALS

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Nanoparticles have become increasingly important in several biomedical applications such as x-ray imaging contrast agents, tumor treatment procedures and in the design of lead-free radiological protection devices. However, the effectiveness of such applications requires the evaluation of the dependence of x-ray absorption on the particle size of materials. In this study we compare the energy absorbed by nanostructured and microstructured materials as a function of the x-ray beam energy, material concentration and sample thickness. For this purpose, we used CuO microparticles with a mean particle size of about 56 μm , and nanoparticles with size in the range 10 - 100 nm. These particles were incorporated separately into a polymeric resin in proportions of 5% and 30% relative to the resin mass. Plates with about 5 x 5 cm^2 in area and uniform thickness were produced for each material. The x-ray generator was a Philips, model MG 450, with a W anode tube. Measurements were performed for beams generated in the range between 25 and 100 kV tube voltages and transmitted through material thickness between 2 and 25 mm. Data were registered with an Amptek XR-100T-CdTe detector. The ^{241}Am , ^{133}Ba and ^{152}Eu sources were used for spectroscopy system calibration and efficiency determination. The primary and absorbed spectra were corrected for all possible partial interactions of the x-rays with the detector. Results show that nanostructured material absorbs more radiation than the microstructured ones for both material concentrations in the resin. For example, for a 5% particle concentration and material thickness of (5.96 - 0.2) mm, the difference between air kerma values is about 16% for 25 kV, 8% for 40 kV and about 2% for 100 kV.

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DELIVERY SYSTEM OF SILVER NANOPARTICLES BASED ON LATEX MEMBRANES: PRELIMINARY RE

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Natural rubber latex (NRL) membranes have already been successfully used in drug delivery systems, to stimulate angiogenesis and tissue regeneration. In the same way, silver nanoparticles have also been used to accelerate wound healing. In this sense, a system containing silver nanoparticles embedded on NRL membranes would present an enhanced healing action. The present paper presents the preliminary results of the development of a delivery system of silver nanoparticles using NRL as a polymeric matrix: NRL-AgNP. The synthetic process of silver nanoparticles and its characterization through TEM micrographs and UV-Vis spectroscopy are presents. The TEM micrographs revealed that the silver nanoparticles are spherical with diameter size around 30 nm. The UV-Vis spectroscopy of the aqueous solution where the NRL-AgNP was immersed revealed the liberation of silver nanoparticles by the NRL membranes and the rate of releasing of silver nanoparticles was determined. The system is aimed for biological applications as a delivery system of silver nanoparticles with potential healing action, specially for dermatological cases.

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HYBRID TiO₂ NANOTUBES FOR APPLICATIONS IN MEDICINE

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The wide bandgap and large exciton binding energy of TiO₂ nanotubes may generate new interesting applications in nanomedicine after their surface modifications with ZnS quantum dots. In this work, the hybrid TiO₂/ZnS nanotubes were prepared. Scanning electron microscopy (SEM), transmission electron microscopy (TEM), fluorescence spectroscopy and X-ray diffraction techniques have been used to investigate the structure, morphology and optical properties of the hybrid TiO₂/ZnS nanotubes. The powder XRD patterns of the TiO₂/ZnS nanocomposites identified the anatase-phase TiO₂, while the ZnS exhibited the sphalerite-phase. The prepared TiO₂/ZnS nanotubes showed new optical properties concerning about the absorption, which is different from those of the TiO₂ or ZnS. Compared with TiO₂ and ZnS, it was observed a blue shift of the UV absorption band for the hybrid TiO₂/ZnS nanotubes. The method of UV/VIS diffuse reflectance spectroscopy was employed to estimate the band-gap energies of the synthesized TiO₂/ZnS nanocomposite. The pure TiO₂ nanotubes shows high emission at 395 nm, corresponding to its bandgap of 4.2 eV (photon wavelength is about 300 nm). The value of band-gap energy decreases with increasing content of ZnS. The sulphur from ZnS appears to be able to doping the TiO₂ nanotubes surfaces, decreasing the value of band-gap energy. In order to use the synthesized TiO₂/ZnS for in vivo bio-cell labeling their emission spectra were obtained by excitation at 488 nm. The TiO₂ coated with ZnS quantum dots (QDs) showed good bio-imaging capability on plant cells.

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ULTRASHORT CARBON NANOTUBE BASED MULTIFUNCTIONAL PROBE AS A CONTRAST AGENT FOR PET/MRI

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We report on the synthesis and preliminary tests of a carbon nanotube based contrast agent for MRI and PET. Ultra-short single wall carbon nanotubes (20-100 nm long) were impregnated with GdCl₃ and ⁶⁴CuCl₂ following a synthetic route developed at Rice University. The resulting structure is of carbon nanotubes internally loaded with composite clusters of paramagnetic Gd³⁺ (content of 3% by mass) labeled with ⁶⁴Cu. Such GdCu@us-SWNT nanoprobe can act as a dual probe for PET/MRI due to the action of the Gd ions as T1 contrast agent combined with the b+ emission of ⁶⁴Cu. The loading of the tubes takes ~4h and is compatible with the 12.5h half-life of ⁶⁴Cu. The hydrophobic tubes were suspended in aqueous solution of 1% Pluronic® for the tests of the probe performance and for in vivo injections, at an initial concentration of ~3mg/mL. A phantom loaded with different concentrations of the probe was used to acquire T1 and T2 maps in a 3T PET/MRI brain system (Siemens) installed at the Martinos Center. T1 and T2 measurements were also performed in a relaxometer of 60 MHz both for dispersions of the probe in pluronic and in rat serum. It was seen that the probe shortens significantly the T1 and T2 of the solution in the test tubes and serum. The kinetics of the probe in vivo was studied using Fisher 344 rats by injecting 1.1 mL of the probe and analyzing the T1 and T2 values of blood samples collected in subsequent times. The maximum effect was observed 2h post-injection. In ~4h, T1 and T2 values returned to their initial values. Despite the good performance of the probe in vitro, preliminary in vivo tests on rats with implanted with glioma tumor cells indicated a weak alteration of the MRI signal, mainly in the liver. The low Gd concentration and low solubility of the pluronic-coated tubes are, at present, limiting their use for in vivo imaging. New amphiphilic coatings need to be tested to improve water solubility of the probe and increase the effective Gd content in vivo.

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DOSIMETRIC RESULTS OF QUALITY CONTROL ACHIEVED WITH 2D IONIZATION CHAMBERS ARRAY MATRIX

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The dosimetric tests are essential to ensure the quality of radiotherapy treatment. Usually, these tests are performed with ionization chambers. However, new measurement instruments provide practical tools for dosimetric analysis. The purpose of this work is to evaluate a series of 17 months of dosimetric quality control test results in three linear accelerators, performed with a 2D ionization chamber array. It was also evaluated the agreement between the dosimetry using this system with the traditional Farmer ionization chamber setup in water. It was used the MatriXX Evolution system within polymethylmethacrylate plates to compose the scattering material. The analyses of absolute point dose, symmetry and flatness were performed using OmniPro-1mRT software. Since the measurements were not performed on the standard reference set-up, new tolerance levels were set. The results show that the quality control performed with MatriXX provides a practical, fast and precise evaluation method for the dosimetric parameters quality assurance of linear accelerators. The difference between the absolute dose measurements with the 2D array and the ionization chamber follows approximately normal distribution and are mostly within 2%, thus it can be concluded that the system used allows the verification of possible fluctuations in constancy of dosimetric parameters.

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CHARACTERIZATION OF AN EXTRAPOLATION CHAMBER AS A PRIMARY STANDARD DOSIMETER FOR

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Patient therapy with beta or electron radiation fields requires high accuracy determination of absorbed dose in tissue. Dose equivalent quantities are also looked for to be determined for radiation protection purpose in the case of skin or eyes human exposures due to accidents or in normal practices. Due to the low penetration and high scattering in matter characteristics, beta radiation is not as simple as gamma dosimetry. Reliable measurements start in primary measurements of the absorbed dose in tissue that is done by the only primary standard dosimeter available, an extrapolation chamber. The 23392 PTW extrapolation chamber is intended to be used as a primary standard dosimeter for beta radiation fields. Characteristics in terms of ionization current saturation, true null depth and response to air density changes were determined. Results provided preliminary data to be used for appropriate corrections for determination of absorbed dose in tissue.

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DEVICE PARAMETER ANALYSIS METHOD FOR DOSIMETRY IN RADIOTHERAPY AND RADIODIAGNOSTICS

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In this communication an innovative method for dosimetry in radiation fields used either to diagnosis or radiotherapy is presented. The method is based on the parameter analysis of an electronic device which works as an ionizing radiation detector. Although not required, such a device is built of semiconductor material and has miniature size. This feature is suitable to provide an electronic equilibrium for dosimetry in radiation beams which the field size is narrow or small like in computed tomography or radiosurgery, respectively. There are several electronic components that can be used as particle detector: a bipolar junction transistor (BJT), MOSFET, photodetector, Zener, TRIAC (Thyristor for Alternated Current) and others. To apply the parameter analysis method the user must have a minimum knowledge about the device chosen to work as a radiation detector. Generally, an electronic component has two terminals for input signal and two terminals for output signal, and its readout depends on a physical quantity which is named here as the radiation dose parameter (RDP), for example, current, voltage, resistance, capacitance, amplification factor, sensitivity for light photons, etc. Actually, the method can be used with four, three or two-terminal devices since it is properly biased so that its RDP signal can be measured. In this work, a particle detector parameter analyzer (PDPA[®]) was developed at Nuclear Instrumentation Laboratory (LIN/CRCN-NE/CNEN) to bias several types of electronic components under radiation beams and simultaneously measure their RDP signal. Selected results can show that it is possible to obtain a high correlation between RDP signal and entrance dose of radiation beams used to diagnosis and radiotherapy, $R^2=0.99986$ and $R^2=0.9987$, respectively.

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PERFORMANCE OF A RING-SHAPED MONITOR IONIZATION CHAMBER IN STANDARD RADIOTHERAPY BEAMS

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Monitoring the X-ray intensity is very important in order to obtain an accurate dose delivery to patients. This accuracy is one of the most important points for the success of a radiotherapy treatment. Therefore, a ring-shaped ionization chamber was developed at Instituto de Pesquisas Energéticas e Nucleares to be used as a monitor chamber for X-radiation beams. This monitor ionization chamber is composed by a PMMA body, collecting electrode and guard ring made of graphite, and an entrance window of thin aluminized polyester foils. It has a central hole for the radiation beam. The main advantage of this kind of ionization chamber in relation to commercial monitor chambers is the changeless characteristics of the beam, since the radiation is not intersected directly by the chamber, due to its central hole. As characterization tests have been performed with satisfactory results using diagnostic radiology X-ray beam qualities, in this work the chamber was studied using radiotherapy qualities.

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CHANGES IN DOSE DUE TO SCATTERING OF PARTICLES IN THE COLLIMATION SYSTEMS OF LIN

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This work is evaluated possible changes to the dose delivered by an accelerator photon and an electron accelerator, the dispersion of these particles with the change in position, collimation systems used for the creation of fields in radiotherapy. The calculations are made in a KDS Siemens linear accelerator operating at 18 MeV in the electron configuration and on a Siemens Primus accelerator operating at 15 MV photons in the settings. In both cases studied the effect of scattering when one of the four jaws is brought to the position of the origin, and compared with the calculation when the jaws are forming a square field. We studied the profiles of these particles deposited dose in air and water phantom in the isocenter and comparing the two systems to analyze the effect of dispersion. Moreover, we investigate the spectrum of influence on the isocenter to study possible changes in energy that can cause this effect. Calculations were made with the code MCNPX 2.5, simulating in each case the geometry of each of the heads of the accelerators as specified by the manufacturer. Was carried out prior to the respective tuning yields measured depth in the hospital

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EVALUATION OF THERAPLAN PLUS ALGORITHM FOR EXTENDED SSD SETUP

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There are radiotherapy treatments which field sizes larger than possible with usual source to surface distances (SSD) are required. A usual solution is the use of two adjacent fields with a moving gap. However, this setup can lead to a systematic underdose and it doesn't avoid overdosed regions, since there is field's superposition from a certain depth. This problem could be solved with the use of an extended source-surface distance setup, substituting two fields for one. A concern about this setup is the dependence between PDD and dose profile with SSD. The purpose of this study is to evaluate the dose calculation of Theraplan Plus (TPP), MDS Nordion, version 3.8, treatment planning system (TPS) for extended SSD. The evaluation was performed by comparing calculated and measured doses (used as benchmark). It was compared field profiles and absorbed doses calculated by the TPS with ionization chamber measurements for 140 cm SSD. It was measured half beam profiles (in plane direction) for the field 10x40 cm² at following depths: 1.6, 3, 5, 8 and 10 cm. At these depths, it was measured central axis absorbed dose for different fields: 5x40, 8x40, 10x40 and 20x40 cm². The measurements were performed with ionization chamber PTW with 0.125 cc in a water phantom for 6 MV Primus/Siemens photon beam. It was delivered 50 MU for each measurement. The calculated field profiles for all depths did not present deviations greater than 3% or 2mm distance to agreement. The TPP central axis absolute dose calculations had an excellent agreement for all fields' sizes and depths (deviations less than 1%). The results show that it's not necessary perform corrections on TPP, neither manufacture specific dose modifier. Therefore, an extended SSD setup can safely be used for treatments with large field size (up to 56 cm).

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USE OF COMPUTED RADIOGRAPH FOR LINACS QUALITY CONTROL

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Radiographic films have been a common tool for Quality Control (QC) tests for Linear Accelerators (LINACs). The published protocols TECDOC 1151 (IAEA) and TG 40 (AAPM) propose the use of radiographic films to ensure that light and radiation fields are coincident and to verify gantry, collimator and couch rotation isocenters. However, digital images are available through new technologies (Electronic Portal Image Device - EPID, Computed Radiograph - CR), compromising the acquisition of these films. The aim of this study is show that CR can be used for QC tests in a Primus/Siemens Linac. This study compared images obtained with X-OmatV KODAK radiographic films scanned by a VIDAR Dosimetry PRO scanner, and digital images acquired with oncologic cassettes FUJI, FCR Capsule. Both used 35x43 cm² cassettes and results were evaluated trough Doselab 4.11 software. We first assessed gantry, collimator and couch rotation isocenter diameters. These tests were done according to TECDOC 1151 recommendations and setups. For conventional films measurements we used 50 MU for each beam position; for CR it was used 2 MU. We also verified the coincidence of light and radiation fields for 10x10 and 20x20 cm² collimators. Finally, we compared the dosimetric field_s length. The rotation isocenter diameters results were as follow: GANTRY _ 0.54 mm (conventional) x 0.92 (CR); UPPER COLLIMATORS _ 0.37 mm (conventional) x 0.50 (CR); LOWER COLLIMATORS _ 0.29 mm (conventional) x 0.20 (CR); COUCH _ 0.07 mm (conventional) x 0.06 mm (CR). The light and radiation fields coincidence were the same for the two methods. No significant difference was found among fields sizes measured with films and CR. Together; the results show that there is an agreement between the conventional films and CR for LINACs QC tests. Therefore, the use of CR images for QC is valid and becomes a very simple method to replace conventional films.

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ABSORBED DOSE IN UTERINE CERVIX CANCER FOR BRACHYTHERAPY HDR

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In this work, absorbed doses measurements in high dose rate brachytherapy (HDRB) for uterine cancer using shielded applicators were obtained. Radiation measurements were made using commercial thermoluminescent dosimeters of Lithium Fluoride doped with magnesium and titanium. Dosimetric effects upon both single shielded ovoid dose distribution as well as single unshielded ovoid containing encapsulated ^{192}Ir were investigated. In order to verify the prescribed doses, the dosimeters were located at different distances from the ovoid surface to 5 cm. Experimental results were compared with those calculated by the Brachy Vision treatment planning system. Measurements were performed within a shielded vaginal colpostats, thermoluminescent dosimeters (TLD) using Manchester technique. The planar dose distributions around a high activity ^{192}Ir were measured and normalized to catheter oriented transverse plane dose points using an ovoid 2.5 cm under the presence of tungsten shield. Results showed that dose distribution on the transverse plane of the unshielded ovoid was most uniform. Meanwhile, dose distribution with shielded ovoid was anisotropy; this could be tungsten shielding effects.

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HIGH ELECTRON BEAM DOSIMETRY USING ZIRCONIUM OXIDE NANOPARTICLES

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The aim of the present work is to determine dosimetric characteristics of high electron beam from linear accelerator (LINACs) for clinical applications using zirconium oxide nanoparticles embedded in polytetrafluoroethylene (PTFE). The irradiations were carried out using high electron beams (2 to 18 MeV) from a linear accelerator (LINAC) Varian, CLINAC 2300C/D, for clinical practice purpose. The electron irradiations were obtained by using the water solid in order to guarantee electronic equilibrium conditions (EEC). Field shaping for electron beams was obtained with electron cones. Glow curve and other thermoluminescent characteristics of ZrO₂ were conducted determined under high electrons beams irradiations. The TL response of the pellets showed an intensity peak centered at around 237°C. TL response as a function of high electron absorbed dose showed a linearity in a wide range. To obtain reproducibility characteristic, a set of pellets were exposed repeatedly for the same electron absorbed dose. The results obtained in this study can suggest the applicability of ZrO₂ pellets for high electron beam dosimetry, provided fading is correctly accounted for.

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STOPPING POWER AND RANGE OF ELECTRONS MONOENERGETIC IN RADIOTHERAPY USING GEANT4

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The study of interaction of radiation with matter is a field of great interest in the medical physics. The computational simulation tools as Monte Carlo have been used in this field. The Geant4 code is a toolkit that incorporates several physical processes and particles which allow its application in medical physics, in particular, in the area of radiotherapy. In this work we performed simulations of monoenergetic electrons in the energy range used in radiotherapy, and compared the results with results of Range and Stopping Power already published by NIST. The simulated results of stopping power of electrons were very close of published with a maximum percentage difference of 12% and the simulated results of Range of electrons were very close of published, showing that Geant4 is appropriated to electrons simulations with energy in the range of radiotherapy.

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EXPERIMENTAL VALIDATION OF A NEW SKIN DOSIMETRY

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This paper presents a assessment of the skin dosimetry in a voxel phantom of the transport code MCNP (Monte Carlo N-Particle) using a new methodology for the skin discrimination. This methodology proposes subdividing the skin voxel phantom volume elements discriminating it with thickness and localization similar to the real. Therefore it was proposed a reproduction in the MCNP code of an experiment using anthropomorphic phantom irradiated with electron beams of the Varian 2100C linear accelerator of “Hospital das Clínicas da Universidade de São Paulo”, looking up for a validation of the calculated data. From the comparison of experimental data with the calculated one it was verified the importance of the correctly skin discrimination to obtain more reliable calculated dosimetric assessments, more reliable and accurate

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ANALYSIS OF HETEROGENEITY CORRECTION OF THE PLANNING SYSTEM XIO-CMS IN IMRT PLAN

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Radiotherapy that uses Intensity Modulated Radiation therapy to the beams (IMRT) is a mode that employs nonuniform fluencies capable of generating isodose curves well conformed to the target volume preserving the adjacent regions. The human body has diverse structures with different electronic densities, such as bone, soft tissue, and air cavities. The complexity of the heterogeneity correction utilization in this mode is due to the small effects of the impact fields generated by the planning system, the presence of heterogeneous tissues and the high gradient of fluencies generated. The aim of this study was to analyze the heterogeneity correction of the planning system XiO-CMS in heterogeneous phantoms through the gamma function and the absolute dose at the isocenter. This study examined six IMRT plans in solid water, cork and aluminum phantoms using the criteria of 3% dose difference and 3 mm distance to agreement. The average value found for the gamma function was 97,04% approved of pixels, and none of the plans had more than 6% of the pixels fail by the gamma function criterion used. The largest percentage difference between the gamma function of aluminum and cork phantom and the gamma function of the solid water phantom, was 3.65% and 3.54% respectively, while the average for aluminum is 1.11% and for cork is 1.63%. The average difference between the absolute dose calculated at the isocenter in the planning system and the absolute dose measured at the isocenter by 2D ion chamber array was 1.24%, the largest percentage difference of 3.43% shown for the aluminum phantom. Thus, it is concluded that the planning system corrects the presence of heterogeneous tissues properly.

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CHARACTERIZATION OF ISO 4037 RADIATION PROTECTION X-RAY BEAMS FOR MONITOR CALIBRATION

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In Radioprotection, Geiger-Müller detectors are used mainly as hand-held radiation monitors. However, handling in different conditions may result in changes in their response. Reliability of measurements can be achieved through periodic calibration of such equipment. This work is result of a project to develop a methodology to characterize ISO 4037-1:2000 standard X-ray beams, as recommended in IAEA Radioprotection Standards, at the IEE-USP Ionizing Radiation Metrology Laboratory (LMRI). Characterization of radiation beams is usually based on parameters such as X-ray tube peak voltage (kVp) and half-value layer (HVL). For kVp determination, it was used a CdTe spectrometer, a positioning and alignment system, collimators and a constant potential X-ray emitting system. The detector was energy calibrated and had its intrinsic efficiency determined from measured spectra of X- and γ -rays from Am-241 and Ba-133 radioactive sources. Subsequently, measured tube X-ray beam spectra were used as standards for determining the maximum energy of photons (since $h\nu_{\max} = e.kVp$). This was done by a least squares method linear regression, applied to the higher energy end of measured spectra. The HVL thickness were determined by logarithmic interpolation of the Cu thickness corresponding to the air kerma rates immediately larger and smaller than half of the rate obtained without filtration. Measurements began by the ISO-Narrow series, and the experimental spectra of the characterized beams were also determined. For HVL measurements, a 30 cm³ ionization chamber was used distant 99.5 cm from the focal spot. For nominal kVp values of 40 kV and 100 kV, respectively, it was obtained 40.03(10) and 100.15(17) kV. For these voltages, obtained HVL values were 0.079(5) and 1.138(52) mmCu, with deviations from standards inside uncertainties. Project should continue with characterization of other series of ISO beams and development of a methodology for calibration of monitors based on GM detectors.

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CALIBRATION OF RADIATION MONITORS AT DIFFERENT SOURCE-DETECTOR DISTANCES IN STANDARD $^{90}\text{Sr}+^{90}\text{Y}$ BEAMS

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Radiation protection monitors have to be calibrated in standard conditions and in terms of the radioprotection quantities. The Calibration Laboratory (LCI) of the Instituto de Pesquisas Energéticas e Nucleares (IPEN) offers calibration services of these kinds of monitors, in relation to beta radiation, since the 80_s ; the measurements are taken at the calibration distances given in the source calibration certificate from the German primary dosimetry laboratory: Physikalisch-Technische Bundesanstalt (PTB). However, there are instruments that do not allow their calibration at these reference distances, because absorbed dose rates in these conditions are not adequate. The objective of this work was to establish a procedure to calibrate the monitors with $^{90}\text{Sr}+^{90}\text{Y}$ sources at other distances. The inverse square law of the response of an ionization chamber was verified. A parallel plate ionization chamber developed at LCI was used in this study. Measurements of the ionization chamber were taken at different distances between source and detector, and the inverse square law was verified, allowing its application in the calibration of radiation monitors.

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RELATION BETWEEN THE ABSORBED DOSE AND THE EXPOSURE INDEX LGM FOR COMPUTED RADIOGRAPHY

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Computed radiography (CR) is gradually replacing conventional screen-film system, using a storage-phosphor image plate (IP) loaded into a cassette. CR images can be stored and analyzed in a computer. The CR system used for this study (Agfa model 30-X with NX acquisition software) calculates an exposure index for each image called IgM (Log Median), related to the absorbed dose to the IP. The IgM value depends on the average gray level of the pixels in the whole image, called Scan Average Level (SAL), which can also be obtained with NX program. The objectives of this study are to obtain a relation between the absorbed dose and IgM value, and to verify if it is possible to decrease the absorbed dose to the patient without compromising the image quality. The parameter used for evaluating the image quality was the signal to noise ratio (SNR). A water phantom (32x16x32 cm³) was used to simulate a human chest, and was irradiated with an x-ray equipment, varying the voltage, current and additional filtration. Two ionization chambers (Radcal; volumes 6 cm³ and 180 cm³, calibrated for radiology beams) were used to evaluate the phantom entrance dose (6 cm³ chamber) and the phantom exit dose (180 cm³ chamber). For each irradiation one image of the phantom was made with the CR system. According to the results it is possible to decrease the entrance dose without significant changes to exit dose, IgM, and SNR. The SNR study showed that for copper filters the rate of change of SNR with the exit dose is higher than for aluminum. So, the use of large atomic number filters can be advantageous for improving the image quality.

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USING A TANDEM IONIZATION CHAMBER FOR QUALITY CONTROL OF X-RAY BEAMS

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X-ray beam qualities are defined by both the mean energies and by the half-value layers. Many international protocols use the half-value layer and the beam voltage to characterize the X-ray beam quality. A quality control program for X-ray equipment includes the constancy check of beam qualities, i.e., the periodical verification of the half-value layer, which can be a time consumable procedure. A tandem ionization chamber, developed at Instituto de Pesquisas Energéticas e Nucleares, was used to determine the HVL and its constancy for five radiotherapy standard beam qualities. This ionization chamber is composed by two sensitive volumes with inner electrodes made of different materials: aluminum and graphite. The beam quality constancy check test was performed during two months and the maximum variation obtained was 1.24% for the radiation beam quality T-10. This result is very satisfactory according to national recommendations.

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CHARACTERIZATION OF A NEW IONIZATION CHAMBER IN RADIOTHERAPY BEAMS: ANGULAR DEPENDENCE AND VARIATION WITH DISTANCE

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A new double faced ionization chamber was constructed at the Calibration Laboratory of IPEN. It has different collecting electrode materials: aluminium and graphite. It was irradiated in standard radiotherapy beams (^{60}Co and X-rays). The chamber response variation with distance and the angular dependence of this ionization chamber were evaluated. It was verified that the chamber response follows the inverse square law within a maximum variation of 11.2% in relation to the reference value. For the angular dependence it showed good agreement with international standards.

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CALCULATION OF CORRECTION FACTORS FOR DOSIMETERS THERMOLUMINESCENT OF LITHIUM FLUORIDE (LiF-100) FOR USE IN 6MV PHOTON BEAMS

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Since the beginning of its use, radiation has already presented harm, justifying the necessity of controlled use. In order to monitor its effects and even avoid them, dosimetry has arisen. For the purpose of ensured all the necessary safety and monitor areas where there is radiation use, a lot of devices able to identify and quantify many types of radiation were developed. However, some these dosimeters are more widely used today like ionizing chamber, chemical dosimeters, photographic dosimeters and thermoluminescent dosimeters (TLD). When a group of TLD is obtained with a quantity n of dosimeters, there is a variation of answer of these dosimeters when they are subjected to the same irradiations conditions, from this comes the importance of individual calibration of these, to select the dosimeters with close answers, reducing the uncertainties of the measures. Therefore, this work presents the calculation of correction factors for the TLD of lithium fluoride (LiF-100) and shows how this factors can improve the TLD's readings.

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ANGULAR DEPENDENCE TESTS OF AN IONIZATION CHAMBER DEVELOPED FOR DETERMINING THE X RADIATION FIELD HOMOGENEITY

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Pencil ionization chambers are widely, if not exclusively, used for computed tomography (CT) dosimetry. Some studies pointed for the possibility of using this type of ionization chambers in other radiation beams, showing that they can be extended for other types of radiation. As these ionization chambers have a small thickness, this work presents a new type of pencil ionization chamber, that was especially designed for determining the radiation field homogeneity. This ionization chamber has a 1.00 cm sensitive volume length, instead of the usual 10 to 15 cm of commercial chambers. In this work the operational characteristics of this new ionization chamber, as the angular dependency and the linearity of response, were evaluated. The results were all in agreement with the IEC 61674 recommendations.

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PRELIMINARY CHARACTERIZATION OF A HOMEMADE IONIZATION CHAMBER FOR USE IN COMPUTED TOMOGRAPHY

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In this work an ionization chamber was developed for use in dosimetry of computed tomography (CT) medical equipment. The main difference between this CT ionization chamber and commercial CT ionization chambers is the material that it is made of. In the construction of this chamber only national low-cost materials were utilized. To evaluate the performance of this chamber several pre-operational tests were undertaken, as saturation curve, recombination loss and polarity effect that showed satisfactory results. The response stability (short- and medium-term stability tests) and stabilization time showed also good results, within the international recommendations. Besides the good results, this ionization chamber presents a simple design and it is made using only low-cost materials.

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OPTIMIZATION OF THE EVALUATION OF IMPORTANT PARAMETERS FROM THE STANDPOINT OF RADIOLOGICAL PROTECTION, FOR RADIOTHERAPY, THROUGH TLD USE

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The proposed methodology aims to optimize the evaluation of important parameters from the standpoint of Radiological Protection, to ensure that factors calculated only during commissioning are assessed more frequently, even with the exhausting of physicists in hospitals. Through this methodology, it was shown that irradiations with only few are able to evaluate several parameters in different positions and depths, making evaluation more practical and fast. The results showed that the thermoluminescent dosimeters used had a slightly higher deviation, however, can still be used for a initial assessment and if something is found wrong in this, another dosimeter more precise, but with more complex methodologies and time-consuming, would be employed, such as ionization chambers, for example.

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MEASUREMENT OF CHARACTERISTIC- TO-BREMSSTRAHLUNG RATIO OF TUNGSTEN X-RAY SPECTRA

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The spectrum emitted by an x-ray tube has two components: the continuous radiation (bremsstrahlung) and characteristic radiation. It is known from studies over the past century that the continuous spectrum is a consequence of the Coulomb interaction that occurs between the incident charged particle and the atomic nucleus. But the characteristic portion was only understood later with the studies of Sommerfeld and the atomic theory of Bohr, which says that the characteristic lines of the x-rays spectrum are consequences of the reorganization of the orbital electrons after the interaction with an incident particle. With improved computing power, the spectrum of x-rays has been studied extensively; computer models were developed to study the theoretical behavior of the beam. Moreover, spectral measurements has been performed and used in comparison with the theoretical results. However, issues such as the ratio between the characteristic lines and continuous spectra (CBR) are not considered, checking the discrepancy between theory and practice. This study aims to undertake a review of theoretical results of the relationship between bremsstrahlung radiation and characteristic lines (CBR), besides to analyze and compare these results with measured and published data.

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ENERGY DEPENDENCE STUDY OF PEN DOSIMETERS

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After the calibration of fifteen direct reading dosimeters (pen dosimeters) with gamma radiation (^{60}Co), they were tested with another gamma radiation source (^{137}Cs) and with beta radiation ($^{90}\text{Sr}+^{90}\text{Y}$). The objective of this work was to study the gamma energy dependence and the difference in relation to the radiation type of these instruments. The results show that there is a very low energy dependence for ^{137}Cs and ^{60}Co beams. However, when the responses of the direct reading dosimeters for gamma (^{60}Co) and beta ($^{90}\text{Sr}+^{90}\text{Y}$) radiations were compared, high radiation type correction factors were obtained.

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ENTRANCE SKIN DOSES MEASUREMENTS IN MAMMOGRAPHY BY THERMOLUMINESCENT TECHNIQUE

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Of the various techniques that can be used for personnel dosimetry, thermoluminescence dosimetry has emerged as a superior technique due to its manifold advantages over other methods of dose estimation. Various phosphors have been therefore investigated regarding their suitability for radiation dosimetry. In this paper, a dosimetry system based on thermally stimulated luminescence (TSL) from nanoparticles of zirconium oxide (ZrO₂) phosphors embedded in polytetrafluorethylene (PTFE) was developed for entrance skin doses measurements (ESD) in mammography. Small ZrO₂ pellets of 5 mm in diameter and 0.8 mm in thickness were used. Measurements both per unit air kerma and absorbed dose were performed using a mammography unit model Glory Elscintec. Experimental results indicate a considerable potential for use in routine control dose measurements in mammography.

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A COMPARISON OF THE IONIZATION CHAMBER AND THE OSL DOSIMETER FOR THE AVERAGE MAM

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Mammography is very effective in early detection of breast cancer. However, there are a lot of patients who have uneasiness to radiation exposure by mammography. The dose of radiation is shown by the average mammary gland dose, but it is difficult to calculate the dose of each patient because it needs the value of the ratio of mammary gland to fat for the calculation and the ionization chamber cannot be used while taking a mammogram. The optically stimulated luminescence dosimeter (OSL) is a dosimeter using the luminescence effect of the aluminum oxide; especially the Nano dots dosimeter is handy in a small disposable type. To calculate the average mammary gland dose of patient by using this, we researched correlation of the OSL and the ionization chamber. Each thickness of breast was measured by using the mamma phantom of 30, 50 and 70 % of the ratio of mammary glands. The ionization chamber and the OSL were set up and irradiated at the same time. The average mammary gland dose was calculated by using the value of the ionization chamber and the half value layer calculated in advance, and the dose was compared with the value of the OSL. The characteristic curve was obtained for the ratio of each mammary gland and the thickness of the breast. The possibility that patient's average mammary gland dose is obtained simultaneously with the mammogram.

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THE MEASUREMENT POSITION OF OSL DOSIMETER IN THE AVERAGE MAMMARY GLAND DOSE

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The average mammary gland dose (AGD) is effective for showing this exposed dose, but it is necessary to understand a glandular and the ratio of the fat. The optically stimulation luminescence dosimeter (OSL) used the emission of light phenomenon of the aluminum oxide. We used this OSL for every patient, and calculating the AGD. The correlation with the OSL and ionization chamber was examined. The mamma phantom of the mammary gland 30%, 50% and 70% were used. Ionization chamber and the OSL were installed and irradiated them at the same time. The measurement position of the ionization chamber set it in the upper section of the mamma phantom. The measurement position of the OSL went with two ways of the upper and lower section of the mamma phantom. We compared the measurements in ionization chamber with the measurements of the OSL. We are able to get a characteristic curve for mammary gland and fat ratio and thickness of the mamma. The result that the precision had better measurements of the OSL nano dot dosimeter which we put in the upper section of the mamma phantom was provided. We can easily measure the mamma phantom which we put in the lower berth. The proofreading constant of two measurements to convert the value of the lower berth into the value of the upper section that precision had good. It showed possibility got the AGD of the patient from with mammography.

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STUDY OF CALIBRATION FACTORS N_d, W FOR IONIZATION CHAMBERS DEDAL TYPE WITH 0.60CC IN GAMMA RADIATION BEAMS OF ^{60}Co

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Study of Calibration Factors N_d, W for Ionization Chambers Dedal Type with 0.60cc in Gamma Radiation Beams of ^{60}Co This work shows the partial results obtained in the research intitled “Improvement of quality control system to be applied at clinic dosimeter calibration (gamma radioactive source of cobalt-60) procedures at Calibration Laboratory (LCI-IPEN)” following the International Atomic Energy Agency (IAEA) protocols, such us, Calibration of Reference Dosimeters for External Beam Radiotherapy (Technical Reports Series N_469), explaining that protocol is a new version (revised version) of Absorbed Dose Determination in External Beam Radiotherapy (Technical Reports Series N_398). In this paper the calibration factors N_d, W were studied for many different kind of clinic dosimeter systems. The calibration factors were obtained after each calibration procedures realized at LCI-IPEN in the clients equipments. The Calibration Laboratory of IPEN perform calibrations during many years, for that it was assembled a data bank with the main calibration information. The studies was performed to determine de average value of calibration factors and their uncertainties for different kind of clinic dosimeters (manufacturers, models, etc.) used in control quality routines of clinics and hospitals. The results shows the variation of the measurements (calibration factors) for each kind of clinic dosimeter systems using ionization chamber with 0.60cc (dedal type), including the lowest and highest variations obtained. The lowest variation obtained in the calibration factors shows the better behavior of clinic dosimeter system, or better, it can operate with stable and safety measurements in control quality procedures.

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FEASIBILITY OF EBT GAFCHROMIC FILM FOR MEASURING UNIFORMITY OF $^{90}\text{Sr}/^{90}\text{Y}$ BETA RADIATION FIELD

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The goal of this work was to evaluate the uniformity of the radiation field from the $^{90}\text{Sr}/^{90}\text{Y}$ source of the beta secondary standard 2 (BSS 2) of the Development Center of Nuclear Technology-CDTN. The EBT model GafChromic[®] radiochromic film was studied as a detector with a ScanMaker 9800XL Microtek scanner and the DoseLab 4.11 program software used for the analysis of measurements. To characterize the EBT films in $^{90}\text{Sr}/^{90}\text{Y}$ fields, in terms of absorbed dose in air, small samples of radiochromic films were given 0.1 to 5.0 Gy. Calibration was done by establishing a correlation between the absorbed dose values and the corresponding radiochromic responses. Beam uniformity was investigated by mapping the field with a sheet of EBT film irradiated with 0.8 Gy. Results showed that the radiation field is uniform within 5% in the diameter of (12.0 ± 0.9) cm. From the isodose lines, it was observed that the center of the radiation field was shifted from the geometric center of the EBT film. Finally, the use of the EBT radiochromic film is feasible for the $^{90}\text{Sr}/^{90}\text{Y}$ beta radiation dosimetry and it is a suitable technique for mapping and detecting inhomogeneous radiation fields.

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THE CONTRIBUTION OF OSL DOSIMETRY IN QUALITY CONTROL IN RADIOTHERAPY

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In 2011 Brazil will have more than 489,000 new cases of cancer. Of these patients, a considerable contingent will be submitted to radiotherapy procedures. Thus, efficient systems that guarantee the quality of the beams used in radiotherapy procedures are extremely important because collaborating with the overall success of treatment. This paper presents the use of OSL dosimetry procedures in quality control in radiotherapy, making verification of the symmetry of treatment of radioactive fields emitted by linear accelerators. The use of OSL dosimetry was compared to procedures performed daily, using ionization chambers. Dosimeters of aluminum oxide doped with carbon (Al₂O₃: C) were distributed on a map, with the delimitation of a field 20x20cm arranged as follows: one in the center of the field, four equidistant distributed, forming a square 10x10cm and 4 remaining distributed equidistant, forming a square of 20x20cm. This arrangement is similar to equipment used for checking the symmetry of radioactive fields using ionization chambers. The analysis of data obtained in the symmetry axis X made a variation of 0.2% in OSL dosimetry while using the equipment provided with an ionization chamber, 0.1%. Noting the Y axis, the variation of data for OSL dosimetry was 0.04% and ionization chambers, 0.1%. The use of OSL dosimetry proved to be simple, accessible instrumentation and making a possible reinterpretation of the data obtained. However, the data suggest that a broad performing procedures using the OSL dosimetry in order to seek a greater familiarity with the system, reducing the variation to the system used routinely.

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USING RADIOCHROMIUM FILM IN DOSIMETRY ON IRRADIATION BLOOD COMPONENTS

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Irradiation above of transfusion (HC) in immunocompromised patients in order to reduce risk of chronic graft versus host disease (GVHD-TA). It is imperative during the process that all HC are irradiated with a minimum dose of 25Gy. Thus, a quality control program should be instituted. This study analyzed the radiochromium film GAFCHROMIC EBT2 as dosimeter for irradiation of HC. Radiochromium films been segmented into multiple pieces of 1.5 X1, 5 cm². The calibration curve was determined within apparatus Gamatron Co-60, AL 6 MV and AL 15mV. In calibration, the films were irradiated in the dose range of 5 to 50 Gy. The response of the film to dose rate was performed with an interval of income from 50 to 500 cGy / min. Optical densities of the films were collected in densitometer. Subsequent analysis of the film, the bags were placed in an acrylic box of dimensions 30X20X30 cm³ dipped in water to be irradiated in parallel opposed fields with a dose of 33Gy isodose curve at 115%. Thirty films were entered in a random way among the bags of blood. Upon completion, recording the optical densities for evaluation of absorbed doses. To validate the radiochromium films in the irradiation of blood, five of the dosimeter RadTag _ was introduced. The GAFCHROMIC EBT2 film suggests low energy dependence in the energy range studied, little variation with dose rate and as important in quality control. Low cost and is easily manipulated. Thus, one can conclude that the film GAFCHROMIC EBT2 is a great alternative in quality control of the irradiation of HC.

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INTER-COMPARATIVE ANALYSIS OF THE MEASURES INSTRUMENTS OF RADIATION TIME AND DOSE IN DENTAL RADIOLOGY BEAMS

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The use of issuing equipments of the ionization radiations requests the constant evaluation of radiometric factors of the beams radiation seeking programs to guide the quality warranty of the procedures. In Brazil, the government organs they regulate the use, ownership and storage of radioactive sources, through appropriate resolutions, which request the constant performance of professionals of the several areas, especially specialists of the radiologic physics. These specialists use measures instruments that need calibration in laboratories that constantly is in warm demand of work, causing arrears in the calibration procedures and provoking difficulties in the service to the users that induce the handling of these instruments for time before even of they be submitted to the minimum necessary rehearsals. This work presents a methodology for inter-comparison of measures instruments of radiometric parameters of dental x-ray beams. The time and radiation dose and the energy of the ionization beam were analyzed, emitted by equipments of dental radiology of 50 kVp and 70 kVp, measured with two different instruments. They were appraised the tests of accuracy, constancy and stability of each one of the analyzed radiometric parameters correlating the two different measurement instruments. It is intended like this, to obtain solid data, also in the literature, that can guide the specialist users when of the urgent need of the use of such equipments when they still meet in elapsing of the sending process for calibration. The results obtained with the measures of inter-comparisons can indicate the methodology presented as useful tool for activation of the specialist users service. However, the need of the submission from the instruments of measure of radiometric factors of the ionization radiation beam to the calibration procedures in international and authorized laboratories that present the necessary certificates for the recognition government institutions organs is emphasized.

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COMPARISON BETWEEN CALIBRATION PROCEDURES OF CT PENCIL IONIZATION CHAMBER

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Dosimetric quantities in computerized tomography (CT) were defined with the aim to assess patient radiation doses for optimization purpose and for verifying the performance of the CT scanners. CT pencil ionization chamber used for dosimetric measurements must be calibrated under specific procedure. The aim of this work was to analyze the difference between the air kerma-length product calibration coefficients obtained by different procedures. Comparisons between two methodologies under study in CTDN and IPEN calibrations were done. Since differences varied from 1.8 to 7.6%, procedures should be revised for corrections and additional comparisons must be performed before offering the CT calibration service to the community.

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EFFECTIVE AND ABSORBED DOSES FOR CT HEAD EXAMINATION CALCULATED USING THE VOXELIZED PHANTOMS MASH AND FASH

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The voxelized phantoms MASH and FASH have been used for calculating conversion coefficients (CCs) due a specific CT head examination performed in a specific Toshiba CT scanner. The CCs have been determined in terms of computed tomography air kerma index calculated in free air (C100,air). This paper has also described the steps taken into account for simulating a Toshiba CT scanner. The x-ray spectrum was selected in according to concordance between calculated C100,c and measured C100,c. For 120 kV, the x-raytbc code has calculated the better C100,c value in relation to C100,c measured in Toshiba CT scanner. The deviation was equal to -6.05%. Finally, the CCs for the voxelized phantoms MASH and FASH have been presented and effective doses calculated for these phantoms were 6.1 and 4.6, respectively, smaller than effective dose obtained though the European guidelines on quality criteria for computed tomography.

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DOSE DISTRIBUTION DOSIMETRY IN COMPUTED TOMOGRAPHY ABDOMINAL EXAMINATION: A PHANTOM STUDY

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Radiation risks from computed tomography (CT) examinations have been recently reported in many studies; due that, caution should be exercised in the patient scanning setting. To keep doses during CT examination as low as reasonably achievable, it is important that the CT scanning parameters are properly adjusted for each individual patient in order to minimize the dose delivered. Locally made thermoluminescent dosimeters (TLDs) were used for determining the absorbed dose and to measure CT dose profiles. Dose distribution in CT abdominal examination in the simulated patients was evaluated. The scanning parameters of the single detector CT were 130 kV, 90 mA, 1.1 sec/rot, a slide thickness of 3 mm and a 1.0 beam pitch. The increasing mapping doses along axis directions were also studied.

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ASSESSMENT OF ORGAN ABSORBED DOSES IN PATIENTS UNDERDOING TWO CHEST X-RAY EXAMINATIONS TECHNIQUES BY MONTE CARLO BASED SOFTWARES AND PHANTOM DOSIMETRY

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X-rays diagnostics provides the highest dose contribution to the population due to exposures to manmade radiation sources. The knowledge benefits and risks of medical procedures with radiation are required and patient doses are also expected to be optimized without reducing the image quality. Dosimetric studies of patients subject to radio diagnostic have got a special attention in Brazil although they are not required in Brazilian legislation. However, in several Brazilian clinics have been observed the use of techniques with lower peak voltage and higher electric charges values in spite the European Commission recommends the high voltages with low electric charge values exactly in order to reduce patient dose. These measurements in patients undergoing x-ray examinations cannot be easily established. Alternatively experimental measurements with physical phantoms, ionization chamber and theoretical calculations with computational software are widely used. Reliable methodologies for patient dose assessment are expected to be validated under many conditions. This work compare three methodologies used for evaluating the organ absorbed doses in patients undergoing chest x-rays at two techniques (80 kVp and 10 mAs; 120 kVp and 2 mAs); they are the PCXMC_ and CALDose_X Monte Carlo based software_s and experimental measurements with TL dosimeters in the anthropomorphic phantom. The experimental measurements showed the technique with high voltage was dose reduced by approximately 60% in the entrance skin (241.4 _Gy for the PA and 291.9 _Gy for the lateral exposure) in relation to low voltage technique (595.1 _Gy in PA and 752.2 _Gy in lateral exposure) and the softwares showed similar dose reduction. The organs doses reduction was approximately of the 40%, shows the importance of adopting techniques which have high voltage values and low electrical charges, unlike usually found on chest x-rays in some hospitals and clinics in Brazil.

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EVALUATION OF THE ATTENUATION FACTOR FOR DENTAL X-RAY BEAMS - EXPERIMENTAL MEASURES AND SIMULATIONS WITH THE MCNP-5C CODE

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This work analyzes the attenuation factor (A.F.) of the X-radiation produced in equipments of dental radiology, comparing experimental measures with simulations computation using the code MCNP-5C. It also analyzes the viability of the use of theoretical simulations for evaluation of the acting of diagnosis X-ray beams of dental use seeking to beacon the quality control decisions demanded by the Government Department Sanitary for license of operation of these equipments. The attenuation of the radiation was verified for three different materials: acrylic, polyethylene and aluminum. Radiation beams of equipments of dental radiology with 70 kVp and 60 kVp of energy were analyzed. The measure of the transmitted radiation dose by the attenuators was accomplished interposing one by one the plates, successively, and measuring the transmission to each thickness, that varied from 0,5 mm to 5,0 mm. For the aluminum, two groups of different manufacture were analyzed, a group of imported plates used in dosimetry, and other material of brazilian manufacture. The difference among values of A. F., obtained for both materials, it varied being 2,8% to 7,8% for thickness among 0,5 mm to 2,0 mm. Comparing the curves of percentage of deep dose (PDD) experimental with the simulated, a medium variation of 3,0% was verified for the brazilian aluminum, 7,5% for the imported aluminum, 1,2% for the polyethylene and 2,6% for the acrylic. In all the materials, the difference between the simulated curve and the experimental increases with the depth.

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EXPLORING THE PARAMETERS OF A WIDELY USED MATHEMATICAL MODEL OF X-RAY TRANSMISSION

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A group of 132 simulated x-ray transmission curves generated considering different applied voltages and total filtration were fitted with Archer Equation. Values for a, b and G equation parameters were obtained from these curves. These values were used to find an equation which describes their behavior as a function of the added filtration. The results for highly filtrated beams presented as exponential decays which tended to a Beer- Lambert type formula when replaced in Archer equation considering. Thus, for highly filtered beams we can relate the linear attenuation coefficient $\mu(E)$ from Beer-Lambert equation with a from Archer Equation. Results establishing relationship between effective energy and b/a ratio were also obtained.

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ANALYSIS OF THE PLAIN OF 70 KVP X-RAY BEAM USING THE MCNP-5C CODE

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The work analyzes the dose distribution profile of originating from radiation dental radiological equipment of 70 kVp energy. The experimental values obtained with the readings in the optical densit_metro of the images produced in radiological films are compared with the simulated plain with Monte Carlo's Method using the MCNP-5C Code. The behavior of the plain of the beam, observed with the computer simulated results, it agrees with the distribution of the experimental values for the different reduction depths studied

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PULSED FLUOROSCOPY AND CARDIAC CATHETERISM

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Catheterism in medical procedures is responsible for high X-ray doses, both to patients and medical staff. Aiming at the reduction of this dose, modern fluoroscopy equipment have been developed using pulsed X-ray. This study presents the results of measurements of occupational doses received during simulated medical procedures, both for pulsed and continuous fluoroscopy, and the calculations allowing to quantify the reduction caused by the use of pulsed technology.

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DOSE TO MEDIUM VERSUS DOSE TO WATER AS AN ESTIMATOR OF DOSE TO POST EMBOLIZATION AVM RADIOSURGERY

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The Embolization is cutting off the blood supply to the AVM with glue introduced by a radiographically guided catheter. Thereby, the target volume (PTV) has tissue inhomogeneity. The purpose of this study is to determine whether dose to medium, D_m , or dose to water, D_w , provides a better estimate of the dose to the AVM radiosurgery. Both the composition and the stopping power mass of the bone, brain and skin were used in the simulation. A difference of 13% was obtained when compared the simulated TMR in MC (D_m) to the TMR calculated by TPS. We can conclude that it is more advisable to use the D_m rather than the D_w .

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DEVELOPMENT OF TWO PHANTOMS TO BE USED IN TESTS IN MAMMOGRAPHY AND IMPLEMENTATION OF RQN-M AND RQB-M QUALITIES

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This study presents the development of two phantoms to be used in tests in mammography, and the previous results obtained with them. These phantoms have been developed using Polymethylmethacrylate (PMMA). The first one, based on the international standard IEC 61267 (2005), has nine plates with 5 mm each, with a rectangular shape, and was used to the implementation of the RQN-M and RQB-M qualities. These qualities have been established in the X-ray system Pantak/Seifert, from the qualities RQR-M, already established using Al and Mo as additional filtration. The second one, based on the IAEA code of practice, TRS 457 (2007), has a semi-circular shape, and can be used in scattering and absorption studies in mammography. This last phantom has some adaptation, when compared with that presented by the TRS-457. It also has 9 plates with 5 mm each, but additionally has one plate used to fix the check source (90Sr + 90Y) during the ionizing chambers stability tests, and another to position de ionizing chamber, during the tests, and three positioning pins, used to maintain the geometry of the arrangement. A test has been made using this last plate, to verify the scattering caused by it during measurements in mammography systems. Results showed that the scattering caused by this plate is negligible, and also reproducible, which would not cause significant changes in the final measurements.

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COMPARISON OF ANTHROPOMORPHIC AND GEOMETRY CHEST PHANTOM FOR DOSE MEASUREMENTS

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Entrance dose measurements in conventional X rays examination are often performed using a geometric acrylic phantom, which has no anatomic similarity with the human chest. More realistic phantoms, called anthropomorphic phantoms, are used almost exclusively for organ dosimetry studies or for image tests. The aim of this work was to evaluate the performance of an anthropomorphic chest phantom, developed locally for image quality tests, as a dosimetric phantom. The anthropomorphic chest phantom is made of epoxy resin, for simulating soft tissue, with human bones and glycerinated heart, and a pair of lungs of foamed polyurethane. The geometric phantom used has dimensions of 30 cm x 30 cm x 15 cm. Conventional X rays images were obtained in VMI equipment, Compact Plus model, at a posterior-anterior (PA) view and focus-film distance of approximately 1.8 meters. Entrance surface doses were measured. The comparison was performed by image analysis and the doses, for different radiological parameters (45-76 kV, 6-80 mAs). Even though the images showed expected advantages of the anthropomorphic phantom, the doses values were similar for both phantoms and they behaved as expected, i.e., decreasing with increasing kV. All the doses values determined were lower than the national diagnostic reference level. So the anthropomorphic phantom is an excellent tool because its broadness, but the geometric phantom is good enough for simple dosimetric measurements in chest radiological images.

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DOSE DISTRIBUTION IN DEPTH IN ICRU TISSUE PHANTOMS AND WATER PRODUCED BY ACCELER

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This work is built head geometry of linear accelerators for clinical use: Varian Clinac 2100C, Siemens Primus, Elekta Inor, Varian Clinac 2100C/D operating at 6, 15, 6 and 15 MV respectively, according to manufacturers specifications.

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AN OCCUPATIONAL DOSE DISTRIBUTION STUDY IN PET SERVICE

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Positron Emission Tomography (PET) is a powerful diagnostic tool, especially for oncology. In PET procedures, the hands' exposition of the workers is potentially higher than the thorax, due to direct handling of the high-energy photons radionuclide. As the dose distribution in the extremities is non-uniform, the conventional monitoring methods (dosimetric ring and bracelet) may underestimate the skin dose equivalent in the most exposed part of the hand, which usually are the fingertips. In this study, two PET services had their workers monitored, during the tasks of preparation and injection of the radiopharmaceutical ¹⁸F-fluorodeoxyglucose (¹⁸F-FDG) in patients, using chips of LiF:Mg,Cu,P thermoluminescent dosimeters (TLD-100H). Each employee worn TLD sets attached on the wrist and fingers of the dominant hand, and on the thorax. The highest dose values were measured on the index finger, which received doses up to 0.4 mSv in a single procedure of ¹⁸F-FDG dose preparation, and 0.27 mSv in one injection. In a potential annual dose extrapolation, assuming this technician performs 840 PET scans (preparation and injection), with these doses values, in one year, his skin dose equivalent on the index finger would be 564 mSv, exceeding the annual skin dose equivalent limit of 500 mSv. Despite the hands_ dose distribution is very sensitive of how to hold the syringe, the dose near to the of index fingertip are always the highest, can be, respectively, 4 and 12 times greater than in the position where dosimetric rings and bracelets are commonly used for routine individual monitoring. Thus, extremity individual monitoring, in addition to the mandatory whole body individual monitoring with thorax doseimeters, are important tools for occupational dose optimization and should also be mandatory for PET technician.

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PEDIATRIC PATIENTS EXTERNAL DOSE MONITORING

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Optimization of radiation doses is emphasized in pediatric patients with differentiated thyroid carcinomas. Patient external dose monitoring is an easy method to estimate effective half-lives for treatment planning. 4 female patients were studied, 13.3 ± 1.5 years old, 50 ± 11 kg corporal weight, who received, in the tracer phase, 107 ± 15 MBq, and for the thyroid ablation, 5.5 ± 0.3 GBq of ^{131}I -NaI. After administration and before the first excretion, it was performed patient external dose monitoring in the therapeutic room or in the patient residence. Before each patient monitoring, it was measured the background radiation without the patient presence. Local dimensions were considered for scattering. It was used sodium iodide cintillator detector positioned at 2 m in front of the cervical region of the patient. The measures were performed in dose rate mode. For the first patient, from 109 samples, effective half-lives were estimated in 12.4 h, and 21.7 h for tracer and therapeutic phases, respectively. The insufficient time collecting in the tracer phase (56 h) didn't allow to simulate the therapeutic phase (128 h). For the second patient, 15 samples collected in 169 h and 177 h for the tracer and therapeutic phase, respectively, indicated effective half-life of 23.9 h for both phases. For the third patient, 23 samples, 75 h and 147 h after the tracer and therapeutic dose, respectively, indicated effective half-lives of 12.8 h and 16.9 h. For the fourth patient, 43 samples in 170 h and 166 h after dose administration indicated effective half-lives of 23.4 h and 23.1 h for the tracer and ablative phases, respectively. Although this methodology is easier applicable, it is necessary to minimize underestimation of residual patient activity, due to high background areas, lack of sensitivity of the radiation detectors used, and the collecting time to monitor the patient before discharge.

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ACTIVITY MEASUREMENT COMPARISONS FOR RADIONUCLIDE CALIBRATORS IN CUBA DURING 2007-2008

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The safe and effective use of the nuclear medicine procedures requires that the amount of radiation delivered to the patient be determined as accurately as possible. During those procedures, it is the amount of injected activity the measured and controlled value and the instrument employed for that - the radionuclide calibrator. The activity measurement comparisons in such devices are an important tool for demonstrating the uncertainty and traceability of the activity measurement values obtained at the end-user level in this field. In the paper, results of national comparisons of ¹³¹I and ^{99m}Tc activity measurements with radionuclide calibrators organized in Cuba in 2007-2008 are presented. The participants_ institutions are 11 hospitals and 2 laboratories of the Centre of Isotopes directly involved in radiopharmaceuticals_ production in the country. Twenty of the twenty one reported results evidence an _acceptable_ performance of the participants, as determined by the 10 % performance criteria adopted. Concerning the proportion of acceptable results, an improvement was revealed in the participants_ performance regarding the one shown in such kind of exercises during the 2002-2004 years. On the other hand, the reasonable uncertainty estimates of the ¹³¹I and ^{99m}Tc measurements reported by the greater part of the participants reveal a qualitatively superior performance in 2007-2008 in relation to the performance obtained in the similar previously organized exercises. Moreover, the outcome of the bilateral comparison for ¹³¹I activity measurements between the National Metrology Institutes for Radioactivity Measurements of Brazil and Cuba, the National Metrology Laboratory for Ionizing Radiation of the Institute of Radiation Protection and Dosimetry (LNMRI-IRD) and the Radionuclide Metrology Department of the Centre of Isotopes (CENTIS-DMR), respectively, is also presented. This bilateral exercise provides additional evidence on comparability of the CENTIS-DMR measurement standards used to calibrate the ¹³¹I reference solution and samples employed during the national comparison.

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OPTICAL RESPONSE AND ENERGY DEPENDENT RESPONSE OF THE ALANINE GEL SOLUTION PRODUCED AT IPEN TO PHOTONS AND ELECTRONS CLINICAL BEAMS

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The DL-Alanine ($C_3H_7NO_2$) is an amino acid tissue equivalent traditionally used as standard dosimetric material in EPR dosimetry. Recently it has been studied to be applied in gel dosimetry, considering that the addition of alanine in the Fricke gel solution improves the radiation induced ferric ions production. The spectrophotometry evaluation technique can be used comparing the two spectrum wavelengths bands: 457 nm band that corresponds to ferrous ions concentration and 588 nm band that corresponds to ferric ions concentration to evaluate the dosimetric properties of this material. The performance of the Alanine gel solution developed at IPEN has been firstly studied using spectrophotometry technique aiming to apply this material to 3D clinical doses evaluations using magnetic resonance imaging - MRI technique. In this work the optical response and energy dependent response of the Alanine gel solution submitted to clinical photons and electrons beams were studied. Different batches of gel solutions were prepared according to Mizuno and maintained at low temperature during 12 h to solidification. Before irradiation the samples were maintained during 1 h at room temperature. The photons and electrons irradiations were carried out using a Varian 2100 C Medical Linear Accelerator of the Radiotherapy Department of the Hospital das Clinicas of the University of São Paulo with absorbed doses between 1 and 40 Gy; radiation field of $10 \times 10 \text{ cm}^2$; photon energies of 6 and 15 MeV and electron with energies between 6 and 15 MeV. The obtained results indicate that signal response dependence for clinical photons and electrons beams for Alanine gel dosimeter is better than 3,6 % (1σ) and the energy dependence response is better 3% (1σ) for both beams. This results indicates that the same calibration factor can be used and the optical response is energy independent in the studied dose range and photons and electrons clinical beams energies .

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DOSIMETRY STUDIES BY ESR IN PHYSICAL SIMULATORS OF PROSTATE TREATMENT

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Radiotherapy of the prostate can be complicated by the presence of metallic prostheses in the femur and pelvis that could be in one side or bilateral. To study the effects of these implants on the treatment planning a phantom was designed to simulate a male individual. This phantom was built with realistic dimensions based on an adult human being. Polymethylmethacrylate (PMMA) or acrylic, water and the metallic prostheses are the materials used. The phantom allows the use of a set of different femur and pelvis simulators, so that it is possible to compare the radiation in the region of interest with one side and two sides prostheses with a the non prostheses case. The evaluation of the dose will be performed with DL-Alanine dosimeters and Electron Spin Resonance (ESR) spectroscopy. Alanine has been widely used as a dosimeter in radiotherapy treatments, being able to measure doses ranging from 1 Gy up to kGy with the advantages of linearity, ESR signal stability with time and tissue equivalent. These dosimeters are placed in an insert made of PMMA that is positioned in the prostate region. The phantom construction was completed and now it is being evaluated with CT to produce images for treatment planning. The ESR dosimeters were also constructed and calibrated.

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PRELIMINARY STUDY OF THE 270 BLOOM FRICKE XYLENOL GEL PHANTOM PERFORMANCE FOR 3-D CONFORMAL RADIOTHERAPY USING MULTIPLE RADIATION FIELDS

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The complex cancer treatment techniques require rigorous quality control. The Fricke xylenol gel (FXG) dosimeter has been studied to be applied as a three-dimensional (3-D) dosimeter since it is possible to produce 3-D FXG phantoms of various shapes and sizes. In this preliminary study the performance of the FXG spherical phantom developed at IPEN prepared using 270 Bloom gelatin from porcine skin made in Brazil was evaluated using magnetic resonance imaging (MRI) technique, aiming to use this phantom to 3-D Conformal Radiotherapy (3DCRT) with multiple radiation fields and clinical photon beams. The obtained results indicates that for all MR images of the FXG phantom irradiated with 6 MV clinical photon beam can be observed clearly the target volume and in the case of coronal image can also be observed the radiation beam projection and the overlap of different radiation fields used. The Fricke xylenol gel phantom presented satisfactory results for 3-D Conformal Radiotherapy and clinical photon beams in this preliminary study. These results encourage the additional tests using complex treatment techniques and they indicate the viability of applying the phantom studied for routine quality control measurements and in 3DCRT and intensity modulated radiotherapy (IMRT) treatment planning.

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ALANINE/ESR DOSIMETRY APPLIED TO GYNECOLOGICAL RADIOTHERAPY

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Spectroscopy by electron spin resonance is an excellent method to detect and identify free radicals. This makes its use possible in analyzing the intensity of signals from free radicals originated by the irradiation of certain materials, such as alanine. The extensive range of linearity and the fact that alanine is a material with energy response equivalent to soft tissues are advantages of this method of ionizing radiation dosimetry. In this study alanine dosimeters will be used in teletherapy using pelvic phantom for the treatment of gynecological malignancies with doses of around 180 cGy. Dosimeters will be inserted in the phantom cavity with properly prepared applicators to verify the effective deposited dose and compare it with the planning dose. Radiotherapy clinical dosimetry is applied in situations that need an actual dose evaluation of the irradiated regions and organs. With this study it will be possible to simulate the deposited dose in the vaginal dome, since this region presents high relapse indices. Moreover, these studies are of great importance for future in vivo applications, having positive effects on treatment outcome.

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