QUALITY ASSURANCE SYSTEM IN RADIONUCLIDE MEDICAL IMAGING

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Some practical experience with quality assurance system for medical imaging using scintillation gamma camera is described.

In 1980 North American based National Electrical Manufacturers' Association - NEMA issued its Standard Publication NU 1-1980 titled Performance Measurements of Scintillation Cameras that caused break at the development of universal systems for quality testing of scintillation cameras imaging performances. This document established a set of precisely defined quantities and standardized procedures of their measurements and interpretations. Protocol was originally intended for gamma camera manufacturers only, but it was used in hospitals as well.

In 1986 revised version of NEMA Standard the system of quantities and measurement procedures was adapted for the use in ordinary image quality testing, and system for evaluation of Single Photon Emission Computerized Tomography added. NEMA protocols were included from the beginning into many quality assurance systems and they soon became worldwide standard, indeed .

Basic quantities used for measurement and quality assurance testing include: Spatial Resolution (a. Intrinsic, b. with Collimator, c. Total, d. with Scattering Medium), Energy Resolution, Intrinsic Spatial Linearity (a. Differential, b. Integral), Point Sensitivity, Energy Resolution (Full Width at Half-Maximum of the Photopeak), Temporal Resolution (Paralyzable Dead Time - a. Intrinsic, b. with Scatter. Maximum Count Rate of Camera, Input Count Rate for a 20% Loss), Uniformity (a. Differential, b. Integral).

Following quantities for gamma camera Orbiter from Siemens manufactured in 1987 were measured: Paralyzable Dead Time using two sources method and formula

$$T=2R_{12}/(R_1+R_2)^2 \cdot \ln\,(R_1+R_2)/R_{12},$$

where R_1, R_2, and R_{12} are the measured net counting rates from source 1, 2, and 1 and 2 combined. (R_1=52540, R_2=69783, R_{12}=98742; T=2.84μs).

Gamma Camera Sensitivity – 2740 $s^{-1}Bq^{-1}$.
Energy Resolution for ^{99m}Tc – 141 keV: 10.3 %
^{201}Tl – 70 keV: 12.1 %
– 164 keV: 9.1 %
Integral Uniformity IU=± 100(Max-Min)/(Max+Min)
for ^{99m}Tc no magnification mean value (5.49±.90) %
^{99m}Tc with magnification (5.00±1.29) % for UFOV
(4.24±1.15) % for CFOV
for ^{201}Tl with magnification (6.00±.71) % for UFOV
(4.46±.48) % for CFOV,

where UFOV and CFOV are Useful Field of View, and Central Field of View respectively.

Mean values for IU were calculated from measurements taken daily during one year.

From the study it was concluded that the most important indicator of image quality are both Integral and Differential Uniformity. It was recommended to measure:

a: Integral and Differential Uniformity daily;

b: Dead Time, Energy Resolution, and Camera Sensitivity quarterly.

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