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TLD AS A TOOL FOR REMOTE VERIFICATION OF OUTPUT FOR RADIOTHERAPY BEAMS: 25 YEARS OF EXPERIENCE

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This paper will summarize the experience at the University of Texas M.D. Anderson Cancer Center (UTMDACC) with thermoluminiscent dosimetry as a quality assurance tool for output and energy monitoring of radiation therapy beams. UTMDACC has two sections, the Radiological Physics Center (RPC) and the Radiation Dosimetry Services (RDS) which offer periodic verifications of machine output to some 1,500 institutions in the US, Canada and some other parts of the world. The two centers process TLD measurements for approximately 8,000 x-ray beams and 7,000 electron beams per year. Throughout the past 25 years the results from monitoring institutions, and the data for commissioning TLD readers, characterization of lithium fluoride TLD-100 powder and the records of a quality assurance program of the system have been accumulated. The precision limits of the system as well as the disagreement with the institutions will be summarized. The methodology of the TLD reading process and the quality assurance program will be discussed in detail. The accuracy achieved with the system will be described as well as the degree of reliability of the entire operation.

Over the past 8 years the RPC has used manually operated TLD readers to read powder. RDS uses manual readers from a different manufacturer. Each TLD sample is weighed and the measurement is reported as TL per unit mass. Nitrogen gas flows through the system during each reading session, beginning 30 minutes before readings are taken, to reduce spurious signal. The powder is produced in large batches that are then dispensed into capsules that hold about 25 mg per capsule. A batch of powder is tested for reproducibility, and then characterized for fading, sensitivity, energy dependence and dose-response linearity. The powder is irradiated and analyzed once and is then discarded. TLD powder is irradiated to a known dose with a cobalt unit at UTMDACC under very tightly controlled conditions to provide standards that are used to derive the relationship between TLD signal and dose. Additional powder is irradiated to a known dose with a second cobalt unit at UTMDACC to provide control samples used for monitoring the reader stability during a session and to test the TLD dose prediction. Sets of standards are read at the beginning and end of each session while sets of controls are interspersed evenly with experimental readings. A typical reading session includes 12 sets of experimental TLD irradiated at participating institutions. Each set consists of three samples for photons and six for electrons.

To maintain high quality results, a comprehensive QA program is in place that includes acceptance testing and commissioning of each instrument and each batch of powder. The program also provides QA verifications for each result, each session, each month of operation and each year of operation. A maintenance and repair program is conducted and carefully documented. Training of technical personnel is geared to the passing on of a uniform method of reading samples with emphasis on repetitivity of actions within each reading cycle. Each cycle is timed and maintained at 2 minutes per sample.

Analysis of the data for several years of operation shows that the system predicts the dose to TLDs irradiated under very controlled conditions (controls) with very high precision (SD = 0.9%). Analysis of the results for beams at different institutions shows a spread of 1.9% for photons and 2.2% for electrons. This spread is the combined result of the variability of the beam energies, the different makes and models of machines, the institutional performance that includes beam calibration, TLD set-up errors and beam drifts.

The data also show that TLD powder, independent of the batch, has fading characteristics that can be predicted using a double exponential equation. Energy correction factors remain very constant from batch to batch and the dose response is also a very predictable value.

The system is used to monitor institutions and is designed to pursue large discrepancies in an expeditious manner that aims at the resolution of the discrepancy either through discussions, more TLD or site visits.

A system has been developed that provides results with a level of confidence about 2%.

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