16 Quality Assurance in Radiation Oncology

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16.1 Introduction

Dose precision in radiation therapy is expected to be on the order of ±5%, based on the fact that certain tumors and normal tissues exhibit steep dose response curves (Herring and Compton 1971). Delivery of radiation with this criterion places great demands on the entire process, although such a level is believed to be achievable (ICRU 1976).

Uncertainties in treatment are due to many factors including: (a) dose calibration at a point in phantom; (b) patient-specific data used for treatment planning; (c) dose calculation in the patient; (d) transfer of the treatment plan to the radiation therapy machine; and (e) day-to-day variations in patient positioning and internal motion of tumor volume and organs at risk. These uncertainties may be categorized as systematic and random. Random uncertainties vary in magnitude and sign and cannot be totally controlled (e.g., the position of the radiation field on the patient may vary from day to day by a few millimeters). Moreover, the degree with which treatments can be reproduced differs among clinical sites and between institutions.

Systematic uncertainties maintain their magnitude and direction over a period of time. For example, the use of an incorrect factor in the calibration of a treatment unit would have the same effect on the dose delivered to all patients. Systematic errors, in principle, should be controllable: for example, the degree of misregistration of field defining apertures can be reduced with periodic review of beam localization films; however, many systematic errors remain, e.g., the approximations used in dose calculation algorithms.

We first need to establish some definitions. Quality assurance (QA) is defined as the set of policies and procedures instituted to ensure the proper and safe delivery of the prescription dose to the patient. Quality control constitutes the actual tests taken to maintain and improve the quality of the treatment. We must also understand that a QA program is an interdisciplinary effort involving radiation oncology...
gists, radiation physicists, dosimetrists, and radiation therapists. Although medical physicists and radiation therapists are more involved in the technical aspects of QA, and radiation oncologists in the medical aspects, the efforts of each group substantially overlap.


16.2 Goals and Structure of a QA Program

A series of publications known as the “Blue Book” have provided a strong rationale for the development, purpose, and need for QA in radiation oncology. Five such reports were published over the period 1968 to 1991 including: A Prospect for Radiation Therapy in the United States (1968); A Proposal for Integrated Cancer Management in the United States: The Role of Radiation Oncology (1972); Criteria for Radiation Oncology in Multidisciplinary Cancer Management (1981); Radiation Oncology in Integrated Cancer Management (1986); and Radiation Oncology in Integrated Cancer Management (1991). The 1991 version published by The Inter-Society Council for Radiation Oncology (ISCRO 1991):

“The purpose of a Quality Assurance Program is the objective, systematic monitoring of the quality and appropriateness of patient care. Such a program is essential for all activities in Radiation Oncology. The Quality Assurance Program should be related to structure, process and outcome, all of which can be measured. Structure includes the staff, equipment and facility. Process covers the pre- and post-treatment evaluations and the actual treatment application. Outcome is documented by the frequency of accomplishing stated objectives, usually tumor control, and by the frequency and seriousness of treatment-induced sequelae.”

The report emphasizes that the complexity of radiation therapy requires a teamwork approach among radiation oncologists, medical physicists, dosimetrists, nurses, and therapists as no one individual has all the skills necessary. This series of publications has not been updated in over a decade, and now more than ever, there is a definite need to do so. Most important is for administrators to understand the need for a robust radiation oncology QA program, and to work with the radiation oncology team and ensure that adequate funding is available to support such a program. For a QA program to be effective, all of the faculty and staff involved with providing radiation therapy to patients must be committed to the QA program.

16.2.1 Physics Staffing

Appropriate physics staffing is an essential component of the radiation oncology QA program. In the past, staffing guidelines were promulgated via the Blue Book and were based on patient load and treatment equipment. The 1991 Blue Book recommended at least one clinical physicist per center for up to 400 patients treated annually (Table 16.1a; ISCRO 1991). Additional clinical physicians are recommended in the ratio of one per 400 patients treated annually. This report makes clear that these staffing levels are for clinical duties only, and additional full-time equivalent (FTEs) medical physicists will be required for translational research, teaching, and administration duties; however, the present physics staffing levels must also take into account the complexity of treatments being performed in the clinic such as IMRT, brachytherapy, and stereotactic radiosurgery, as such procedures are physics intensive.

The most detailed information currently available regarding medical physics work effort is in the reports by Abt Associates (1995, 2003). These reports were the result of the American College of Medical Physics (ACMP) and the American Association of Physicists in Medicine (AAPM) engaging Abt Associates to conduct a study that measured what was termed Qualified Medical Physicist (QMP) work for medical physics services, and to develop a relative work value scale depicting the relative amount of QMP work required for each medical physics service. The results of that survey were published in 1995 (Abt Associates 1995). This report was updated in 2003 due to the recognition that the many changes in medical physics practice and technology