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The American College of Radiology will periodically define new practice guidelines and technical standards for radiologic practice to help advance the science of radiology and to improve the quality of service to patients throughout the United States. Existing practice guidelines and technical standards will be reviewed for revision or renewal, as appropriate, on their fifth anniversary or sooner, if indicated.

Each practice guideline and technical standard, representing a policy statement by the College, has undergone a thorough consensus process in which it has been subjected to extensive review, requiring the approval of the Commission on Quality and Safety as well as the ACR Board of Chancellors, the ACR Council Steering Committee, and the ACR Council. The practice guidelines and technical standards recognize that the safe and effective use of diagnostic and therapeutic radiology requires specific training, skills, and techniques, as described in each document. Reproduction or modification of the published practice guideline and technical standard by those entities not providing these services is not authorized.

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ACR TECHNICAL STANDARD FOR THE PERFORMANCE OF BRACHYTHERAPY PHYSICS: MANUALLY LOADED TEMPORARY IMPLANTS

PREAMBLE

These guidelines are an educational tool designed to assist practitioners in providing appropriate radiologic care for patients. They are not inflexible rules or requirements of practice and are not intended, nor should they be used, to establish a legal standard of care. For these reasons and those set forth below, the American College of Radiology cautions against the use of these guidelines in litigation in which the clinical decisions of a practitioner are called into question.

The ultimate judgment regarding the propriety of any specific procedure or course of action must be made by the physician or medical physicist in light of all the circumstances presented. Thus, an approach that differs from the guidelines, standing alone, does not necessarily imply that the approach was below the standard of care. To the contrary, a conscientious practitioner may responsibly adopt a course of action different from that set forth in the guidelines when, in the reasonable judgment of the practitioner, such course of action is indicated by the condition of the patient, limitations on available resources, or advances in knowledge or technology subsequent to publication of the guidelines. However, a practitioner who employs an approach substantially different from these guidelines is advised to document in the patient record information sufficient to explain the approach taken.

The practice of medicine involves not only the science, but also the art of dealing with the prevention, diagnosis, alleviation, and treatment of disease. The variety and complexity of human conditions make it impossible to always reach the most appropriate diagnosis or to predict with certainty a particular response to treatment.

Therefore, it should be recognized that adherence to these guidelines will not assure an accurate diagnosis or a successful outcome. All that should be expected is that the practitioner will follow a reasonable course of action based on current knowledge, available resources, and the needs of the patient to deliver effective and safe medical care. The sole purpose of these guidelines is to assist practitioners in achieving this objective.

I. INTRODUCTION

Brachytherapy is a method of treatment in which sealed radioactive sources are used to deliver radiation by interstitial, intracavitary, intraluminal, or surface application. This standard has been developed by the American College of Radiology (ACR) to outline a standard of physics practice related to one area of this modality: the manual application of low-dose-rate (LDR) brachytherapy sources.

Since the practice of brachytherapy physics occurs under a variety of settings, the judgment of a Qualified Medical Physicist, in conjunction with a physician, should be used to apply these standards to individual practices. Finally, radiation safety requirements must be in compliance with appropriate federal and state regulations.

II. QUALIFICATIONS AND RESPONSIBILITIES OF PERSONNEL

Qualified Medical Physicist

A Qualified Medical Physicist is an individual who is competent to practice independently in one or more of the subfields in medical physics. The ACR considers

certification and continuing education and experience in the appropriate subfield(s) to demonstrate that an individual is competent to practice one or more of the subfields in medical physics, and to be a Qualified Medical Physicist. The ACR recommends that the individual be certified in the appropriate subfield(s) by the American Board of Radiology (ABR), the Canadian College of Physics in Medicine, or for MRI, by the American Board of Medical Physics (ABMP) in magnetic resonance imaging physics.

The appropriate subfields of medical physics for this standard are Therapeutic Radiological Physics and Radiological Physics.

A Qualified Medical Physicist should meet the [ACR Practice Guideline for Continuing Medical Education \(CME\)](#). (ACR Resolution 17, 1996 – revised in 2008, Resolution 7)

Where required, the medical physicist must have a license to practice therapeutic radiological physics. In addition, the credentials and delineated privileges of the medical physicist should be confirmed through the medical staff membership process in the appropriate category, if available, since clinical brachytherapy physics involves direct contact with patients and their hospital records.

The medical physicist should institute a documented peer-review mechanism for reviewing the brachytherapy physics program.

III. RESOURCES

A. Personnel Requirements

Beyond what is required for external beam irradiation, active brachytherapy programs require additional physics and support personnel due to the uniqueness and relative complexity of each case.

When a medical dosimetrist is available to the brachytherapy service, this individual should be certified by the Medical Dosimetry Certification Board.

B. Equipment Needs

Each facility should have instrumentation to independently verify the source strength provided by the manufacturer. This should be done with a well ionization chamber with a calibration directly traceable to the National Institute of Standards and Technology (NIST). At a minimum, the facility must have an indirectly traceable verification of the source manufacturer's calibration by way of a source strength comparison.

Calibrated survey instruments that are appropriate in energy response and range for the sources used must be

available. A backup meter should be readily available in case of primary instrument failure.

The facility must have instrumentation to perform periodic sealed-source leak testing or arrange to have this service provided.

Appropriate local shielding, storage facilities, transportation containers, and manipulation devices must also be available.

A computerized system for isodose computation shall be available to calculate point doses and to generate isodose distributions.

Proper maintenance, calibration, and updating of this equipment must be carried out under the supervision of the medical physicist.

IV. QUALITY ASSURANCE PROGRAM

A. Introduction

Quality assurance (QA) in radiation oncology may be defined as those administrative policies, quality improvement (QI) procedures, and quality control (QC) measurements that ensure a consistent and safe fulfillment of the dose prescription. The medical physicist is responsible for a QA program that assures the accurate delivery of the prescribed dose to the specified volume.

Quality control for sealed sources includes maintaining an ongoing review for adherence to regulatory and licensing requirements. Accordingly, the medical physicist shall develop, implement, supervise, and review the policies and procedures that encompass sealed sources and their use and maintain proper written documentation. When these activities relate to radiation safety, they should be carried out in conjunction with the institutional radiation safety officer.

B. Sealed Sources

Since the radiation characteristics of encapsulated sources depend on the source encapsulation and the distribution of the activity within the source, it is incumbent on the medical physicist to obtain the following information and to evaluate its effect on clinical dosimetry: physical and chemical form, source encapsulation, and uniformity of radionuclide distribution within the source.

Sealed sources with long half-lives shall be coded to distinguish among sources that have the same radionuclide and capsule design but different activities.

1. Calibration of sources

Brachytherapy sources used in radiation oncology shall have calibrations with direct or secondary traceability to national standards.

Each institution should have the ability to independently verify the source strength provided by the manufacturer. The medical physicist shall establish acceptability limits for sources of a batch, as well as a course of action if the source strength does not fall within these limits.

All radionuclides with a half-life greater than 6 months should be calibrated upon receipt. Autoradiographs shall be performed on these sources prior to initial use to verify the uniformity of each source.

For radionuclides with a half-life of less than 6 months, a random sample of at least 10% of the sources or two ribbons (whichever is greater) from each manufacturer's lot number should be calibrated upon receipt.

2. Instrumentation

For direct calibration of sources, a well ionization chamber with NIST-traceable calibration and known axial response is recommended. The constancy of the chamber must be checked with a long-lived sealed source upon receipt, after repair, and prior to each use or weekly. For direct calibration of sources, the well ionization chamber must be calibrated at least every 2 years.

For verifying source strength, describing batch variation, and confirming source identity according to strength, an uncalibrated well ionization chamber may be used in conjunction with a NIST-traceable calibrated source by the replacement method to provide relative response. The sensitivity, linearity (if appropriate), and reproducibility of the instrument must be documented annually.

3. Brachytherapy applicators

The medical physicist shall determine the source location, the coincidence of dummy and active sources, and the location of shields for intracavitary applicators prior to initial use. Such applicators should be radiographically inspected annually and physically inspected prior to each use. For appropriate interstitial applicators, the coincidence of dummy and active sources shall be verified prior to initial use.

4. Radiation safety

Radiation safety practices shall be consistent with the institution's radioactive material license, license amendments, and existing regulations. Nevertheless, the medical physicist in conjunction with the Radiation Safety Officer (RSO) should be responsible for developing, overseeing, and documenting radiation safety procedures, including but not limited to those listed below:

- a. Written procedures for ordering, receiving, returning, and/or disposing of radioactive materials and for performing patient surveys following source removal.
- b. An inventory control program sufficient to locate any and all sealed sources at any time.
- c. Emergency procedures for leaking sources and loss of or dislodging of sources.
- d. Procedures for the safe handling, preparing, cleaning, sterilizing, and sorting of sources.
- e. Leak tests of inventoried long-half-lived sources.
- f. Identification of sources.

C. Treatment Planning and Dosimetry

All implants should be planned, at least to the extent of determining an appropriate source distribution. A consistent means of specifying and documenting absorbed dose must be in place. This may be based on traditional systems of brachytherapy dosimetry. Such specification should include a description of technique and applicator, source strength, anatomical description of target volume, dose to target volume, dose to reference and/or tolerance points, and the time-dose pattern. Prior external beam and brachytherapy doses to target volumes should also be documented with each implant's dosimetry.

Corrections for decay of source strength must be made regularly to reflect a 2% or greater change in source strength.

1. Localization - dosimetry images

The position of all intracavitary, intraluminal, and interstitial implants should be verified before treatment with appropriate medical imaging modalities. The medical physicist, dosimetry personnel, or responsible radiation oncologist should be present during the localization of the applicators.

2. Computerized planning system

Computerized planning systems shall undergo rigorous acceptance tests and commissioning to ensure that the dose calculation algorithm properly converts the source calibration and conversion factors into the appropriate absorbed

dose distribution, and that hardware and software were installed properly. All users must receive proper training. An in-service program should be given and documented for new users and following software releases. Periodic tests must be implemented to ensure the accuracy of dose calculation algorithms, software changes, hardware changes, and source data files.

3. Patient dose calculation

An additional and independent method should be used to validate the dose calculation results of the computerized planning systems. This validation should be consistent with the written prescription and completed before 50% of the dose is delivered.

The source positions entered into the computerized planning systems should be verified.

D. Clinical Medical Physics Management

1. Source loading and placement

The medical physicist or medical dosimetrist shall be available for consultation during applicator placement and loading. Prior to placement, the prescribed loading of applicators shall be independently confirmed.

2. Medical physics consultation

The medical physicist shall develop and implement a program for review and analysis of patient status including changes in the physics aspects of the treatment regime, consultation on and participation in patient setup and treatment modifications, and reviews of patient-specific treatment and technical notes

3. Dosimetry report

A written dosimetry report shall be completed by the medical physicist for each brachytherapy procedure. The report should include:

- a. Description of the sources.
- b. Description of the technique and source pattern used.
- c. Dose rate and total time of implant.
- d. Total source strength.
- e. Prescribed dose.
- f. Isodose distributions in appropriate planes.
- g. Evidence of an independent review of dose calculation.

E. New Procedures

In conjunction with the medical director and/or the appropriate physician, the medical physicist must define basic standards of practice and develop a reasonably

prudent course of action to determine the quality and safety of any new procedures prior to initiation. New devices/applicators must be evaluated with respect to integrity, suitability for use with the radioactive sources, and effects on dose distributions. A written report of the evaluation shall be distributed in accordance with institutional policy.

V. DOCUMENTATION

The medical physicist is responsible for maintaining proper, complete, and accurate records required by regulatory agencies or accrediting bodies. Records documenting the frequency of performance of the QA program, including QI procedures and results of QC measurements, are important, both in retrospective analysis of trends and in documenting current status. It is recommended that a mechanism be established to review these records with the medical director and administration on a documented, periodic basis.

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