PRACTICE STANDARDS FOR THE MEDICAL DOSIMETRIST
Approved - May 2019

I. THE PROFESSION OF MEDICAL DOSIMETRY

The process of care in radiation oncology involves close collaboration between a team of qualified individuals. The radiation oncology team ensures every patient undergoing radiation treatment receives the appropriate level of medical, emotional, and psychological care before, during, and after treatment, through a collaborative multidisciplinary approach. The primary radiation oncology team consists of, but is not limited to, radiation oncologists, oncology-focused advanced practice providers, medical physicists, medical dosimetrists, oncology nurses, and radiation therapists [1].

Medical dosimetrists are unique in health care. Medical dosimetrists receive their basic education in a technological and scientific discipline, while their practical training is grounded in the clinical applications of dosimetric principles. Medical dosimetrists work in diverse health care organizations providing therapeutic clinical services to oncology patients. Medical dosimetrists in radiation oncology, in collaboration with the radiation oncologist, develop, optimize, and monitor patient treatment plans and provide oversight to high level treatment procedures [2].

The medical dosimetrist is now a recognized occupation by the United States Bureau of Labor Statistics and is listed in the 2018 Standards Occupational Classification Manual. The Standards Occupational Classification Manual describes the occupation of medical dosimetrists as "*generate radiation treatment plans, develop radiation dose calculations, communicate and supervise the treatment plan implementation, and consult with members of the radiation oncology team"* [3].

Medical dosimetry is not a radiologic or imaging science and, therefore, does not fall under the umbrella of organizations or associations that represent these occupations or professions. The American Association of Medical Dosimetrists (AAMD) is the primary resource, worldwide, for the profession of medical dosimetry. As such, the AAMD has ownership of medical dosimetry professional documents [4,5]. A medical dosimetrist may or may not be required to have a background in radiation therapy.

II. PREAMBLE

These Practice Standards are designed to assist Qualified Medical Dosimetrists (QMDs) in defining their roles in the technical services that they provide in radiation oncology. This document stresses that it is essential that the QMD be an active participant in the collaborative team approach to patient care and that effective communication with the radiation oncology team is essential for providing quality patient care [1].

The QMD is an individual who is competent to practice in collaboration with the Radiation Oncologist (RO) and a Qualified Medical Physicist (QMP). The QMD uses critical thinking and problem-solving skills as well as exercises judgment in the performance of medical dosimetry procedures [2].

An individual shall be considered eligible to practice if they are certified by the Medical Dosimetrist Certification Board (MDCB) [2].

Board eligible medical dosimetrists, including recent graduates of Joint Review Committee on Education in Radiologic Technology (JRCERT) accredited medical dosimetry educational programs, should practice under the guidance of a QMD and a QMP until successful completion of the medical dosimetry certification exam.

The American Association of Medical Dosimetrists (AAMD) recommends all personnel practicing in Medical Dosimetry attain certification provided by the MDCB. Accordingly, CMD (Certified Medical Dosimetrist) is recognized as the appropriate credential for the Medical Dosimetrist [2]. The certification of medical dosimetrists by the MDCB is also recommended in the ACR-ASTRO Practice Parameter for Radiation Oncology [3].

In addition to the above qualifications, a QMD shall meet and uphold the AAMD Code of Ethics and the Ethical Standards of the MDCB [2,4,5].

III. INTRODUCTION

The Scope of Practice is designed to educate professionals in the fields of health care, education, other communities of interest, and the general public regarding the qualifications and abilities of the Qualified Medical Dosimetrist. This document can be used by individual facilities to develop job descriptions and practice responsibilities [1].

The first *Statement on the Scope and Standards of Medical Dosimetry Practice* was approved in 2001. In 2012, *The Scope of Practice of the Medical Dosimetrist* was revised; and in 2013, *The Practice Standards of the Medical Dosimetrist* was developed. All these documents have been developed by AAMD Task Groups whose members were selected from the AAMD, American Association of Physicists in Medicine (AAPM), American Society for Radiation Oncology (ASTRO), and the Medical Dosimetrist Certification Board (MDCB) [1].

These Practice Standards for the Medical Dosimetrist shall be considered the baseline for quality medical dosimetry practice. The goal was to make these standards applicable to the medical dosimetrist in any setting. As a "Living" document, these Practice Standards will be reviewed and modified as needed. These Practice Standards are not intended to supplant any federal/state/local regulations or laws, though currently there are no laws explicitly governing the practice of medical dosimetry [1].

Professionals who employ this document must be cognizant of state and federal laws affecting their practice, as well as institutional policies and guidelines. The intent is not to supersede these laws or affect the interpretation or implementation of such laws. It may serve, however, as a model for the development or modification of licensure laws [1, 2].

IV. PROCESS OF RADIATION THERAPY

The clinical use of ionizing radiation is a complex process involving trained personnel who carry out a variety of interrelated activities. The following information is specifically related to the QMD [1].

A. Clinical Evaluation

The Radiation Oncologist (RO) has the ultimate responsibility to perform a complete and thorough initial and ongoing evaluation of each patient. Beyond that, however, the QMD has an obligation to communicate to the RO any further information found during the process of assessing and designing a radiation treatment plan. The QMD 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 QMD's course of action should be in accordance with department/institution policies and procedures [1].

The QMD should have access to the patients' clinical evaluation information and be familiar with basic patient anatomy as demonstrated by computed tomography (CT) and other imaging modalities used in radiation treatment planning (i.e. magnetic resonance imaging (MRI), positron emission tomography (PET), and ultrasound).

The QMD should be cognizant of any limitations that would possibly impact radiation treatment planning or radiation treatment delivery. These limitations may include poorly chosen immobilization devices, suboptimal positioning, inadequate scan volume, physical or mental inability of patient to cooperate for treatment, etc. Where appropriate, the QMD should discuss any potentially modifiable factors with the RO so that a decision could be made regarding the utility of re-simulation.

After the radiation treatment planning process is complete and prior to the initiation of radiation therapy, the QMD shall ensure that all treatment parameters are clearly documented, orders are approved by the responsible RO, and the checks by the QMP are complete. For a patient undergoing external beam radiation, the QMD should maintain discussions with the RO

and Radiation Therapists (RTTs) regarding the treatment sites and changes in the treatment area that may affect depth or volume of calculation. Any changes should be evaluated to determine the necessity of an adjustment in the original radiation treatment plan, as per the direction of the RO. Any changes in the planned treatment prescribed by the radiation oncologist, such as adjustment in immobilization, new calculations, or design of a new dosimetric treatment plan must be documented on the record and approved by the radiation oncologist.

B. Establishing Treatment Goals

The QMD must clearly know the physician-directed treatment goals for the radiotherapy patient. The treatment goals are a "documented, patient-specific planning directive that guides treatment planning staff and defines target and normal tissue volume goals" and are a standard requirement for APEx accreditation (standard 2.2). Treatment goals should be specified for all the recommended organs at risk as delineated by disease site in Table 1 of the "Standardizing Normal Tissue Contouring for Radiation Therapy Treatment Planning: An ASTRO Consensus Paper." The QMD, in consultation with the RO, evaluates the patient to provide knowledge and guidance for the following [1,2]:

- Delineation of previously irradiated areas through review and/or reconstruction of previous treatment plan(s).
- Information on dose tolerances of normal tissues and critical structures.
- Selection of the therapeutic modalities to achieve treatment goals.
- Delineation of the specified critical structure volumes.
- Verification of patient positioning and immobilization to ensure reproducibility.

C. Informed Consent

Informed consent provides necessary documentation reflective of the conversation the physician had with the patient, legal guardian, and/or the family members. The conversation details all relative information pertaining to, but not limited to: diagnosis, staging, treatment, adjuvant treatment, alternative options, prognosis, and all possible side effects. Acquiring the legal signature of either the patient or the legal guardian indicates an understanding of the treatment(s) and procedure(s) that are to be performed. Informed consent, with appropriate documentation, must follow institutional policies and procedures and comply with state and federal law. Informed consent for radiation oncology procedures must be obtained by a licensed physician qualified to perform the procedure and witnessed by another staff member, verifying the understanding and agreement to seek further diagnostic and therapeutic treatment. It is important to understand that informed consent is a continuous process, valid throughout the course of treatment, unless the patient either refuses treatment and/or seeks alternative treatment. As a member of the radiation oncology team, the QMD may be called upon to serve as a witness to the informed consent [1,2,3].

D. Patient Education

Effective education is vital throughout the patient's treatment process. The patient's individualized needs should be addressed. The patient's preference may guide the QMD's choice of education materials and methods [1]. It is important to review all information given to the patient with the patient. Accurate and easily understandable educational information helps to ensure the desired treatment outcome [2].

The responsibility to educate the patient and the family may be shared by many members of the radiation oncology team. The QMD should be prepared to provide accurate and appropriate patient education in accordance with departmental/institutional policies. This communication should facilitate the establishment of a positive relationship with the patient, family members, and health care providers while preserving all measures of patient confidentiality [3,4].

Accurate and appropriate patient education by the QMD includes, but is not limited to:

- Assess the patient's need for information.
- Provide reassurance and privacy.
- Address patient questions and concerns regarding the procedure.
- Refer questions about diagnosis, treatment, or prognosis to the patient's physician.
- Explain and instruct at a level that the patient can comprehend and retain.
- Provide specific information regarding the treatment, including the delivery of radiation, instruction for the daily maintenance of treatment field markings, and instruction on self-care procedures [3].

E. Simulation of Treatment

Simulation can be broadly defined as the process of establishing and documenting the treatment position, the volume to be treated, and the normal structures adjacent to or within this volume. This includes the determination of optimal simulation techniques, patient positioning, and positioning aids and immobilization devices [1,2].

The QMD, in accordance with departmental/institutional policy, should participate in the development of optimal treatment strategies using critical thinking skills and technical knowledge during the simulation process that results in attainable radiation therapy plans.

This participation may include, but is not limited to, the following [2,3,4]:

- Patient data acquisition via computer generated data sets from medical imaging devices such as CT, PET, MR, etc.
- Patient data acquisition via manual methods such as physical measurements and wire contour.
- Input into the use or necessity of ancillary treatment devices and patient immobilization techniques.

- Advise on any additional patient positioning techniques needed for simulation.

F. Fabrication of Treatment Aids

Accuracy and reproducibility of the patient setup, at time of simulation, is essential to prevent a geometric miss of the intended target volume during daily treatment. Devices and methods used to aid in the positioning, immobilizing, and stabilizing of the radiotherapy patient, are critical to the success of the patient's treatment. The shielding of normal tissue, the use of compensating filters, bolus, masks, body cradles, etc. are designed to improve treatment accuracy and reduce treatment toxicity. These treatment aids should be carefully designed and used where clinically appropriate [1,2].

The QMD should be involved in the consultation, development, and fabrication of treatment aids and devices. The QMD works in collaboration with the QMP and the RO to design and fabricate optimal treatment aids, as necessary [3,4].

G. Segmentation

It cannot be emphasized enough that the RO is ultimately responsible for the integrity and accuracy of segmentation performed for their patient. It should be noted that in a 2-year period, the Radiation Oncology Healthcare Advisory Council (RO-HAC) identified more than 60 Radiation Oncology Incident Learning System (RO-ILS) events containing an issue with contours, including problematic plans with critical structures not contoured and normal tissues incorrectly or incompletely delineated [1]. The QMD, at the direction of the RO, may be called upon to perform duties related to segmentation. The QMD should be skilled at this task and is encouraged to review the atlases and references in "Standardizing Normal Tissue Contouring for Radiation Therapy Treatment Planning: An ASTRO Consensus Paper" for any questions about the delineation of normal tissues [2]. However, there undoubtedly will be some normal tissues that are more challenging and the QMD may not be able to assist with these structures despite an earnest effort. The QMD should not be asked to complete segmentation tasks that exceed their training, knowledge of anatomy, knowledge of the patient, or their scope of practice. For instance, the generation of a breast planning treatment volume (PTV) that is defined by the borders of the tangent fields set by the RO is within the scope of practice of the QMD; however, the segmentation by the QMD of a gross tumor volume (GTV) in the lung is not.

The QMD should be aware that requests to determine gross tumor volumes (GTVs) and clinical target volumes (CTVs) are outside the scope of practice of the QMD, and that the QMD who submits to these requests is in violation of the Medical Dosimetrist Certification Board Ethical Standards, specifically standard 12. The QMD should be allowed to voice their concerns on requests that are outside of their scope of practice without fear of retribution [3,4].

H. Image Fusion

The practice of modern radiotherapy involves the quantitative use of several types of imaging data. The image data from various modalities are used in treatment planning, treatment

delivery, and treatment monitoring [2]. Modern imaging modalities for radiation treatment planning include 3D and 4D computed tomography (CT), magnetic resonance imaging (MRI), ultrasound (US), single photon emission computed tomography (SPECT), and positron emission tomography (PET) [3]. During the process of treatment delivery, planar and volumetric x-ray imaging technology (directly integrated with the treatment delivery system, such as cone-beam CT) is used to automatically or manually match the treatment planning image data. Some treatment imaging systems utilize x-rays, ultrasound, or MRI to provide near real-time analysis of anatomical regions of interest and soft-tissue changes, allowing for motion management, plan adaptation, response assessment, etc. [2].

Depending on the treatment planning and delivery techniques in use, there may be diverse and numerous datasets to match for treatment planning, delivery, etc. [1]. Since the patient's position and orientation is virtually never identical between two image sets (with the notable exception of multiple modalities used to acquire imaging data at the exact same time), image matching often requires registration, fusion, and deformation techniques [2]. Technical training is required before independently performing imaging manipulation techniques, and each image match used for treatment planning or delivery should be checked by both a RO (who ultimately approves the anatomical matching) and a QMP (for audit of the technical aspects of image matching).

The QMD, working in collaboration with the RO and the QMP, may participate in, but is not limited to, the following [4]:

- All aspects of image registration, fusion, and deformation registration, including acquiring image sets and importing image information software, if applicable.
- Selection of anatomical region of interest and the fusion/registration/deformation to match desired anatomy.
- Rescaling, as needed, for use in the treatment planning system.
- Exporting to treatment planning system, if applicable.

I. Physics

Accurate calculations are required to provide dose delivery, matching the RO's prescription for all treatments, both external beam and brachytherapy [1].

The QMD uses knowledge of the physical properties of treatment units in external beam radiotherapy to perform dose calculations, whether manual or computer-generated [1,2,3,4]. These calculations may include, but are not limited to, beam modifying devices, irregular fields, gaps and/or feathering for adjacent fields, and dose to points away from the beam central axis. Calculations for brachytherapy – typically to establish dwell times and cumulative dose distributions - require the QMD to use knowledge of radioactive isotopes, radioactive decay, source construction, optimal geometry of source placement, and physical properties of treatment units [1,2,3,4].

The QMD is thoroughly trained in the physics of dose delivery calculations, and may perform them independently with appropriate QMP review, or may provide dosimetry assistance for a QMP [2].

In addition, the QMD is trained in the basic physics of dosimetry measurements and quality assurance (QA) of treatment delivery units and may perform dosimetric measurements and QA under the oversight of a QMP [1,2,3,4].

J. Patient Evaluation During Treatment

Throughout the entire course of treatment, each patient should be continuously monitored for any unwanted side effects, reactions, and therapeutic responses as directed by the RO or QMP [1]. Typically, this face to face review will be performed by the RTTs, nursing staff, and physicians. The QMD should respond to concerns voiced by any of these staff members and be able to lend expertise as to the potential changes in delivery of the planned treatment as affected by these anatomic changes. The QMD may suggest re-simulation, for instance, if there is a concern that anatomic changes are of a significant nature. The RO should be informed of the concerns of staff members any time it is determined to be appropriate.

The QMD may be involved in the monitoring of the patients in accordance with institutional/departmental policy. Patient monitoring and evaluation may include the following [2,3]:

- Periodic review of the patient treatment record
- Patient weight gain/loss
- Anatomic changes, particularly those resulting in changes to the effectiveness of immobilization devices, effective separation, or changes detected by imaging guidance
- Changes in the patient surface as detected by surface imaging

K. External Beam Treatment

External beam treatment (EBT) is the delivery of ionizing radiation to a patient from a controlled and regulated radiation-producing machine. Machines that deliver external beam irradiation are medical linear accelerators and particle therapy units. EBT planning can be planned and/or calculated using 2D/3D treatment, Intensity Modulated Radiation Therapy (IMRT), Image Guided Radiation Therapy (IGRT), Stereotactic Radiosurgery (SRS), Stereotactic Body Radiosurgery (SBRT), Total Body Irradiation (TBI), and any other source of EBT treatment methods. EBT planning also includes the use of individualized immobilization devices, patient localization, skin bolus techniques, computer-generated radiographic image reconstruction, and sophisticated breath control techniques and motion detection. The QMD, in collaboration with the RO and QMP, participates in the following activities in accordance to each institution's policies [1,2,3,4]:

- Consultation during simulation
- Design of treatment modifying devices, including bolus
- Radiation treatment planning

- Associated calculations
- Appropriate documentation
- Quality assurance

L. Radiation Treatment Planning

1. Classical Radiation Treatment Planning

Classical radiation treatment planning uses patient data acquired from external patient body contours, measurements of patient thickness, and single plane radiographic images. The treatment plans and calculations are usually generated by hand using isodose curves or treatment planning systems, where the patient information is digitized or scanned into the treatment planning system.

a. Two-Dimensional (2D) Radiation Treatment Planning

2D radiation treatment planning refers to a traditional technique of planning from a 2D single plane radiographic image or a single external patient contour that is most often acquired using lead wire or plaster strips in conjunction with physical measurements. The contour must contain the central ray location, point of calculation, and one collimator axis of a beam that is coplanar with the contour plane [1]. Two examples of a single plane image include radiographs taken during simulation using a conventional simulator, and a single axial CT slice from a CT exam [1,2]. Multiple radiographs can allow for organs at risk to be identified (i.e. spinal cord, lungs, heart, kidneys, bladder, and rectum) [2]. The QMD, working in collaboration with the RO and the QMP, may participate in, but is not limited to, the following activities [3, 4]:

- Acquisition of patient data from manual contour and physical measurements
- Incorporation of patient contours and physical measurements while applying principles and concepts of radiation physics and treatment machine properties to develop an optimal radiation treatment plan based upon the RO written directive
- Understand and perform calculations pertaining to beam modifying devices, irregular fields, gaps for adjacent fields, and off-axis calculations
- Evaluation of information generated from the radiation treatment plan to measure its appropriateness and efficacy
- Accurate transfer of treatment parameters into the patient treatment record
- Assistance with the patient set-up and treatment execution

2. Modern Radiation Treatment Planning

The main distinction between modern radiation treatment planning and classical radiation therapy treatment planning is modern radiation treatment planning requires the availability of 3D and 4D anatomic information and a treatment planning system that can calculate 3D and 4D dose distributions and dose-volume statistics for contoured structures. The anatomic information is usually obtained in the form of closely spaced transverse images, which can be processed to reconstruct anatomy in any plane, or in three or four dimensions. Visible tumor, critical structures, and other relevant landmarks are outlined slice by slice by the treatment planner [1]. The QMD is an active participant in modern radiation treatment planning techniques.

a) Three-Dimensional Conformal Radiation Treatment (3D CRT) Planning

3D CRT is a type of external beam radiation treatment planning that utilizes image-based studies to acquire a 3D visualization of the treatment site and surrounding area. The treatment planning CT is done with the patient in a reproducible position using treatment immobilization devices. When used in conjunction with treatment planning evaluation tools, an optimal treatment field arrangement of tailored radiation treatment fields is utilized to deliver conformal doses of radiation to the tumor and affected area while reducing dose to nearby healthy tissue [1,2].

b) Intensity-Modulated Radiation Therapy (IMRT) Treatment Planning

Intensity-Modulated Radiation Therapy (IMRT) to include Volumetric Modulated Arc Therapy (VMAT) is an inverse radiation treatment planning technique in which the dose across the treatment site is modulated resulting in sharp dose gradients between target and non-target areas in a conformal manner while delivering minimal dose to critical structures and surrounding normal tissue. This is accomplished using multiple beam projections and beams containing multiple segments to modify the beam intensity across the field. The QMD specifies desired dose constraints for the target(s), adjacent structures, critical structures, beam energy, and beam orientation. The treatment planning system will optimize a plan and create intensity fluences for each beam based on data input and prioritization of structures to deliver a dose distribution to meet planning objectives [1]. IMRT requires sophisticated treatment planning systems and specialized training for all personnel involved.

c) Four-Dimensional (4D) Radiation Treatment Planning

4D radiation treatment planning adds the dimension of motion to the treatment planning image. It involves respiratory correlated CT (4D CT) imaging and image guided tracking of tumor motion. 4D radiation treatment planning should be employed when respiratory motion is a concern, particularly in the thoracic and abdominal regions [1]. There are several techniques for 4D radiation treatment planning such as gating and non-gating approaches [2,3]. It may be used in IMRT and Stereotactic Body Radiotherapy/Stereotactic Ablative Radiotherapy (SBRT/SABR)-radiation-treatment planning with the aim of maximizing tumor dose by tracking and compensating for target motion during radiation treatment delivery while minimizing normal tissue dose to surrounding structures [4]. 4D planning and 4D CT data acquisition requires sophisticated helical multi-slice CT scanners, treatment planning systems, and specialized training for all personnel involved.

d) The Role of the QMD in Modern Radiation Treatment Planning

Currently 3D CRT, IMRT, VMAT, and 4D treatment planning techniques represent the latest in modern radiation treatment planning. As the field of radiation oncology evolves

the QMD will continue to be an active participant in modern radiation treatment planning.

The QMD participation includes, but is not limited to the following activities, which are performed in collaboration with the QMP and the RO, in accordance to each department/institution's policies and procedures [1,2,3]:

- The QMD shall communicate with the therapy staff as to any challenges that may present themselves at time of simulation.
- Treatment setup points are to be set in a manner that does not impede or further complicate treatment.
- Ensure proper orientation of volumetric patient image data on the RTP system from CT and other fused image data sets.
- Proper delineation of treatment devices as agreed upon by the QMP.
- Image Fusion (rigid or deformable) using diagnostic imaging such as MRI, PET/CT, 4D CT Scans and other diagnostic CTs (containing oral or IV contrast). These diagnostic studies can be fused to the Treatment Planning CT to aid the RO in the delineation of treatment volumes (TVs) and aide the dosimetrist in the contouring of normal structures.
- Participate in the analysis of organ motion and delineation.
- Contour clearly discernible critical normal structures.
- Identify any items which may change during treatment as defined by initial simulation (contrast, gas, etc.).
- Review of targets as designed by RO.
- Design and generate the radiation treatment plan under the direction of the RO and the QMP, ideally using a written directive specific to the site of disease being treated. Including Dose Volume Histograms (DVHs), dose distributions, dose clouds, and TV rendering.
- Evaluate plan with RO showing TV's coverage, dose to critical and/or normal structures and knowledge of tolerance dose constraints.
- Transfer treatment plan parameters (including beam monitor units) and planning images to the record and verify treatment delivery software.
- Assist in the QA of the treatment plan as defined by department policies and procedures.
- Generate all technical documentation required to implement the radiation treatment plan.
- Available to assist the RTT with the first treatment and to assist with verification for subsequent treatments as necessary.
- Provide input in the continuation of care with respect to patient setup as requested by the RO.
- Participate in peer review of contours, prescription, radiation treatment plan, and verification images in conjunction with other members of the radiation oncology team.

- Assist QMP and RO in the analysis of dose changes with respect to habitus changes.
- Bill accordingly and in compliance with institutional policies, applicable insurance provider guidance documents and current procedural terminology definitions when selecting appropriate billing codes.

M. Stereotactic Radiosurgery (SRS)/Stereotactic Body Radiotherapy (SBRT)

Stereotactic Radiosurgery (SRS) is external beam radiation treatment techniques designed specifically to deliver very high doses of radiation for cranial lesions in one to five fractions. Additionally, Stereotactic Body Radiation Therapy (SBRT) is similar, but designed for extra cranial lesions in one to five fractions. The term Stereotactic Ablative Radiotherapy (SABR) is also used to describe these techniques. Specialized radiation planning techniques, or even specific treatment planning systems are utilized to design a dosimetric treatment plan that will not only have high target doses, but steep dose fall off outside of the target volume [1,2,3].

A high level of coordinated efforts on the part of the RTT (in both simulation and treatment), RO, QMD, and QMP must be practiced assuring safe and accurate treatment delivery. Strict quality assurance measures, as well as machine tolerance parameters must be utilized for SRS & SBRT procedures. If medical dosimetry training did not include SRS/SBRT/SABR training and direct clinical experience, then specific training and mentoring in these procedures should be obtained prior to performing any stereotactic treatment planning procedure. In addition, there may be vendor specific delivery systems that require additional training.

For the QMD participation includes, but is not limited to the following activities, which may be performed in collaboration with the QMP and RO, in accordance to each department/institution's policies and procedures:

- Contour clearly discernible critical normal structures.
- Ensure proper orientation of volumetric patient imaging data on the radiation therapy treatment planning (RTP) system (from computed tomography and other fused image data sets).
- Design and generate the radiation treatment plan under the direction of the RO and the QMP as required.
- Generate all technical documentation required to implement the radiation treatment plan.
- Be available for the first treatment and assist with verification for subsequent treatments as necessary.

N. Craniospinal Irradiation (CSI)

Craniospinal Irradiation (CSI) is a highly specialized technique utilized in the treatment management of central nervous system malignancies such as medulloblastoma, neuroectodermal tumors, ependymomas, gliomas and some leukemias. CSI is particularly demanding technically due to the potential gaps, overlaps or unacceptable dose distributions that may be encountered. Multimodality imaging is typically used for better target delineation. Immobilization devices are generally non-invasive and are chosen to significantly reduce patient movement, prevent target misalignment, and to improve the accuracy of treatment delivery [1,2,3,4].

A high level of coordinated effort on the part of the RTT (in both simulation and treatment), RO, QMD, and QMP must be practiced assuring safe and accurate treatment delivery.

The QMD may perform the following duties in collaboration with and, as appropriate, under the oversight of a QMP and RO in accordance with each department/institutional policies and procedures:

- Participation in radiation treatment simulation during creation of immobilization devices and acquisition of treatment planning images.
- Ensure integrity and accuracy of volumetric patient image data in the treatment planning system (import, registration, fusion, etc.).
- Contour clearly discernible normal structures.
- Participate with the RO and the QMP regarding treatment set up decisions (allowable couch angles, treatment machine, energies, etc.) as needed and/or requested.
- Design and generate the radiation treatment plan/calculations in consultation with the RO and, as needed, the QMP.
- Generate all technical documentation required for the implementation of the radiation treatment plan, in conjunction with the RO.
- Transfer the plan parameters (including beam monitor units, field sizes, DRRs, etc.) to the treatment delivery unit, or verify accurate transferal if this process is computer automated.
- Participate in dose measurements and/or QA measurements as requested by and under the oversight of the QMP.
- Participate, as necessary, in the first treatment setup/preparation and to assist with subsequent treatments.

O. Image Guided Radiotherapy (IGRT)

Image-guided radiation therapy (IGRT) can be defined broadly as radiation therapy that employs imaging to maximize accuracy and precision throughout its entire process of radiation therapy. It includes target and normal tissue delineation, radiation delivery, and adaptation of therapy to anatomic and biological changes over time in individual patients [1]. The image guidance that occurs at the time of radiation delivery within the treatment room is usually called in-room IGRT or simply IGRT [1,2].

For the QMD, the following duties may be performed, in collaboration with, the QMP and RO in accordance to each department/institution's policies and procedures [2,3]:

- Consult with and communicate the treatment plan to the multi-professional radiation treatment team.
- Contour clearly discernible critical normal structures.
- Ensure proper orientation of volumetric patient image data from CT and other fused image data sets on the radiation treatment planning system (TPS)
- Design and generate the treatment plan under the direction of the radiation oncologist and medical physicist.

- Generate all technical documentation required for accurate implementation of the IGRT treatment plan.
- Devise and transfer well-defined digitally reconstructed radiographs (DRRs) and transfer CT image data sets that were used to generate the treatment plan.
- Be available for the first treatment and assist with verification for subsequent treatments as necessary.

P. Total Body Irradiation (TBI)

Total Body Irradiation (TBI) has played an important role in bone marrow transplant (BMT). TBI has primarily three objectives: immunosuppression to avoid rejection of donor transplant; eradication of malignant cells such as in the case of leukemia, lymphoma, and some solid tumors; and eradication of cell populations in genetic disorders [1].

For the QMD, the following duties may be performed, in collaboration with a QMP and in accordance with each department/institution's policies and procedures [2,3,4,5,6,7]:

- Generate the dose calculations for treatment.
- Patient simulation and measurements.
- Assist with patient setup and immobilization.
- Assist with measurements on phantom prior to patient setup for dose verification.
- Assist with pre-treatment verification measurements.
- Participate in QA under the supervision of the QMP.
- Assist the RTT as the patient set-up and treatment is executed.

Q. Total Skin Electron Irradiation (TSEI)

Low energy electrons are useful for treating superficial lesions covering large areas of the body, such as mycosis fungoides and other cutaneous lymphomas. At these energies, electron beams are characterized by a rapid falloff in dose beyond a shallow depth and a minimal x-ray background. Thus, superficial skin lesions extending to about 1 cm depth can be effectively treated without exceeding bone marrow tolerance [1]. This therapy is also identified in the literature by combinations of words in part abstracted from total skin electron therapy together with additions such as: whole body or whole skin, superficial irradiation, or electron beam [2].

The majority of TSEI procedures are typically time-consuming and resource intense due to multiple fields, multiple patient orientations per fraction, and in-vivo dosimetry.

TSEI procedures require that a rigorous quality assurance program be established. The QMD may be called upon to assist the QMP with the various types of dosimetric measurements that are performed prior to initiating TSEI procedures [1,2].

For the QMD, the following duties may be performed, in collaboration with a QMP and RO in accordance with each department/institution's policies and procedures [2,3]:

- Assist with patient positioning and field verification.
- Design shielding of specific anatomic sites or organs (e.g. eyes).
- Perform in-vivo dosimetry (e.g. evaluate uniformity of dose and confirm monitor unit calibrations).
- Plan boost fields and assist with treatment setup (e.g. soles of feet, perineal area, etc.).

R. Proton Therapy

Proton beam radiotherapy is used to treat most of the tumors that are traditionally treated with x-rays and electrons. The most used applications are the treatment of tumors in close vicinity of critical normal structures. Protons inherently have less entrance and exit dose; therefore, the integral dose is significantly less than photons. Hence, protons are a preferred modality in the treatment of pediatric tumors where there is always a concern for a possible development of secondary malignancies during the lifetime of the patient. Protons are also beneficial for treatment of recurring head and neck cancers due to effective tumor control and acceptable acute and late toxicity profiles [1,2,3,4].

The QMD should be eligible to participate in all aspects of proton beam therapy. To be effective the QMD should possess a working knowledge of:
- The interactions of protons with matter.
- The radiobiology of charged particles.
- How protons are generated and delivered.
- The dosimetry of proton beams.
- Radiation treatment planning with proton beams.
- The uncertainties related to proton therapy.
- The quality assurance program of institution.

The QMD should then be eligible to participate in the development of optimal treatment strategies, in accordance with the written directive, that result in attainable proton therapy plans. Such duties could include:
- Image import and registration.
- Localization of tumor volumes.
- Localization of critical structures.
- Generation of isodose distributions.
- Evaluation of information obtained from dosimetric treatment plans, such as isodose distributions, dose volume histograms (DVHs), and other data.
- Performance of dose calculations.
- Accurate transfer and documentation of treatment parameters.

S. Brachytherapy

Brachytherapy is a method of treatment in which sealed radioactive sources are used to deliver radiation at a short distance by interstitial, intracavitary, or surface application. Using

brachytherapy techniques, a high radiation dose can be delivered locally to the tumor with rapid dose falloff in the surrounding normal tissue [1].

For the QMD, the following duties may be performed in collaboration with a QMP and RO in accordance with each department/institution's policies and procedures [2,3,4,5,6,7]:

- Image import and registration.
- Implant localization.
- Treatment planning.
- Treatment plan review.
- Associated calculations.
- Source assay.
- Source inventory.
- Source preparation.
- Source transportation.
- Consultation during applicator placement.
- Consultation in determining the strength of the radioactive source(s) and arrangement of the source(s) in applicators.
- Participation in low dose rate (LDR), pulsed dose rate (PDR), and high dose rate (HDR) procedures.
- Order, load and/or remove radioactive isotopes.
- Performance of quality assurance of PDR and HDR remote after-loader systems and associated treatment equipment (e.g. applicators, transfer tubes, etc.).
- Performance of quality assurance of LDR treatment equipment.

It is imperative that the QMD be appropriately trained in emergency procedures, be compliant with all NRC or agreement state regulations for procedures and training and follow the principles of ALARA to minimize exposure to patients, staff, themselves, and others [3,4,5,6,7].

The QMD is considered eligible to do all the above listed tasks, unless specifically prohibited by state statute or NCRP regulations in agreement states that allow other individuals to administer ionizing radiation to patients, provided it is under the personal supervision of an authorized user. The QMD is therefore considered eligible to administer ionizing radiation to patients in NCRP agreement states if the QMD has been appropriately trained. [2].

V. QUALIFICATIONS AND RESPONSIBILITIES

A. Qualifications and Certification

A Qualified Medical Dosimetrist (QMD) is an individual who has the knowledge and skills to practice in collaboration with a RO and a QMP. This individual uses critical thinking and problem-solving skills as well as exercises discretion and judgment in the performance of medical dosimetry procedures. [1,2]

As a member of the radiation oncology team, the QMD has knowledge of the overall characteristics and clinical relevance of radiation oncology in the management of cancer or other disease processes, with special expertise in radiation therapy treatment planning.

It is expected that an individual will hold themselves qualified to practice in medical dosimetry only when the knowledge and skills to perform dosimetric tasks has been established. An individual shall be considered eligible to practice independently if they are certified by the Medical Dosimetrist Certification Board (MDCB).

The American Association of Medical Dosimetrists (AAMD) recommends all personnel practicing Medical Dosimetry attain, at a minimum, certification provided by the Medical Dosimetrist Certification Board (MDCB). Accordingly, the CMD (Certified Medical Dosimetrist) is recognized as the appropriate credential for the Medical Dosimetrist.

B. Responsibilities

The essential responsibility of the QMD is to demonstrate an understanding of topics including, but not limited to cancer, radiation biology, radiation therapy techniques, radiation oncology physics, equipment technology, radiation safety and protection, anatomy, physiology, and mathematics to generate radiation treatment plans. Once the radiation treatment plan has been generated the QMD is responsible for communicating the plan to the RO, and QMP for 2nd check and then to the RTT for implementation. The QMD must maintain a commitment to a high degree of accuracy, attention to detail, and safety. The QMD uses critical thinking skills when performing radiation treatment planning, plan evaluation, recognizing and resolving equipment problems and treatment discrepancies [1,2,3,4].

The QMD should always be aware of the limitations of their skills, knowledge, credentials, and experience, and should only undertake tasks they are qualified to perform. Certification alone does not qualify a QMD to perform all procedures in the Scope of Practice/Practice Standards. Additional training, education, and experience should be acquired when appropriate [3]. The QMD will follow all federal and state regulations regarding licensing, certification and registration and will disclose known limitations when relevant [1].

C. Education

The AAMD recommends that any QMD entering the medical dosimetry field be prepared for this profession by earning the minimum of a baccalaureate degree, completing a medical dosimetry educational program accredited by the JRCERT and obtaining certification by the Medical Dosimetrist Certification Board (MDCB) [1,2,3,4,5].

Beginning in 2017, minimum requirements for MDCB eligibility include a baccalaureate degree and graduation from a JRCERT accredited Medical Dosimetry educational program. The AAMD fully supports the 2017 initiative [1,2,3,4,5].

VI. PATIENT AND PERSONNEL SAFETY

Each facility should have in place policies and procedures to provide for the safety of patients and personnel. These should include attention to the physical environment, the proper use, storage, and disposal of medications and hazardous materials and their attendant equipment, and methods for addressing medical and other emergencies [1].

The Qualified Medical Dosimetrist may be involved in activities designed to enhance the safety of patients as well as the public and health care providers during diagnostic and therapeutic services [2]. The role of the QMD in safety and quality in cancer care delivery includes, but is not limited to [3]:

- Participating in pretreatment team discussion to anticipate dosimetric and safety challenges during a patient's imaging procedures and treatment. This might include literature review, consideration of radiation dose from image guidance, and analysis of the patient's previous radiation treatment history.
- Participating in recommendations and decisions for appropriate patient positioning, positioning devices, immobilization for simulation and treatment, and other strategies to mitigate potential dosimetric and safety challenges, in collaboration with the rest of the radiation oncology treatment team.
- Communicating information about treatment strategy to the rest of the radiation oncology team to assure safety and accuracy.
- Providing feedback about the development of patient-specific planning directives from the physician to the dosimetry team to facilitate clear directives of any governing agencies.
- Participating in departmental peer review (e.g. chart rounds, new start conference, etc.).
- Participating in departmental safety team efforts – a critical component of a culture of safety - to discuss near misses, treatment deviations, incident learning reports, and any unsafe conditions that cause or might cause harm to patients or employees [3].
- Maintaining collaborative partnerships with all other members of the radiation oncology treatment team to promote patient and employee safety.
- Maintaining thorough knowledge of departmental emergency policies, including recognition of a patient emergency and activation of department emergency procedures.
- Adhering to all institutional safety guidelines and standards always.
- Practicing all quality assurance measures prescribed by institutional guidelines.
- Practicing ALARA (as defined in 10 CFR 20.1003).
- Following and promoting current professional safety and quality guidelines (e.g. AAMD, AAPM, ASTRO) as applicable to clinical practice if institutional guidelines do not meet these standards.

VII. CONTINUING EDUCATION

The QMD should continually strive to improve their knowledge and skill sets related to the medical dosimetry profession [1]. The field of radiation oncology is a continuously growing and rapidly evolving field. Participation in appropriate continuing medical dosimetry education activities and sharing knowledge and skills with colleagues is essential [2]. Each licensed,

credentialed, and/or certified member will undertake and document continuing professional education as required by the appropriate licensing authority [3].

VIII. QUALITY IMPROVEMENT (QI)

A Quality Improvement (QI) Program is recommended for every radiation oncology facility. A Quality Improvement Program's goal includes, but is not limited to, the following: identifying problems, creating action plans, verifying action plans were performed, and evaluating the effectiveness of the action plans [1,2,3].

The QMD should participate in the departmental QI program per departmental policies. The following duties fall into the scope of practice for the QMD, although the QMD may require some additional training to become proficient in these safety techniques:

- Participation in incident learning systems.
- Participation in root cause analysis.
- Assistance in formulation of department-specific corrective and quality improvement actions.

IX. DOCUMENTATION AND COMMUNICATION

Radiation oncology incorporates the science and technology of complex, integrated radiation treatment delivery and the art of managing individual patients.

Timely, accurate, and effective communication with all members of the radiation oncology treatment team is critical to quality patient care. Communication may be physically written (hardcopy), electronic (digital), or direct [1,2,3]. Therefore, systems that facilitate clear, unambiguous and efficient communication among all team members are critical [4,5].

The participation of the QMD in both documentation and communication is essential to the process of patient data acquisition, radiation treatment planning, treatment evaluation, accurate treatment delivery, quality improvement and quality management for radiation oncology patients [2,3,4,5].

The QMD must clearly and accurately communicate with the RO and the QMP during the radiation treatment planning process [2,3,4,5].

The QMD must accurately transfer and document the treatment parameters either manually or electronically, according to department policies, and then clearly communicate the treatment plan to the RTTs [2,3,4,5].

The QMD may be involved in the performance and documentation of daily and weekly checks of calculations, treatment delivery, and treatment charting, depending upon departmental policies. The QMD also participates in documentation as related to fiscal practices, such as billing, in accordance with institutional policies [2,3,4,5].

The QMD is expected to participate in the documentation of dosimetry/departmental procedures, and to openly and effectively communicate with all members of the radiation oncology team [2,3,4,5]. The QMD is expected to adhere to regulations under the Health Insurance Portability and Accountability Act of 1996 (HIPAA) and the HIPAA Privacy Rule in communication of certain Protected Health Information (PHI). The QMD is expected to follow all institutional guidelines concerning PHI [1,5].

The safe delivery of radiation therapy has never been a simple matter and is now exceedingly complex. There is a vigorous awareness of safety in medicine and radiation oncology. Therefore, the QMD should understand the ways in which they can contribute to the safety culture in their workplace. The QMD should foster a sense of teamwork both within teams and across teams. The QMD should pay attention to communication around handoffs and transitions. The QMD should engage in honest reporting about any adverse events. The QMD should display commitment to organizational learning. The QMD should adopt a non-punitive response to error, free from shaming or judgment. The QMD should also be vocal about any practices which might negatively impact a patient [2,3,4,5].

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AAMD Task Group

Approved – May 2019

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IV. QUALIFICATIONS AND RESPONSIBILITIES

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