CAMPEP Accredited
Residency Program in Medical Physics

University Hospitals Case Medical Center
Cleveland, Ohio

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I. Program Goals and Objectives

The goal of the Clinical Medical Physics Residency Program at the University Hospitals Case Medical Center (UHCMC) is to prepare individuals to practice independently as a certified medical physicist in Radiation Oncology. Clearly, few individuals can be experts in all areas of Medical Physics, but the graduate should have the experience and knowledge base necessary to implement and maintain routine clinical procedures, and establish novel techniques.

Major objectives of the program include:

1. Prepare the graduate for certification in the specialty of Medical Physics (Therapeutic, i.e. Radiation Oncology) by an appropriate certification Board.

2. Provide a broad based in-depth training that will permit the graduate to immediately contribute to the quality of medical care received by the radiation oncology patient.

Training will take place under the close supervision of experienced radiation oncology physicists. The program emphasizes all areas of training and experience that will be needed by a radiation oncology medical physicist in a "state-of-the-art" treatment facility, as well as exposes them to management of a single accelerator community-based free-standing facility.

II. Program Evolution and History

In its inception, Radiation Oncology at University Hospitals Case Medical Center was first a Division of the Department of Radiology. This held true for decades until Radiation Oncology became an autonomous department in 1999. The Medical Residency program in Radiation Oncology was first accredited on October 1, 1977 and had one graduate per year (on average). It is currently operating under a 5-year accreditation by the American Council of Graduate Medical Education (See Appendix A). In March 31, 2005, the Department of Radiation Oncology initiated its most recent educational/training program: the Clinical Medical Physics Residency Program in Radiation Oncology (Appendix B).

The University Hospitals Case Medical Center has been designated by the NCI as a Comprehensive Cancer Center in 1998 and nationally ranked 18th best Cancer Center in 2012 by US News & World Report. It is a natural evolution that in the Department of Radiation Oncology we have a high quality training program for medical physicists. The Department of Radiation Oncology has 15 full-time medical physicists on staff and 17 full-time Radiation Oncology clinical faculty. The department currently has 6 physician residents in the Radiation Oncology Residency Program.

We have moved into our new Seidman Cancer Center in May 2011. This state-of-the-art facility allowed us the space, technology, and expansion of clinical services to be able to pursue an increase in the number of residents in medical physics and to pursue the accreditation of the residency program. The physics residents have access to all personnel, equipment, and institutional resources in the same way any member of the physics staff has. The physics residents also have dedicated office and laboratory space.

Our approach to the training of Medical Physicist has been similar to the evolution that has been going on nationally. To fill our demands of clinical practice of medical physics support for IMRT QA, image fusion and routine quality assurance of linear accelerators and special projects (Tomotherapy and Cyberknife), entry-level positions were available in the Department to work and be trained by senior Board-certified medical physicists. This served as an excellent mechanism to bring on talented post-doctoral candidates for the special projects and masters or doctoral level candidates for the on-going supervised QA work. Specifically, among our first residents, Dr. Ravi Kulasekere (Medical Physics – Univ. of Michigan) was recruited from a national search to provide physics support for TomoTherapy.
(2005) as was Dr. James Brindle (Nuclear Engineering – Univ. of Florida) for Cyberknife acceptance and commissioning (2006). Also, making maximum use of the high technology pool available in the Cleveland area, Mr. Randy Smith (BS - Industrial Engineering and MS in Physics), Ms. Yuxia Zhang (MS - Chemical Engineering) and Dr. Carl Shields (Ph.D. - Polymer Chemistry) were recruited locally (2002-2007). These five individuals were trained as a Univ. of Wisconsin style “Rad Lab” based program while performing their clinical duties. No special time allotment from clinical duty was given to them to complete the course of study, but their medical physics training was provided on an individualized basis and opportunity was given to each to acquire the necessary prerequisite/remedial course work. Three out of five of these individuals are now board certified physicists in therapy and the other two are in the Board Certification process. Two of these candidates were able to pass the ABR oral examination without necessarily completing the full residency training as outlined (Dr. Brindle, Ms. Zhang). In the period from 2007 to the present, we have taken on another five residents, one of which was Ph.D. graduate student in Biomedical Engineering, two Master levels physicist coming to us from other CAMPEP approved graduate programs. To date, one of these physicists (Mr. Anton) has completed the recently reformatted residency training program shown here (2010-2011), one has already passed his ABR orals and continues to complete the residency (Dr. Zheng, expected to complete in December 2012), and the remaining 3 continue on in the program. All five have been admitted to the ABR certification process. Funding for just one candidate was considered to be CAMPEP compatible, namely in 2010 this individual was allowed to pursue the structured residency rotation outlined in this document as part of his assignment (See support letter – Ms. Mangosh and Dr. Machtay). The four others are permitted to participate in the clinical rotations and competencies training but the stipulations of their employment do not specifically provide set aside time. For these individuals, residencies can last for three or more years for them to complete their training and prerequisites.

Going forward (since 2012), the full-time residency training program will have a duration of 2 years per candidate. For the full-time residency program we will only accept candidates graduating from a CAMPEP approved graduate program and fund only one full-time resident whose primary assignment is to participate in the training program. This fund is allocated by the department for training of a full-time physics resident.

However, in many respects, the exclusion of those talented individuals who cross our paths in a University setting with an industrial or interdisciplinary training and research background is potentially unfortunate. Another path based on our previous experience may be considered. Our request to the CAMPEP authority would be to consider these talented individuals who may have an advanced degree (such as Ph.D.) or Ph.D. student/candidate to be eligible for a part-time program. This part-time program would be of 3 years to 5 years long, depending on the status of the candidate during admission into the part-time program as well as available financial supports in the department. For example, a candidate having a Ph.D. degree will be eligible to a 3- or 4-year program and a Ph.D. student may be suitable for 5-year program. For admission in 2014, they must complete a CAMPEP approve graduate program. Out of this 3-/5-years the candidate must have 2 full years of clinical training by rotating through at least 12 modules (as detailed in Section IV.B, page 9-15). We envision accommodating 2 candidates in part-time program depending on the availability of funds (research, education, or clinical assistance) in the department. Our program is CAMPEP accredited since 2013. Currently (in 2015), we have three full-time residents.

III. Program Structure and Governance

The Department of Radiation Oncology is an autonomous department within University Hospitals Case Medical Center. All medical physics faculty have appointments at Case Western Reserve University School of Medicine or University Hospital Case Medical Center and medical physics residents are either employees of the University Hospitals Case Medical Center or affiliated employment through Case Western Reserve University. There are currently 15 medical physics
faculty, four of which (Drs. Podder, and Wessels) are directly associated with the administration of the Clinical Medical Physics Residency. We have 18 full-time physics faculty and we are expecting to increase to 20 when the Proton Therapy at Main campus is clinically operational. All faculty members are board certified by the ABR in Therapeutic Radiology. Drs. Wessels and Sohn have served as Oral examiners for the ABR in the past 7 years. The medical residency program in Radiation Oncology currently has 6 residents. There are 17 full-time physicians Radiation Oncology faculty. The department also includes the Radiation Biology Program that has 3 outstanding faculty mentors from wide ranging areas of research including Hypoxic Cancer Biology, Radiation Biology, and Radiation Oncology. Apart from the radiation biology course, the medical physics residents have convenient access to the radiation biology faculties as well as the labs. They are encouraged to contact the radiation biology program for continual information and participating in course work and research projects. Extramural funded physics research efforts include several sponsored projects from federal agencies (NIH/NCI, DoD, DoE, etc.) as well as from various foundations, industries, and pharmaceuticals.

See Appendix D for the Organizational Chart.

The Clinical Medical Physics Residency Program (CMPRP) utilizes two committees within the program: the Education Committee and the Selection Committee. The Education Committee consists of the Core Medical Physics Faculty (Drs. Podder, Cheng, Geis, Sohn, and Wessels), the Dosimetry Supervisor (Mr. Dobbins), Radiation Oncologist, (Drs. Ellis, Biswas, Mansur), Radiation Biology (Drs. Oleinick, Welford), Chief Radiation Oncology Resident, Chief Medical Physics Resident, Department Administrator (Ms. Denise Moore) and Department Chair (Dr. Machtay). This committee meets once a year to review the curriculum content and revise it, if required. The CMPRP Selection Committee consists of Drs. Podder, Cheng, Geis, Sohn, Colussi, Wessels, Ellis, Biswas, Mansur, Machtay, Oleinick, Welford, Mr. Dobbins and Chief Medical Physics Resident. This committee meets following each interview cycle. The program Director is selected by the CMPRP Education Committee. The Co-director of the program is selected by the director of the program in consultation with the CMPRP Education Committee. The program is governed by the director of the program with the help from Co-directors. The Director reports relevant matters to the Division Director and the Chair of the department.

The departmental facilities are substantial, featuring a wide array of treatment modalities and an adequate number and variety equipment (details can be found in Section VII.C.). Nine faculty members of the Medical Physics Division are based full-time in the Radiation Oncology department on main campus. Eight additional physicists are full time at 9 off-site facilities (Satellite Centers) which are located in the range of 9 - 65 miles from the main campus (more information are in Table 1). All the full-time physicists (15 in total) and one part-time physicist at main campus are part of the team teaching physics residents and MD residents. A majority of the teaching team are faculty of the Case Western Reserve University. All physicists are well qualified to assist in the Physics residency training program either through didactic lectures or mentoring for clinical competencies as described in Section C. Residents in medical physics are also engaged in assisting annual linear accelerator QA and IMRT QA at Satellite Centers.

Currently we have the funding capacity for 3-4 Medical Physics residents. All current trainees (Dr. Zheng, Mr. Fabien, Mr. Rhodes, and Mr. Albani) have passed ABR Parts 1, 2, and/or their ABR oral exam. Because of specific funding restrictions mandated by a CAMPEP-approved program, only one resident position will be available in 2014. The residents will be recruited through national search by placing advertisement in suitable media such as the AAPM website and hospital/university websites. In the past, a large number (40 – 60) of potential applicants were solicited under the advertised heading of “entry level or junior physicist position”. Applicant CV’s were first ranked in terms of suitability to the position and then phone interviews were conducted with applicants ranked from 1 – 10. Usually, the top 2 to 3 applicants were brought in for an interview and seminar paid by the department. Candidates were interviewed by 8 – 10 members of the Faculty and Staff of the
Department and written evaluation were filled out. Going forward, the recruitment and interview process will be carried out as outlined in Sections V (A, B). Residents are required to complete at least 12 of the 15 rotation modules during 2 years of clinical training (details are in Section IV). Incoming residents are provided with written copies of department policy regarding expected performance and training schedule (Section IV and Appendix E) as well as expected behavior in the clinical and department. Upon successful completion of the training, a certificate of completion of residency training is issued with the medical physics Director, and department Chair as signatories.

Table 1: A brief statistics of the department.

<table>
<thead>
<tr>
<th>RT Centers</th>
<th>Distance from Main Campus</th>
<th>No. of Physicians</th>
<th>No. of Physicists</th>
<th>Major Tx equipment</th>
<th>No. of pt. treatment per day (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Campus (CMC &amp; SCC)</td>
<td>0 miles</td>
<td>8</td>
<td>9</td>
<td>Linac (3), Mabetron (1), GammaKnife (1), Cyberknife (1), HDR (1), Proton (yr. 2016)</td>
<td>82</td>
</tr>
<tr>
<td>Chagrin Highlands Health Center SCC</td>
<td>9 miles</td>
<td>1</td>
<td>1</td>
<td>Linac (1)</td>
<td>35</td>
</tr>
<tr>
<td>Westlake Health Center</td>
<td>16 miles</td>
<td>1</td>
<td>1</td>
<td>Linac (1)</td>
<td>22</td>
</tr>
<tr>
<td>Southwest General Hospital</td>
<td>19 miles</td>
<td>1</td>
<td>1</td>
<td>Linac (1), Tomo (1)</td>
<td>20</td>
</tr>
<tr>
<td>Lake Health/ Univ. Hospitals SCC</td>
<td>25 miles</td>
<td>2</td>
<td>1</td>
<td>Linac (2), HDR (1)</td>
<td>38</td>
</tr>
<tr>
<td>Geauga Med. Center SCC</td>
<td>27 miles</td>
<td>1</td>
<td>1</td>
<td>Linac (1)</td>
<td>15</td>
</tr>
<tr>
<td>Mercy Medical Center</td>
<td>32 miles</td>
<td>1</td>
<td>1</td>
<td>Linac (2)</td>
<td>32</td>
</tr>
<tr>
<td>Firelands Regional Medical Center</td>
<td>65 miles</td>
<td>1</td>
<td>1</td>
<td>Linac (1)</td>
<td>15</td>
</tr>
<tr>
<td>Parma Comm. Gen. Hospital</td>
<td>16 miles</td>
<td>1</td>
<td>1</td>
<td>Linac (1)</td>
<td>16</td>
</tr>
<tr>
<td>Portage Medical Center</td>
<td>37 miles</td>
<td>1</td>
<td>1</td>
<td>Linac (1)</td>
<td>(new)</td>
</tr>
<tr>
<td><strong>TOTAL =</strong></td>
<td><strong>17 + 2 part-time</strong></td>
<td><strong>18 + 3 part-time</strong></td>
<td><strong>Linac (14), Mabetron (1), Tomo (1), GammaKnife (1), Cyberknife (1), HDR (2), Proton (yr. 2016)</strong></td>
<td><strong>275 (approx.)</strong></td>
<td></td>
</tr>
</tbody>
</table>

Note: No resident is required to go to Firelands Regional Medical Center due to the long travel.

**IV Training Requirements**

**A. Requirements for Successful Program Completion**

The Clinical Medical Physics Residency Program is 2 years in length to include a minimum of 12 rotations, attendance at case conferences, recommended readings, a maximum of 2 didactic courses, written report assignments, and oral examinations. In addition to the experiences from didactic training and clinical rotations, the Medical Physics residents receive clinical training through their participation in monthly and annual quality assurance on the linear accelerators, perform patient-
specific IMRT quality assurance measurements with a gantry-mounted diode array and/or with film and ionization chambers as well as perform electron cutout measurements. The resident will become familiar with all aspects of treatment planning (from manual calculation to computer-assisted planning) for both electron and phone clinical cases. As the resident progresses through the clinical rotations, they begin to participate in post-planning and weekly chart review, high dose rate brachytherapy quality assurance, and assist the “physicist of the day” providing first response physics support to all activities within the clinic. Attendance in required courses (if any) and required number conferences (75% attendance) are mandatory. The resident is expected to participate in research studies and publish in scientific conferences/meetings such as AAPM and ASTRO as well as in journals. The resident must follow the department policy and behave as per clinical, departmental and institutional norms. The progression of the resident through these clinical responsibilities is evaluated and discussed with the resident during regular weekly meetings with the program directors. The purpose of these meetings is to discuss with the residents their progression through the program; i.e., successful completion of each rotation, participation in conferences and courses, their evolution in QA participation, and general performance within the department. These meetings also provide the residents an opportunity to voice any concerns they may have about the learning environment. Minutes of the meetings are taken and stored on the L-drive of a server computer which is accessible to department staffs and residents.

B. Design and Content

Medical physics residents are trained by rotating through a minimum 12 (core) out of 15 possible comprehensive clinical and didactic rotations (details are below in this section and also in Appendix F). Each rotation has an evaluation for the resident’s performance at the end of the rotation (Appendix G). Written acceptance of the Clinic Module and/or graded Radiation Laboratory are administered and reviewed following each clinical rotation. All core rotations (total 12) must be completed for the resident to be eligible for completion of the program requirements. However, the resident is encouraged to complete all 15 rotations.

The evaluation is specified either as a written “Clinical Competency” or graded “Radiation Laboratory” review of the rotation subspecialty. The highlights of the knowledge base acquired and the learning opportunities they experience in each rotation are summarized below in the order experienced by the resident.

Orientation of New Resident: A new resident starts with a two week long formal rotation in the department and facilities to become familiar with the department and staff as well as to become comfortable in the work environment. A senior medical physicist (normally the Director or Associate Director of the program) is in-charge of this orientation. Details regarding new resident orientation are provided in Section V.

1. Dosimetric Systems rotation (core): Two weeks orientation of the new resident is followed by the Dosimetric Systems rotation which is the first in the series of the 15 rotations (see rotation schedule in Appendix E). During this rotation, the medical physics resident develops a basic understanding of the design, characteristics, and clinical limitations of several radiation measurement systems: ionization chambers, radiographic and radiochromic film, diodes, thermoluminescent dosimeters, diode arrays and ion chamber arrays. All radiation measurement systems to be used by the resident throughout the program are to be operated by the resident during this rotation under the supervision of a qualified Medical Physicist. During this process the resident develops an understanding of the specifications and capabilities of these systems. The resident also develops an understanding of the design and utility of multiple phantom systems, with the most complex system (3D water tank) being operated by the resident during linear accelerator (LINAC) annual QA and calibrations. The resident compiles the signed clinical module and associated documentation regarding the learning opportunities that were experienced during the rotation. The rotation concludes with an oral examination given by the mentor who is a qualified staff physicist. For more details see Appendix F.
2. **Linear Accelerator (LINAC) Acceptance Testing/ Commissioning/ Annual QA rotation (core):**

During this rotation, the medical physics resident performs the tasks necessary to accept and commission a LINAC, including the annual QA of the system. The resident will develop an understanding of linear accelerator fundamentals relevant to commissioning, beam optics, flattening, and control parameters, collimation, beam specs and non-beam specs, and more. Residents will also determine the data necessary to commission 1 photon and 1 electron beam in the Pinnacle treatment planning system, collect that data, and format it for commissioning, as well as determine the data necessary to perform MU calculations for 1 photon and 1 electron beam. Finally, an Annual Quality Assurance procedure will be performed for one of the systems during this rotation. The resident compiles the signed clinical module and associated documentation regarding the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the mentor. For more details see Appendix F.

3. **TG-51 Calibration and MU Calculations rotation (core):**

Under the supervision of a staff physicist, the medical physics resident performs an accelerator calibration using the AAPM's TG-51 protocol. The resident generates a report of his/her results for the calibrated accelerator. The report will include a summary of the processes describing the individual steps that were taken to perform the calibration. The MU calc portion is designed for residents to develop the knowledge base required for MU calculations. The concepts and terminology behind these calculations (TMR, PDD, PSF, CSF, ISF, OAR, WF, TF, VWOAR, etc., Clarkson integration, Day’s method, etc., calculation Point’s Eye View and multiple source models, surface irregularities, tissue inhomogeneities, electrons) is covered. During the rotation the resident checks with the therapists or the “physicist of the day” for the Sim and Treat cases, performs the calculations from the field data in Mosaiq, and independently verifies the results provided by the Pinnacle treatment planning system. Beam data collection skills may have been learned in other rotations, but if not, time will need to be scheduled on the machines for this purpose. The resident compiles a written report detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the mentor. For more details see Appendix F.

4. **TPS Modeling/ Acceptance/ Commissioning rotation (core):**

The TPS modeling rotation provides the medical physics resident the opportunity to accept and commission a three-dimensional treatment planning system. During the rotation resident will determine all input data needed to characterize the CT scanner, linear accelerator, photon beam energy, and electron beam energy. The resident will utilize data acquired during the previous rotations to commission the system for photon and electron beam energy and compare the results with measurements. The resident is expected to learn each component of the beam modeling within the planning system, as well as treatment planning dose engines for both photons and electrons. The resident will learn to evaluate their results in the context of published literature including task group reports. The resident compiles clinical module detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the mentor. For more details see Appendix F.

5. **Treatment Planning rotation I (core):**

This rotation is the resident’s introduction into treatment planning, which includes observing the Medical Dosimetrists during the treatment planning process of multiple anatomical sites (Brain, Head and Neck, Lung & Esophagus, Breast, Abdomen & Rectum, Pelvis & Bladder, Skin, Sarcoma, whole CNS, and Prostate) and develops treatment plan for each site observed. Additionally, the resident will develop an understanding of the different 3D photon beam dose algorithms, electron beam dose algorithms, non-dosimetric calculations performed by the planning system (e.g., DRRs, contouring tools, etc.), and dose evaluation tools. The resident performs treatment plans cases for wide range of anatomical sites, transfers all data to required information systems, and performs all required quality assurance for those plans. The resident compiles a clinical module detailing the learning opportunities that were experienced during the
6. Treatment Planning rotation II (core): This rotation is focused on Intensity Modulated Radiation Therapy (IMRT) and Volumetric Modulated Arc Therapy (VMAT). The medical physics resident will be introduced to optimization, critical organ doses, parallel vs. serial organs, typical dose-volume constraints, and dose calculation algorithms specific to IMRT/VMAT, film as a dose measuring device, small field dosimetry, and the basics of imaging for IMRT/VMAT. During the rotation, residents will follow a patient from the CT scan process all the way through the initial treatment delivery. This will require shadowing the CT therapists, the dosimetrist, the medical physicist, and the linac therapists. With the first patient, it will be observation. With the second patient, it will be supervised performance of the tasks. With a phantom, it will be an independent performance of the tasks. There are a fair number of IMRT/VMAT patients (H&N, Lung, GI and GU) in our department, and there will be no lack of opportunities. The resident will work through the Competency Module detailing the learning opportunities that were experienced during each part of the process. The resident compiles a clinical module detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the mentor. For more details see Appendix F.

7. Brachytherapy rotation (basics, LDR and HDR) (core): The rotation is structured to provide the medical physics resident with knowledge of brachytherapy basics and brachytherapy applications. The resident should develop a knowledge base including radioactive decay, characteristics of radioactive sources, source calibration, calculation of dose distributions, different systems of implant dosimetry and implantation techniques. Basic definitions in dose specification will be covered, along with an overview of remote afterloading systems and various applicators. During the rotation the resident will observe the medical physicist during brachytherapy procedures, perform source calibration checks, and perform computerized and hand calculated dosimetry to include fundamental calculation techniques. The resident should develop the imaging and treatment planning of brachytherapy, along with patient-specific and system quality assurance. The resident will learn the principles of both interstitial brachytherapy (e.g., prostate seed implantation for LDR) and intracavitary brachytherapy (e.g., cervix, uterus/vagina treatment for HDR). During the rotation the resident will assist the medical physicist during brachytherapy procedures and reproduce treatment plans and quality assurance tests for multiple procedures. The resident compiles the signed clinical module and associated documentation regarding the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the mentor. For more details see Appendix F.

8. Room Design, Radiation Protection and Radiation Safety rotation (core): The shielding and design rotation is structured to give the medical physics resident experience in designing facilities appropriate for radiation oncology equipment. The resident is asked to design the shielding for different types of rooms typically found in a radiation oncology department, including a high energy linear accelerator vault and an HDR vault. The resident consults with the physics mentor during the rotation to discuss the specifics of the design process. The mentor will propose alternate scenarios that force the resident to re-work the design using different clinical or occupancy criteria. The resident is also expected to perform portions of a radiation survey around existing vaults to gain practical experience in obtaining and analyzing low level radiation data. The resident compiles a written report detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the mentor. For more details see Appendix F.

9. Imaging for Simulation, Planning and Treatment Verification rotation (core): During this rotation, the medical physics resident will gain an understanding of the Radiotherapy Simulation process, ranging from CT-based virtual simulation to 4DCT and the utility of multimodality imaging. Also, the resident will follow a patient through the CT (PET/CT) simulation process, with an emphasis being on geometric aspects of the process (setup geometry specification, immobilization, marking,
tattoos, CT including x-ray technique, and transfer to planning system). The resident is expected to understand the virtual simulation process and perform a virtual simulation procedure on a phantom – from start to finish with portal film verification. Finally the resident will observe the use of combined imaging modalities in the simulation process (such as MRI and CT for SRS) and follow a patient through the image-guided setup simulation process. The planning and treatment verification part of the rotation is structured to provide the medical physics resident with knowledge of portal imaging systems used either during the simulation/planning process or during treatment verification. The resident will develop knowledge in basic medical imaging physics and the terms that impact image quality, the design and application of different electronic portal imaging systems, and the necessary processes for commissioning and continuing quality assurance of portal imaging systems. During the rotation the resident will perform monthly and annual quality assurance on 4DCT and different portal imaging systems. The resident compiles a written report detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the mentor. For more details see Appendix F.

10. Image Guided Radiation Therapy (IGRT) rotation (core): During the IGRT rotation, medical physics residents will participate in the clinical implementation of prospective and retrospective CT image acquisition, gated treatment delivery, treatment planning process for IGRT (including mult-modality image registration and fusion), and data export/import into each system. The resident will observe and participate in the IGRT treatment planning and delivery process and understand the functionality of the systems utilized. Quality assurance of every aspect of each IGRT system will be studied, from image acquisition through verification and treatment delivery. The resident compiles the signed clinical module and associated documentation regarding the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the mentor. For more details see Appendix F.

11. Floor Physicist (i.e., Physicist of the Day) rotation (core): This rotation will provide the resident with the fundamental knowledge and practical training for proficiency with day-to-day clinical operations as the floor physicist. Resident performs all clinical tasks under the supervision of a senior staff physicist, i.e. the mentor. The resident is expected to learn and become experience with all the details about the clinical tasks that need to be performed in the clinical workflow and the responsibilities of the physicist on clinical duty. The performance of the resident is evaluated with an oral examination given by the mentor. For more details see Appendix F.

12. Professional and Process/Practice Issues rotation (core): This module contains two sub-modules: A - Professional (Legal and Ethical) Issues and B – Process (Failure Mode and Effect Analysis (FMEA) and Total Quality Management (TQM)) Issues. More details about these two sub-modules are provided below.

A. Professional (Legal and Ethical) Issues: In this rotation the resident will be give an overview of his/her legal and ethical commitments as a medical physicist. The resident will learn about current NRC regulations and other legalities involving federal and state regulations and enforcements. The resident will also learn about various ethical aspects such as ethical principles, ethical encounters or dilemmas, clinical conflicts, public responsibility, employer/employee relationships, conflict of Interest, human/animal research principles, scientific principles, scientific misconduct and publication practices. The resident is expected to be very familiar with the legal and ethical issues related to medical physics practice.

B. Process/Practice (FMEA & TQM) Issues: In this part of the rotation the resident will be provided an overview of strategies and methods for the total quality management (TQM) of radiation therapy – how to improve the level of quality control and quality assurance in radiation therapy by establishing quality control system in radiation therapy, standardization of radiation therapy workflow, strengthening quality control of devices and physical technique and paying attention to safety protection and staff training. Resident will learn about failure mode and effect analysis (FMEA) and
how to use/apply FMEA in clinical procedures and/or in radiation therapy. The resident will do a small project on FMEA related a clinical procedure/process (e.g. prostate seed implant, or a HDR procedure or IMRT where a failure occurred/detected) as a part of the practice for FMEA. During this project the resident will thoroughly analyze the process failure and assess the severity. Based on the analysis suggestions for rectification or improvement will be made and associate professional (legal and/or ethical) as well economical issues/implications will be analyzed. The resident is expected to thoroughly understand the concept of FMEA and its implementation as well as how to improve overall quality of any radiation therapy process or system by using FMEA. At the end of this rotation the resident's performance will be evaluated with an oral examination taken by the mentor. For more details see Appendix F.

13. Stereotactic Radiosurgery rotation: The SRS rotation is designed to give the medical physics resident experience with a stereotactic radiosurgery systems – GammaKnife and/or CyberKnife. The resident first reviews the key principles of SRS then actively participates in both the treatment process and the quality assurance process. The treatment process for a patient involves image acquisition, treatment planning, and treatment delivery. The resident will participate alongside a staff physicist in clinical SRS treatments during this rotation. The resident compiles the signed clinical module and associated documentation regarding the learning opportunities that were experienced during the rotation. The resident is given an oral exam by the mentor at the end of the rotation. For more details see Appendix F.

14. Special Procedures rotation: Total Body Irradiation (TBI), Total Skin Electron Irradiation (TSEI), and Intraoperative Irradiation (IORT). This rotation prepares the medical physics resident to develop and commission a total body irradiation program. The resident will develop knowledge of the clinical basis for TBI, equipment, dosimetry issues in TBI, field uniformity, beam energy/penetration, blocking, beam data for TBI, and hand calculations. During the rotation the resident will observe/attend a TBI simulation, fabricate the blocks under supervision, verify the block attenuation on the machine, attend/observe in-vivo dose measurements for TBI, perform hand calcs and compare to diode results. Additionally, the resident gains an understanding of total skin electron and intraoperative irradiation. The resident will reinforce their basic knowledge of electron beam dosimetry and develop knowledge in the clinical basis and beam data required for TSEI and IORT, equipment, dosimetry issues in TSEI and IORT, field uniformity, beam energy/penetration, field shaping, collimation and patient alignment, collimation and energy adjustment. During the rotation the resident will develop an understanding of intraoperative cone effects on electron beam, as well as the effect of different electron applicators (including IORT cones and TSEI beam definer on effective source position). Electron shielding using lead sheets vs. cerrobend blocks will also be measured. The resident compiles a written report detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the mentor. For more details see Appendix F.

15. Proton Therapy rotation: In this rotation the resident will be given an overview of the proton therapy techniques. The resident will learn through observation and direct participation in the clinical physics activities. The resident will participate in technical aspects of patient care under the supervision of staff physicists. These activities include quality assurance testing (daily, monthly, annual, patient-specific), patient treatment simulation, treatment planning, review of patient positioning, beam/range modulating device design and application. The resident is expected to learn and gather experience in both technical aspects and clinical aspects of proton therapy. At the end of the rotation the resident's performance will be evaluated by taking an oral examination by the mentor. For more details see Appendix F. This rotation is expected to start from 2015-2016.

16. Research rotation: Resident may opt for dedicated research time, provided he/she is in a good position to complete the 12 core rotations successfully and on-time. Research topic(s) can be selected based on the resident's interest and availability of a suitable guide/supervisor.
C. Sample Training Plans

Didactic Training
Clinical conferences, seminars, small discussion groups, journal clubs and one-on-one instruction are integral part of the program. The resident will participate in the following:

- Medical Physics Resident Meeting (bi-weekly)
- Radiation Oncology Chart Rounds conferences (weekly)
- Radiation Oncology Grand Rounds conferences (bi-weekly)
- Physics Division Meetings (monthly)
- Medical Physics Seminars (bi-weekly/monthly)
- Site-specific Tumor Board conferences (vary)
- Assigned readings with course work or clinical rotation (as required)

Timeline for meetings and courses:

<table>
<thead>
<tr>
<th>Fridays: 2:30-4:00 pm</th>
<th>Radiation Oncology Chart Rounds conferences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday, Wednesday, Thursday: 8:00 – 9:00 am</td>
<td>Oncology case conferences and Grand rounds</td>
</tr>
<tr>
<td>Wednesday: 3:00 – 4:00 pm</td>
<td>Physics Residents meeting</td>
</tr>
<tr>
<td>Every 2nd Monday of the month</td>
<td>Physics Division meetings</td>
</tr>
<tr>
<td>Summer, Fall, &amp; Spring Semester: 1.5 hours per week</td>
<td>Medical Physics of Radiation Oncology (optional)</td>
</tr>
<tr>
<td>Summer &amp; Fall Semester: 3 hours per week</td>
<td>Radiation Biology (optional)</td>
</tr>
</tbody>
</table>

The following two courses offered by the Radiation Oncology department are now combined for the Medical Physics residents and the Radiation Oncology residents. These courses are optional for the Medical Physics residents, i.e. any Medical resident can attend any lecture if he/she and/or the mentor/director feel that the resident will benefit attending any particular lectures.

Medical Physics of Radiation Oncology (optional): This course is designed to help the student better understand the principles and application of physics in radiation therapy. At the conclusion of the course, the student should understand the following areas: Atomic and Nuclear Structure, The Production of Photons and Electrons, Radiation Interactions, Treatment Machines and Simulators, Photons and X-Rays, Electron Beams, External Beam Quality Assurance, Radiation Protection and Shielding, Imaging for Radiation Oncology, Three-dimensional Conformal Radiation Therapy (3DCRT) including International Commission on Radiation Units (ICRU) Concepts, Intensity Modulated Radiation Therapy (IMRT), and Beam-Related Biology, Assessment of Patient Setup and Verification, Importance of Image-guidance in Radiation Therapy, Importance of Tumor Motion Management, Special Procedures, Brachytherapy, Hyperthermia, and Particle Therapy.


Radiation Biology (optional): This course provides a comprehensive introduction to all modern principles necessary for developing a strong working knowledge of Radiation Biology. Areas of focus include radiation chemistry, the physics of interaction of ionizing radiation with biological material, radiation protection, radiation mutagenesis and carcinogenesis, radiation therapy and the effects of radiation on signal transduction and gene expression. The emphasis is placed on mammalian
radiobiology; however, principles derived from lower organisms are also discussed. Students will attend 1 didactic lecture/wk (1.5 hrs) given by experts on each respective topic, as well as making oral and written presentations on student selected cutting edge topics relevant to Radiation Biology in the 21st century. Radiation biology topics to be covered include: Radiation Protection, Human Radiobiology, Metabolic Oxidative Stress and Radiation Effects, Radiation Therapy, Radiation Mutagenesis, Radiation Carcinogenesis, Radiation Teratology, Radiation-induced DNA Damage and Repair, Radiation Effects on the Cell Cycle, Radiation Effects on Signal Transduction and Gene Expression, Bystander Effects, Genomic Instability, Radiation-induced Adaptive Responses, and Modes of Cell Death.


**Clinical Rotations**

During each rotation the residents are expected to acquire all necessary data and information pertinent for the rotation to establish the relevant procedures for their own Radiation Oncology department. For example, the MU calculation rotation includes the acquisition of all measurement data, tabulation of data, and creation of independent MU calculation tools to perform this task. They may spend significant time reviewing the literature for the rotation (AAPM Task Group reports, journal publications, textbook, and other reference materials) in their preparation for the written report and oral exam for the rotation. In addition to the rotation, residents are participating clinically in several ways, depending on their demonstrated competency and evolution within the program; routine quality assurance of all machines and equipment, IMRT measurements, electron cut out measurements, treatment planning checks, weekly chart reviews, brachytherapy planning and procedures, and responding to all clinical physics requests following the “Physicist of the Day.” Details of the elements of clinical training of each rotation are provided in Appendix F.

**Example Daily Schedule:**

Below is a summary of a sample day on any given rotation. This does not reflect individual rotation requirements.

7:30 – 8:30 a.m. Conference/ Grand Rounds/ Seminar

4:00 – 5:30 p.m. Medical Physics of Radiation Oncology (Tuesday) - optional
OR
Radiation Biology (weekly 8:30 am; Monday) - optional

Throughout the day: (a) review literature, (b) collect and analyze data, (c) document findings, (e) meet with mentor, (f) called to machines to observe/perform procedures, (g) work on rotation report and/or work on assignment/task given by the rotation mentor.

5:00/5:30 – 7:00 p.m. IMRT QA, monthly QA, electron cut-out, QA documentation analysis and reporting.

Teaching opportunities for residents: Medical Physics residents have the opportunity to teach Medical Radiation Oncology residents in the basics of Therapeutic Radiological Physics. Teaching any of these lectures will depend upon the medical resident’s suitability and interest. The presentation of a CAMPEP approved seminar has served in the past as an excellent vehicle to demonstrate abilities in a special topic or research area.
D. Evaluation of the Curriculum

The mentor responsible for a given rotation proposes the creation or modification of the rotation’s design and content. At the end of each rotation, the resident is also given the evaluation form for evaluating the content of the clinical rotation as well as to evaluate the faculty mentor (see Appendix H). The resident submits the evaluated form and suggestions to the program director. Additionally, at the end of the residency program (at the end of final rotation), the resident is asked to evaluate the whole program and make suggestions for improvement (see Appendix I, also see Appendix J). The proposal by the mentor and the comments by the residents are then reviewed by the program director and associate directors for approval and implementation. Suggestions about content, effectiveness, and areas of improvement of the program from each of the mentors of the rotations and the residents are reviewed and compiled by the program director and associate directors. The compiled review report is then presented to the CMPRP Education Committee for further discussion and implementation. The clinical rotation contents and the residency program curriculum are revised as per any modifications approved by the program director and/or the CMPRP Education Committee. Then the modifications are informed to the residents in writing. Any substantial modifications are implemented in such a way so that they do not affect the current residents adversely.

V. Residents

A. Admissions

The applications are primarily accepted through AAPM MP-RAP (CAP). The admissions process begins once application materials are received. A folder is made for the candidate and an email is sent to let them know we received their application materials. This email includes the following links to provide them with information about our program, our institution, benefits, the field of medical physics, and the community of University Heights, Cleveland, Ohio.

Medical Physics Residency Program at the University Hospitals Case Medical Center
University Hospitals Benefits Program:

Educational Requirements:
A Masters or Doctoral degree from a CAMPEP accredited program is required for 2 year full-time residency program. Candidate for 3-/5- year part-time program (i.e., Research-Residency program) may be selected for residency from a non-CAMPEP graduate program. Candidate with PhD degree will be eligible for 3-/4-year program and PhD students for 5-year program. These residents in part-time program must complete two year full residency equivalent training (completing at least 12 core modules listed in Section IV.B.); their research work will not be counted as part of clinical training; they must complete remedial courses (if any) as per CAMPEP guidelines. As mentioned in Section II, these candidates for part-time (Research-Residency) program must have graduate degree from a CAMPEP approved program to be eligible for the American Board of Radiology (ABR) examinations and certification.

Application Requirements
Applicants will submit the following items (or as decided by the AAPM MP-RAP) for initial evaluation:

1. Official college and graduate transcripts
2. A personal essay describing career goals and interest in medical physics
3. Three letters of recommendation from the applicant’s college/graduate instructors, and/or employers.
4. A curriculum vitae, if the applicant has relevant work experience.
After the deadline, all complete applications are divided equally among the faculty physicists to review. The program director (with the help of senior faculty members) reviews and ranks all applicants. They rate each applicant as one of the following and include rationale:

- Do invite to interview
- Don’t invite to interview
- Undecided

The faculty physicists and the program Directors (Selection Committee) meet to review application evaluations. If candidates receive (2) Do Invite rankings or (2) don’t invite rankings, they are not discussed. If they receive (2) different or undecided ranks, they are discussed. The faculty physicists determine the list of candidates for whom an invitation for interviewing is extended. Approximately 5-7 candidates are invited to interview for each medical physics resident opening. They are invited via email, with the invitation letter and agenda as an attachment. Ranked candidates are listed with the MP-RAP or NMS.

If an applicant is not chosen to invite for an interview, he/she is informed by an email about our decision. Up to 5-7 candidates can be brought over a 2 month period. They rotate through interviews with the Selection Committee:

- Radiation Oncology Chair or Vice Chair or Radiation Oncology Medical Residency Program Director(s)
- At least 3 faculty physicists
- Physics Residency program Director(s)
- Dosimetrist, Radiobiologist or lead Therapist
- Chief Physics Resident

Each candidate may be asked to give a seminar (as schedule permits) that is announced in advance in the department and relevant sections of the institute. Each Selection Committee member submits an evaluation form for each interviewee to the program coordinator. The coordinator enters all evaluations into a table that is distributed to the Selection Committee prior to the selection meeting. The evaluation scores are also entered into a spreadsheet so each candidate is ranked by average score across interviewers. In the selection meeting the strengths and weaknesses of each candidate are discussed and each member of the Selection Committee ranks the candidates. The composite ranking is provided to the program director for the selection of candidates.

**B. Recruitment Efforts**

We recruit via AAPM MP-RAP and national matching. We have a close working relationship with the Case Departments of Biomedical Engineering, Physics, and Computer & Electrical Engineering. Emails were sent to these departments, requesting that they share information about our residency program with their graduate students. The application due date is mentioned in the advertisement and emails. The admission process takes about 6-8 weeks.

**C. Enrollment**

Our program capacity is 4 full-time residents (2-year program). Two residents are funded directly by the Department of Radiation Oncology, School of Medicine Case Western Reserve University (SOM – CWRU) and UHCMC, 1 position is slated to be funded asPhysicist Assistant according to HR position description at UHCMC, and the fourth position is currently sponsored by PRN funding. Minimum funding for this program has been specified at 1-2 residents per 2 year cycle. The salary or benefits for the two funding sources (SOM – CRWU and Physicists Assistant) are projected to be comparable with other medical physics residency programs.

**D. Evaluation of Resident Progress**

After each rotation, the resident submits a written report or clinical module rotation form (see Appendix F). The written report (if any) of the completed module should not be more than ten pages long.
containing six sections as Introduction, Materials & Methods, Results & Discussion, Conclusion, and References. An oral examination is administered by the mentor at the end of each rotation (evaluation form is in Appendix G). This is evaluated and graded by the mentor and/or associate directors along with an evaluation of the resident's ability to articulate their knowledge developed during the rotation and ability to respond to oral examination. The mentor discusses the conclusions with the resident, and provides the resident and the program director a copy of the mentor's evaluation for the rotation. The evaluation form includes written report grade, oral exam grade, comments, recommendations, overall recommended grade of pass, fail or conditional pass and remediation if conditional pass. The pass/ fail in the written report and/or the oral examination is at the discretion of the mentor and/or associate directors and/or program directors. Any disagreement are discussed and resolved rationally. The program directors review the performance evaluations with the resident during the resident’s quarterly review. Any critical issues such as fail or conditionally pass are immediately discussed with the program director.

Residents meet with the program directors and associate directors weekly to discuss their progress. These meetings are useful for providing guidance and praise/criticism. With the resident, the program director reviews the rotations since the last progress meeting, conference participation, recommended readings, remediation, if necessary, and outstanding assignments. Minutes are taken at these meetings. We recognize the amount of time spent by the resident in writing their reports and preparing for their oral exam is substantial. We view this process as an important tool in the resident's successful learning progress, and must be balanced with the clinical responsibilities managed by the resident. Resident discusses the evaluation of their mentors during their quarterly review with the program director. This information is received and consolidated by the program director, and discussed by the director with each mentor annually (or as needed). Examples of evaluation forms are included in Appendix G.

It is to be noted that a resident can continue the clinical rotation even if he/she fails in maximum one rotation. He/she will be given two additional opportunities to clear the failed or conditionally passed rotation. The failed rotation must be cleared before starting a new rotation. However, the resident can start a new rotation if he/she is conditionally passing a rotation. The resident cannot have more than two conditionally pass rotations at any point of time. To make up the lost time, the resident’s schedule has four months allocated for electives (Elective I-III) in Appendix E. The program director and associate directors will discuss with the resident and try to understand the resident’s cause of failure in the rotation. The resident will be given opportunity to spend more time in the clinic with the mentor and other physicists as well as will be provided with supplemental reading materials and necessary guidelines to succeed.

Guidelines for Resident Dismissal

Residents and fellows may be discharged by the Program Director for failing a clinical rotation, failing a required course, unprofessional or unethical conduct, illegal actions, or gross unsatisfactory performance. A decision not to renew a contract made within 4 months of expiration or a decision to cancel a renewed contract before the beginning of the contract period shall be considered a discharge. After explaining the grounds for discharge to the resident, the Program Director shall give written notice of the discharge to resident, including a statement of the grounds for the action.

Individual disciplinary actions (except suspension or discharge) and other departmental actions affecting the individual resident may be reviewed by a committee if an affected resident requests such a review within ten days of his or her becoming aware of the action. The committee will be selected by the Program Director and composed of at least two active clinical staff members and one resident. The only exception in to this review is when the resident has already been afforded an opportunity to present information to such a committee which advised the Program Director before the action and the resident has been informed of the Program Director’s action in writing. After its review, the committee
will submit its recommendations to the Program Director. If the committee recommends a change in the action, the Program Director will then reconsider the action, giving due consideration to the review committee’s recommendation. The resulting decision of the Program Director shall be provided to the resident and the Chair of the Department of Radiation Oncology in writing and shall be final, unless the resident believes that the action could significantly threaten his or her intended career development. Actions will not be postponed while they are being reviewed, unless the Program Director in his or her discretion decides to do so.

If the resident submits a written request to the Chair of the Department of Radiation Oncology within 10 days of receipt of the Program Director’s written decision (described in the previous paragraph) and the request includes the reasons for the belief that the action could significantly threaten the house staff member’s intended career development, the Chair will review the decision, if he or she finds the alleged threat to be significant. The Chair may seek the advice of an ad hoc committee as part of the review. If the action is non-renewal of a contract prior to completion of the training program, the decision of the Chair shall be given to the resident and Program Director in writing and is final. For all other actions, if the Chair recommends that the Program Director modify the decision, the Program Director will then reconsider the action, in consultation with the Chair. The resulting decision of the Program Director shall be provided to the resident and the Chair in writing.

E. New Resident Orientation

Here is an example of a new resident orientation schedule:

Week #1:
Monday
8:30 a.m. Report to Program Director, Radiation Oncology (B181/ B153A)
1:00 p.m. Receive Badge – Human Resources Office
          Take ID card request with you. See Ms. Edie Cawley (B153D)
2:00 p.m. Health Screening (will need to bring immunization records, green
          hospital addressograph card (pick this up at registration in main lobby on way to screening) and photo ID badge). Health Screening will be in HR dept.

Tuesday
8:00 a.m. – 5:00 p.m. New employee orientation, including departmental organization,
                      facilities, staffing, safety (rad and non-rad), basic policies and
                      procedures, and Mosaiq training

Wednesday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: Patient Treatments on Linear Accelerators
                      (Radiation Therapist)

Thursday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: Patient Simulation in CT; MRI (Radiation
                      Therapists)

Friday
8:00 a.m. – 10:30 a.m. Shadowing in Seidman CC: Treatment Planning in Dosimetry
                      (Dosimetrist)
10:30 a.m. – 11:30 a.m. Benefits Orientation with House Staff
12:30 a.m. – 5:00 p.m. Shadowing in Seidman CC: Treatment Planning in Dosimetry
                      (Dosimetrist)

Week #2:
Monday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: Brachytherapy (Physicist)

Tuesday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: Stereotactic Radiosurgery (Physicist)
Wednesday
7:30 a.m. – 11:30 a.m. UHCMC Benefits Orientation – as applicable
12:30 p.m. – 4:30 p.m. Shadow a RO physician in Seidman CC

Thursday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: Physicist of the Day (Physicist)

Friday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: RO Physician and Nursing Staff

F. Safety
The following safety training and safety issues are covered in resident safety orientation, which is conducted by the Supervisor of Dosimetry:

- PPE Training
- Mandatory Reporting
- Bloodborne Pathogens
- Safety and Infection Control Test
- HIPAA Training
- Culture Diversity Training
- Patient and Staff Rights and Responsibilities
- Gowns
- Patient Safety
- CPR Certification
- Health Protection Office staff training and test (includes Radiation Safety)
- Hazard Communication Safety Training
- Hazmat Training and Test
- Fire and Tornado Plans and Procedures
- Code Blue Procedures
- Universal Precautions
- Sharps Disposal

All residents perform on-line radiation safety training and complete an exam administrated by the Radiation Safety Office during their initial two-week orientation, as outlined above. Additionally, the rotation titled “Room Design, Radiation Protection and Radiation Safety” does include radiation safety training, with the intention of the mentor to assure the residents have successfully comprehended the components of safety instructions and training on each clinical system used (e.g., brachytherapy, linac, and other high-voltage device safety) in each of the rotations throughout their training.

VI. Program Administration
A. Structure within Hospital or Medical Center
The expected process for an internal review of the program would be the same as for all programs at the University Hospitals Case Medical Center. An Organizational Chart of the Radiation Oncology within University Hospitals Case Medical Center has been provided in Appendix D. Three divisions of the Department of Radiation Oncology are: (i) Radiation Oncology, (ii) Medical Physics and (iii) Radiation Biology. First two divisions are mainly administered by the hospital (as shown in the chart in Appendix D). Division of Radiation Biology being a non-clinic entity is mainly governed by the CWRU. Faculties from all three divisions have joint appointments or affiliations with both the institutes (UHCMC and CWRU). The Organizational Chart in Appendix D shows the relationship among the three divisions. Additional information regarding the program administration and structure with department can be found in Sections III and VI.C.
B. Role of Program Director(s)
The Residency Program Director is appointed by the Division Director and the Department Chair. The current Director, Dr. Podder, is ABR certified medical physicist (therapeutic) having more than 8 years of clinical experience. He is an Associate Professor in Radiation Oncology at Case Western Reserve University. He is actively involved in teaching, research and clinical activities at UHCMC. He directly report to the physics division director. He coordinates and conducts in interview process, convening meeting, keeping track of resident’s rotation, documents, progress and resolving issues and concerns as required. The co-director, Dr. Wessels, has 35 years of experience in academic and clinical medical physics. He has been an ABR examiner over the last decade and has had experience bringing together a Ph.D. Program in Medical Physics for the college of Arts and Sciences at another University Medical Center (George Washington University 1983-1999) and a Master Degree Program in Health Physics (Health Sciences and Technology – MIT/Harvard (1981-83). Dr. Wessels is Professor of Radiation Oncology at CWRU and Director of Medical Physics and Dosimetry. He reports to the chair of the department and the vice-president of clinical operation. He assists the program director in various matters related to the medical physics residency program.

C. Committees and Meetings
The Education Committee is responsible for establishing the didactic courses and clinical rotation content. This committee consists of senior Physics Faculty, the Medical Residency Program Director, Dosimetry Supervisor, Director of Radiation Biology and Chief Resident of Medical physics (details are in section III. Program Structure and Governance). The committee meets annually. Minutes are recorded and retained indefinitely. In addition, the curriculum is an open agenda item at a monthly physics faculty meeting.

The Selection Committee is responsible for interviewing and evaluating Medical Physics residency candidates who have come to the institution for an interview. All interviewing candidates are discussed and ranked, the results of which are provided to the Medical Physics Program Director for the selection of candidates. This committee consists of all senior physics faculty, and also includes the Medical Residency Program Director, a dosimetrist, a Radiation Biologist, and the Radiation Oncology Department Chair (details are in section III. Program Structure and Governance). The committee meets following each interview cycle. Minutes are recorded and retained indefinitely. The Medical Physics Program Director chairs both the Education and Selection committees.

The program director and associate directors meet residents in weekly meeting for discussing progress, issues, concerns, and future plans. Minutes of the meetings are recorded and electronically stored in L-drive.

D. Records Available for Review
The following records are kept permanently:

1. Residency program committee minutes including:
   • Education Committee minutes
   • Selection Committee minutes

2. Resident applications:
   • Application forms
   • Transcripts
   • Candidate interview evaluations

3. Residents:
   • Training schedules
   • Rotation objectives and expectations
VII. Resources

A. Staff
Currently, there are 18 full-time and 2 part-time (9 full-time and 1 part-time physicists are in the main campus). A majority of them have PhD degrees.

B. Finances
Current Typical Financial Support for Medical Physics Residents Support:

Currently (in 2012), the salaries vary between $40,000 - 60,000 with benefits (Chief Resident – Case/UHCMC), UHCMC employee (2 residents) and without benefits (IMRT PRN staff – 1 resident). Health Insurance and Non-medical Benefits available for Case staff, UHCMC benefits or independent PRN staff. Residents are covered by the Institution’s Professional Liability Insurance for malpractices. Residents joining the CAMPEP Program at UHCMC will have a salary of $45,000 (the minimum; may go up depending on education and experience) plus the UHCMC benefit package.

Travel and Academic support: $300.00/yr (books) and one annual meeting during residency – for all residents

Typical living expenses in University Circle, Cleveland, OH
Housing: $750/month average for 1 bedroom
Utilities: $200/month
Health Care: out of pocket – varies

C. Facility

Radiation Oncology (overall)  
The Radiation Oncology Department at UH Case Medical Center (UHCMC) expanded into the new state of the art Seidman Cancer Center (SCC), which is located at an adjacent building, in the May of 2011. The new facility at SCC houses 2 state of the art Eleka linear accelerators with on-board cone beam kVCT, MVCBCT, respiratory gating capabilities, VMAT and a HexaPOD robotic couch. A third LINAC, Versa HD, will be commissioned in the beginning of 2016 and will primarily treat SBRT patients. A Siemens 4D-CT is installed and clinically used in the new Radiation Oncology department. The Clinic has access to several Siemens MR scanners at the Department of Radiology (in both UHCMC and SCC) ranging from 1.5T to 3T as well as a Phillips PET/CT scanner. A dedicated special procedures room houses the brachytherapy procedures. A variety of treatment options are available through the Department of Radiation Oncology at Seidman Cancer Center, including: Three-Dimensional Conformal Radiation Therapy (3DCRT), Intensity Modulated Radiation Therapy (IMRT), Volumetric Modulated Arc Therapy (VMAT), Image Guided Radiation Therapy (IGRT), Brachytherapy (HDR and LDR), Permanent Prostate Seed Implant (PSI), Cervical Cancer using Tandem-Ovoids or Syed Template, Eye Plaque, Intraoperative Radiation Therapy (IORT), and Radiolabeled Monoclonal Antibody Therapy. The MOSAIQ record and verification system is integrated with the clinical equipment and planning system to make the department truly paperless and filmless.

A radiosurgery suite is located in an adjacent separate facility (the older one) where a GammaKnife, a Cyberknife, and a TomoTherapy (discontinue for clinical use in April 2015) treatment units are housed
along with a clinic-ready linac (a second linac is about to be decommissioned). Intracranial radiosurgery is performed with the GammaKnife which was upgraded to the Perfexion in the spring of 2010. The CyberKnife was originally installed in the spring of 2007 and recently went through a major upgrade in the spring of 2010. The TomoTherapy unit is currently used for IGRT treatments.

The physics residents have access to all personnel, equipment and institutional resources, the same as any member of the physics staff. The physics residents have dedicated office, laboratory space and computer facilities. Each resident is provided with a workspace in close proximity to physics faculty offices within the department. The residents having computer with intranet and internet access to electronic journals through the School of Medicine Library on campus. The Department has a library with numerous journals and a number of medical physics text that was acquired by CMPRP. Residents are also encouraged to travel with a faculty physicist to any of the 6 satellites within 35 miles radius (note that one of the satellites is at about 65 miles away and residents are not required to go there). These tools provide the resident learning opportunities in conventional radiation therapy and beyond. Specifically, with regards to the satellite location, they participate in weekly review of patient treatment records, equipment performance records, daily QA records, and perform monthly QA and annual QA on treatment delivery and simulation systems. Some of the physics staff from satellite facilities are involved in teaching physics resident through special lectures, guiding/supervising when the residents are in their facilities for performing assigned tasks. The physics residents are encouraged to participate in research and clinical studies with physics faculties, radiation oncologists and radiation biologists. Major facilities and patient treatment statistics are summarized in Tables 4a and 4b.

All the radiation therapy facilities under University Hospitals have adequate dosimetry equipment. Some of the major dosimetric equipment at main campus are listed below (numbers of equipment are in the parenthesis).

- WP-300 Manual Water Phantom (2)
- Blue (water) Phantom (1)
- Electrometer (5)
- Densitometer (2)
- Film Dosimeter Cassette Holder (2)
- I’MMATRIX (2)
- MAPCHECK (1)
- PROFILER (2)
- Ionization (well-type) Chamber (6)
- Ion Chamber (11)
- Survey Meter (4)
- Thermometer (3)
- Barometer (3)
- In-vivo dosimetry systems (2)
- Sr-90 source for ionization chamber calibration (1)
Advanced Technology Programs
The Department of Radiation Oncology, an integral part of University Hospitals Seidman Cancer Center and the Case Western Reserve University School of Medicine, is setting national standards for the delivery of high-quality, cost-effective care and research. The Department provides treatment and consultation for both pediatric and adult cancers and offers the region’s most comprehensive array of advanced technologies. Treatment and consultation are provided in seven locations (six satellites and one main center) throughout Northeast Ohio. The Proton Radiation Therapy is being planned for 2014.

Patient Care Treatment Options
A variety of treatment options and equipment are available through the Department of Radiation Oncology at main campus of University Hospitals, which has two centers (i) Seidman Cancer Center (SCC, new one), and (ii) Bolwell Center (or existing UHCMC).

At Seidman Cancer Center (SCC, new one):
- Three-Dimensional Conformal Radiation Therapy (3DCRT)
- Intensity Modulated Radiation Therapy (IMRT)
- Volumetric Modulated Arc Therapy (VMAT)
- 4D-CT simulator
- 3-D and deformable Image Fusion (MIMvista)
- Intraoperative Radiation Therapy (IORT)
- Total Body Irradiation (TBI)
- Total Skin Electron Irradiation (TSEI)
- Radiolabeled Monoclonal Antibody Therapy
- Brachytherapy (LDR, HDR)
- MOSAIQ record and verification system
- Auto-sequencing, collision avoidance
- Advanced Multileaf Collimation (MLC) system
- Virtual wedge
- High-resolution amorphous Silicon flat panel imager
- Respiratory gating system
- Active Breathing Control (ABC)
- Megavoltage cone beam imaging
- HexaPOD robotic couch for patient positioning
- Image-Guided Radiation Therapy (IGRT)

At Bolwell Center (existing UHCMC):
- 3DCRT, SRT, SBRT
- Tomo Therapy (out of clinical service since April 2015)
- CyberKnife
- GammaKnife
- One clinic-ready linac
- Proton Radiation Therapy – Planned for 2016
Table 2a: Departmental statistics (also see Table 1 for additional information).

<table>
<thead>
<tr>
<th>Major equipment (main and satellites)</th>
<th>LINAC (14), Tomo Therapy (1), Cyberknife (1), Gammaknife (1), HDR (2), CT/CT-Sim (6), 4D-CT (1), CBCT (4), Proton (expected to be ready by 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients treated per day</td>
<td>80 at Main Campus with combined average of 270 at the 7 campuses</td>
</tr>
<tr>
<td>Treatment types</td>
<td>3D-CRT, IMRT, VMAT, IORT, TSEI, TBI, Intra- and extracranial radiosurgery, Brachytherapy (HDR, LDR, PSI)</td>
</tr>
<tr>
<td>Staffing</td>
<td>Physicians: 9 in main campus, 9 at satellites, Physicists: 18 full-time and 2 part-time (9 full-time in main campus, 9 full-time in satellites, and 2 part-time at satellites), Dosimetrists: 17, Therapists: 40, Nurses: 14, Billing &amp; Scheduling Clerks: 14</td>
</tr>
<tr>
<td>Research and Clinical Trials</td>
<td>Funding: NIH/NCI, DoD, Industries/Pharmaceuticals, Co-operative groups: RTOG, ACOSOG, COG, GOG, ZCOG, NSABP, NCCTG, ACRIN</td>
</tr>
<tr>
<td></td>
<td>Patient Accruals per year: RTOG (60), other (80)</td>
</tr>
</tbody>
</table>

Table 2b: Brachytherapy and Special Procedures performed at Main Center per year (approx.)

<table>
<thead>
<tr>
<th>HDR</th>
<th>LDR/ PSI (I-125, Pd-103, Cs-137)</th>
<th>IORT</th>
<th>TBI</th>
<th>TSEI</th>
</tr>
</thead>
<tbody>
<tr>
<td>125</td>
<td>65</td>
<td>30</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>IMRT/VMAT</td>
<td>Cyberknife (SBRT pt)</td>
<td>500</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

Research and Development
The UH Case Medical Center (UHCMC), (note that Seidman Cancer Center is a part of UHCMC) Clinical Trials Unit (CTU) provides a centralized infrastructure to support cancer related research. The CTU's mission is to provide the highest quality nursing, data management, regulatory, financial and quality assurance services for the conduct of clinical trials for the benefit of our patients and investigators. Many of our UHSCC clinical trials are offered at regional sites and affiliates. Faculty members of the Radiation Oncology Department participate in clinical trials of various cooperative groups such as RTOG, ACOSOG, COG, GOG, ZCOG, NSABP, NCCTG, and ACRIN. There are several funded projects (funded by federal, agencies state, industries) in the department in which some of the physics faculties along with the faculties from Radiation Oncology and Radiation Biology are involved as principal investigators (PIs), Co-Pis, and Co-Investigators (Co-Is). The Medical Physics division is actively involved in translational research. There are collaboration opportunities for the residents with basic scientists in Radiation Biology as well as scientists in Bioengineering, Electrical and Computer Engineering, and Radiology. Participation in these research and development activities provides the residents a very good opportunity to extend their knowledge and experience in
the field. Moreover, these activities enable the residents to attend scientific conferences and meetings as well as publish in peer-reviewed journals.

VIII. Future Plans

A. Summary of Strength and Needs
The University Hospitals Case Medical Center, i.e. SCC and Bolwell Center is a tertiary care patient care center in Cleveland, a city which is undergoing rapid renovation and upgrading of a 20 mile “high-tech corridor.” Our program is fully integrated within the university, providing us collaboration and teaching/learning opportunities with University physicists, imaging scientists in Bioengineering, Electrical and Computer Engineering, Radiology, and Radiation Biology. We currently participate in teaching in several programs: Clinical Medical Physics Residency Program in Radiation Oncology, Radiation Oncology Medical Residents and graduate level Medical Physics courses in the Radiation Biology Program. Finally, we have several active research projects with faculty members of the three groups mentioned above.

The Department of Radiation Oncology is a part of the NCI-designated “Case Comprehensive Cancer Center”. The Department of Radiation Oncology is designated a “Center of Excellence” at the UHCMC, having recently moved into an expanded, 250,000 sq. ft. state-of-the-art Seidman Cancer Center that includes 4DCT, CT/PET, and a 3-Tesla MRI in Radiation Oncology used for functional imaging and treatment simulation. The department is truly paperless and filmless.

B. Further Developments and Improvement
Because we are part of an academic institution, we have a number of different ways to teach our residents. We are continually assessing our curriculum and delivery based on the needs of the individual residents. We anticipate including a greater emphasis on diagnostic imaging physics as applied to radiation oncology, as image guidance in radiation therapy is increasing in importance.

Proton Therapy – Announcement of new program - 2014
On May 15, 2011, University Hospitals Seidman Cancer Center announced to open Northeast Ohio's first proton therapy center, a $30 million investment with a mix of capital, bonds and philanthropy. We expect to have the proton center clinically read by the end of 2016. Currently, there are only ten other clinical proton centers in the country.

The proton treatment delivers radiation to hard-to-reach cancer tumors more accurately and efficiently than conventional radiation therapy, and with fewer toxicity and harmful side effects. Proton therapy uses a powerful beam of protons that targets and matches treatment to the shape of a tumor. As much as 50 to 70 percent more normal tissue surrounding a cancerous tumor remains untouched with proton therapy than with traditional radiation therapy. Proton therapy is used to treat malignancies such as certain brain, head and neck and pelvic cancers and some prostate cancers. The main clinical focus will be to support the pediatric service for the Department of Radiation Oncology and the Rainbow Babies and Children’s Hospital. Seidman’s proton therapy center is expected to treat between 200-400 patients each year. It is expected that by rotating through proton therapy module (rotation module #15), the medical physics residents will be able to glean very useful knowledge and experience.
Appendix A – ACGME Accreditation (removed)

Appendix B – Residency Course Outline in 2005-2007 (removed)

Appendix C – List of Publications (removed)
# Appendix E – Clinical Rotation Summaries, Mentors, and Evaluation Criteria

Radiation Oncology Clinical Medical Physics Resident Rotation - Year 1

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Duration (month)</th>
<th>Rotation (rotation #)</th>
<th>Mentors</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>Orientation</td>
<td>TP, BW</td>
</tr>
<tr>
<td>2</td>
<td>1.5</td>
<td>Dosimetric Systems (#1)</td>
<td>YZZ, VC, CL</td>
</tr>
<tr>
<td>3</td>
<td>1.5</td>
<td>Treatment Planning I (#5)</td>
<td>DD, MM, GP</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>Treatment Planning II (#6)</td>
<td>GP, MM, TP</td>
</tr>
<tr>
<td>5 (flexible)</td>
<td>1.5</td>
<td>Linear Accelerator Acceptance/ Commissioning/ Annual QA (#2)</td>
<td>PG, DD, MM, TP</td>
</tr>
<tr>
<td>6 (flexible)</td>
<td>1.5</td>
<td>TG-51 Calibration and MU Calculations (#3)</td>
<td>YZZ, VC, PG, TP</td>
</tr>
<tr>
<td>7 (flexible)</td>
<td>1.5</td>
<td>TPS Modeling / Acceptance / Commissioning (#4)</td>
<td>YZZ, BC, JY, PG</td>
</tr>
<tr>
<td>8</td>
<td>1.5</td>
<td>Imaging for Simulation, Planning and Treatment Verification (#9)</td>
<td>YZZ, GP, AB, PG</td>
</tr>
<tr>
<td>9</td>
<td>1.0</td>
<td>Vacation / Sick Leave / Family Leave / Conferences</td>
<td>TP, BW</td>
</tr>
</tbody>
</table>

Radiation Oncology Clinical Medical Physics Resident Rotation - Year 2

<table>
<thead>
<tr>
<th>Sequence</th>
<th>Duration (month)</th>
<th>Rotation (rotation #)</th>
<th>Mentors</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>1.0</td>
<td>Image Guided Radiation Therapy (IGRT) (#10)</td>
<td>YZZ, AB, GP, JWS</td>
</tr>
<tr>
<td>10 (flexible)</td>
<td>2.0</td>
<td>Brachytherapy (#7)</td>
<td>VC, BG, TP</td>
</tr>
<tr>
<td>11 (flexible)</td>
<td>1.5</td>
<td>Floor Physicist (Physicist of the Day) (#11)</td>
<td>YZZ, VC, GP, RK, TP</td>
</tr>
<tr>
<td>12</td>
<td>1.0</td>
<td>Room Design, Radiation Protection and Radiation Safety (#8)</td>
<td>VC, CL, PG, VC, BW</td>
</tr>
<tr>
<td>13</td>
<td>1.5</td>
<td>Professional and Process/Practice Issues (#12)</td>
<td>TP, RK, PG, BW</td>
</tr>
<tr>
<td>14</td>
<td>1.5</td>
<td>Catch up (#1-12) or Elective I (#13 - CK &amp; GK)</td>
<td>YZ, JY, JWS, TP, BW</td>
</tr>
<tr>
<td>15</td>
<td>1.5</td>
<td>Catch-up (#1-12) or Elective II (#14 - TBI, TSEI &amp; IORT)</td>
<td>YZZ, JY, VC</td>
</tr>
<tr>
<td>16</td>
<td>1.0</td>
<td>Catch-up (#1-12) or Elective III (#15 - Proton)</td>
<td>RJ, CWC, BW</td>
</tr>
<tr>
<td>17</td>
<td>1.5</td>
<td>Dedicated Research Module (if time permits)</td>
<td>TP, BW</td>
</tr>
<tr>
<td>18</td>
<td>1.0</td>
<td>Vacation / Sick Leave / Family Leave / Conferences</td>
<td>TP, BW</td>
</tr>
</tbody>
</table>

Attendance at the following conferences is required (at least 75%):

Grand Rounds: Tuesdays, 8:00 – 9:00 am

Chart Rounds: Fridays, 2:00 – 4:00 pm

A total of 12 out of the 15 rotations must be completed for the resident candidate to be eligible for completion of the program requirements. The mentor of the clinical rotation evaluates the resident’s performance at the end of each rotation (see Appendix G). Quarterly review of the resident’s progress is performed by the Directors (see Appendix J).
Appendix F – Detailed Summary of the Clinical Rotations
Clinical and Didactic rotation descriptions

(please see in the next page)
New Resident Orientation

Clinical Medical Residency Program
Department of Radiation Oncology
University Hospitals Case Medical Center

Name of the Resident: _____________________________________________

Start date: _______________________     Completion date: _________________

Name of the Mentor: __________________________________________________

New Resident Orientation schedule and attendance

Week #1:

Monday
8:30 a.m. Report to Program Director, Radiation Oncology (B181/ B153A)
1:00 p.m. Receive Badge – Human Resources Office

Tuesday
8:00 a.m. – 5:00 p.m. New employee orientation, including departmental organization, facilities, staffing, safety (rad and non-rad), basic policies and procedures, and Mosaiq training

Wednesday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: Patient Treatments on Linear Accelerators (Radiation Therapist)

Thursday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: Patient Simulation in CT; MRI (Radiation Therapists)

Friday
8:00 a.m. – 10:30 a.m. Shadowing in Seidman CC: Treatment Planning in Dosimetry (Dosimetrist)
10:30 a.m. – 11:30 a.m. Benefits Orientation with House Staff
12:30 a.m. – 5:00 p.m. Shadowing in Seidman CC: Treatment Planning in Dosimetry (Dosimetrist)

Week #2:

Monday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: Brachytherapy (Physicist)

Tuesday
8:00 a.m. – 5:00 p.m. Shadowing in Seidman CC: Stereotactic Radiosurgery (Physicist)

Wednesday
7:30 a.m. – 11:30 a.m. UHCMC Benefits Orientation – as applicable
12:30 p.m. – 4:30 p.m. Shadow a RO physician in Seidman CC
Thursday
8:00 a.m. – 5:00 p.m.  Shadowing in Seidman CC: Physicist of the Day (Physicist)

Friday
8:00 a.m. – 5:00 p.m.  Shadowing in Seidman CC: RO Physician and Nursing Staff

F. Safety Training
The following safety training and safety issues are covered in resident safety orientation, which is conducted by the Hospital/ Program Director/ Physics Div. Director/ any qualified personnel:

- Personal Protective Equipment (PPE) Training
- Mandatory Reporting
- Bloodborne Pathogens
- Safety and Infection Control Test
- HIPAA Training
- Culture Diversity Training
- Patient and Staff Rights and Responsibilities
- Gowns
- Patient and Resident Safety
- CPR Certification
- Health Protection Office staff training and test (includes Radiation Safety)
- Hazard Communication Safety Training
- Hazmat Training and Test
- Fire and Tornado Plans and Procedures
- Code Blue Procedures
- Universal Precautions
- Sharps Disposal

Comments: ________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Signature of the Resident, Date    Signature of the Mentor, Date
1. **Dosimetric Systems rotation (core)**

A. **Skills**
   a. Linac Operation
      i. F1 “Treat” mode
      ii. F5 “V & R” mode with Mosaiq
   b. Use of an Ionization Chamber and Electrometer to read Dose
   c. Setting up of water tank
   d. Manual Film Densitometry
      i. H&D curve creation
      ii. Running a film processor
      iii. Converting optical density values to dose

B. **Knowledge Base**
   a. Design and Basic Operation of Dose Measurement Devices
      i. Ion Chambers
      ii. Film
      iii. Metal Oxide Semiconductor Field Effect Transistor (MOSFET)
      iv. Diodes
      v. Thermoluminescence Dosimeters (TLD)
      vi. Optically Stimulated Luminescence Dosimetry (OSLD)
   b. Design and Basic Operation of Electrometers
   c. Phantoms
      i. Solidwater Slabs
      ii. Anthropomorphic
      iii. Water Tanks

C. **Clinical Processes**
   a. Commissioning of Dose Measurement Systems
      i. Ion Chambers / Electrometers
      ii. Film
      iii. Silicon diodes
      iv. TLDs/ OSLDs
   b. Commissioning of 3D Water Tank
   c. Ion chamber Dosimetry System Effects
      i. Leakage
      ii. Stem Effect
      iii. Signal-to-noise for different chamber volumes
      iv. Variation with bias level and polarity at different dose rates
      v. Variation with changes in water temperature
   d. Perform dose profile measurements with each detector and compare results.
   e. Manual Film Densitometry
      i. H&D curve creation (10x10 field size, 6MV x-rays)
         1. depths of 1.5 cm and 10 cm in solid water,
         2. EDR2, XV, and Radiographic film

**Learning opportunities**

Observe physicist measurements performed with ion chamber and phantom: monthly calibration, electron cutout measurements, IMRT/VMAT QA. Observe dose verification on patient using TLDs.
Reading List

1. The Physics of Radiation Therapy, 3rd ed., Khan, Chs. 6 and 8 (focus on pp 144-154).
2. Comprehensive QA for Radiation Oncology (Reprinted from Medical Physics, Vol. 21, Issue 4) (1994) Radiation Therapy Committee Task Group #40; 37 pp. focus on Table IV.

Assessment

The resident will take an oral exam. An understanding of the principles behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated.

Summary of Resident’s activities:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained _______________yes ___________no

Mentor’s Signature ________________________________   Date________________
Module: Dosimetry Systems

Competency: Dosimetry Systems

Objectives: This module intends to provide fundamental knowledge and sufficient practical training experience for active competency in IVD, Film, TLD Dosimetry and Cutout measurements.

1. **Physics Class:**
   - Mentor sign and Date: _____________________

2. **Reading Guidelines:**
   - Complete assigned reports and literature
   - Mentor sign and Date: _____________________

3. **Measurements and Data Collection**
   - Participate in actual patient IVD diode measurements
   - Calibrate/Modify Calibration of IVD style Device
   - Create an H and D Curve using EDR Film/Linac and RIIT Software
   - Use RIIT or similar software to do film analysis using H and D curve created above
   - Perform e- cutout measurements to determine cutout output factor
   - Perform TLD Patient Measurements
   - Use Mapcheck or Matrixx array style device to perform dose measurements and analysis
   - Perform Special Physics consults for IVD measurements of pace makers in patients.
   - Learn to pour a simple block or device.
   - Mentor sign and Date: _____________________

4. **Documentation and Reporting**
   - Documentation of Testing and data
   - Writing Special Physics Consults as appropriate
   - Mentor sign and Date: _____________________
2. Linear Accelerator Acceptance Testing/Commissioning/Annual QA rotation (Core)

Knowledge Base – From Didactic courses

1. Linear Accelerator Acceptance/Testing
   a. Fundamental concepts of linear accelerators, beam production and control.
   b. Medical linear accelerator safety features.
   c. The acceptance testing process

2. Radiotherapy Beam Data Collection for Commissioning
   a. Data definitions.
   b. Measurement (acquisition) techniques and underlying principles.

3. Medical Radiotherapy Equipment QA
   a. Linac QA
   b. Other treatment machine QA

4. Linear Accelerator Fundamentals Relevant to Commissioning
   a. Basic beam optics
   b. Beam flattening
   c. Significance of beam control parameters
   d. Collimation
      i. Rectangular Jaws
      ii. MLC
      iii. Electron Collimation
   e. Medical Linear Accelerator Specifications
   f. Non-beam specifications
   g. Beam specifications
   h. Acceptance Tests
      i. Safety-related tests (Radiation survey)
      ii. Acceptance vs. Commissioning Data Collection
      iii. Non-beam tests
      iv. Beam modifier and Accessory testing

5. Commissioning Data Acquisition Tasks
   a. Data acquisition using scanning water phantom.
      i. Types and significance of scans
      ii. Scans with different detectors
      iii. Scans with different beam modifiers
      iv. Point data acquisition
      v. Film/planar data acquisition.
   b. Understanding of measurement selection,

6. Analysis of Measurements and Preparation for Commissioning
   a. Preparation for MU Calc data
   b. Preparation for TPS beam commissioning
   c. Conceptual understanding of objectives with respect to commissioning

Reading List:
   Chapters 5, 6, 7.


Acceptance testing and Annual QA Assessment:

The resident will provide a written report of principles and process of Linear Accelerator Acceptance Testing, Commissioning Measurements and Annual QA with an overview and detailed descriptions of the relevant underlying principles for each major step. The report should also contain data acquired through measurements or experiment as well as analysis thereof. Finally, an understanding of the principles behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated in an oral exam setting.

Summary of Resident’s activities:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ____________ yes ____________ no

Mentors Signature _________________________ Date _________________________
Module: Linear Accelerator Annual Calibration

I. Objective: Provide the resident with the fundamental knowledge and practical training for proficiency in the annual calibration of a Linear Accelerator in accordance with AAPM Task Group 142.

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Read AAPM Report 142 (TG-142), AAPM report 46 (TG-40)</td>
<td>_______</td>
</tr>
<tr>
<td>2. Read AAPM Report 67 (TG-51), AAPM TG-21</td>
<td>_______</td>
</tr>
<tr>
<td>3. Read AAPM TG-106</td>
<td>_______</td>
</tr>
</tbody>
</table>

III. Clinical Activities:

The resident will work with one of the senior physicists to observe and perform the steps listed below. At the conclusion of these activities a write-up shall be submitted summarizing the checks performed and findings.

<table>
<thead>
<tr>
<th>Tasks related to AAPM TG-142</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe</td>
<td>Perform</td>
</tr>
<tr>
<td>Mechanical, Dosimetry, and Safety Checks (Table III)</td>
<td>_______</td>
</tr>
<tr>
<td>Respiratory Gating Checks (Table III) – if applicable</td>
<td>_______</td>
</tr>
<tr>
<td>Dynamic/Universal/Virtual Wedges (Table IV)</td>
<td>_______</td>
</tr>
<tr>
<td>Multileaf Collimation (Table V)</td>
<td>_______</td>
</tr>
<tr>
<td>Imaging (Table VI)</td>
<td>_______</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Other Tasks related to Annual Calibration</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observe</td>
<td>Perform</td>
</tr>
<tr>
<td>Set-up and alignment of water tank</td>
<td>_______</td>
</tr>
<tr>
<td>Analyze data and perform daily and monthly consistency checks</td>
<td>_______</td>
</tr>
<tr>
<td>Prepare final report and associated documentation</td>
<td>_______</td>
</tr>
<tr>
<td>Preparation/Irradiation of RPC TLDs</td>
<td>_______</td>
</tr>
<tr>
<td>Other checks as outlined in previous years</td>
<td>_______</td>
</tr>
</tbody>
</table>
3. TG-51 Calibration and MU Calculations rotation (core):

A. TG – 51 Assessment

The resident will present a report of his/her TG-51 results for the calibrated accelerator. The report will include a summary of the processes describing the individual steps that were taken to perform the calibration. The resident will take an oral exam at the conclusion of the rotation. The resident should be able to demonstrate knowledge of the calibration process and other relevant information obtained from the reading lists.

1. Skills
   a. Operation of ionization chamber
   b. Operation of electrometer
   c. Operation of linear accelerator
   d. Water tank set up
   e. Know how to adjust linear accelerator output
   f. Spreadsheet development and verification

2. Knowledge Base
   a. TG-51 protocol
   b. Electrometer/Chamber
   c. Chamber/electrometer ADCL calibration
   d. Reference point determination
   e. Calibration point determination
   f. Electrical and mechanical safety
   g. Linac operation
   h. Set up water tank
   i. Position chamber at calibration point
   j. Connect electrometer
   k. Measure ionization
   l. Convert to dose
   m. Convert to dose/MU at reference point
   n. Demonstrate ability to change accelerator output *
   o. Document results

Under no circumstances should any dosimetric parameters be altered on any radiation producing equipment without direct supervision by a staff physicist

Learning opportunities

Perform TG-51 calibration for all energies on one accelerator with at least one photon energy > 10 MV. Print report summary and present results to physicist for review.

Reading list

AAPM Task Group 51 Protocol
AAPM Task Group 21 Protocol
The Physics of Radiation Therapy, 3rd ed., Khan, Ch. 8
B. MU calculations

1. Skills
   a. Read Dosimetry Tables for photons and electrons
   b. Use of an Ionization Chamber and Electrometer to read Dose
   c. Use of a water tank for profile and depth dose measurements
   d. Operate the Record & Verify system
   e. Operate the Linac
   f. Use and understand second check software (RadCalc)
   g. Determine the needed beam data for an MU calc

2. Knowledge Base
   a. TMR, PDD, PSF, CSF, ISF, OAR, WF, TF, VWOAR, etc.
   b. Clarkson Integration, Day’s method, etc.
   c. Calculation Point’s Eye View and multiple source models
   d. Surface Irregularities
   e. Tissue inhomogeneities
   f. Electrons: VSID, obliquity, field size limits (range)

3. Clinical Processes
   a. MU calcs for Sim and Treat
      i. Whole Brain
      ii. SVC
      iii. Cord compression
      iv. Heterotopic
   b. MU calc check for simple plans (e.g. 4 field box)
   c. MU calc check for multiple field-in-field (Forward IMRT) plans
   d. MU calc check for IMRT boosts
   e. MU calcs for breast (account for flash, off-axis calc points, irregular contour)
   f. MU calcs for electrons, various SSDs, calc points, bolus

Learning opportunities

Patients that are good examples of the items in section C need to be identified. The resident needs to check with the therapists or the POD for the Sim and Treat cases. For those cases that are planned (a,b,c), a list of sample patients can be selected, and the resident can perform the calculations from the field data in Mosaiq and compare the results against Pinnacle. Beam data collection skills may have been learned in other rotations, but if not, time will need to be scheduled on the machines for this purpose (Elekta’s MLCi2 or Agility, or Versa HD)

Reading List

Recommended
The Physics of Radiation Therapy, 3rd ed., Khan, all of Chs.9 and 10, Ch 11, (focus on section 1 to 5), Ch. 12 (focus on sections 4 and 5), ch. 14 (focus on sections 1 to 6).

Suggested
Radiation Therapy Physics, Hendee, Ibbott and Hendee, Chs. 7 and 8.
Blackburn’s Introduction to Clinical Radiation Therapy Physics (edited by S. Shahabi), focus on chapters 1 to 12 and 15.
Monitor Unit Calculations for External Photon & Electron Beams
**Assessment**

The resident will present a report that includes hand calculations and semi-automated hand calculations (excel spreadsheets, etc.) for representative cases. He/she should also present a table of MU calculation data that he has collected himself for one photon and one electron energy. He/she should demonstrate an understanding of the differences in dose calculations between the planning system and the hand calculation. Finally, the resident will take an oral exam. An understanding of the principles behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated.

Mentor Assessment:

**Summary of Resident’s activities:**
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ________________yes ____________no

Mentor’s Signature ________________________________   Date _________________
4. TPS Modeling / Acceptance / Commissioning (core)

Module - Commissioning of Philips Pinnacle or other Planning System

Objectives: This module intends to provide the resident with a basic understanding of the TPS, its functions and capabilities.

1. Physics Class: Treatment Planning
   - Mentor sign and Date: _____________________

2. Reading Guidelines:
   - Read planning system physics guide (e.g. Pinnacle Physics, Instructions for Use, and Pinnacle Physics, Reference Guide).
   - Mentor sign and Date: _____________________

3. Equipment:
   - Scanning water tank (e.g. Wellhofer) and data acquisition software (e.g. Omni-Pro Accept).
   - Diode/chamber array (e.g. Sun Nuclear Profiler) to be used for virtual wedge profile acquisition.
   - Mentor sign and Date: _____________________

4. Collect and Model Beam Data:
   - Create a new machine in the treatment planning software.
   - Gather and enter physical machine characteristics.
   - Scan and import required photon beam PDD’s and profiles, open and wedged.
   - Measure and enter required photon output factors, open and wedged.
   - Measure and import profiles for virtual wedged beams.
   - Model all open and wedged photon beams.
   - Scan and import electron beam PDD’s and profiles for each energy and cone.
   - Scan in-air electron profiles for virtual source distance and sigma-theta-X calculation.
   - Measure and enter required electron cone output factors over range of clinical SSD’s.
   - Model all electron beams.
     - Mentor sign and Date: _____________________

5. Validate Model and Commission Machine
   - Create and test model validation plan to include measurements, with on-site physicist, of machine orientations, wedges, MLCs, etc.
   - Commission machine in the treatment planning software.
   - Prepare dosimetry book for distribution to physicist and dosimetrists.
   - Mentor sign and Date: _____________________
Recommended Reading List:


Assessment

The resident will present a report that includes photon and electron beam modeling for treatment planning system, verification of modeling accuracy and its clinical implementation. He/she should compare the results obtained with the published data. Finally, the resident will take an oral exam. An understanding of the principles behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated.

Mentor Assessment:

Summary of Resident’s activities:

_________________________________________________________________________________
_________________________________________________________________________________
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_________________________________________________________________________________

Competency attained ______________ yes ____________no

Mentor’s Signature __________________________ Date _________________
5. Treatment Planning I rotation (Core)

A. Prepare Knowledge Base
   a. Determination of Data Required for TPS Modeling
   b. General Operation of Planning System
   c. 3D Photon Beam Dose Algorithms
      i. Convolution Method
      ii. Polyenergetic Spectra
      iii. Inhomogeneity Corrections
      iv. Collapsed Cone Convolution
      v. Output Factors
      vi. Monitor Units
   d. Electron Beam Dose Algorithms
      i. Pencil Beam model
      ii. Verification Data
   e. Non-dosimetric Parameters within Treatment Planning Systems
      i. CT dataset resolution
      ii. CT number to electron density
      iii. Contouring thresholds / expansion / contraction
      iv. Transformations / Projections in Beams-eye-view
      v. Digitally Reconstructed Radiographs
   f. Dose Evaluation Tools
      i. Dose grid resolution
      ii. Isodose lines
      iii. Tolerance of Normal Tissues
      iv. Dose-Volume Histograms
      v. TCP/NTCP
   g. Treatment Planning Protocols
   h. Data transfer
      i. DICOM formats / RT Objects
   j. Treatment Planning Quality Assurance
   k. Record and Verify system data import/ verification/ approval

B. Clinical Processes – Use Clinical Module Work Sheet
   a. Observe 3-D Treatment Planning
      i. Brain, Lung & Esophagus, Breast, CNS, Abdomen & Rectum, Pelvis & Bladder, Prostate, Skin, and GYN.
   b. Determine the treatment planning protocol for each anatomical site observed.
      i. Prescription summary (total, fractionation, max/min)
      ii. Typical imaging techniques
      iii. fields, beam energy, beam shaping/ blocking
      iv. Regions of interest and their associated doses
   c. Create Treatment Plans
      i. Brain, Breast, Lung, Rectum, Prostate, GYN, GI, CNS, Sarcoma, Skin.
   d. Perform Quality Assurance on all plans

Learning opportunities

Observe dosimetrists in performing the treatment planning process, and understand the functionality of the planning system. After adequate hands-on time with the planning system and observing 10 different types of cases from 10 different sites (Brain, Breast, Prostate, H&N, whole CNS, GI, GYN, Skin, Sarcoma) perform treatment planning for 13 cases including (i) t cases from each site of Breast, Prostate, and Lung, (ii) and one case from each site of Brain, H&N, whole CNS, GI, GYN, Skin,
Sarcoma. Quality assurance of every aspect of the plan, from plan evaluation through verification within the record and verify system.

Treatment Planning - Operation and Clinical Module

A. Skills
   a. TPS system operation
      i. Login
      ii. Access to Patient Database
      iii. Access to Syntegra/Planning
   b. Mosaiq Verify and Record system

B. Knowledge Base
   a. Determination of Data Required for TPS Modeling
   b. 3D Photon/Electron Beam Dose Algorithms
   c. Operation of Planning System
   d. Treatment Planning Methods/Techniques
   e. Dose Evaluation Tools
   f. Data transfer
   g. DICOM formats / RT Objects
   h. Treatment Planning Quality Assurance
   i. Record and Verify system data import/approval
Module: Treatment Planning I

I. Objective: Provide the resident with an introduction to dosimetry and treatment planning

II. Didactic Activities:

A. Photon Dosimetry

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Attend 6 hours of lab in dosimetry provided in physics residents’ syllabus (if applicable/available).</td>
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<tr>
<td>2. Review Chapters 9 &amp; 10 in Khan (3rd ed.) for basic dosimetry calculations. Submit following problems from Hendee Chapter 7: 1, 3, 5, 7, 9, &amp; 11.</td>
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</tbody>
</table>

B. Electron Dosimetry

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
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</thead>
<tbody>
<tr>
<td>1. Review Chapter 14 and example problems in Khan (3rd ed.) for treatment planning. Submit problem 7 from Chapter 8 of Hendee.</td>
<td></td>
</tr>
</tbody>
</table>

III. Clinical Activities:

The resident will work with the therapist/dosimetrist/physicist to observe and perform the steps listed in A and B below for the designated number of patients.

A. Pre-planning process:
   - Patient set-up and immobilization
   - CT simulation (including isocenter placement)
   - Secondary image acquisition and image fusion (if requested by MD)
   - Importing images into PHILIPS Pinnacle Treatment Planning System

B. Planning process:
   - Plan/patient set-up (couch removal, localization)
   - Contour (both normal tissues and target)
   - Point placement (isocenter and calc. points, if necessary)
   - Beam placement and calculation
   - Plan evaluation
   - Plan review with physician
   - Plan export to Mosaiq and RadCalc
   - Plan review with floor physicist

When observing or creating a particular treatment plan, particular attention should be paid to the following items in the planning process:
   - Prescription dose summary (total dose, fractionation, min. and max.)
   - Imaging techniques utilized
   - Fields used, beam energy, blocks
   - Potential organs at risk (OAR) and their associated dose limits.
### Observed Patient Cases (10):

<table>
<thead>
<tr>
<th>Type</th>
<th>Lung</th>
<th>Prostate</th>
<th>Breast</th>
<th>Brain</th>
<th>GI</th>
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<td>Patient Initials:</td>
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<table>
<thead>
<tr>
<th>Type</th>
<th>GYN</th>
<th>H&amp;N</th>
<th>whole CNS</th>
<th>Skin</th>
<th>Sarcoma</th>
</tr>
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<tr>
<td>Patient Initials:</td>
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</table>

*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

### Planned Patient Cases (13):

<table>
<thead>
<tr>
<th>Type</th>
<th>Lung (2)</th>
<th>Prostate (2)</th>
<th>Breast (2)</th>
<th>Brain</th>
<th>GI</th>
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<tbody>
<tr>
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<table>
<thead>
<tr>
<th>Type</th>
<th>GYN</th>
<th>H&amp;N</th>
<th>whole CNS</th>
<th>Skin</th>
<th>Sarcoma</th>
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*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

### Assessment

The resident will present a report giving an overview of all the processes, describing the individual steps conceptually, and results from their assessment of treatment planning methods. Finally, the resident will take an oral exam. An understanding of the principles behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated.

Mentor Assessment:

Summary of Resident's activities:
Competency attained ______________yes   ____________no

Mentor's Signature ________________________________   Date ____________________________

Reading List
2. User Manual for Treatment Planning System (e.g. Pinnacle Beam Modeling, planning, etc.)
6. Treatment Planning II rotation (core)

I. Skills
   A. Treatment planning
      1. Must complete the Treatment Planning I rotation
      2. Read a Dose Volume Histogram
      3. Transfer a plan to a phantom
      4. Obtain the dose matrices of the plan
      5. Specify Dose-Volume constraints
   B. Film Densitometry
      1. H&D curve creation
      2. Running a film processor
      3. Scanning Film
      4. Converting pixel values to dose
   C. Use of an Ionization Chamber and Electrometer to read Dose
   D. Operate the Record & Verify system
   E. Operate the Linac
   F. CT scanning a phantom and importing it into the planning system
   G. Positioning a phantom – determining shifts from fiducials to isocenter

II. Knowledge Base
   A. Optimization – an introduction
   B. Critical organ doses, parallel vs serial organs, typical dose-volume constraints
   C. Dose calculation algorithms specific to IMRT
   D. Film as a dose measuring device
   E. Small field dosimetry – measurement and modeling in the planning system
   F. Imaging for IMRT – CT basics

III. Clinical Processes
   A. IMRT planning
   B. VMAT planning
   C. IMRT & VMAT chart check (in MOSAIQ)
   D. IMRT & VMAT QA
      1. Patient specific
      2. Delivery system specific
   E. IMRT boosts
   F. IMRT & VMAT delivery
   G. Film densitometry QA

Learning opportunities

Take a patient from the CT scan all the way through the initial treatment delivery. This will require shadowing the CT therapists, the dosimetrist, the medical physicist, and the linac therapists. With the first patient, it will be observation. With the second patient, it will be supervised performance of the tasks. With a phantom, it will be an independent performance of the tasks. There are a fair number of IMRT patients in our department, and there will be no lack of opportunities. Since the rotation is broken into parts A and B, the observations/shadowing of a patient needs to be addressed in part A, while the phantom studies and the film QA needs to be addressed in part B.
Reading List

1. Radiation Therapy Physics, Hendee, Ibbott and Hendee, Ch. 11, focus on pp 270 to 277, Ch. 15, focus on pp. 394-397.
2. The Physics of Radiation Therapy, 3rd ed., Khan, Chs. 19 and 20, Ch 8 (focus on pp 151-153) and Ch 14 (pp 304-305).
3. Treatment Planning in Radiation Oncology, Khan and Potish, editors, Chs. 8 (focus on pp 172-176), 9, 12.
4. Radiation Therapy Planning, Bentel, see the summaries (“Morbidity”) at the end of the various anatomical sections in chapters 9 through 13 to get a good idea of dose tolerances for various organs.
5. http://www.sprawls.org/resources/CTIMG/module.htm- This is a nice intro to CT image acquisition. Needed to understand the data acquisition requirements for IMRT.
Module: Treatment Planning II

I. **Objective:** This module intends to demonstrate fundamental knowledge and sufficient practical experience for active competency in LINAC-based intensity modulated radiation therapy (IMRT) and quality assurance (QA).

II. **Didactic Activities:**

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
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<tbody>
<tr>
<td>1. Read Chapter 21 in Khan (3rd ed.)</td>
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</table>

III. **Clinical Activities:**

The resident will work with the therapist/physicist to observe and perform the steps listed in A – C below for the designated number of patients.

A. Simulation/Treatment Planning activities:
   - Observe patient set-up and immobilization in CT-Sim
   - Transfer images from CT to PHILIPS PINNACLE
   - Set-up patient-planning objectives, avoidance, and DVH
   - Utilize DMPO for plan optimization

B. Patient-specific quality assurance:
   - Review patient QA protocol
   - QA phantom selection/planning
   - Run the QA treatment and analyze using RIT and/or Mapcheck
   - Perform relative calibration for energy being used
   - Create H and D Film and curve
   - Use Film and/or array analysis software (i.e. Mapcheck, Matrixx or RIT)

C. Treatment day activities:
   - Ensure treatment chart and plan are ready for treatment (review 1st day sheet)
   - Ensure applicable IGRT is ready for treatment utilization (i.e., calibration, etc.)
   - Treatment console operation/machine operation

**Observed Patient Cases (IMRT):**

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<thead>
<tr>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
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<tr>
<td>Planned Patient Cases (IMRT):</td>
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<td>Case #2</td>
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<th>Observed Patient Cases (VMAT):</th>
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<th>Planned Patient Cases (VMAT):</th>
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<th>Case #4</th>
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*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc).*

**Assessment:**

The resident will prepare a written report summarizing their experiences and present this information to the mentor during an oral exam. The resident will develop knowledge of IMRT and VMAT planning and related patient-specific QA. Out of 10 cases (IMRT/VMAT as tabulated above) the resident must select at least three cases from anatomical sites other than Prostate, and Head & Neck.

**Mentor Assessment:**

Summary of Resident’s activities:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained _______________ yes ______________ no

Mentor’s Signature ________________________________   Date ____________________________
7. Brachytherapy rotation (core)

7A. Brachytherapy (Basics and LDR)

A. Skills
   1. Radiation Safety
      a. Safe source handling
      b. Time/distance/shielding
   2. Radiation Dosimetry
      a. Electrometer
      b. Re-entrant well chamber
   3. Treatment Planning
      a. Dose prescription – Written directive
      b. Dose objectives – DVH parameters

B. Knowledge Base
   1. Radioactive Decay
      a. Alpha
      b. Beta
         i. Electron capture
         ii. Internal conversion
      c. Gamma
   2. Radioactive Sources Commonly Used in Radiotherapy
      a. Radium
         i. Decay
         ii. Source construction
         iii. Source specification
         iv. Exposure rate constant
         v. Applications
         vi. Physical characteristics
      b. Cesium-137
      c. Cobalt-60
      d. Iridium-192
      e. Gold-198
      f. Iodine-125
      g. Palladium-103
      h. Cesium-131
   3. Calibration of Brachytherapy Sources
      a. Specification of source strength
         i. Activity
         ii. Exposure rate at distance
         iii. Equivalent mass of radium
         iv. Apparent activity
         v. Air kerma strength
      b. Exposure rate calibration
         i. Open-air measurements
         ii. Well-type ion chambers
   4. Calculation of dose distributions
      a. Exposure rate
         i. Sievert Integral
         ii. Effects of inverse square law
      b. Absorbed dose in tissue
      c. Modular dose calculation model: TG-43
d. Isodose curves

5. Systems of Implant Dosimetry
   a. Paterson-Parker
      i. Planar implants
      ii. Volume implants
      iii. Paterson-Parker tables
      iv. Determination of implant area or volume
   b. Quimby
   c. Memorial
   d. Paris
   e. Computer

6. Computer Dosimetry
   a. Localization of sources
      i. Orthogonal imaging method
      ii. Stereo-shift method
   b. Dose computation

7. Implantation Techniques
   a. Surface molds
   b. Interstitial therapy
   c. Intracavitary therapy
      i. Uterine cervix
      ii. Uterine corpus

8. Dose Specification: Cancer of the Cervix
   a. Milligram-hours
   b. The Manchester System
      i. Bladder dose
      ii. Rectum dose
   c. The International Commission on Radiation Units and Measurements System
      i. Absorbed dose at reference points

9. Remote Afterloading Units
   a. Advantages
   b. Disadvantages
   c. High-dose rate versus low-dose rate

C. Clinical Processes
   1. Source Calibration check
      a. HDR
      b. LDR seed
   2. Low Dose Rate Cesium Implant
      a. Dosimetry planning
      b. Hand calculation (time)
   3. Implant Dosimetry Hand Calculation
      a. Paterson-Parker tables
      b. Quimby System
      c. Memorial System
      d. Paris System
   4. Eye Plaques
      a. COMS (Collaborative Ocular Melanoma Study) protocol
      b. Treatment planning/prescription
      c. Seed ordering
         i. Single Source Strength Assay
         ii. Plaque construction
      d. Plaque placement/recovery source disposal
5. Prostate Seed Implants
   a. Volume Study
      i. Ultrasound imaging
      ii. Volume estimate
      iii. Contouring – volume for planning
   b. Treatment planning
      i. Dose-volume constrained
      ii. Nomogram based
   c. Seed ordering
   d. Source strength assay
   e. Implant QA checklist
   f. Implant Procedure
      i. Seed sterilization
      ii. Needle placement
      iii. Seed placement
      iv. Cystoscopy (seed recovery from bladder)
      v. Recovery/disposal of waste seeds
   g. Post Implant Dosimetry
      i. CT-based planning/assessment
      ii. Dose-volume parameters

Learning Opportunities:
The resident is expected to perform extensive reading of background materials.
1. Observe HDR source exchange. Participate in HDR source calibration check.
2. Observe and participate in LDR source calibration check measurements.
3. Write up solutions to the following exercises:
      The resident is encouraged to write solutions to as many more of these problems in
      Chapter 13 as they desire.
   c. Johns and Cunningham (reference 3) pg. 497: 8, 9, 10, 11, 14, 15, 16, 17.

Reading List:
1. Radiation Therapy Physics 3rd Ed, Hendee, Ibbott and Hendee, Chapter 1 (focus pp 8-19),
   Chapters 12 & 13, Chapter 15 (pp 399-408).
2. The Physics of Radiation Therapy, 3rd Ed, Khan, Chapters 1 & 2 (focus pp 20-23), Chapter 15,
   Chapter 17 (pp 444-447).
4. Brachytherapy Physics, 2nd Ed (2005 AAPM Summer School Proceedings), Thomadsen,
   Rivard, Butler (Eds), Chapters 1, 2, 3, 4, 5 (Overview & Fundamentals), Chapters 12, 13
   (Localization), Chapters 14, 15, 16 (Dosimetry).
5. Code of Practice for Brachytherapy Physics (Reprinted from Medical Physics, Vol. 24, Issue
6. ICRU. Dose and volume specification for reporting intracavitary therapy in gynecology. ICRU
   Report No. 38. Bethesda, MD: International Commission on Radiation Units and

Assessment:
The resident will prepare a written report summarizing their experiences and present this information
.to the physics faculty during an oral exam. This report will include hand calculations performed for the
various pencil and paper exercises.
Module: Brachytherapy – Low Dose Rate (LDR)

(This module may be truncated if adequate number of cases are not available due to change in clinical practice at UHCMC. Residents will participate in available cases).

I. Objective: This module intends to provide fundamental knowledge and sufficient practical experience for active competency in low dose rate (LDR) brachytherapy using tandem & ovoids (Cs-137) or Syed-Neblett applicator (Ir-192/Cs-137).

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
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</thead>
<tbody>
<tr>
<td>1. Attend 5 hours of class for brachytherapy provided in the physics residents’ syllabus.</td>
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<tr>
<td>2. Read Chapter 15 in Khan (3rd ed.) and chapter 13 in Hendee (3rd ed.) for brachytherapy overview.</td>
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<tr>
<td>4. Submit following problems from Hendee – Chapter 13: 1, 4, 5, 12, 13, 14, 15</td>
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<tr>
<td>5. Review types of low dose rate applicators with physicist/therapists.</td>
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III. Clinical Activities:

The resident will work with the therapist/physicist to observe and perform the steps listed in A and/or B below for the designated number of patients.

A. Pre-treatment planning (Syed only):
   - Observe CT/MR scans
   - Import images into PHILIPS PINNACLE treatment planning system
   - Create treatment plan per physicians’ objectives
   - Assist therapist(s) with seed ordering
   - Prior to treatment, participate in seed assay

B. Treatment day process (Both T & O and Syed):
   - Observe CT scan
   - Observe target/critical structure delineation
   - Create treatment plan per physicians’ objectives
   - Perform 2nd check calculation
   - Prepare applicator for afterloading
   - Perform cesium source inventory
   - Observe loading of sources into patient
   - Participate in room survey

C. Eye Plaque procedure
   - Planning/prescription
   - Seed ordering/assay plaque construction
   - Plaque placement
   - Plaque removal/seed disposal
## Observed Patient Cases (if available):

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<th>Case</th>
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*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

## Planned Patient Cases (if available):

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## Mentor Assessment:

**Summary of Resident’s activities:**

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ______________ yes ____________ no

Mentor’s Signature ________________________________   Date ____________________________


Module: LDR Brachytherapy – Prostate Seed Implant (PSI)

I. Objective: This module intends to provide fundamental knowledge and sufficient practical experience for active competency in prostate seed implantation.

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
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<tbody>
<tr>
<td>1. Attend 5 hours of class for Brachytherapy provided in the physics residents’ syllabus (if necessary).</td>
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<tr>
<td>2. Read Chapter 23 in Khan (3rd ed.) for PSI overview. Submit following problems from Hence Chapter 13: 14, 15.</td>
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<tr>
<td>3. Read following AAPM Reports: TG-43/U1/S1/S2, TG-64, TG-137.</td>
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<tr>
<td>4. Review prostate seed device/applicator with physicist/therapists.</td>
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</table>

III. Clinical Activities:

The resident will work with the therapist/physicist to observe and perform the steps listed in A and B below for the designated number of patients.

A. Pre-treatment process:
   - Volume study via ultrasound
   - Target and normal tissue delineation
   - Pre-treatment plan for seed determination
   - Seed ordering with therapists
   - Seed assay and enter data into spreadsheet

B. Treatment day planning process in operating room (OR):
   - Input seed data/patient information into treatment planning system
   - Plan/assist radiation oncologist with treatment plan
   - Ensure/verify seed inventory
   - Perform patient and room survey after procedure is complete

C. Post-treatment activities:
   - Perform CT-based assessment
   - Perform final dose assessment

Observed Patient Cases:

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*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

**Reading List:**

1. Collaborative Ocular Melanoma Study Group, “Collaborative Ocular Melanoma Study (COMS) randomized trial of I-125 Brach therapy for choroid melanoma”, multiple COMS Reports. See Ed Pennington for copies.
2. Radiation Therapy Physics 3rd Ed, Hence, Abbott and Hence, Chapter 13 (focus pp 322-329).
3. The Physics of Radiation Therapy, 3rd Ed, Khan, Chapter 22 (HDR), Chapter 23 (Prostate Implants) and Chapter 24 (Intravascular Brachytherapy).
4. Brachytherapy Physics, 2nd Ed (2005 AAPM Summer School Proceedings), Thomason, River, Butler (Eds.), Chapter 6 (HDR), Chapter 7 (HDR QA), Chapters 28-33 (Prostate Brachytherapy) Chapter 34 (Eye plaques).
10. Dose Prescription and Reporting Methods for Permanent Interstitial Brachytherapy for Prostate Cancer (AAPM TG #137).

**Assessment:**

The resident will prepare a written report summarizing their experiences and present this information to the physics faculty during an oral exam. This report will include any treatment planning results performed by the resident.

**Mentor Assessment:**

Summary of Resident's activities:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ______________ yes ____________no

Mentor’s Signature ________________________________   Date ____________________________
7B. Brachytherapy (HDR)

A. Skills
   1. Brachytherapy Safety
      a. Safe source handling
      b. Time/distance/shielding
   2. Brachytherapy Dosimetry
      a. Exposure Rate Constant Formalism
      b. Air Kerma Strength Formalism
   3. Brachytherapy Treatment Planning
      a. Dose prescription – Written directive
      b. Dose objectives – DVH parameters

B. Knowledge Base
   1. Source Exchange/Calibration check
   2. Daily (day of treatment) QA
   3. Applicator/catheter placement
   4. Imaging for treatment planning
      a. Orthogonal images
      b. Reconstruction geometry
      c. CT-based planning
   5. Dose prescription/fractionation/rational
   6. Treatment planning
      a. Written Directive
      b. Dose planning objectives
      c. Critical structure doses
      d. Treatment planning procedures
      e. Treatment plan QA
   7. Treatment delivery
      a. Pre-treatment survey
      b. Attach catheters/applicator
      c. Authorized User/Medical Physicist requirements
      d. Treatment progress assessment
      e. Post-treatment survey
      f. Recovery/remove catheters/applicator
   8. Emergency procedures
      a. Annual HDR safety training
      b. Manual source retract
      c. Stuck source
      d. Patient safety

C. Clinical Processes
   1. High Dose Rate Procedures
      a. Vaginal Cylinder
      b. Tandem and Ovoids
         i. Fletcher-Suit-Delcos applicator
         ii. Orthogonal Images
         iii. Bladder rectal dose points
         iv. Prescription dose (Point A)
         v. Dose optimization points
         vi. Treatment plan assessment
         vii. Treatment plan QA
         viii. Treatment Delivery
ix. Patient recovery
c. Interstitial Implant
   i.  CT-based planning
   ii. Dose-Volume assessment
   iii. Manual plan/dose manipulation
d. Endobronchial
   i.  Pre-planned treatment template
   ii. Endoscopic-guided catheter placement
   iii. Pre-treatment verification imaging
e. MammoSite (partial breast irradiation)
   i.  Prescription dose/fractionation/rational
   ii. CT-based planning/assessment
   iii. Point dose prescription/dwell time calculation
   iv. Pre-treatment verification imaging

Learning Opportunities:

This rotation requires reading an extensive amount of background material.

Accompany the medical physicist during brachytherapy procedures at least one time for each of the following: eye plaque planning/seed ordering, eye plaque construction, eye plaque placement and removal procedure, prostate implant planning volume study, prostate implant treatment planning session, prostate implant procedure, prostate implant post implant dosimetry assessment, HDR vaginal cylinder (VC) placement procedure, HDR tandem and ovoid/ring (T&O/R) placement procedure, HDR VC simulation and planning session, HDR T&O simulation and planning session, HDR VC treatment delivery, HDR T&O/R treatment delivery. Observe as many less frequently performed clinical cases as possible (endobronchial, MammoSite, interstitial implants).

Participate in the brachytherapy treatment planning with the qualified medical physicist for each of the following clinical cases: eye plaque, prostate implant, high dose rate tandem and ovoid/ring, and high dose rate vaginal cylinder.

Perform the monthly HDR QA and single source activity assays for prostate and eye plaque implants. Perform one set of hand calculation (following TG-43) for clinical sources and attend in HDR source exchange activities.
Module: Brachytherapy – High Dose Rate (HDR)

I. Objective: This module intends to provide fundamental knowledge and sufficient practical experience for active competency in high dose rate brachytherapy.

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
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<tbody>
<tr>
<td>1. Attend 6 hours of class for brachytherapy provided in the physics residents' syllabus (if necessary).</td>
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<tr>
<td>2. Read/review Chapter 15 in Khan (3rd ed.) for brachytherapy overview, Section 18-5 in Modern Technology of Radiation Oncology (Van Dyke, 1999).</td>
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<td>3. Read following AAPM Reports: TG-41 and TG-59.</td>
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<td>4. Submit following problems from Hendee – Chapter 12: 4, 5, and 6.</td>
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<tr>
<td>5. Review types of high dose rate applicators with physicist/therapists.</td>
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III. Clinical Activities:

The resident will work with the therapist/physicist to observe and perform the steps listed in A and/or B below for the designated number of patients.

A. Vaginal Cylinder:
   
   *Pre-treatment activities*
   - Observe CT scan
   - Import CT scan into Oncentra treatment planning system
   - Perform/assist in critical structure contouring
   - Generate linear plan
   - Generate optimized plan
   
   *Treatment day(s) activities*
   - Verify linear and optimized plans
   - Verify treatment parameters including time and activity (after 1st fraction)

B. MammoSite:
   
   *Pre-treatment activities*
   - Observe CT scan
   - Import CT scan into Oncentra treatment planning system
   - Perform/assist in critical structure contouring
   - Generate treatment plan
   - Check the plan using TG-43 formulation
   
   *Treatment day(s) activities*
   - Verify treatment parameters including time and activity (after 1st fraction)

C. Other types of HDR brachytherapy cases, which occur less frequently, can be observed as well. These cases can be substituted for one of the observed cases.
### Observed Patient Cases:

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### Planned Patient Cases:

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*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

### IV. Quality Assurance/Calibration/Safety

The resident will work with the special procedures therapist/physicist to perform the daily QA. The resident will work with the physicist to actively participate in tasks associated with the monthly QA, the source exchanges, and other related activities. The resident will also attend at least one of the scheduled HDR safety training sessions proctored by the Nucletron field service engineer.

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<td>Monthly QA</td>
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<td>Source Exchange:</td>
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<td>Oncentra Update:</td>
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<td>Safety Training:</td>
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*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

Mentor Assessment:

Summary of Resident’s activities:

_________________________________________________________________________________
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_________________________________________________________________________________
Competency attained ______________ yes   ____________no

Mentor’s Signature ________________________________   Date ____________________________
8. Room Design, Radiation Protection and Radiation Safety rotation (core)

A. Skills
   a. Interpretation of architectural drawings
   b. Survey meter operation
   c. Use of spreadsheet for data analysis
   d. Linac/HDR operation

B. Knowledge Base
   a. Understand radiation safety principles
   b. Understand dose limits/regulatory requirements
   c. Understand barrier material composition and preferences
   d. Understand process of neutron production
   e. Barrier HVL/TVL values
   f. Methodology of barrier thickness computation
   g. Understand differences between head leakage, scatter and primary radiation

C. Clinical Process
   a. Apply radiation safety principles to situations found in a radiation oncology clinic
      i. Time-Distance-Shielding
      ii. Brachytherapy safety and source accountability
      iii. Operational safety practices for linac, CT, PET, HDR, and MR
      iv. Patient safety
   b. Identify allowable radiation limits for occupationally exposed individuals
   c. Identify allowable radiation limits for members of the general public
   d. Identify/define controlled areas vs. non controlled areas
   e. Identify sources of radiation exposure found in typical radiation therapy facility
   f. Compute workloads
      i. Accelerator
      ii. HDR
      iii. LDR
      iv. Conventional simulator
      v. CT scanner
   g. Determine use factors for various radiation sources
   h. Determine occupancy factors for regions adjacent to sources of radiation
   i. Calculate barrier thickness
   j. Measure actual exposure outside treatment vault/HDR unit.

D. Learning opportunities
   a. The resident will demonstrate to the mentor that he/she has developed a solid grasp of radiation safety practices that need to be implemented in a typical radiation oncology facility.
   b. Compute barrier thicknesses for a typical linear accelerator room layout.
   c. Compute barrier thicknesses for a typical HDR suite
   d. Measure exposure at door and in rooms adjacent to linear accelerator
   e. HDR room survey
   f. Neutron survey
   g. Film Badge area monitoring
   h. Optional: Patient specific shielding design (i.e., fetal dose reduction)
Reading list

1. NCRP Report 49
2. NCRP Report 151 (S:\OncShare\PHYSICS\NCRP_Reports)
3. The Physics of Radiation Therapy, 3rd ed., Khan, Ch. 16
5. Shielding Techniques, 2nd ed McGinley
6. AAPM task group 32 – Fetal Dose
7. AAPM online refresher courses

Assessment

The resident will compile a report describing the individual steps that were taken to perform the shielding design and analysis for the linear accelerator vault and/or HDR suite assigned in the learning opportunities. This report should be written as if the intended recipient was the architect in charge of designing the facility.

While the bulk of this rotation involves a shielding design project, the resident's overall understanding of radiation safety will be evaluated during this rotation. Radiation safety training is a continuous process throughout the 2 year rotation. Specific safety topics should have been addressed in previous rotations. The mentor will use this rotation to evaluate the resident on their understanding of safety issues by asking pertinent questions that the resident should be able to answer. Should the resident fail to answer any questions to the mentor's satisfaction he/she will be asked write a report covering the specific safety issues that need further study.

The resident will take an oral exam at the conclusion of the rotation. The resident should be able to demonstrate knowledge of these processes and other relevant information obtained from the reading lists.

Mentor Assessment:

Summary of Resident’s activities:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained _______________ yes ____________no

Mentor’s Signature _______________________ Date___________________________
9. Imaging for Simulation, Planning and Treatment Verification rotation (core)

9A. Imaging for Simulation

A. Prerequisite Skills

a. Radiation Safety – X-ray machine operation
b. Human Anatomy – common bony landmarks
c. Fundamental Physics of Radiographic Imaging
   i. Radiation Interactions with Matter
      1. Photoelectric Effect, Compton, Pair Production
      2. Attenuation and Scatter
   ii. Basic Imaging Parameters
      1. Contrast
      2. Detective Quantum Efficiency
      3. Signal to Noise Ratio
      4. MTF

d. Introductory Imaging Technologies
   i. Imaging Detector Concepts
      1. Films
      2. Fluoroscopy
      3. Computed Radiography
      4. Ion Chamber Arrays
      5. Diode Arrays (Asi)
      6. Other planar X-ray imagers
   ii. X-ray CT
   iii. PET
   iv. MRI
   v. Ultrasound

B. Knowledge Base

a. Principle understanding of simulation process.
b. Fundamental Principles of Simulation Equipment
   i. CT/4D-CT
   iii. Immobilization and Localization aids.
   v. Image co-registration (“fusion”) and the role of multimodality imagery in simulation.
   vi. PET/CT
   vii. Temporally-Registered Imagery (4D).

c. Medical Physicist Role in Simulation and Equipment Management
   i. Conventional Simulation
      1. Process emphasizing physicist role (i.e. historical breast)
      2. QA of Simulator
      3. QA of imaging chain
      4. QA of X-ray generator
   ii. CT Simulation
      1. CT numbers, electron density, and relationship to Radiation Oncology treatment planning.
      2. Diagnostic CT v. Planning CT (or Simulator)
      3. CTSim QA
         a. Mechanicals, lasers, fiducials
b. Imaging
   
c. Heterogeneity correction tables

iii. PET/CT
   1. Radiation isotope safety
   2. QA
   3. Issues in utilizing PET images in simulation.

iv. MRI
   1. Application as image set for fusion
   2. Potential as primary simulation modality
   3. QA for RTMRI

v. Use of “other” modes in RT Simulation (such as photogrammetry, Ultrasound, setup “aids”).

C. Clinical Processes
   
a. CT Simulation
b. VSIM as an alternative to CT Sim
c. Sim Aids: Radiocam, Sonosite, etc.

Learning Opportunities:

- Attend a conventional simulation for EBRT. Observe patient setup, use of fluoroscopy and image capture, and annotation of films.
- Follow a patient through the CT (PET/CT) simulation process. Emphasis should be on geometric aspects of the process (setup geometry specification, immobilization, marking, tattoos, CT including x-ray technique, and transfer to planning system).
- Note: Much of this is done for phantom as part of monthly CT simulator QA.
- Follow a patient and then take a phantom through the VSIM process.
- Observe the use of combined imaging modalities in the simulation process (such as MRI and CT for SRS).
- Follow a patient through the Optical Image guided setup simulation process, attend CT, bite block registration, and initial treatment.
- Perform Radiocam and Sonosite QA.
- Perform CT (PET/CT) QA to include using the ACR phantom.

Reading List:

2. Christensen’s Physics of Diagnostic Radiology (In order) Chapters 14, 15, 19, 12, 24.
3. Perry Sprawl’ On-line lectures:
**Observed Patient CT-Sim Setup Cases** (1 H&N, 1 Lung, 1 Breast, 1 Cyber, 1 GYN/Prostate):

<table>
<thead>
<tr>
<th>Case Type:</th>
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*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

**Perform (with RTTs) Patient CT-Sim Setup Cases** (1 H&N, 1 Lung, 1 Breast, 1 Cyber, 1 GYN/Prostate):

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**Assessment:**
The resident will present a report that describes the simulation process and equipment in Radiation Therapy. This report should include descriptions of the relevant underlying principles of the systems used, and an overview of all the processes, describing the individual steps conceptually. The report should also contain descriptions of any experiments or measurements performed and analyses of same. Finally, the resident will take an oral exam. An understanding of the principles behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated.

**Mentor Assessment:**

Summary of Residents activities:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ___________ yes ___________ no

Mentor’s Signature ____________________________   Date ____________________________

- 68 -
9B. Imaging for Planning and Treatment Verification

A. Skills

1. Fundamental Understanding of Basic Radiotherapy Process
   a. Simulation imaging
   b. Treatment planning
   c. Treatment delivery/verification

2. Basic Understanding of Radiological Imaging Modalities
   a. X-ray film/fluoroscopy
   b. X-ray CT
   c. MRI
   d. PET (PET/CT)

3. Basic Imaging Science
   a. Contrast Resolution
   b. Signal to Noise
   c. Image Quality
      i. Point/Line spread function
      ii. Modulation transfer function
   d. Digital imaging
      i. Quantum mottle
      ii. Noise frequency/spectrum
      iii. Detective Quantum Efficiency

B. Knowledge Base

1. Radiotherapy Simulation
   a. CT simulation/virtual simulation
   b. DRR generation
      i. Set-up verification
      ii. Portal image verification
   c. X-ray simulator
      i. Set-up verification
      ii. Portal image verification

2. Verification Imaging in Radiotherapy
   a. Kilovoltage x-ray images
      i. Simulator set-up images
      ii. Simulator portal images
      iii. Beams eye view DRR from CT
      iv. Set-up/Portal verification
   b. Megavoltage x-ray images
      i. X-ray film/cassette
      ii. Comparison to hardcopy DRR
      iii. Electronic portal images
   c. Ultrasound localization
      i. Set-up verification
      ii. SonArray system
   d. Megavoltage conebeam CT
      i. 3-D localization
      ii. Adaptive targeting

3. Electronic Portal Imaging Devices
   a. Fluoroscopic screen/camera based systems
      i. Principles of operation
      ii. Disadvantages/Limitations
ii. Clinical prevalence

Liquid Ion Chamber based systems
i. Principles of operation
ii. Disadvantages/Limitations
iii. Clinical prevalence

c. Active Matrix Flat Panel (aSi) based systems
i. Principles of operation
ii. Advantages/Limitations
iii. Clinical prevalence

D. Clinical Processes
a. CT simulation
i. Patient set-up
ii. Isocenter localization
b. Digital Reconstructed Radiograph
i. Generation
ii. Clinical use
c. Electronic Portal Imaging Devices
i. Principles of operation
ii. Daily/monthly quality assurance testing
iii. Set-up/portal image verification
iv. Megavoltage conebeam computed tomography

Learning Opportunities:

1. Clinical Use of Images
2. Portal Imaging Detector Systems
3. Image Quality
4. Commissioning and QA

Reading List:

2. The Physics of Radiation Therapy, 3rd Ed, Khan, Chapter 12 (focus on pp 228 – 244), Section 12.7 (Patient Positioning) pp 264 – 268.
Assessment:
The resident will prepare a written report summarizing their experiences and present this information to the physics faculty during an oral exam. The resident will develop knowledge of portal imaging systems used during the simulation/planning process and during treatment verification. The application of different electronic portal imaging systems will be studied by comparison of systems from Varian and Siemens. The resident will perform the necessary processes for commissioning the EPID systems, as well as identify and perform continuing quality assurance. During the rotation the resident will perform monthly and annual quality assurance on different portal imaging systems.

Mentor Assessment:
Summary of Resident's activities:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
Competency attained ____________ yes ____________ no

Mentor’s Signature ________________________________  Date ____________________________
10. Image Guided Radiation Therapy (IGRT) rotation (core)

A. Skills
   a. TPS system operation
   b. Linear Accelerator operation
   c. KV Cone Beam CT (and 4D CBCT, if applicable)
   d. Megavoltage cone-beam operation – (if available)
   e. MR and PET/CT operation

B. Knowledge Base
   a. Prospective and Retrospective CT principles
   b. Gated treatment delivery principles
   c. Treatment planning process for IGRT
   d. Data export/import into each system

C. Clinical Processes
   a. Perform Quality Assurance on each of the IGRT components
      i. 4D image acquisition
      ii. gated delivery
      iii. megavoltage conebeam
   b. Export IGRT Treatment Plans for
      i. Brain, Head and Neck, Lung, GI/GYN, and Prostate.
   c. Perform image registration and fusion for multimodality imaging utilized in treatment planning
      i. CBCT with CT
      ii. PET with CT
      iii. MRI with CT

Learning opportunities
Observe and participate in the IGRT treatment planning and delivery process and understand the functionality of the systems utilized. Quality assurance of every aspect of each IGRT system studied, from image acquisition through verification and treatment delivery.

Reading List
2. Radiation Therapy Committee Task Group #53.


Module: IGRT

I. Objective: This module intends to demonstrate fundamental knowledge and sufficient practical experience for active competency in IGRT.

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Read AAPM TG-104 report and TG-179</td>
<td></td>
</tr>
<tr>
<td>2. Read AAPM TG-76 report</td>
<td></td>
</tr>
<tr>
<td>3. Read Chapter 21 in Khan (3rd ed.) and AAPM TG-101 report</td>
<td></td>
</tr>
</tbody>
</table>

III. Clinical Activities:

The resident will work with the therapist/physicist to observe and perform the steps listed in A – C below for the designated number of patients.

A. Simulation/Treatment Planning activities:
   - Observe patient set-up and immobilization in CT-Sim
   - Observe and/or assist with the 4D-CT image acquisition and motion management
   - Transfer images from CT to Philips Pinnacle (or relevant Tx planning system)
   - Set-up patient-planning objectives, avoidance,
   - Calculate and optimize treatment plan (through Full dose and Final dose steps)

B. Patient-specific quality assurance:
   - Review patient QA protocol
   - IMRT/VMAT/SBRT phantom selection/planning
   - Run the IMRT/VMAT/SBRT treatment and analyze

C. Treatment day activities:
   - Ensure QA and First Day Checklist are filled-in, reviewed and is approved for treatment
   - Ensure treatment chart, Mosaiq, and treatment plan are ready for treatment
   - Treatment console operation/machine operation

Observed Patient Cases (Brian, Lung, GI/GYN, prostate, H&N):

<table>
<thead>
<tr>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
<th>Case #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Type:</td>
<td>_______</td>
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<td>_______</td>
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<tr>
<td>Patient Initials:</td>
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<tr>
<td>Mentor sign:</td>
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</tbody>
</table>

Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)
Planned Patient Cases (Brain, Lung, GI/GYN, prostate, H&N):

<table>
<thead>
<tr>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
<th>Case #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Type:</td>
<td>_______</td>
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<tr>
<td>Patient Initials:</td>
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<tr>
<td>Mentor sign:</td>
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</tbody>
</table>

*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc).*

**IV. Machine-related Quality Assurance/Calibration/Safety**

The resident will work with the therapist/physicist to perform the daily QA. The resident will work with the physicist to actively participate in all other tasks listed below.

<table>
<thead>
<tr>
<th>Tasks:</th>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily QA</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Monthly QA</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Patient Archive/Retrieval</td>
<td>_______</td>
<td>_______</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Cluster Server Operation</td>
<td>_______</td>
<td>_______</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Data Server Operation</td>
<td>_______</td>
<td>_______</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Post-service checks after Linac/Target change</td>
<td>_______</td>
<td>_______</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Follow FSE for PMI</td>
<td>_______</td>
<td>_______</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Annual QA Review:</td>
<td>_______</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

**Assessment:**

The resident will present a report giving an overview of all the processes, describing the individual steps conceptually, and results from their experimental studies and quality assurance verification measurements in IGRT. Current capabilities and remaining challenges of the use of multimodality imaging in radiation therapy treatment planning should be discussed. Finally, the resident will take an oral exam. An understanding of the principles behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated.

Mentor Assessment:

Summary of Residents activities:

_________________________________________________________________________________

_________________________________________________________________________________

Competency attained ___________ yes ___________ no

Mentor’s Signature _______________________ Date___________________________
11. **Floor Physicist (Physicist of the Day) rotation (core)**

I. **Objective:** Provide the resident with the fundamental knowledge and practical training for proficiency with day-to-day clinical operations as the floor physicist. Resident will perform all tasks under the supervision of a senior physicist.

II. **Didactic Activities:**

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Review functionality of clinical software programs: Impac Mosaiq, Lifeline Software's RadCalc, and Sun Nuclear's Daily QA3</td>
<td></td>
</tr>
</tbody>
</table>

III. **Clinical Activities:**

The resident will work with the designated floor physicist of the day on the activities listed below:

A. **Daily Quality Assurance**
   - Review morning machine quality assurance data for all treatment units and identify any parameters outside of specification

B. **Complete 25 initial treatment plan/chart checks**
   - Check patient prescription in Mosaiq compared to the physician approved treatment plan
   - Check second MU calculations (generated in RadCalc)
   - Provide treatment day physics assistance
   - Perform final physics chart checks

C. **Complete 50 weekly treatment plan/chart checks**
   - Overall check of chart for completeness & signatures
   - Check fractions treated & dose site summary
   - Check the tolerance table values in Mosaiq compared those found in the treatment chart.
   - For applicable plans, review diode measurements to ensure readings are within the expected range and transcribed into Mosaiq.

D. **Complete 25 final treatment plan/chart checks**
   - Work through Final Physics Checks spreadsheet
   - Become familiar with process of billing (senior physicist is responsible for billing)

E. Under the supervision of the senior physicist, assist with clinical issues that arise during the treatment day

*Note:* It is the responsibility of the resident to track (by spreadsheet) work associated with the items above. For a given chart check, annotate the type of chart check, date, patient initials, MRN, and senior physicist reviewing the work

**Assessment:**
The resident's performance will be evaluated based on his/her understanding and confidence of handling clinical situations, behavior and relationship with other clinical staff and patient. An oral
examination will be taken by the mentor and/or other staff physicist worked with the resident in this rotation.

Mentor Assessment:

*Summary of Resident’s activities:*
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ________________yes ____________no_______________

Mentor’s Signature _______________________ Date___________________________
12. Professional (Ethical and Legal) and Process/Practice (FMEA and TQM) Issues rotation (core)

12A. Professional (Ethical and Legal) Issues

A. Skills
   a. Thorough with clinical workflow
   b. Familiar with legal and ethical terminology

B. Knowledge Base
   a. Understand radiation therapy processes
   b. Understand radiation safety principles
   c. Understand privacy of patient information
   d. Understand cultural differences
   e. Understand the departmental policy and procedure
   f. Understand HIPAA,
   g. Understand JCHAO
   h. Understand research with patient data
   i. Understand scientific publications
   j. Understand dose limits/regulatory requirements

C. Learning opportunities
   a. The resident will demonstrate to the mentor that he/she has developed a solid understanding of legal and ethical issues related to radiation therapy.

Reading list

1. Nuclear Regulatory Commission (NRC) reports.
   a. Part 19 -- Notices, Instructions and Reports to Workers: Inspection and Investigations
   b. Part 20 -- Standards for Protection Against Radiation
   c. Part 35 -- Medical Use of Byproduct Material

2. NCRP Report 49

3. NCRP Report 151 (S:\OncShare\PHYSICS\NCRP_Reports)

   b. Part 173 -- General Requirements for Shipments and Packagings

5. Food and Drug Administration Title 21, Code of Federal Regulations.
   a. Part 361 -- Prescription Drugs for Human Use Generally Recognized As Safe And Effective And Not Misbranded: Drugs Used In Research
   b. Part 892 -- Radiology Devices
   c. Part 900 -- Mammography
   d. Part 1000 -- General
   e. Part 1020 -- Performance Standards For Ionizing Radiation Emitting Products


The resident will compile a very brief report describing the individual’s understanding of the ethical and legal issues related to radiation therapy. Should the resident fail to answer any questions to the mentor's satisfaction he/she will be asked write a report covering the specific ethical and/or legal issues that need further study. The resident will take an oral exam at the conclusion of the rotation. The resident should be able to demonstrate knowledge of these processes and other relevant information obtained from the reading lists.

Mentor Assessment:

Summary of Resident’s activities:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ____________yes ____________no

Mentor’s Signature _______________________ Date___________________________
12B. Process/Practice (FMEA and TQM) Issues

A. Skills
   a. Interpretation of treatment deviation or failure
   b. Use of spreadsheet for data analysis

B. Knowledge Base
   a. Understand radiation therapy processes and principles
   b. Understand dose limits/regulatory requirements
   c. Understand failure mode
   d. Understand effect and criticality of failure
   e. Understand Fault Tree Analysis (FTA) in radiation therapy (RT)
   f. Understand Failure Mode and Effect Analysis (FMEA) in RT
   g. Understand quality control in RT
   h. Understand total quality management (TQM) in RT

C. Clinical Process
   a. Find a suitable deviation/failure case from clinic
   b. Analyze the case using FMEA
   c. Root cause analysis (RCA)
   d. Event taxonomies
   e. Sensitivity analyses
   f. RPN scoring
   g. Models error propagation across sub-processes and steps including QC/QA checks
   h. Decide which process steps need QA/QC checks to mitigate high risk errors identified by FMEA
   i. Complementary QA and QM process design tools for improving RT Quality
   j. Prepare a report for rectification and/or improvement toward TQM
   k. Discuss the associate ethical, legal, and economical implications

D. Learning opportunities
   a. The resident will demonstrate to the mentor that he/she has developed a solid grasp of FMEA and TQM in radiation therapy.

Reading list

Assessment
The resident is expected to learn about TQC and FMEA issues and methods. Understanding and knowledge of the resident in these regards will be assessed. The resident will do a project on FMEA related to one of the RT process (e.g., IMRT, VMAT, HDR, SBRT, SRS, etc.) to demonstrate his/her understanding of the FMEA in particular and TQ in broader sense. The resident will take an oral exam at the conclusion of the rotation. The resident should be able to demonstrate knowledge of these processes and other relevant information obtained from the reading lists.

Mentor Assessment:

Summary of Resident’s activities:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ____________ yes ____________ no

Mentor’s Signature _______________________ Date___________________________
13. Stereotactic Radiosurgery rotation (elective)

A. Prerequisite Skills
   a. SRS Principles
   b. Operation of Gamma, CyberKnife and Elekta Snergy in SRS mode
   c. MU calculation (TPR, PSF, CF, ISF) for conventional treatments
   d. Use of ion chamber/electrometer/diodes/MOSFETs
   e. Film dosimetry
   f. Treatment planning basics for each modality

B. Knowledge Base
   a. Small field dosimetry
   b. Film measurements for small fields
   c. SRS Beam modeling
   d. Patient immobilization
      i. Frame
      ii. Frameless
   e. Treatment Planning
      i. Reference frame coordinate system
      ii. Image fusion
      iii. Target localization
      iv. Isocenter selection
      v. Dose verification
   f. Delivery
      i. Gantry/collimator/couch alignment
      ii. Floor stand isocenter location
   g. Verification (QA) of delivery process

C. Clinical Process
   a. Geometrical Alignment
      i. Patient Position
      ii. Verify alignment using Diode and film
      iii. Verify target simulator
      iv. Verify target localization accuracy using absolute phantom
      v. Patient Immobilization
         1. Frame placement
         2. Frameless
   b. Beam data acquisition
      i. Measure small field TPR
      ii. Measure small field output factors
      iii. Create data table of TPR/OPF/Calibration data
   c. Planning system commissioning
      i. Enter beam data into planning system
      ii. Verify planning system beam data
      iii. Verify localization for frame treatments
      iv. Verify localization for frameless treatments
   d. Treatment planning
      i. Perform image fusion
      ii. Create single isocenter plan
         1. Identify arc/couch limitations
         2. Establish arc/couch angle presets
      iii. Create multiple isocenter plan
1. Explain isodose line normalization
2. Explain isodose line prescription
e. Plan Transfer to R&V/Linac
   i. Transfer data to Mosaiq
   ii. Transfer isocenter coordinates or plan to Gamma or CyberKnife
   iii. Perform independent MU calculations
f. Delivery
   i. Identify patient safety precautions
   ii. Perform pre treatment QA
   iii. Participate/observe frameless delivery
   iv. Participate/observe frame delivery
   v. Operate linac, gamma or CyberKnife in QA mode (simulated treatment)
g. Workflow
   i. Generate SRS workflow diagram
   ii. Perform Failure Mode Analysis

Learning opportunities
- Perform QA on radiosurgery system using absolute phantom.
- Obtain small field TPR and OPF for two collimator sizes.
- Verify physics data in planning system.
- Establish mechanism for independent MU calculations.
- Create and execute a single isocenter plan on a phantom. Measure the dose delivered to the phantom and compare it to the planned dose.
- Follow a frame patient through all steps of process (frame placement, imaging, planning and delivery.) See item C. above.
- Follow a frameless patient through all steps of process (bite plate generation, imaging, planning and delivery.) See item C. above.
- Using workflow diagram, identify critical failure points and make recommendations on how to minimize or eliminate critical failures.

Reading list
1. AAPM report 54, Stereotactic Radiosurgery
4. The Physics of Radiation Therapy, 3rd ed., Khan, Ch.21

Assessment:
The resident will acquire TPR/OPF/Calibration data for 2 small collimator fields. Upon successful demonstration of the acquired data, the staff physicist will give the resident data for all other collimator sizes. The resident will assemble a data book of the SRS planning data. He/she will format the data (TPR/ OPF/ OAF/ CAL) appropriate to enter into the planning system and to use for independent calculations. The resident will perform QA on the mechanical system, from localization to delivery giving quantitative analysis of the geometrical errors at each step of the process. The resident will be expected to observe as many actual SRS treatments as possible during their rotation.

The resident will take an oral exam (complete Module in CyberKnife or Gamma Knife) at the conclusion of the rotation. The resident should be able to demonstrate knowledge of these processes and other relevant information obtained from the reading lists.
Module: Radiosurgery – Gamma Knife

I. Objective: This module intends to demonstrate fundamental knowledge and sufficient practical experience for active competency in GammaKnife Stereotactic Radiosurgery Procedures.

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Attend 1.5 hours of class for GammaKnife provided in the physics residents’ syllabus.</td>
<td></td>
</tr>
<tr>
<td>2. Read Chapter 21 in Khan (3rd ed.).</td>
<td></td>
</tr>
<tr>
<td>3. Read AAPM Reports: TG-42, TG-101</td>
<td></td>
</tr>
<tr>
<td>4. Read “Licensing Guidance Gamma Knife Perfexion”</td>
<td></td>
</tr>
<tr>
<td>(L:\physics\GammaPerfexion\Licensing Guide _NRC)</td>
<td></td>
</tr>
<tr>
<td>5. Review entire GammaKnife system with physicist/therapists.</td>
<td></td>
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</tbody>
</table>

III. Clinical Activities:

The resident will work with the physicist to observe and perform the steps listed in A – C below for the designated number of patients.

A. Pre-planning activities:
   • Observe frame placement
   • Observe MRI scans
   • Open a new patient in Leksell Treatment Planning System (TPS)
   • Input skull coordinates into TPS
   • Import DICOM data in TPS
   • Multi-view (Image fusion and co-registration, if necessary)

B. Treatment planning activities:
   • Contouring (all to be reviewed by senior physicist/attending physician)
   • Place the target (formerly “Matrix”) according to physician-confirmed lesions
   • Place treatment shots as needed to achieve physician’s prescription
     o Utilize the dynamic-shaping tool when necessary
   • Review plan upon completion
     o Check for clearance, zero-dose shots

C. Treatment day activities:
   • Assist with treatment patient set-up in room
   • Assist therapists with collision checks (if necessary)
   • Prepare special medical physics consult for physicist review and signature
   • Verify source strength on plan with values found in GammaKnife daily QA book.
   • Observe the initial portion of the treatment (approximately 25%)
   • Perform final physics check on chart

For each set of cases (Observed and Planned), a single metastasis, a multiple, and AVM cases must be included in the five documented cases. One case should include a fusion/co-registration.
Observed Patient Cases:

<table>
<thead>
<tr>
<th>Case Type:</th>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
<th>Case #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Initials:</td>
<td>_________</td>
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<tr>
<td>Mentor sign:</td>
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</table>

Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)

Planned Patient Cases:

<table>
<thead>
<tr>
<th>Case Type:</th>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
<th>Case #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Initials:</td>
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<tr>
<td>Mentor sign:</td>
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<td>_________</td>
</tr>
</tbody>
</table>

Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc).

IV. Quality Assurance/Calibration/Safety

The resident will work with the therapist/physicist to perform the daily QA. The resident will work with the physicist to actively participate in tasks associated with the monthly and annual QA.

<table>
<thead>
<tr>
<th>Tasks:</th>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily QA</td>
<td>_________</td>
<td>_________</td>
<td>_________</td>
<td>_________</td>
</tr>
<tr>
<td>Monthly QA</td>
<td>_________</td>
<td>_________</td>
<td>_________</td>
<td>N/A</td>
</tr>
<tr>
<td>Review output factor measurements:</td>
<td>_________</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Review annual calibration films:</td>
<td>_________</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Receive emergency training:</td>
<td>_________</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: Collect documentation (electronic or paper) for the

Mentor Assessment:
Summary of Resident’s activities:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
Competency attained ______________yes ____________no

Mentors Signature ________________________________   Date ____________________________
Module: Radiosurgery – CyberKnife

I. Objective: This module intends to demonstrate fundamental knowledge and sufficient practical experience for active competency in Cyber-Knife Stereotactic Radiosurgery Procedures

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Attend 1.5 hours of class for CyberKnife provided in the physics residents’ syllabus.</td>
<td></td>
</tr>
<tr>
<td>2. Read Chapter 21 in Khan (3rd ed.).</td>
<td></td>
</tr>
<tr>
<td>3. Read AAPM Reports: TG-42, TG-101</td>
<td></td>
</tr>
<tr>
<td>4. Review entire CyberKnife system with physicist/therapists.</td>
<td></td>
</tr>
</tbody>
</table>

III. Clinical Activities:

The resident will work with the therapist/physicist to observe and perform the steps listed in A – C below for the designated number of patients.

A. Simulation/Treatment Planning activities:
   • Observe initial set-up in treatment room
   • Observe treatment planning simulation/image acquisition (CT, MR, PET, etc.)
   • Import all acquired images into MultiPlan treatment planning system
   • Perform necessary image fusion using either seed points or manual manipulation
   • Contour normal tissue structures
   • Determine the proper tracking method and alignment (i.e. Align Center)
   • Create treatment plan per physician’s objectives

B. Post-treatment planning activities:
   • Perform second check of plan monitor units (MU Check).
   • Authorize the plan at the Admin. workstation
   • Create the digitally reconstructed radiographs (DRRs) at the CDMS workstation
   • Prepare the physics BED calculation
   • Input necessary information into MOSAIQ for treatment

C. Treatment day activities:
   • Assist with treatment patient set-up in room
   • Align the patient for treatment (with assistance of RTT for image acquisition)
   • Create a Synchrony model for treatment (if applicable).
   • Observe the treatment and provide necessary assistance to therapists
   • Perform final physics check on chart (upon completion of patient’s final fraction).
Observed Patient Cases:

<table>
<thead>
<tr>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
<th>Case #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Type:</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Patient Initials:</td>
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</tr>
<tr>
<td>Mentor sign:</td>
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<tr>
<td>Date:</td>
<td></td>
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</tr>
</tbody>
</table>

Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)

Planned Patient Cases:

<table>
<thead>
<tr>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
<th>Case #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Type:</td>
<td></td>
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<tr>
<td>Patient Initials:</td>
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<tr>
<td>Mentor sign:</td>
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</tr>
<tr>
<td>Date:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)

IV. Quality Assurance/Calibration/Safety

The resident will work with the therapist/physicist to perform the daily QA. The resident will work with the physicist to actively participate in tasks associated with the monthly QA and AQA phantom delivery.

<table>
<thead>
<tr>
<th>Tasks:</th>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily QA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly QA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AQA Delivery:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Annual QA Review:</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)

Mentor Assessment:

Summary of Resident’s activities:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ____________ yes ____________ no

Mentor’s Signature _______________________ Date___________________________

- 87 -
14. Special Procedures rotation (elective)

A. Prerequisite Skills
   a. Radiation Safety – X-ray machine operation
   b. Human Anatomy – common bony landmarks
   c. Introductory MV Imaging
   d. Introduction to custom shielding used in Radiation Therapy.

B. Knowledge Base
   a. Clinical Basis for TBI
   b. Equipment
   c. Dosimetry issues in TBI
      i. Field uniformity
      ii. Beam energy/penetration
      iii. Blocking
   d. Beam Data for TBI – hand calculations

C. Clinical Processes
   a. Simulation and Custom Block management
   b. MU calculations
   c. In-vivo dose measurement
   d. Custom compensation

D. Commissioning of a TBI Program

Learning Opportunities

1. Observe/attend a TBI simulation, Fabricate the blocks under supervision; verify the block attenuation on the machine.
2. Collect sufficient TBI beam data to perform hand calculations.
3. Perform measurements to determine efficacy of the current TBI flattening filter.
4. Attend/observe in-vivo dose measurement for TBI. Perform hand calcs and compare to MOSFET results.

Assessment
The resident will provide a written report of principles and process of Total Body Irradiation with an overview and detailed descriptions of the relevant underlying principles for each major step. Some emphasis should also be placed on practical issues in establishing a TBI program. The report should also contain data acquired through measurements or experiment as well as analysis thereof. Finally, an understanding of the principles behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated in an oral exam.
Clinical Competency: Total Body Irradiation (TBI)

I. Objective: Provide the resident with the fundamental knowledge and practical training for proficiency in the Total Body Irradiation (TBI).

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Review/read Chapter 18 in Kahn (3rd ed.), AAPM Report 17 (TG-29), Chapter 17A in Modern Technology of Radiation Oncology (Van Dyke, 1999).</td>
<td></td>
</tr>
<tr>
<td>2. Attend 1.5 hours of class provided in physics residents’ syllabus.</td>
<td></td>
</tr>
</tbody>
</table>

III. Clinical Activities:

The resident will work with one of the physicists and/or dosimetrists to observe the steps below for one TBI case and perform the same steps listed below for three additional cases.

A. Pre-treatment
   • Review physician prescription
   • Obtain measurements for patient
   • Observe CT scan for applicable treatments
   • Perform dosimetry calculations
   • Fabricate special custom lung block using cerrobend
   • Create custom compensators
   • Perform chart check (Mosaiq, treatment chart)

B. Treatment
   • Assist with in-vivo dosimetry set-up
   • Provide treatment day physics assistance
   • Perform final physics chart check

Patient Cases

<table>
<thead>
<tr>
<th>Patient Initials:</th>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed Case</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mentor sign:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)
Mentor Assessment:

Summary of Resident’s activities:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained _______________ yes ____________ no

Mentor’s Signature _______________________ Date___________________________

Reading List:
1. Van Dyk et al, AAPM Report 17 /TG-29 “Physical Aspects of Total and Half Body Irradiation”
7. A literature review is strongly suggested for this topic.
Total Skin Electron Irradiation (TSEI) and Intraoperative Radiotherapy (IORT)

A. Prerequisite Skills
   a. Radiation Safety – Treatment machine operation
   b. Human Anatomy – common bony landmarks
   c. Introduction to custom shielding used in Radiation Therapy.
   d. Introduction to electron beam dosimetry.

B. Knowledge Base
   a. Dosimetry of electron beams
   b. Clinical Basis for TSEI- and IORT
   c. Equipment
   d. Dosimetry issues in TSEI- and IORT
      i. Field uniformity
      ii. Beam energy/penetration
      iii. Field Shaping
         1. Collimation and patient alignment (IORT).
         2. Collimation and energy adjustment (TSEI).
   e. Beam Data for TSEI- and IORT – hand calculations

C. Clinical Processes
   a. Clinical indications and conditions treated
   b. Simulation and Field shaping
   c. MU calculations
   d. In-vivo dose measurement
   e. Custom compensation

D. Commissioning of a TSEI Program
   a. General electron beam commissioning
   b. Specifics related to TSEI- commissioning.

Learning Opportunities:

Perform measurements of:
- Effect of SSD change on electron beam characteristics.
- Electron beam collimation and effects of surface shielding.
- Obliquity effects.

Assessment:

The resident will provide a written report of principles and process of Total Skin Electron Irradiation and Intraoperative Irradiation with an overview and detailed descriptions of the relevant underlying principles for each major step. Some emphasis should also be placed on practical issues in establishing TBI and IORT programs. The report should also contain data acquired through measurements or experiment as well as analysis thereof. Finally, the resident will take an oral exam. An understanding of the principles behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated.
Mentor Assessment:

Summary of Resident’s activities:

_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ___________yes ____________no

Mentor’s Signature _______________________ Date___________________________
Module: Intraoperative Radiation Therapy (IORT)

I. Objective: Provide the resident with the fundamental knowledge and practical training for proficiency in intraoperative radiation therapy (IORT).

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Review/read Chapter 14 in Kahn (3rd ed.),</td>
<td></td>
</tr>
<tr>
<td>2. Read AAPM report (TG-72)</td>
<td></td>
</tr>
<tr>
<td>3. Attend 1.5 hours of class provided in physics residents’ syllabus.</td>
<td></td>
</tr>
</tbody>
</table>

III. Clinical Activities:

The resident will work with one of the physicists and/or therapists on the steps listed below for five cases.

A. Pre-treatment
- Observe location of all treatment applicators
- Verify the warm-up and/or monthly quality assurance calculations
- Review IORT dosimetry book in operating room
- Prepare required documents for treatment

B. Treatment
- Observe/assist with docking of unit
- Perform MU calculation based on physician’s directive (verified by physicist)
- Monitor treatment delivery
- Complete all necessary documentation

<table>
<thead>
<tr>
<th>Patient Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type:</td>
</tr>
<tr>
<td>Patient Initials:</td>
</tr>
<tr>
<td>Mentor sign:</td>
</tr>
<tr>
<td>Date:</td>
</tr>
</tbody>
</table>

Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)
IV. Machine-related Quality Assurance/Calibration/Safety

The resident will work with the therapist/physicist to perform the daily QA. The resident will work with
the physicist to actively participate in tasks associated with the monthly QA.

<table>
<thead>
<tr>
<th>Tasks:</th>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perform daily QA</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Perform monthly QA</td>
<td>_______</td>
<td>_______</td>
<td>_______</td>
</tr>
<tr>
<td>Assist in annual QA: N/A</td>
<td>_______</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)

Mentor Assessment:

Summary of Resident's activities:
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________
_________________________________________________________________________________

Competency attained ____________yes  ____________no

Mentor’s Signature _______________________ Date___________________________
Module: Total Skin Electron Irradiation (TSEI)

(This module may be truncated if adequate number cases are not available due to change in clinical practice at UHCMC. Residents will participate in available cases).

I. **Objective**: Provide the resident with the fundamental knowledge and practical training for proficiency in the Total Skin Electron Irradiation (TSEI).

II. **Didactic Activities**:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Attend 1.5 hours of class provided in physics residents’ syllabus.</td>
<td></td>
</tr>
</tbody>
</table>

III. **Clinical Activities**:

The resident will work with one of the physicists and/or dosimetrists to observe the steps below for one TSEI case and perform the same steps listed below for three additional cases.

A. **Pre-treatment**
   - Review physician prescription
   - Perform dosimetry calculations with special attention to energy selection and determination
   - Perform chart check (Mosaiq, treatment chart)

B. **Treatment**
   - Assist with in-vivo dosimetry set-up
   - Provide treatment day physics assistance
   - Perform final physics chart check

**Patient Cases**

<table>
<thead>
<tr>
<th>Patient Initials:</th>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mentor sign:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*
Reading List:

3. Chapter 14, particularly section 14.8.
14. A literature review is strongly suggested for this topic.

Mentor Assessment:

Summary of Resident’s activities:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Competency attained ______________yes   ____________no

Mentor’s Signature ___________________________   Date ____________________________
15. Proton Therapy rotation (elective) (expected to start in 2016, some modifications may be required)

I. Objective: This module intends to demonstrate fundamental knowledge and sufficient practical experience for active competency in GammaKnife Stereotactic Radiosurgery Procedures.

A. Prerequisite Skills
   a. Experienced in QAs with linear accelerator
   b. EBRT with photons and electron beams
   c. MU calculation (TPR, PSF, CF, ISF) for EBRT treatments
   d. Use of ion chamber/electrometer/diodes/MOSFETs
   e. Film dosimetry
   f. Treatment planning for photon and electron beams

B. Knowledge Base
   a. Dosimetry of heavy charged particles
   b. Concept of SOBP
   c. Uncertainties in proton therapy
   d. Small field dosimetry
   e. Compensator design
   f. Patient immobilization
   g. Treatment Planning
      i. Image fusion
      ii. Delineation of anatomical structures
      iii. Dose computation
      iv. Dose verification and nanalysis
   h. Delivery technique
      i. Verification (QA) of delivery process

C. Clinical Process
   a. Beam data acquisition
      i. Measure small field TPR
      ii. Measure small field output factors
      iii. Create data table of TPR/OPF/Calibration data
   b. Planning system commissioning
      i. Enter beam data into planning system *
      ii. Verify planning system beam data
      iii. Verify localization for frame treatments
      iv. Verify localization for frameless treatments
   c. Treatment planning
      i. Perform image fusion
      ii. Create single isocenter plan
         1. Identify arc/couch limitations
         2. Establish arc/couch angle presets
      iii. Create multiple isocenter plan
         1. Explain isodose line normalization
         2. Explain isodose line prescription
   d. Plan Transfer to R&V/Linac
      i. Transfer data to Mosaiq
ii. Transfer isocenter coordinates or plan to Gamma or CyberKnife
iii. Perform independent MU calculations
iv. Perform patient-specific plan QA
e. Geometrical Alignment
   i. Patient Position
   ii. Verify alignment using laser, image
   iii. Patient Immobilization
f. Delivery (observe or assist RTT)
   i. Identify patient safety precautions
   ii. Perform pre treatment QA
   iii. Operate the proton machine (observe)
   iv. Review or verify treatment completion & documentation

II. Didactic Activities:

<table>
<thead>
<tr>
<th>Task</th>
<th>Mentor Sign/Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Attend 3.0 hours of class for Proton Therapy provided in the physics residents’ syllabus.</td>
<td>__________</td>
</tr>
<tr>
<td>2. Read Chapter 26 in Khan (4th ed.).</td>
<td>__________</td>
</tr>
<tr>
<td>3. Read AAPM Reports: TG 20</td>
<td>__________</td>
</tr>
<tr>
<td>4. Read book “Proton and Charged Particle Radiotherapy”, by DeLaney and Kooy</td>
<td>__________</td>
</tr>
<tr>
<td>5. Read “Symposium on the promise and perils of proton radiotherapy” (L:\physics\RedidentTeaching\Proton\Symposium2008)</td>
<td>__________</td>
</tr>
</tbody>
</table>

III. Clinical Activities:

The resident will work with the physicist to observe and perform the steps listed in A – C below for the designated number of patients.

A. Pre-planning activities:
   • Observe imaging (CT/MR/PET)
   • Import DICOM data in TPS
   • Image fusion

B. Treatment planning activities:
   • Contouring (all to be reviewed by senior physicist/attending physician)
   • Setup beams
   • Handling of uncertainties
   • Compute dose as per prescription
   • Analyze and verify the plan (2nd calc)
   • Perform patient-specific plan QA
   • Perform initial plan check (to be reviewed and approved by senior staff physician)

C. Treatment day activities:
   • Assist with treatment patient set-up in room
   • Assist therapists with collision checks (if necessary)
   • Prepare special medical physics consult for physicist review and signature
• Observe the treatment (1st fraction)
• Perform final physics check on chart

For each set of cases (Observed and Planned), at least three different anatomical sites must be included in the five documented cases. One case should include a fusion/co-registration.

### Observed Patient Cases:

<table>
<thead>
<tr>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
<th>Case #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Type:</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Patient Initials:</td>
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<tr>
<td>Mentor sign:</td>
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<tr>
<td>Date:</td>
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</tr>
</tbody>
</table>

*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

### Planned Patient Cases:

<table>
<thead>
<tr>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
<th>Case #5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case Type:</td>
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<tr>
<td>Patient Initials:</td>
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<td>Mentor sign:</td>
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<tr>
<td>Date:</td>
<td></td>
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</tr>
</tbody>
</table>

*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

### IV. Quality Assurance/Calibration/Safety

The resident will work with the therapist/physicist to perform the daily QA. The resident will work with the physicist to actively participate in tasks associated with the monthly and annual QA.

<table>
<thead>
<tr>
<th>Tasks:</th>
<th>Case #1</th>
<th>Case #2</th>
<th>Case #3</th>
<th>Case #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily QA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Monthly QA</td>
<td></td>
<td></td>
<td></td>
<td>N/A</td>
</tr>
<tr>
<td>Review output factor measurements:</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Review annual calibration films:</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Receive safety training:</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Note: Collect documentation (electronic or paper) for the various steps (i.e., printouts, etc.)*

### Assessment:

The resident will provide a written report of learning experience about Proton Therapy. The report should also contain data acquired through measurements or experiment as well as analysis thereof. Finally, the resident will take an oral exam. An understanding of the principles
behind the processes as well as comprehension of other relevant information from the reading lists must be demonstrated.

Mentor Assessment:

Summary of Resident's activities:
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________
____________________________________________________________________________

_________________________
Competency attained ____________ yes   ____________ no

Mentors Signature _____________________________ Date ______________
16. Research module/rotation (elective)

I. Objective: This module intends to prepare the resident for identifying clinical oriented problems and develop the skills necessary for solving those problems. The resident will work under the direct supervision of the research guide/mentor on well identified problem(s)/topic(s) and highly expected to publish meaningful scientific articles.

Assessment:

The resident will provide a written report of the research topic and research performance. The report should contain the purpose of the research, methodology, data collection, results and discussions, conclusions, and future directions. An understanding of the research topic(s) as well as comprehension of other relevant information from the research must be demonstrated. Finally, the resident will take an oral exam.

Mentor’s and/or Director’s Assessment:

List of Publications:

Summary of Resident’s activities:

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
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________________________________________________________________________
________________________________________________________________________

Oral Exam. ____________ passed ____________ failed

Mentor’s Signature __________________________ Date ______________

Director’s Signature __________________________ Date ______________
Appendix G – Resident Evaluation Form

Clinical Medical Physics Residency
University Hospitals Case Medical Center, Department of Radiation Oncology

Rotation Specific Evaluation Form (See Clinical Competency Form)
Medical Physics Training Evaluation – Written Report and Oral Exam

Resident _______________________________ Date: __________________

Rotation Topic _______________________________

Reviewer _______________________________

Written Report Grade ____________

<table>
<thead>
<tr>
<th>Unsatisfactory</th>
<th>Satisfactory</th>
<th>Superior</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>9</td>
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</table>

Comments ____________________________________________________________

Oral Exam Grade ____________

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<tr>
<th>Unsatisfactory</th>
<th>Satisfactory</th>
<th>Superior</th>
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<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
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<td>8</td>
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<tr>
<td>3</td>
<td>6</td>
<td>9</td>
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</table>

Comments ____________________________________________________________

Recommendations _____________________________________________________

Overall recommended grade  (Pass, Fail, or Conditional Pass)

Remediation (if Conditional Pass) _______________________________________

Signed _______________________________ Date: __________________

Mentor/ Faculty Member
Appendix H – Clinical Rotation Evaluation Form (by resident)

Clinical Medical Residency Program
Department of Radiation Oncology
University Hospitals Case Medical Center

Clinical Rotation Evaluation (by Resident)

Name of the Clinical Rotation: _____________________________________________

Start date: _______________________     Completion date: _________________

Name of the Mentor: ____________________________________________________

<table>
<thead>
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<th>Contents</th>
<th>(Circle one)</th>
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<td>Design of rotation</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Relevance</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Adequacy</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Equipment</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Software/ computer</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Facility/ environment</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Opportunity to learn</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Mentor’s knowledge</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Mentor’s availability</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Clarity of instruction</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Mentor’s help</td>
<td>N/A 1 2 3 4 5</td>
</tr>
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Additional Comments and Suggestions:

Design and content of the rotation: _____________________________________________
__________________________________________________________________________
__________________________________________________________________________

Equipment/ software/ facilities/ mentor: _______________________________________
__________________________________________________________________________
__________________________________________________________________________

Name and Signature of the Resident: __________________________________________

Date: __________________________
Appendix I – Residency Program Evaluation Form (by resident)

Clinical Medical Residency Program
Department of Radiation Oncology
University Hospitals Case Medical Center

Residency Program Evaluation (by Resident)

Start date: ______________________   Completion date: ___________________

<table>
<thead>
<tr>
<th>Contents</th>
<th>1 - lowest, 5 - highest</th>
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<td>Relevance</td>
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</tr>
<tr>
<td>Adequacy</td>
<td>N/A 1 2 3 4 5</td>
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<tr>
<td>Equipment</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Software/ computer</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Facility/ environment</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Opportunity to learn</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Evaluation methods</td>
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<tr>
<td>Clarity of instruction</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Mentor’s help</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Associate director’s role</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Director’s role</td>
<td>N/A 1 2 3 4 5</td>
</tr>
<tr>
<td>Help in critical issues</td>
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</tr>
<tr>
<td>Overall standard of the program</td>
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</table>

Additional Comments and Suggestions:

Design and content of the rotation: ____________________________________________
___________________________________________________________________________
___________________________________________________________________________

Equipment/ software/ facilities/ mentor/ directors: ____________________________
___________________________________________________________________________
___________________________________________________________________________

Name and Signature of the Resident: __________________________________________
Date: ____________________________
Appendix J – Residency Program Evaluation Form (Director-Resident)

UHCMC Radiation Oncology Clinical Medical Physics Residency
Quarterly Progress Report

Resident:
Start Date:
Evaluation Period:

Conference Participation:

Didactic Course And Recommended Readings Progress:

Clinical Participation:

Program Director Comments:
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________

_____________________________    __________________________
Program Director signature    Date

_____________________________    __________________________
Resident signature     Date
Appendix K – Course Syllabi (removed)

III Radiation Biology for Radiation Therapy (removed)

Appendix L – Applicant Ranking Sample (removed)

Appendix M – Interview Invitation Letter (removed)

Appendix N – Email to Non-invited Applicants (removed)

Appendix O – Interview Evaluation Form (removed)

Appendix P – Interview Evaluation Summary (removed)

Appendix Q – Candidate Evaluation Ranking (removed)

Appendix R – Sample Offer Letter (removed)

Appendix T – Letters of Institutional Commitment (removed)

Appendix U – Benefits (removed)
## Appendix V – List of Physics Faculty and Staff and their Biographical Sketches

List of Physics Faculty, Staff and Current Residents

<table>
<thead>
<tr>
<th>Name (abbreviation)</th>
<th>Degree</th>
<th>Designation</th>
<th>Main Campus/ Satellite</th>
<th>Employment (full/part-time)</th>
<th>Role in Physics Residency Program</th>
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</thead>
<tbody>
<tr>
<td>Chee-Wai Cheng (CWC)</td>
<td>Ph.D.</td>
<td>Professor</td>
<td>Main</td>
<td>Full</td>
<td>Faculty</td>
</tr>
<tr>
<td>Valdir Colussi (VC)</td>
<td>Ph.D.</td>
<td>Associate Professor</td>
<td>Main</td>
<td>Full</td>
<td>Faculty</td>
</tr>
<tr>
<td>Paul Geis (PG)</td>
<td>Ph.D.</td>
<td>Assistant Professor</td>
<td>Main</td>
<td>Full</td>
<td>Faculty</td>
</tr>
<tr>
<td>Chunhui Luo (CL)</td>
<td>Ph.D.</td>
<td>Assistant Professor</td>
<td>LUSCC</td>
<td>Full</td>
<td>Faculty</td>
</tr>
<tr>
<td>Marcel Marcu (SMM)</td>
<td>M.S.</td>
<td>Assistant Professor</td>
<td>SWG</td>
<td>Full</td>
<td>Faculty</td>
</tr>
<tr>
<td>Tarun Podder (TP)</td>
<td>Ph.D.</td>
<td>Associate Professor</td>
<td>Main</td>
<td>Full</td>
<td>Director - Faculty</td>
</tr>
<tr>
<td>Jason Sohn (JWS)</td>
<td>Ph.D.</td>
<td>Professor</td>
<td>Main</td>
<td>Full</td>
<td>Faculty</td>
</tr>
<tr>
<td>Barry Wessels (BW)</td>
<td>Ph.D.</td>
<td>Professor</td>
<td>Main</td>
<td>Full</td>
<td>Co-Director – Faculty</td>
</tr>
<tr>
<td>Jiankui Yuan (JY)</td>
<td>Ph.D.</td>
<td>Assistant Professor</td>
<td>Main</td>
<td>Full</td>
<td>Faculty</td>
</tr>
<tr>
<td>Yuxia Zhang (YZ)</td>
<td>M.S.</td>
<td>Instructor</td>
<td>Main</td>
<td>Full</td>
<td>Faculty</td>
</tr>
<tr>
<td>Yiran Zheng (YZZ)</td>
<td>Ph.D.</td>
<td>Instructor</td>
<td>Main</td>
<td>Full</td>
<td>Faculty</td>
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<tr>
<td>Ande Bao (AB)</td>
<td>Ph.D.</td>
<td>Staff Physicist</td>
<td>Main/ WestLake</td>
<td>Full</td>
<td>Teaching Staff</td>
</tr>
<tr>
<td>Albin Gonzalez (AG)</td>
<td>Ph.D.</td>
<td>Staff Physicist</td>
<td>Mercy – Lorain</td>
<td>Full</td>
<td>Teaching Staff</td>
</tr>
<tr>
<td>Bill Gordon (BG)</td>
<td>M.S.</td>
<td>Staff Physicist</td>
<td>Main/ Geauga</td>
<td>Full</td>
<td>Teaching Staff</td>
</tr>
<tr>
<td>Frederick Jesseph</td>
<td>M.S.</td>
<td>Staff Physicist</td>
<td>Main</td>
<td>Full</td>
<td>Teaching Staff</td>
</tr>
<tr>
<td>Ray Kaczur (RK)</td>
<td>M.S.</td>
<td>Physicist</td>
<td>LUSCC/Floati</td>
<td>Part-Time-PRN</td>
<td>Clinical Mentor</td>
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<tr>
<td>Gisele Pereira (GP)</td>
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<td>Part-Time</td>
<td>Teaching Staff</td>
</tr>
<tr>
<td>Carl Shields (CS)</td>
<td>Ph.D.</td>
<td>Staff Physicist</td>
<td>Firelands</td>
<td>Full</td>
<td>Teaching Staff</td>
</tr>
<tr>
<td>Gary Shields (WGS)</td>
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<td>Physicist</td>
<td>(Floating)</td>
<td>Part-Time-PRN</td>
<td>Clinical Mentor</td>
</tr>
<tr>
<td>Mark Smith (MS)</td>
<td>M.S.</td>
<td>Physicist</td>
<td>PMC/ Main</td>
<td>Full-Time-PRN</td>
<td>Clinical Mentor</td>
</tr>
<tr>
<td>Randall Smith (RS)</td>
<td>M.S.</td>
<td>Staff Physicist</td>
<td>Chagrin</td>
<td>Full</td>
<td>Teaching Staff</td>
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<tr>
<td>David Albani (DA)</td>
<td>M.S.</td>
<td>Part-Time Resident</td>
<td>Main</td>
<td>Full - PRN</td>
<td>Resident</td>
</tr>
<tr>
<td>Justin Cantley (JC)</td>
<td>Ph.D.</td>
<td>Full-Time Resident</td>
<td>Main</td>
<td>Full</td>
<td>Resident</td>
</tr>
<tr>
<td>Soyoung Lee (SL)</td>
<td>Ph.D.</td>
<td>Full-Time Resident</td>
<td>Main</td>
<td>Full</td>
<td>Resident</td>
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Curriculum Vitae of the Physics Faculty and Staff (removed)

Appendix W - CAMPEP Invitation – Preliminary Discussion (removed)