Self Study Template

Residency Program in Medical Physics

University of Iowa Hospitals and Clinics

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Program Director

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CONTENTS

Appendices

A Program Overview

A.1 Program Objectives

The goal of the Clinical Medical Physics Residency Program at the University of Iowa Hospitals and Clinics (UIHC) 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 Radiation Oncology Physics 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 expose them to management of a single accelerator community-based free-standing facility.

A.2 Organizational Structure

The Department of Radiation Oncology is an autonomous department within the College of Medicine at the University of Iowa. All medical physics faculty and medical physics residents are employees of the University of Iowa, providing service to the University of Iowa Hospitals and Clinics. There are currently 6 medical physics faculty, one of whom is the Clinical Medical Physics Residency Program Director. The number of faculty will increase to 8 by the end of the current calendar year, and to 9 during the following calendar year. One of the physics faculty is a board certified MRI diagnostic physicist. The medical residency program in Radiation Oncology currently has 5 residents, being increased to 7 by July 2008. There are 6 physician Radiation Oncology faculty. The department also includes the Free Radical and Radiation Biology Program that has 19 outstanding faculty mentors from wide ranging areas of research including Cancer Biology, Free Radical Biology, Radiation Biology, Cardiology, Physiology, Anatomy and Cell Biology, Internal Medicine, Radiology, Surgery, Chemistry, and Radiation Oncology.

See Appendix A for the Organizational Chart.

We have the capacity for 3 Medical Physics residents. The start date will always be staggered by one year for two residents.

The Clinical Medical Physics Residency Program utilizes two committees within the program: the Education Committee and the Selection Committee. The Education Committee consists of the Medical Physics faculty, the Chief Therapist, and the RTT Program Director. This committee meets once a year to discuss/revise curriculum content. The Clinical Medical Physics Residency Program Selection Committee consists of the Medical Physics faculty and Chief Therapist, along with a dosimetrist, Radiation Biology faculty member, and the Radiation Oncology Department Chair. This committee meets following each interview cycle.

The departmental facilities are tremendous. In May of 2005 the Department of Radiation Oncology moved into a newly constructed 40,000 square foot facility. This new facility is state of the art with the latest Siemens imaging and treatment delivery technology: 4 Siemens ONCOR linear accelerators with gating and megavoltage cone beam CT, 3T MAGNETOM Trio MRI scanner, 4-D Biograph PET/CT scanner, mobile C-arm for fluoroscopy and kV cone beam CT, optical image guidance, and an active and diverse brachytherapy program (HDR, prostate seed implants, eye plaque implants, etc.). Specialized equipment and/or features include the IMRT delivery, 4D imaging/treatment planning/ delivery, frame-based and frameless linac stereotactic radio-surgery/therapy with both cones and micro-multileaf collimator, and image guidance provided by multiple technologies. As the Medical Physics Division is actively involved in translational research, collaboration opportunities for our residents with basic scientists in Radiation Biology as well as scientists in Bioengineering, Electrical and Computer Engineering, and Radiology are plentiful. Equipment in our department is summarized below in section E3.

All of the members of the Medical Physics Division are based full time in the Radiation Oncology department on campus, but one day per week a physicist travels to an off-site free-standing cancer center approximately 90 miles from Iowa City at the Mercy Hospital in Clinton, Iowa. The center in Clinton treats approximately 10 patients a day on a Varian 2100D, uses Varis R&V system along with physical charts, and a conventional simulator.

A.3 History of Program Development

In its inception Radiation Oncology was first a division of the Department of Radiology. This held true for decades until Radiation Oncology became an autonomous department in July of 2001. The Medical Residency program in Radiation Oncology was first accredited on October 1, 1977, has averaged one graduate per year, and is currently operating under a 5-year accreditation by the American Council of Graduate Medical Education (See Appendix B). Our department has a long standing graduate program in Radiation Biology, which became a degree-awarding program in 1962 and has since awarded approximately 150 Master of Science or Doctorates of Philosophy degrees. Finally, in October of 2004 the Department of Radiation Oncology initiated its most recent educational/training program: the Clinical Medical Physics Residency Program in Radiation Oncology. On October 1, 2004, our first resident commenced training in our department. He completed the program on October 31, 2006.

University of Iowa Hospitals and Clinics is the state teaching hospital in Iowa. It is a natural evolution that in the Department of Radiation Oncology we have a top-notch training program for medical physicists. The Department of Radiation Oncology has six medical physicists on staff and six Radiation Oncology clinical faculty. The department currently has 5 physician residents in the Radiation Oncology Residency Program.

We moved into our brand new facility in May 2005, which 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, the same as any member of the physics staff.

B Training

B1. Program Completion Requirements

The Clinical Medical Physics Residency Program is 24 months in length to include 13 rotations, attendance at case conferences, recommended readings, 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 quality assurance on the linear accelerators, perform IMRT quality assurance measurements in film and ionization chambers, and perform electron cutout measurements. 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 become the “physicist of the day” providing first response physics support to all activities within the clinic. Courses and conferences are mandatory. The progression of the resident through these clinical responsibilities is evaluated and discussed with the resident during quarterly reviews with the program director. The purpose of the quarterly review is to discuss with the resident 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. This review also provides the residents an opportunity to voice any concerns they may have about the learning environment.

B2. Design and Content

Residents move through 13 comprehensive rotations. 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.

Dosimetric Systems rotation – The Dosimetric Systems rotation is the first in the series of the 13 rotations. 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 film, MOSFETs, and diodes. All radiation measurement systems to be used by the resident throughout the program are to be commissioned by the resident during this rotation. 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 commissioned by the resident. 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 physics staff.

Linear Accelerator Acceptance Testing/Commissioning/Annual QA rotation – During this rotation the medical physics resident will perform the tasks necessary to accept and commission a linear accelerator, 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 a written report detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the physics staff.

Brachytherapy rotation – The rotation is structured to provide the medical physics resident with a 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. During the rotation the resident will observe the medical physicist during brachytherapy procedures, perform source calibration checks, and computerized and hand calculated low dose rate dosimetry, including fundamental calculation techniques. The resident should develop the imaging and treatment planning of brachytherapy, along with patient specific and system quality assurance. Additionally, the resident will learn the principles of prostate seed implant brachytherapy as well as eye plaques. 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 a written report detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the physics staff.

<u>TG-51 Calibration and MU Calculations rotation</u> – 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 Lantis, 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 physics staff.

<u>TPS Modeling rotation</u> – 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's will determine all input data needed to characterize the CT scanner, linear accelerator, a single photon beam energy, and a single electron beam energy. The resident will utilized data acquired during the previous rotations to commission the system for a single 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 a written report detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the physics staff

<u>Treatment Planning rotation</u> – 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, and Prostate) and develop treatment planning protocols 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 then imports all necessary data, models a photon and electron beam, and commissions the treatment planning system. Once commissioned, the resident performs treatment plans for selected cases (Brain, Head and Neck, Lung, Breast, Rectum, and Prostate), transfers all data to required information systems, and performs all required quality assurance for those plans. 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 physics staff.

<u>IMRT rotation</u> – These two rotations are focused on Intensity Modulated Radiation Therapy. The medical physics resident will be introduced to optimization, critical organ doses, parallel vs. serial organs, typical dose-volume constraints, dose calculation algorithms specific to IMRT, film as a dose measuring device, small field dosimetry, and the basics of imaging for IMRT. During the rotation residents will take 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 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. The resident compiles a written report detailing the learning opportunities that were experienced during each rotation section. Each rotation section concludes with an oral exam given by the physics staff.

Radiotherapy Simulation rotation – During this rotation the medical physics resident will gain an understanding of the Radiotherapy Simulation process, ranging from conventional simulation using planar images and fluoroscopy, through CT based virtual simulation, to 4DCT and the utility of multimodality imaging. While participating in this rotation the resident will attend a conventional simulation for external beam radiation therapy (Clinton site), observe patient setup, use of fluoroscopy and image capture, and annotation of films. 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 finishing 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 Optical Image guided setup simulation process. 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 physics staff.

Stereotactic Radiosurgery rotation – The SRS rotation is designed to give the medical physics resident experience in commissioning a stereotactic radiosurgery system. The resident first reviews the key principles of SRS then actively commissions a system by measuring the geometrical and dosimetric parameters of a clinically operational SRS system. The commissioning process involves all aspects of a clinical SRS system including localization, dosimetry, treatment planning, and delivery. The resident will participate alongside a staff physicist in clinical SRS treatments during this rotation. The resident generates a written report and is given an oral exam by the physics staff at the end of the rotation.

Special Procedures rotation: Total Body Irradiation, Total Skin Electron and Intraoperative Irradiation – This rotation prepares the medical physics resident to develop and commission a total body irradiation program. The resident will develop a knowledge of the clinical basis for TBI, equipment, dosimetry issues in TBI, field uniformity, beam energy/penetration, blocking, beam data for TB, 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, collect sufficient TBI beam data to perform hand calculations, perform measurements to determine efficacy of the current TBI flattening filter, attend/observe in-vivo dose measurements for TBI, perform hand calcs and compare to MOSFET results. 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 TBE and IORT, equipment, dosimetry issues in TBE and IORT, field uniformity, beam energy/penetration, field shaping, collimation and patient alignment, collimation and energy adjustment. During the rotation the resident will perform measurements of the scattering or "spoiling" effect on electron beams at different source distances, and develop an understanding of intraoperative cone effects on electron beam, as well as the effect of different electron applicators (including IORT cones and TBE 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 physics staff.

Imaging for Planning and Treatment Verification rotation – The rotation is structured to provide the medical physics resident with a knowledge of portal imaging systems used either during the simulation/planning process or during treatment verification. The resident will develop a 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 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 physics staff.

Image Guided Radiation Therapy (IGRT) rotation – 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 multi-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 a written report detailing the learning opportunities that were experienced during the rotation. The rotation concludes with an oral exam given by the physics staff.

Room Design, Radiation Protection and Radiation Safety rotation
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 physics staff.

See Appendix C for detailed rotation content.

B3. Sample Training Plans

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

- Radiation Oncology journal club
- Medical Physics journal club
- Medical Physics and Oncology case conferences
- Radiation Oncology Chart Rounds conferences
- Physics section meetings
- Assigned readings

The following courses are required:

- Medical Physics (077:211)
- Radiation Biology course (077:103)
- Anatomy & Physiology course (803:001)
- Clinical Oncology course (803:001)

Timeline for meetings and courses:

Monday 7:30-8:30 am	Radiation Oncology Chart Rounds conferences
Tuesday – Thursday 7:30-8:30 am	Medical Physics and Oncology case conferences
Every other Wednesday 3-4 pm	Medical Physics journal club
Every other Wednesday 3-4 pm	Physics section meetings
Spring Semester 4 hours per week	Medical Physics (077:211)
Fall Semester 3 hours per week	Radiation Biology course (077:103)
Fall and Spring Semesters 2 hours per week Monday 2-4 pm	Anatomy & Physiology course (803:001)
Fall and Spring Semesters 2 hours per week Thursday 2-4 pm	Clinical Oncology course (803:001)

The only courses now combined between the Medical Physics residents and the RTT students will be Anatomy & Physiology and Clinical Oncology.

The Anatomy & Physiology Course content is designed to educate students on the cross-sectional anatomy of the human body. Material covered includes a brief review of gross anatomy and physiology, with an in depth look at cross-sectional anatomy for each of the body systems. The course presents normal anatomy using CT and MR cross-sections.
Text: Sectional Anatomy for Imaging Professionals, Kelley, Lorrie; Petersen, Connie. Mosby.

The Medical Physics Course is designed to help the student better understand the principles and application of physics in radiation therapy. By the end 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 and Beam-Related Biology, Assessment of Patient Setup and Verification, Special Procedures, Brachytherapy, Hyperthermia, and Particle Therapy. Text: The Physics of Radiation Therapy 3rd edition, Faiz M. Khan, Lippincott Williams & Wilkins 2003.

The Radiation Biology course provides a comprehensive introduction to all modern principles necessary for developing a strong working knowledge of Radiation Biology. Topics 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 3 didactic lectures/wk 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. Exciting and emerging topics of Radiation Biology to be covered: 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.
Text: Radiobiology for the Radiologist (5th ed), EJ Hall

The Clinical Oncology course is designed to provide the student with an understanding of the concepts of cancer, its causes, effects on the human body and current treatments. There is an emphasis on the practical application of radiation therapy principles and their appropriate use in the clinical setting. The epidemiology, etiology, detection, diagnosis, patient condition, treatment and prognosis of neoplastic disease will be presented, discussed and evaluated in relationship to histology, anatomical site and patterns of spread. The Radiation Therapist's responsibility in the management of neoplastic disease will be examined and linked to the skills required to analyze complex issues and make informed decisions while appreciating the character of the profession.

See Appendix D for course syllabi.

During each rotation the resident is expected to acquire all necessary data 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 measurements, tabulation of data, and creation of independent MU calculation tools to perform this task. They spend significant time reviewing the literature for the rotation (task group reports, journal publications, text book materials) in their preparation for the written report and oral exam.

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 systems, IMRT measurements, electron cut out measurements, weekly chart reviews, treatment planning checks, brachytherapy planning and procedures, and responding to all clinical physics requests following the "Physicist of the Day."

Teaching opportunities for residents:
Medical Physics residents have the opportunity to teach the RTT and Medical Radiation Oncology resident in the basics of Therapeutic Radiological Physics

B4. Training Administration

After each rotation, each physics faculty completes an evaluation of the resident's written report and oral exam including the pass/fail criteria along with recommendations for correcting the report or strengthening the resident's understanding in particular areas, or a conditional pass with specifically defined remediation. A summary of the resident's rotation performance and evaluation is composed by the rotation mentor, provided to and discussed with the resident, and provided in summary to the program director. The program director reviews the performance evaluations with the resident during the resident's quarterly review.

The mentor responsible for a given rotation proposes the creation or modification of the rotation's design and content. This proposal is reviewed and approved by the physics faculty.

A Medical Physics Resident Handbook has been established based on this Self Study. The Handbook describes goals, expectations, and policies for the program, including the dismissal of the failing resident that is fully described in Section C7 of this Self Study.

C Residents

C1. Admissions

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 Iowa City.

Medical Physics Residency Program at the University of Iowa
University of Iowa Hospitals and Clinics
Benefits
AAPM Report #36
The Role of a Physicist in Radiation Oncology
The community

After the deadline, all complete applications are divided among five of the physicists to review. For example, if there are 27 applications, each physicist reviews 5 to 6 applications, while the program director 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

See Appendix E

The faculty physicists and the program director 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 ten to fifteen candidates are invited to interview. They are invited via email, with the invitation letter and agenda as an attachment.

See Appendix F

If an applicant was not chosen to invite for an interview, they are sent an email letting them know our decision.

See Appendix G

Up to seven candidates are brought in on one day. They rotate through interviews with the Selection Committee:
Radiation Oncology Department Head
Radiation Oncology Medical Residency Program Director
Each of the faculty physicists
A dosimetrist
Chief Therapist
Radiobiologist

Each Selection Committee member submits an evaluation form for each interviewee to the program coordinator. (See Appendix H.) The coordinator enters all evaluations into a table (See Appendix I.) 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. (See Appendix J) 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. See Appendix K for sample offer letter.

Table 1: Chronological list of residents admitted into the program over the past 5 years

Resident Name	Residency start date	Finish Date	Graduate Degrees, University, Year
Sample, James	10/1/04	10/31/06	MS in Clinical Research, Campbell University, 2003 MS in Health Physics, Colorado State University, 1976
Shukla, Hemant	4/1/06	3/31/08	MS in Biomedical Engineering, University of Tennessee Health Science Center, 2004
Nixon, Earl	7/1/06	6/30/08	MS in Biomedical Engineering, University of Iowa, 2006

C2. Recruitment Efforts

An example of the advertisement that was posted on the AAPM website for the July 2007 position is included in Appendix L. We recruit via our website. We have a close working relationship with the University of Iowa 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.

C3. Enrollment

Our program capacity is 3 residents. The staff supervisor is John E. Bayouth, PhD, Medical Physics Residency Program Director. Two residents are funded by the University of Iowa Hospitals & Clinics and one resident is funded by the Department of Radiation Oncology.

July 1 is the targeted start date. If the department continues to support a third residency position, we would like to have the 3rd resident starting out of phase with the others (January 1) in order to allow a mentor for a given rotation to only have one resident during the rotation. There is no difference in salary or benefits for the two funding sources.

Table 2: Alphabetical list of current residents

Resident	Year Entered	Anticipated Finish
Nixon, Earl	2006	2008
Shukla, Hemant	2006	2008

C4. New Resident Orientation

Here is an example of a new resident orientation schedule:

Monday

1:00 p.m. Receive Badge – Human Resources Office (4-7394) C110 GH
Take blue ID card request with you. Pick this up from Diane.

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 – 6-3631) Health Screening will be in 1005-2 Boyd Tower

Tuesday New employee orientation, including departmental organization, facilities, staffing, safety (rad and non-rad), basic policies and procedures, and LANTIS training

Wednesday Shadowing in CEIGRT: Patient Treatments on Linear Accelerators (Radiation Therapist)

Thursday Shadowing in CEIGRT: Patient Simulation in CT; MRI (Radiation Therapists)

Friday

8:00 a.m. Shadowing in CEIGRT: Treatment Planning in Dosimetry (Dosimetrist)

10-11 a.m. Benefits Orientation with House Staff
Left at compass; first door on left.

Monday Shadowing in CEIGRT: Brachytherapy (Physicist)

Tuesday Shadowing in CEIGRT: Stereotactic Radiosurgery (Physicist)

Wednesday

7:30 – 11:30 UIHC Orientation East Room RCP 8008
Take elevator F to the 8th floor; go right off the elevator and down the hall to the end. Breakfast will be included

12:30 – 3:00 Benefits Orientation Yerington Conference Rm. E140GH
Go to the wooden compass on the 1st floor, turn east and follow the hallway to the Finance & Accounting Services door; enter and turn right.

Thursday Shadowing in CEIGRT: Physicist of the Day (Physicist)

Friday Travel to Clinton, Iowa (Physicist)

Monday Shadowing in CEIGRT: Patient Consult, On-treatment visit, follow-up (Radiation Oncologist)

C5. 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 Conference or Dosimetry class (weekly 7:00 – 9:00 am; Thursdays)

9:00 – 11:30 Anatomy & Physiology (Thursdays)
OR
Clinical Oncology (weekly 1:00 – 2:00 pm; Tuesdays)

Throughout the day:
Review literature
Collect and analyze data
Document findings
Meet with mentor
Work on rotation report
Called to machines to observe/perform procedures

5:00 – 7:00 IMRT QA, monthly QA, electron cut-out,
QA documentation, analysis and reporting

C6. Evaluation of Resident's Progress

After each rotation, the resident submits a written report. This is evaluated by each physics faculty and graded, along with an evaluation of the resident's ability to articulate their knowledge developed during the rotation and ability to respond to oral examination. Each faculty member submits an evaluation form for the written report and oral examination to the mentor of the rotation. The 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 mentor of the rotation reviews these forms, discusses them with examiners, and completes an evaluation form constituting the final and definitive evaluation for the rotation. 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.

Residents meet with the program director once every three months to discuss their progress. These are informal meetings, which 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. The program director completes a quarterly progress report and discusses it with the resident.

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's discuss 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 M.

C7. 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 will be reviewed by a committee selected by the Program Director, if an affected resident requests such a review within ten days of his or her becoming aware of the action, unless 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. The committee will be composed of at least two active clinical staff members and one resident. 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 nonrenewal 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.

D Program Administration

D1. 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 of Iowa Hospitals & Clinics.

D2 Program Director

The Residency Program Director is appointed by the Department Chair. The current director has 12 years of experience in academic and clinical medical physics. He is certified by the American Board of Radiology in Therapeutic Radiological Physics.

D3. Committee Meetings

The Education Committee is responsible for establishing the didactic courses and clinical rotation content. This committee consists of all physics faculty, the Medical Residency Program Director, Chief Therapist, and the RTT Program Director. The committee meets annually. Minutes are recorded and retained indefinitely. In addition, the curriculum is an open agenda item at a bi-weekly 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 physics faculty, and also includes the Medical Residency Program Director, a dosimetrist, Chief Therapist, a Radiation Biologist, and the Radiation Oncology Department Chair. The committee meets following each interview cycle. Minutes are recorded and retained indefinitely.

D4. Records

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
   Rotation evaluations
   Examination results
   Oral examination evaluations
   Quarterly progress reports

E. Resources

E1. Staff

John Bayouth, Ph.D., Director, Medical Physics, ABR Certified

Joseph Modrick, Ph.D., Assistant Professor, ABR Certified

Manickam Muruganandham, Ph.D., Assistant Professor, ABR Certified

Edward Pennington, M.S., Associate, ABR Certified

R Alfredo C Siochi, Ph.D., Assistant Professor, ABR Certified

Timothy J. Waldron, M.S., Associate, ABR Certified

Prabhat Goswami, Ph.D., Assistant Professor,Free Radical and Radiation Biology Graduate Program

Mindi TenNapel, M.B.A., Director, RTT Program

The current physicist staff to physics resident ratio is 6:3.

See Appendix N for staff biosketches.

E2. Finances

Typical Financial Support and Burden for Medical Physics Residents
Support:
Salary $42,012
Health and Non-medical Benefits $3,466
Travel and Academic support $300.00 and one annual meeting during residency
Book allowance $500/year

Burden:
Housing $550/month average for 1 bedroom
Utilities $200/month
Health Care out of pocket $0.00
Books, etc. $1,500.00/residency

See Appendix O for compensation and benefits.

E3. Facilities

The Department recently expanded into a 40,000 sq.ft, state-of-the-art facility that includes 4DCT, CT/PET, and a 3-Tesla MRI in Radiation Oncology used for molecular/functional imaging and treatment simulation. The department is truly paperless and filmless. Four of five treatment vaults have been filled with Siemens Oncor Avant Garde linear accelerators, including both extensive optical tracking and on-board MV conebeam on all accelerators. These tools, along with our KonRad, Corvus, FastPlan, BrachyVision, and Philips Pinnacle treatment planning systems, will complement our active research and clinical programs. A complete list of our equipment is provided below:

Linear Accelerators:
- Oncor Avant Garde: energy_6 MV x-rays, with and without flattening filter
- Two Oncor Avant Gardes: energy_6/10 MV x-rays, 6-21 MeV electrons
- Oncor Avant Garde: energy_6/18 MV x-rays, 6-21 MeV electrons
- 82 leaf MLCs and OPTIVIEW 1000 on all machines

Treatment vaults:
- Infra-red optical guidance and ultrasound guidance in all rooms
- Gating and treatment delivery in all rooms
- One system capable of Moduleaf Multileaf collimator (2.5 mm leaf width), TBI, and Radiosurgery

Imaging:
- Siemens Biograph 40 PET/CT scanner with Zsharp for 0.6 mm slice thickness and respiratory gating on both PET and CT acquisition
- Siemens Magnetom Trio: 3T MRI for morphological, molecular, and functional imaging
- Siemens Mobile Fluoroscopic C-arm
- Philips Ultrasound

Treatment Planning:

- Philips Pinnacle with IMRT, DMPO, Syntegra Fusion, and Model-based segmentation
- Siemens KonRad with IMRT
- NOMOS Corvus
- Fastplan (Radiosurgery)
- BrachyVision and Variseed (Brachytherapy)
- Coherence Dosimetrist Workspace

Information Systems:

- LANTIS Record and Verify System (70 licenses on over 100 workstations)
- COHERENCE (12 Oncologists, 4 RTT, 5 Dosimetrists, 5 Physicists Workspaces)
- IDX (Hospital Information System)
- Inform Patient Record (IPR, the hospital patient record)

(1) Department Statistics

Patients treated per day	85	
Treatment types	External beam	
	IMRT	
	Intra and extracranial radiosurgery	
	Brachytherapy	
Staffing	Physicians	5.2 on-site, one off-site
	Physicists	6
	Dosimetrists	5
	Therapists	15
	RNs	6
	Billing and Scheduling clerks	6

Our primary treatment delivery system at UIHC is our four new Siemens Oncor linear accelerators. These linear accelerators (linacs) are computer-controlled systems with state-of-the-art technology:

- LANTIS record and verify system
- COHERENCE Suite of Oncology Workspaces
- SIMTEC auto-sequencing,
- 3D Multileaf Collimation system
- VIRTUAL WEDGE
- high-resolution amorphous Silicon flat panel imager
- respiratory gating
- megavoltage conebeam imaging
- collision avoidance
- Intensity Modulated Radiation Therapy (IMRT)
- Intensity Modulated Radiosurgery (IMRS)

The RadioCameras System is an optical guidance system that allows us to determine the patient position. Prior to the CT scan, patients are outfitted with a maxillary biteplate equipped with a fiducial system that is both CT opaque and optically identifiable by RadioCameras. For treatment, RadioCameras' optical tracking system automatically tracks the target position, enabling high-precision positioning of the target to treatment isocenter. During treatment, the system provides real-time monitoring of the patient position. Patient repositioning and monitoring are achieved with submillimetric accuracy for each radiation fraction.

The Siemens Biograph CT/PET Simulation System is a high-resolution 40-slice CT capable of tracking respiratory motion. This technology directly links PET images revealing the metabolic functions of cancer, and when combined with the anatomic images of CT, has shown better sensitivity. The new technological advancements available uses ultra-fast Lutetium Oxyorthosilicate (LSO) crystal technology, delivering exceptional image quality in the shortest scanning time possible today – with whole-body scans taking less than 15 minutes. The LSO-based biograph systems are now available with new HI-REZ technology, which offers optimum resolution for better image definition. In addition, LSO technology brings significant advantages to high-throughput, three-dimensional (3D) image acquisition. Pico-3D technology optimizes the signal-to-noise ratio and lesion detectability, as well as offering significant benefits in scanning flexibility across all doses and patient sizes.

Finally, the MAGNETOM Trio is the first generation of true 3T whole-body 3T MR systems. One great advantage of a MR system with a magnetic field strength of 3.0 Tesla or greater is the capability of performing high resolution and spectroscopic imaging of the prostate gland and other sites without using coils or other devices that distort the anatomy. Such distortion is not acceptable as it lessens the accuracy in aiming the radiation beams used for patient therapy. In addition, the 3.0 Tesla scanner provides the ability to perform functional imaging of areas of the brain to differentiate healthy from diseased tissue so that the healthy areas can be avoided during treatment. This scanner has guaranteed homogeneity on 40 cm field-of-view, including in the z-direction, and the standard high order shim enable best spine and abdominal imaging ever in the coronal plane.

Each resident has his or her own workspace within the department, and a computer with intra-net and internet access. The resident workspaces are located directly in the clinic and across the hall from the primary hallway for physics faculty offices. The resident has access to electronic journals through the Hardin Library on campus, by virtue of their computer access privilegesThe Department has a library with numerous journals and the following publications that were acquired specifically for the Medical Physics Residency Program:

(Additions to Library list)

Blackburn's Introduction to Clinical Radiation Therapy Physics	edited by Shahabi	0-944838-06-5
Radiation Therapy Physics, 3rd ed	Hendee, Ibbott, Hendee	0-471-39493-9
The Physics of Radiology, 4th ed	Johns, Cunningham	0-398-04669-7
Treatment Planning in Radiation Oncology	Khan, Potish (eds)	0683-04607-1
The Modern Technology of Radiation Oncology, Vol1	Van Dyk (ed)	0-944838-38-3
The Modern Technology of Radiation Oncology, Vol2	Van Dyk (ed)	1-930524-25-0
Monitor Unit Calculations for External Photon & Electron Beams	Gibbons (ed)	1-883526-08-6
Shielding Techniques, 2nd ed	McGinley	1-930524-07-2
A Practical Guide to Intensity-Modulated Radiation Therapy	Memorial Sloan Kettering Cancer Center	1-930524-13-7
Intensity-Modulated Radiation Therapy: The State of the Art	Palta, Mackie (eds)	1-930524-16-1
The Physics of Radiotherapy X-Rays from Linear Accelerators	Metcalfe, Kron, Hoban	0-944838-76-6
The Q Book, The Physics of Radiotherapy X-Rays from Linear Accelerators	Metcalfe, Kron, Hoban	0-944838-86-3
Brachytherapy Physics, 2nd ed (2005 AAPM Summer School Proceedings)	Thomadsen, Rivard, Butler (eds)	1-930524-24-2
CT Simulation for Radiotherapy	Jani (ed)	0-944838-32-4
The Essential Physics of Medical Imaging, 2nd ed.	Bushberg, Seibert, Leidholdt, Boone	0-683-30118-7
Magnetic Resonance Imaging: Principles, Methods, and Techniques	Sprawls	0-944838-97-9
A non-Mathematical Approach to Basic MRI	Smith, Ranallo	0-944838-02-2
Accreditation Programs and the Medical Physicist	Dixon, Butler, Sobol	1-930524-04-8
Radiation Detection and Measurement	Knoll	0-4710-7338-5
Medical Dosimetry Certification Study Guide	Rajan	1-930524-18-8
Introduction to Radiological Physics and Radiation Dosimetry	Attix	0-4710-1146-0
Christensen's Physics of Diagnostic Radiology	Curry, Dowdey, Murry	0-8121-1310-1
Review of Radiological Physics	Huda, Slone	0-7817-3675-7
Basics of PET Imaging : Physics, Chemistry, and Regulations	Saha	0-3872-1307-4

F Safety

The following safety training and safety issues are covered in resident safety orientation, which is conducted by the Chief Therapist:

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 Health Protection 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 radiation safety that have been addressed in each of the rotations throughout their training (e.g., brachytherapy, linac commissioning, etc.).

G. Future Plans

G1. Summary of Strength and Needs

The University of Iowa Hospitals and Clinic (UIHC) is a tertiary care patient care center in the small Midwestern town of Iowa City, a city completely dominated by the University. 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, Radiation Therapy Technologists, and graduate level Medical Physics courses in the Radiation Biology Program. Furthermore, we are pursuing the establishment of a graduate program in Medical Physics, which will provide additional learning opportunities for the Medical Physics residents. Finally, we have at least one active research project with a faculty member from each of the groups mentioned above.

The Department of Radiation Oncology is designated a “Center of Excellence” at UIHC, having recently moved into an expanded, 40,000 sq.ft. state-of-the-art facility 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. Four of five treatment vaults have been filled with Siemens Oncor Avant Garde linear accelerators, including both extensive optic tracking and on-board MV conebeam on all accelerators. Treatment planning systems include KonRad, Corvus, FastPlan, BrachyVision, and Philips Pinnacle. Residents are also encouraged to travel with a faculty physicist to a satellite hospital ~ 90 miles away, one that has a Varian 21EX, conventional simulation, and the Varis verify and record system. These tools provide the resident learning opportunities in conventional radiation therapy and beyond.

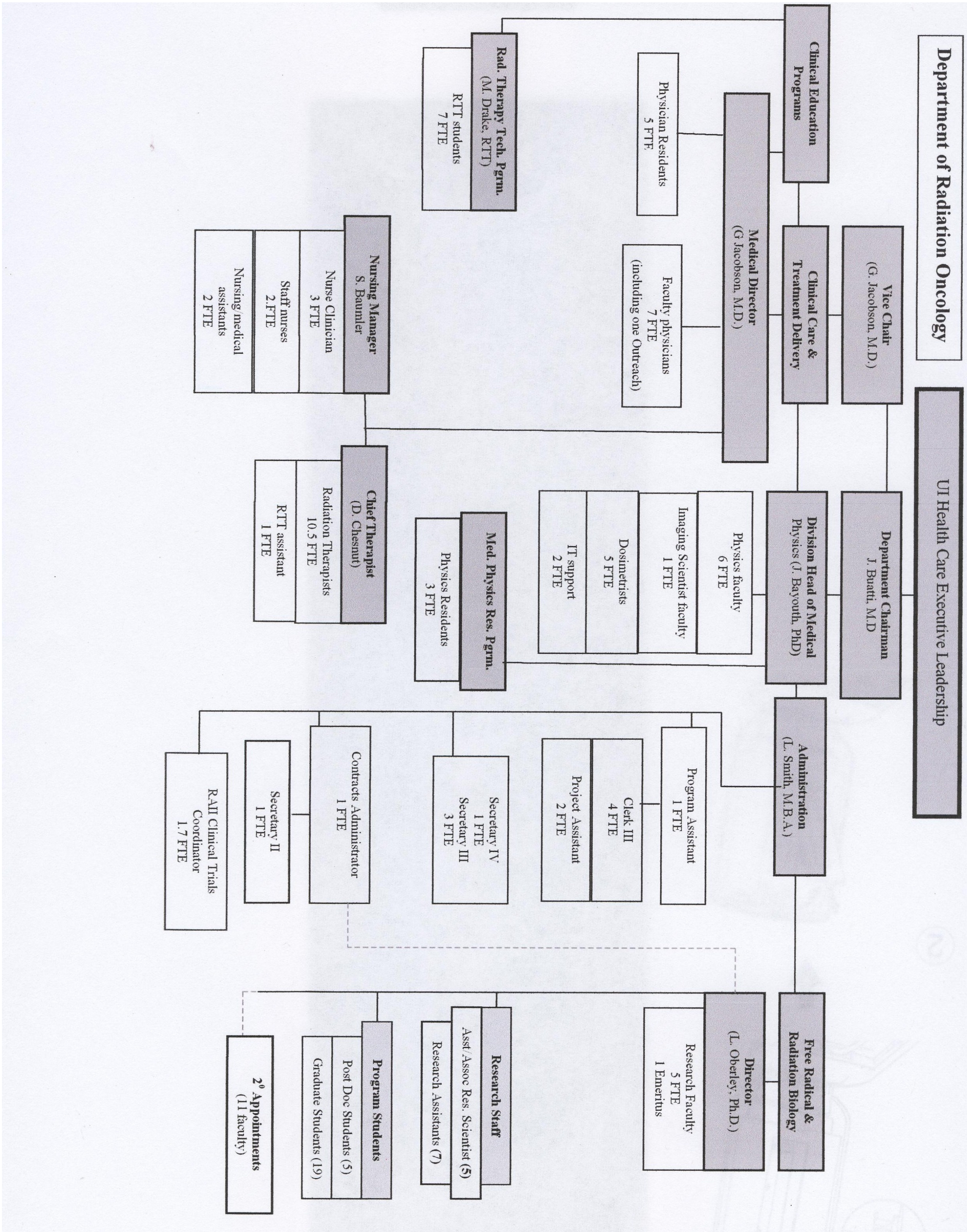
Specifically, with regards to the satellite location, they participate in weekly review of patient treatment records, equipment performance records, daily QA records, and perform monthly quality assurance on treatment delivery and simulation systems. The residents are invited to travel to the satellite location one day each week, but are required to attend 12 times each year.

The Medical Physics Division is currently expanding. In the next 16 months we hope to reach a staffing level of nine physicists along with six dosimetrists, two programmers, and one imaging scientist. This will meet an existing need within our program, providing the faculty sufficient protected time to expand our research program and provide the residents with structured research opportunities.

G2. 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.

Appendix A – Organizational Chart



Appendix B – ACGME Accreditation

ACGME

Accreditation Council for Graduate Medical Education

515 North State Street
Suite 2000
Chicago, Illinois 60610

Phone 312.755.5000
Fax 312.755.7498
www.acgme.org

April 22, 2004

Geraldine M. Jacobson, MD,MPH
Director Radiation Oncology Residency
University of Iowa Hospitals and Clinics
200 Hawkins Drive
Iowa City, IA 52242

Dear Dr. Jacobson:

The Residency Review Committee for Radiology, operating with the accreditation authority that has been delegated to it by the Accreditation Council for Graduate Medical Education, has reviewed the information submitted regarding the following residency program:

Radiation Oncology

University of Iowa Hospitals and Clinics Program
University of Iowa Hospitals and Clinics
Iowa City, IA

Program 4301811033

Based on all of the information available to it at the time of its recent meeting, the Residency Review Committee accredited the program as follows:

Status: Continued Full Accreditation
Length of Training: 4
Maximum Number of Residents: 7
Effective Date: 3/23/2004
Progress Report Due Date: 6/1/2004
Approximate Date of Next Site Visit: 03/2009 FS

The Committee commented about the following issues:

1. Residents are required to perform numerous administrative tasks that should be designated more appropriately to support staff. The site visitor reported that clerical staff in a number of divisions appeared to be inexperienced and minimally trained. In addition, residents are expected to triage phone calls, arrange logistics for patients' treatment in other institutions across the state, and finally, to complete other associated paperwork because of a nurse coordinator shortage.

2. The site visitor reported that space allocated to residents is not conducive to independent work or learning. Although residents are provided cubicles and a work area, adjacent space is described as 'busy traffic areas'. The Committee acknowledged the information that a new facility

will be completed in approximately 2 years. The program director, however, should ensure that the plans in process address resident space needs.

The program director is asked to submit a response to these two issues IN TRIPLICATE by June 1, 2004 for review by the Committee at the July, 2004 meeting. The report should be reviewed by the Graduate Medical Education Committee and co-signed by the Chair of the GMEC.

At the time of the next site visit and review the Committee will look carefully at the issues identified below:

1. Evaluation processes do not ensure the residents' confidentiality. The site visitor reported that although residents complete handwritten evaluations of the faculty and the program annually, the trainees are reluctant to include critical comments because of concerns that faculty will recognize individual's handwriting styles. Procedures to ensure resident confidentiality should be developed and implemented.

2. The final summary evaluation provided residents does not include a statement verifying that the graduate is competent to practice independently.

3. There is no documentation that the program director reviews resident logs twice-yearly. While the site visitor stated that semi-annual meetings between the residents and program director occur, there was no documentation that resident log review was addressed during these sessions.

The program's request for an increase in the resident complement from 5 to 7 positions was approved.

The next survey of the program will occur in approximately 5 years.

It is the policy of the ACGME and of the Residency Review Committee that each time an action is taken regarding the accreditation status of a program, the residents must be notified.

This office must be notified of any major changes in the organization of the program, including discontinuation of rotations to participating institutions, as well as changes in leadership. When corresponding with this office, please identify the program by number and name as indicated above.

Sincerely yours,

Linda M. Thorsen
Executive Director
Residency Review Committee for Radiation Oncology
(312)755-5029
lmt@acgme.org

CC: Mark C. Wilson, MD,MPH

Appendix C – Clinical Rotation Summaries

Radiation Oncology Clinical Medical Physics Resident Rotation - Year 1+ (13 months)

{months}	Primary Rotation	Mentor
0.5	Orientation	JEB
2	Dosimetric system acceptance testing/Commissioning/QA	JEB
2	Linear Accelerator Acceptance Testing / Commissioning / Annual QA	JM/TW
2	Brachytherapy	JM
2	Treatment machine calibration (TG51) & Monitor Unit Calculations	EP/AS
1.5	TPS Modeling / Acceptance / Commissioning /	JEB
2	Treatment Planning A&B	JEB
1	Vacation / Sick Leave / Family Leave / Conferences	

Radiation Oncology Clinical Medical Physics Resident Rotation - Year 2 (11 months)

{months}	Primary Rotation	Mentor
2	Intensity Modulated Radiation Therapy (IMRT)	AS
1	Treatment Simulation Process	TW
2	Stereotactic radiosurgery	EP
2	Special Procedures: Total Body Irradiation, Total skin electrons (TSE) & Intraoperative radiation therapy (IORT)	TW
1	Imaging for planning and treatment verification	JM
1	Image Guided Radiation Therapy (IGRT)	JEB
1	Shielding/Room Design/Radiation Protection Survey / Radiation Safety	EP
1	Vacation / Sick Leave / Family Leave / Conferences	

Attendance at the following conferences is required:

Case Conference	Wednesdays 7:30 – 8:30
Case Conference	Thursdays 7:30 – 8:30
Chart Rounds	Mondays 7:30 – 8:30

Recommended readings:

Title	Author(s)	ISBN
(list that residents must own)		
The Physics of Radiotherapy, 3rd ed	Khan	0-7817-3065-1
Medical Imaging Physics, 4th ed	Hendee, Ritenour	0-471-38226-4
Physics in Nuclear Medicine, 3rd ed	Cherry, Sorensen, Phelps	0-7216-8341-X
Radiobiology for the Radiologist, 5th ed	Hall	0-7817-2649-2
Radiation Therapy Planning, 2nd ed	Bentel	0-0700-5115-1
Introduction to Health Physics, 3rd ed	Cember	0-0710-5461-8
A Primer on Theory and Operation of Linear Accelerators in Radiation Therapy	Karzmark, Morton	0-944838-66-9
Linear Accelerators for Radiation Therapy, 2nd ed	Greene, Williams	0-7503-0476-6

Examinations will be administered following each clinical rotation.

Rotation Plan for Dosimetric Systems

A. Skills

a. Linac Operation
   i. F1 “Treat” mode
   ii. F5 “V & R” mode with Lantis / Primeview
b. Use of an Ionization Chamber and Electrometer to read Dose
c. 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. Thermoluminesence Dosimeters (TLD)
b. Design and Basic Operation of Electrometers
c. Phantoms
   i. Slabs
   ii. Anthropomorphic
   iii. Water Tanks

C. Clinical Processes

a. Commissioning of Dose Measurement Systems
   i. Ion Chambers / Electrometers
   ii. Film
   iii. Metal Oxide Semiconductor Field Effect Transistor (MOSFET)
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, 6VM x-rays)
      1. depths of 1.5 cm and 10 cm in solid water,
      2. EDR2 film and XV

Learning opportunities

Observe physicist measurements performed with ion chamber and phantom: monthly calibration, electron cutout measurements, IMRT QA. Observe dose verification on patient using MOSFET dosimeters.

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

3. Diode in Vivo Dosimetry for Patients Receiving External Beam Radiation Therapy (2005) Radiation Therapy Committee Task Group #62; 84pp.
4. Acceptance testing of an automated scanning water phantom David E. Mellenberg, Robert A. Dahl, and C. Robert Blackwell Med. Phys. **17**, 311 (1990)
5. Radiochromic Film Dosimetry (Reprinted from Medical Physics, Vol. 25, Issue 11) (1998) Radiation Therapy Committee Task Group #55; 23 pp.

Assessment

The resident will present a report that describes each of these systems, how they operate, and results from their commissioning process. The report must give an overview of all the processes, describing the individual steps conceptually. 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.

Rotation Plan for Room Design, Radiation Protection and Radiation Safety

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 accountibility
      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

NCRP Report 49
NCRP Report 151 (S:\OncShare\PHYSICS\NCRP_Reports)
The Physics of Radiation Therapy, 3rd ed., Khan, Ch. 16
State of Iowa regulations (http://www.idph.state.ia.us/eh/radiological_health.asp)
Shielding Techniques, 2nd ed McGinley
AAPM task group 32 – Fetal Dose

AAPM online refresher courses

Assessment

The resident will compile a report describing the individual steps that were taken to perform the shielding analysis. A second report should be written of the shielding requirements for the linear accelerator vault and 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. A third report will be created estimating the yearly dose that one would expect in selected areas based on actual measurements.

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.

Rotation for Linear Accelerator Acceptance Testing/Commissioning/Annual QA

Note: This rotation has three major components. The student is expected to devote sufficient time and effort to each area to attain a comprehensive understanding of each area as well as the over-arching synthesis of all 3.:

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

A. Prerequisite Skills

a. Radiation Safety –X-ray machine operation
b. Fundamentals of Radiation Detection/Measurement
   i. Use of ionization chambers, diodes.
   ii. Use of electrometer
c. Introduction to Monitor Unit calculation parameters (ISF, CF, PSF,TPR, SSD, etc.).
d. Use of radiographic films/processor.

B. Knowledge Base

a. Linear Accelerator Fundamentals Relevant to Commissioning
   i. Basic beam optics
   ii. Beam flattening
   iii. Significance of beam control parameters.
   iv. Collimation
      1. Rectangular Jaws
      2. MLC
      3. Electron Collimation
b. Medical Linear Accelerator Specifications
   i. Non-beam specifications
   ii. Beam specifications
c. Acceptance Tests
   i. Safety-related tests (Radiation survey).
   ii. Acceptance vs Commissioning Data Collection
   iii. Non-beam tests
   iv. Beam modifier and Accessory testing.
d. Commissioning Data Acquisition Tasks
   i. Data acquisition using scanning water phantom.
      1. Types and significance of scans
      2. Scans with different detectors
      3. Scans with different beam modifiers
   ii. Point data acquisition
   iii. Film/planar data acquisition.
   iv. Understanding of measurement selection,
e. Analysis of Measurements and Preparation for Commissioning

i. Preparation for MU Calc data
ii. Preparation for TPS beam commissioning

f. Annual QA
   i. Conceptual understanding of objectives with respect to commissioning.
   ii. Relevant measurement selection, performance and documentation of same.

C. Clinical Processes

a. On-going QA: Use of constancy values and standards.
b. MU Calcs: Where do those numbers come from, anyway?
c. Non-routine QA and Commissioning
   i. Post repair QA not requiring recommissioning
   ii. Post-repair QA requiring recommissioning

D. Learning Opportunities:

a. Determine data necessary to commission 1 photon and 1 electron beam in Pinnacle. Collect that data, and format it for commissioning.
b. Determine the data necessary to perform MU Calculations for 1 photon and 1 electron beam. Collect the data and in a later rotation confirm that MU calculations agree with measurements for a range of depths, field sizes and beam modifiers.
c. Participate in the Annual QA on a linear accelerator.

Assessment:
The resident will provide a written report of principles and process of Linear 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.

Reading List:

Horton, J.L., "Handbook of Radiation Therapy Physics", Prentice-Hall (1987).
Chapters 5,6,7.

AAPM Report #46 TG-40 Report "Comprehensive QA for Radiation Oncology"
http://www.aapm.org/pubs/reports/rpt_46.PDF

Starkschall G., Steadham R., et al, **"Beam-commissioning methodology for a three-dimensional convolution/superposition photon dose algorithm,"** Journal of Applied Clinical Medical Physics, 1:1 p 8 – 27, (2000).
http://www.jacmp.org/cJournal/archive.php?op=read&mode=pdf&articleid=4

AAPM Report #62 TG-53 Report "Quality Assurance for Clinical Radiotherapy Treatment Planning" http://www.aapm.org/pubs/reports/rpt_62.pdf

AAPM Report #56 TG-35 Report "Medical Accelerator Safety Considerations", http://www.aapm.org/pubs/reports/rpt_56.pdf

AAPM Report #7 TG-18 Report on Neutron dosimetry, http://www.aapm.org/pubs/reports/rpt_04.pdf

AAPM Report #13 TG-26 and TG-22 Report "Physical Aspects of Quality Assurance in Radiation Therapy", http://www.aapm.org/pubs/reports/rpt_13.pdf

AAPM Report #19 TG-27 Report "Neutron Measurements Around High Energy X-ray Radiotherapy Machines", http://www.aapm.org/pubs/reports/rpt_19.pdf

"Medical Linear Accelerator Fundamental Principles", Waldron T., Internal Handout/lecture materials.

Rotation Plan for TG-51 Calibration

A. Skills

a. Operation of ionization chamber
b. Operation of electrometer
b. Operation of linear accelerator
c. Know how to adjust linear accelerator output
d. Spreadsheet development and verification

B. Knowledge Base

a. TG-51 protocol
b. Electometer/Chamber/water tank setup
c. Chamber/electrometer ADCL calibration
d. Reference point determination
e. Calibration point determination
f. Electrical and mechanical safety
g. Linac operation

C. Clinical Process

a. Set up water tank
b. Position chamber at calibration point
c. Connect electrometer
d. Measure ionization
e. Convert to dose
f. Convert to dose/MU at reference point
g. *Demonstrate* ability to change accelerator output *
h. Document results
i. Develop TG-51 reference data for future use

Learning opportunities

a. 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

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.

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

Rotation Plan for MU calculations

A. **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 (adac check, MU31, RTP Filter)
    g. Determine the needed beam data for an MU calc

B. **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)

C. **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 (C.b,c,d), a list of sample patients can be selected, and the resident can perform the calculations from the field data in Lantis 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 (perhaps on Oncor D.)

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 should also present a table of MU calculation data that he has collected himself for one photon and one electron energy. He 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.

Rotation Plan for Treatment Planning – A

A. Skills
  a. TPS system operation
    i. Login
    ii. Access to Patient Database
    iii. Access to Syntegra/Planning

B. Knowledge Base
  a. Determination of Data Required for TPS Modeling
  b. 3D Photon Beam Dose Algorithms
    i. Convolution Method
    ii. Polyenergetic Spectra
    iii. Inhomogeneity Corrections
    iv. Collapsed Cone Convolution
    v. Output Factors
    vi. Monitor Units
  c. Electron Beam Dose Algorithms
    i. Hogstrom / Shiu Pencil Beam model
    ii. Verification Data
  d. Non-dosimetric Calculations 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
  e. Dose Evaluation Tools
    i. Dose grid resolution
    ii. Isodose lines
    iii. Tolerance of Normal Tissues
    iv. Dose-Volume Histograms
    v. TCP/NTCP

C. Clinical Processes
  a. Observe Treatment Planning
    i. Brain, Head and Neck, Lung & Esophagus, Breast, Abdominal & Rectum, Pelvis & Bladder, and Prostate.
  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, blocking,
    iv. Regions of interest and their associated doses

Learning opportunities

Observe dosimetrists in performing the treatment planning process, and understand the functionality of the planning system. Hands-on time with the planning system to learn functionality of all options.

Reading List

1. Pinnacle Beam Modeling User Manual
2. A convolution method of calculating dose for 15-MV x rays, TR Mackie, JW Scrimger, JJ Battista, Medical Physics, Vol 12, Issue 2 (1985).

3. Investigation of the convolution method for polyenergetic spectra, N Papanikolaou, T Rockwell Mackie, C Meger-Wells, M Gehring, P Reckwerdt, Medical Physics, Vol. 20, Issue 5 (1993).
4. Separation of Photon Beam Output Factor into its Phantom and Machine Components using the Convolution/Superposition Method, N. Papanikolaou, T. Rockwell Mackie, B.R. Thomadsen, D.M.D. Frye, B. Paliwal and C.M. Sanders, University of Wisconsin Medical School, Madison WI.
5. Monitor Unit Calculations for Convolution and Monte Carlo Dose Planning Systems, R. Mackie, N. Papanikolaou, B. Thomadsen, P. Reckwerdt, T. Holmes, C. Sanders. 1994 AAPM, Anaheim CA.
6. Tolerance of normal tissue to therapeutic irradiation, B Emami, J Lyman, A Brown, L Cola, M Goitein, JE Munzenrider, B Shank, LJ Solin, M Wesson, Int J Radiation Onc Bio Phys, Vol. 21, Issue 1 (1991).
7. Dose-volume histograms, RE Drzymala, R Mohan, L Brewster, J Chu, M Goitein, W Harms, M Urie, Int J Radiation Onc Bio Phys, Vol. 21, Issue 1 (1991).
8. Collapsed cone convolution of radiant energy for photon dose calculation in heterogeneous media, A Ahnesjo, Medical Physics, Vol. 16, Issue 4 (1989).
9. Electron beam dose calculations, K Hogstrom, M Mills, P Almond, Phys. Med. Biol., Vol. 26, Issue 3 (1981).
10. On methods of inhomogeneity corrections for photon transport, J Wong, J Purdy, Medical Physics, Vol. 17, Issue 5 (1990).

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 protocols. 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.

Rotation Plan for Treatment Planning - B

A. **Skills**

   a. TPS system operation

      i. Login

      ii. Access to Patient Database

      iii. Access to Syntegra/Planning

   b. LANTIS 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 Protocols

   e. Dose Evaluation Tools

   f. Data transfer

   g. DICOM formats / RT Objects

   h. CERR

   i. Treatment Planning Quality Assurance

   j. Record and Verify system data import/approval

C. **Clinical Processes**

   a. Create Treatment Plans

      i. Brain, Head and Neck, Lung, Breast, Rectum, and Prostate.

   b. Perform Quality Assurance on all plans

Learning opportunities

Perform the treatment planning process and understand the functionality of the planning system. Quality assurance of every aspect of the plan, from plan evaluation through verification within the record and verify system.

Reading List

1. Pinnacle Beam Modeling User Manual
2. LANTIS users manual

3. Quality Assurance for Clinical Radiotherapy Treatment Planning (Reprinted from Medical Physics, Vol. 25, Issue 10) (1998) Radiation Therapy Committee Task Group #53; 57 pp.
4. G. Kutcher *et al.*, ‘‘Comprehensive QA for radiation oncology: Report of AAPM Radiation Therapy Committee Task Group 40,’’ Med. Phys. **21**, 581–618 (1994)
5. Verification data for electron beam dose algorithms, A Shiu, S Tung, K Hogstrom, J Wong, R Gerber, W Harms, J Purdy, R Ten Haken, D McShan, B Fraass, Medical Physics, Vol. 19, Issue 3 (1992).
6. G. Starkschall, R. E. Steadham, R. A. Popple, S. Ahmad, and I. I. Rosen, "*Beam commissioning methodology for a 3-D convolution/superposition photon dose algorithm*," J. Appl. Clin. Med. Phys. **1**, 8–27 (2000).
7. G. Starkschall, R. E. Steadham, N. H. Wells, L O’Neill, L. A. Miller, and I. I. Rosen, "On the need for monitor unit calculations as part of the beam commissioning methodlogy for a radiation treatment planning system," J. Appl. Clin. Med. Phys. **3**, 86–94 (2000).

Assessment

The resident will present a report giving an overview of all the processes, describing the individual steps conceptually, and results from their treatment planning. 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.

Rotation Plan for IMRT A & B

A. Skills

a. Treatment planning
   i. Has the resident completed the Treatment Planning Rotation?
   ii. Read a Dose Volume Histogram
   iii. Transfer a plan to a phantom
   iv. Obtain the dose matrices of the plan
   v. Specify Dose-Volume constraints
b. Film Densitometry
   i. H&D curve creation
   ii. Running a film processor
   iii. Scanning Film
   iv. 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

B. 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

C. Clinical Processes

a. IMRT planning
b. IMRT chart check (LANTIS, CERR)
c. IMRT QA
   i. Patient specific
   ii. Delivery system specific
d. IMRT boosts
e. IMRT delivery
f. 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

Recommended

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).

Suggested

1. Treatment Planning in Radiation Oncology, Khan and Potish, editors, Chs. 8 (focus on pp172-176), 9, 12,
2. 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.
3. 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.

Assessment

The resident will present a report that includes printouts of the relevant steps for the phantom plan: The IMRT QA report (Doseviewer), the ion chamber measurement spreadsheet, and the relevant pages from the treatment plan (dose distributions in various planes, constraints used in the optimization, plan parameters for the beams). In addition to this, the resident will create a plot of the H and D curve used for the film dosimetry. The report must also give an overview of all the processes, describing the individual steps conceptually (i.e. not the details of which buttons to push but rather an overview that indicates how one might go about the same steps on a different planning system or with a different tool set). 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.

Rotation Plan for : Radiotherapy Simulation

A. Prerequisite Skills

a. Radiation Safety –Xray machine operation
b. Human Anatomy –common bony landmarks
c. Fundamental Physics of Radiographic Imaging
    i. Radiation Interactions with Matter
        1. Photoelectric Effect, Compton, Pair Prod
        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 Xray imagers
    ii. Xray CT
    iii. PET
    iv. MRI
    v. Ultrasound

B. Knowledge Base

a. Principle understanding of simulation process.
b. Fundamental Principles of Simulation Equipment
    i. "Conventional Simulator" –Plane Films and Fluoroscopy.
    ii. CT
    iii. Immobilization and Localization aids.
    iv. Other simulation technologies: PETCT, MR, US, Photogrammetric.
    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 Xray generator
    ii. CT Simulation
        1. CT numbers, electron density, and relationship to Radiation Oncology treatment planning.
        2. Diagnostic CT v. 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. Conventional Simulation and Planning from Plane Films
b. CT Simulation
c. VSIM as an alternative to CT Sim
d. Sim Aids: Radiocam, Sonosite, etc.

Learning Opportunities:
Attend a conventional simulation for EBRT (Clinton site). 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 xray 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, biteblock registration, and initial treatment.
Perform Radiocam and Sonosite QA.
Perform CT (PET/CT) QA to include using the ACR phantom.

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.
Resident should come up with their own schedule for the rotation

Reading List:
"Quality assurance for computed-tomography simulators and the computed-tomography simulation process: Report of the AAPM Radiation Therapy Committee Task Group No. 66," Med Phys 30 (10), 2003, p. 2762.

Christensen's Physics of Diagnostic Radiology (In order) Chapters 14, 15, 19, 12, 24.

Perry Sprawl' On-line lectures:

http://www.sprawls.org/ppmi2/IMGCHAR/

http://www.sprawls.org/resources/CTIMG/module.htm

Johns & Cunningham, "The Physics of Radiology," Chapter 16.

"The phantom portion of the American College of Radiology (ACR) Computed Tomography (CT) accreditation program: Practical tips, artifact examples, and pitfalls to avoid", Med Phys 31(9), 2004 p. 2423.

AAPM Report #14, "Performance specifications and acceptance testing for x-ray generators and automatic exposure devices", 1985.

Rotation Plan for Total Body Irradiation

A. Prerequisite Skills

a. Radiation Safety –Xray 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
Observe/attend a TBI simulation, Fabricate the blocks under supervision, verify the block attenuation on the machine.

Collect sufficient TBI beam data to perform hand calculations.

Perform measurements to determine efficacy of the current TBI flattening filter.

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.

Reading List:

Van Dyk et al, AAPM Report 17 /TG-29 “Physical Aspects of Total and Half Body Irradiation”

Johns & Cunningham, “The Physics of Radiology,” Chapter 11.

Perez CA, “Principles and Practice of Radiation Oncology” Chapter 11.

Zierhut, Dietmar et al, “Cataract incidence after total-body irradation”, IJBORP 45(1) p. 131, 2000.

Thomas, Oliver et al, “Long-term complications of total body irradiation in adults”, IJBORP 49 (1) p.125, 2001.

Faraci, Maura, et al, “Very late nonfatal consequences of fractionated TBI in children undergoing bone marrow transplant”, IJORBP 63(5) p. 1568, 2005.

A literature review is strongly suggest for this topic.

Rotation Plan for Stereotactic Radiosurgery

A. Prerequisite Skills
   a. SRS Principles
   b. Operation of Linac 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. LANTIS/PRIMEVIEW

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

C. **Clinical Process**
   a. Geometrical Alignment
      i. Position floor stand
      ii. Verify alignment using films
      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 LANTIS
        ii. Transfer isocenter coordinates to Radiocam for frameless treatment
        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 (simulated treatment)
    g. Workflow
        i. Generate SRS workflow diagram
        ii. Perform Failure Mode Analysis

* Current software limitations do not allow multiple machines to be defined in the planning system. The existing clinical planning data integrity must not be compromised, therefore, any actions that may potentially alter the clinical data must be closely supervised by a member of the physics staff.

Learning opportunities

Perform QA on radiosurgery floor stand system using absolute phantom.
Perform QA on radiocam localization 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

AAPM report 54, Stereotactic Radiosurgery
Radiosurgery Vol 4, Kondizielka ed., Karger 2002, pages 251-261
Fastplan Stereotactic Radiosurgery Treatment Planning Software Manual.
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 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.

Rotation Plan for Brachytherapy A (Basics)

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
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

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:
    a. Hendee (reference 1) pg. 294: 12-4, 12-5 and 12-6.
    b. Hendee pp 329-330: 13-1, 13-4, 13-5, 13-6, 13-8, 13-9, 13-12, 13-13, 13-14, 13-15. 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).
3. The Physics of Radiology (4th Ed.), Johns and Cunningham, Chapter 13.
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 10) (1997) Radiation Therapy Committee Task Group #56; 42 pp. http://www.aapm.org/pubs/reports/rpt_59.pdf
6. ICRU. Dose and volume specification for reporting intracavitary therapy in gynecology. ICRU Report No. 38. Bethesda, MD: International Commission on Radiation Units and Measurements, 1985.

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.

Rotation Plan for Brachytherapy B (Applications)

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. Eye Plaques
    a. COMS (Collaborative Ocular Melanoma Study) protocol
    b. Treatment planning/prescription
    c. Seed ordering
        i. Single Source Strength Assay
        ii. Plaque construction
    e. Plaque placement/recovery source disposal

2. 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

3. **High Dose Rate Brachytherapy**
    a. Source Exchange/Calibration check
    b. Daily (day of treatment) QA

c. Applicator/catheter placement
d. Imaging for treatment planning
   i. Orthogonal images
   ii. Reconstruction geometry
   iii. CT-based planning
e. Dose prescription/fractionation/rational
f. Treatment planning
   i. Written Directive
   ii. Dose planning objectives
   iii. Critical structure doses
   iv. Treatment planning procedures
   v. Treatment plan QA
g. Treatment delivery
   i. Pre-treatment survey
   ii. Attach catheters/applicator
   iii. Authorized User/Medical Physicist requirements
   iv. Treatment progress assessment
   v. Post-treatment survey
   vi. Recovery/remove catheters/applicator
h. Emergency procedures
   i. Annual HDR safety training
   ii. Manual source retract
   iii. Stuck source
   iv. Patient safety

C. Clinical Processes

1. Eye Plaque procedure
   a. Planning/prescription
   b. Seed ordering/assay plaque construction
   c. Plaque placement
   d. Plaque removal/seed disposal
2. Prostate Implant procedure
   a. Volume study
   b. Treatment planning
   c. Source strength assay
   d. Implant procedure
   e. Seed recovery
   f. Post Implant Dosimetry
3. 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 pot implant dosimetry assessment, HDR vaginal cylinder (VC) placement procedure, HDR tandem and ovoid (T&O) placement procedure, HDR VC simulation and planning session, HDR T&O simulation and planning session, HDR VC treatment delivery, HDR T&O 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, and high dose rate vaginal cylinder.

Perform the daily HDR QA and single source activity assays for prostate and eye plaque implants.

Reading List:

1. Collaborative Ocular Melanoma Study Group, “Collaborative Ocular Melanoma Study (COMS) randomized trial of I-125 brachytherapy for choroidal melanoma”, multiple COMS Reports. See Ed Pennington for copies.
2. Radiation Therapy Physics 3rd Ed, Hendee, Ibbott and Hendee, 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), Thomadsen, Rivard, Butler (Eds.), Chapter 6 (HDR), Chapter 7 (HDR QA), Chapters 28-33 (Prostate Brachytherapy) Chapter 34 (Eye plaques).
5. Code of Practice for Brachytherapy Physics (Reprinted from Medical Physics, Vol. 24, Issue 10) (1997) Radiation Therapy Committee Task Group #56; 42 pp. http://www.aapm.org/pubs/reports/rpt_59.pdf
6. Dosimetry of Interstitial Brachytherapy Sources (Reprinted from Medical Physics, Vol. 22, Issue 2) (1995) Radiation Therapy Committee Task Group #43; 26 pp. http://www.aapm.org/pubs/reports/rpt_51.pdf
7. Update of AAPM Task Group No. 43 Report: A revised AAPM protocol for brachytherapy dose calculations. Medical Physics, Vol. 31, Issue 3 (2004); Radiation Therapy Committee Task Group #43; 42pp. http://www.aapm.org/pubs/reports/rpt_84.pdf
8. High Dose-Rate Brachytherapy Treatment Delivery (Reprinted from Medical Physics, Vol. 25, Issue 4) (1998) Radiation Therapy Committee Task Group #59; 29 pp. http://www.aapm.org/pubs/reports/rpt_61.pdf
9. Permanent Prostate Seed Implant Brachytherapy (Reprinted from Medical Physics, Vol. 26, Issue 10) (1999) Radiation Therapy Committee Task Group #64; 23 pp. http://www.aapm.org/pubs/reports/RPT_68.pdf
10. Intravascular Brachytherapy Physics. Medical Physics, Vol. 26, Issue 2 (1999); 34pp. Radiation Therapy Committee Task Group #60.

In addition, various other research articles of interest selected in consultation with the mentoring physicist should be read in preparation for presentation at the monthly journal club.

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.

Rotation Plan for Total Skin Electron and Intraoperative Irradiation

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 Tbe- and IORT
    c. Equipment
    d. Dosimetry issues in Tbe- and IORT
        i. Field uniformity
        ii. Beam energy/penetration
        iii. Field Shaping
            1. Collimation and patient alignment (IORT).
            2. Collimation and energy adjustment (Tbe-).
    e. Beam Data for Tbe- 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 TBI Program**
    a. General electron beam commissioning
    b. Specifics related to Tbe- commissioning.

Learning Opportunities:

Perform measurements of

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

Observe IORT and Tbe at (other institiution).

Assessment:

The resident will provide a written report of principles and process of Total Skin Electron Irradiation and Intraopertive 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 Tbe 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.

Reading List:

Perez & Brady, "Principles and Practice of Radiation Oncology", Lippincott, 2nd ed, 1992, Chapters 10 and 22.

Khan, F.M., "The Physics of Radiation Therapy", Williams & Wilkins (1984)
Chapter 14, particularly section 14.8.

Clinical Electron-Beam Dosimetry, Reprinted from Medical Physics (Vol. 18, Issue 1) (1991) Radiation Therapy Committee Task Group #25; 40 pp.

Intraoperative radiation therapy using mobile electron linear accelerators: Report of AAPM Radiation Therapy Committee Task Group No. 72. (2006); 43pp.

Commissioning of a mobile electron accelerator for intraoperative radiotherapy
Michael D. Mills, Liliosa C. Fajardo, David L. Wilson, Jodi L. Daves, and William J. Spanos
J. Appl. Clin. Med. Phys. **2**, 121 (2001)

Use of routine quality assurance procedures to detect the loss of a linear accelerator primary scattering foil
M. G. Davis, C. E. Nyerick, J. L. Horton, and K. R. Hogstrom
Med. Phys. **23**, 521 (1996)

A study of the effect of cone shielding in intraoperative radiotherapy
Nikos Papanikolaou and Bhudatt Paliwal
Med. Phys. **22**, 571 (1995)

The dosimetric properties of an intraoperative radiation therapy applicator system for a Mevatron-80
Charles E. Nelson, Richard Cook, and Susan Rakfal
Med. Phys. **16**, 794 (1989)

The dosimetric properties of an applicator system for intraoperative electron-beam therapy utilizing a Clinac–18 accelerator
Edwin C. McCullough and Joseph A. Anderson
Med. Phys. **9**, 261 (1982)

Khan, F.M., "The Physics of Radiation Therapy", Williams & Wilkins (1984)
Chapter 14, particularly section 14.8.

Total Skin Electron Therapy: Technique and Dosimetry(1987)

Multiple scattering theory for total skin electron beam design
John A. Antolak and Kenneth R. Hogstrom
Med. Phys. **25**, 851 (1998)

Spatial distribution of bremsstrahlung in a dual electron beam used in total skin electron treatments: Errors due to ionization chamber cable irradiation

Indra J. Das, John F. Copeland, and Harry S. Bushe
Med. Phys. **21**, 1733 (1994)

Dosimetric study of total skin irradiation with a scanning beam electron accelerator
Subhash C. Sharma and David L. Wilson
Med. Phys. **14**, 355 (1987)

Physical aspects of a rotational total skin electron irradiation
E. B. Podgorsak, C. Pla, M. Pla, P. Y. Lefebvre, and R. Heese
Med. Phys. **10**, 159 (1983)

A literature review is strongly suggested for this topic.

Rotation Plan for Rotation in 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

iii. Clinical prevalence

b. 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

1. CT simulation
   a. Patient set-up
   b. Iscocenter localization
2. Digital Reconstructed Radiograph
   a. Generation
   b. Clinical use
3. Electronic Portal Imaging Devices
   a. Principles of operation
   b. Daily/monthly quality assurance testing
   c. Set-up/portal image verification
   d. Megavoltage conebeam computed tomography

Learning Opportunities:

Clinical Use of Images

Portal Imaging Detector Systems

Image Quality

Commissioning and QA

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.

Reading List:

1. Radiation Therapy Physics 3rd Ed, Hendee, Ibbott and Hendee, Chapter 9.
2. The Physics of Radiation Therapy, 3rd Ed, Khan, Chapter 12 (focus on pp 228 – 244), Section 12.7 (Patient Positioning) pp 264 – 268.
3. The Physics of Radiation Therapy, 3rd Ed, Khan, Chapter19 pp 467 – 474.
4. Marks JE, et al. "Localization error in the radiotherapy of Hodgkin's disease and malignant lymphoma with extended mantle fields," Cancer (NY) **34**, 83-90 (9174).
5. Rabinowitz J, et al. "Accuracy of radiation field alignment in clinical practice," Int. J. Radiat Oncol., Biol., Phys. **11**, 1857-67 (1985).
6. Nixon E. "Hydrogenated Amorphous Silicon Active Matrix Flat Panel Imagers (a-Si:H AMFPI) Electronic Portal Imaging Devices. Graduate Research Paper. University of Iowa. 2005.

7. Pang G and Rowlands J A Electronic portal imaging with an avalanche-multiplication-based video camera *Med.Phys.* **27** 676–84. 2000.
8. Rajapakshe R, Luchka, and Shalev S, "A quality control test for electronic portal imaging devices," Med. Phys. 23, 137-1244 !996).
9. Gilhuijs KG, et al. "Optimization of automatic portal image analysis." Med. Phys. 22, 1089-1099 (1995).
10. Fristch DS, et al. "Core based portal image registration for automatic radiotherapy treatment verification." Int. J. Radiat. Oncol., Biol., Phys. 33, 1287-300 (1995).
11. Herman MG, "Clinical use of on-line portal imaging for daily patient treatment verification," Int. J. Radiat. Oncol., Biol., Phys. 28 (4) 1017-1023 (1994).
12. Herman MG, et al. "Effects of respiration on target and critical structure positions during treatment assessed with movie-loop electronic portal imaging," Int. J. Radiat. Oncol., Biol., Phys. 39, 163 (1997).
13. Mubata CD, et al., "Portal imaging protocol for radical dose-escalation radiotherapy treatment of prostate cancer," Int. J. Radiat. Oncol., Biol., Phys. 40, 221-231 (1998).
14. Lebesques JV, et al., "Clinical evaluation of setup verification and correction protocols: Results of multicenter Studies fo the Dutch cooperative EPID Group," The Fifth International EPID Workshop, Phoenix AZ, 1998. p. 20.
15. Kirby MC, et al. "The use of an electronic portal imaging device for exit dosimetry and quality control measurements." Int. J. Radiat. Oncol., Biol., Phys 31, 593-603 (1995).
16. Hansen VN, "The application of transit dosimetry to precision radiotherapy," Med Phys. 23, 713-721 (1996).

Assessment:

The resident will prepare a written report summarizing their experiences and present this information to the physics faculty during an oral exam.

Rotation Plan for Image Guided Radiation Therapy (IGRT)

A. **Skills**
    a. TPS system operation
    b. Linear Accelerator operation
    c. MVision Megavoltage cone-beam operation
    d. Z-Med SonArray and Radiocam operation
    e. Biograph 40 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. SonArray ultrasound system
        ii. Radiocam infra red optical guidance system
        iii. 4D image acquisition
        iv. gated delivery
        v. megavoltage conebeam
    b. Export IGRT Treatment Plans for
        i. Brain, Head and Neck, Lung, and Prostate.
    c. Perform image registration and fusion for multimodality imaging utilized in treatment planning
        i. MVCT with CT
        ii. PET with CT
        iii. MRSI 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
Quality Assurance for Clinical Radiotherapy Treatment Planning (Reprinted from Medical Physics, Vol. 25, Issue 10) (1998)

Radiation Therapy Committee Task Group #53; 57 pp.

Z-Med SonArray and Radiocam user manual

Sanford L. Meeks, Wolfgang A. Tomé, Lionel G. Bouchet, et al. Patient Positioning Using Optical And Ultrasound Techniques. AAPM Summer School 2003

Siemens MVision users manual

Jean Pouliot, Ph.D., Ali Bani-Hashemi, Ph.D., Josephine Chen, Ph.D., et al. Low-Dose Megavoltage Cone-Beam CT For Radiation Therapy. Int. J. Radiation Oncology Biol. Phys., Vol. 61, No. 2, pp. 552–560, 2005

Nicole M Wink, Michael F McNitt-Gray and Timothy D Solberg. Optimization of multi-slice helical respiration-correlated CT: the effects of table speed and rotation time. Phys. Med. Biol. **50** (2005) 5717–5729

X. Allen Li,a_ Christopher Stepaniak, and Elizabeth Gore, Technical and dosimetric aspects of respiratory gating using a pressure-sensor motion monitoring system, Med. Phys. 33 (1):145-54, 2006

Vincent Gregoire, Jean-François Daisne and Xavier Geets, Comparison of CT- and FDG-PET-defined GT: In regard to Paulino et al. (Int J Radiat Oncol Biol Phys 2005;61:1385-1392), International Journal of Radiation Oncology*Biology*Physics, Volume 63, Issue 1, , 1 September 2005, Pages 308-309.;

Arnold C. Paulino and Mary Koshy, In Response to Dr. Gregoire et al., International Journal of Radiation Oncology*Biology*Physics, Volume 63, Issue 1, 1 September 2005, Page 309.

C. Clifton Ling, John Humm, Steven Larson, Howard Amols, Zvi Fuks, Steven Leibel and Jason A. Koutcher. Towards multidimensional radiotherapy (MD-CRT): biological imaging and biological conformality. International Journal of Radiation Oncology*Biology*Physics, Volume 47, Issue 3, Pages 547-857 (1 June 2000)

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.

Radiation Therapy Program
University of Iowa Hospitals and Clinics
Anatomy and Physiolgy Course

Course content is designed to educate students on the cross-sectional anatomy of the human body. Material covered includes a brief review of gross anatomy and physiology, with an in depth look at cross-sectional anatomy for each of the body systems. Course presents normal anatomy using CT and MR cross-sections.

Text:
Sectional Anatomy for Imaging Professionals
Kelley, Lorrie; Petersen, Connie. Mosby

Instructor: Mindi TenNapel
E-mail: mindi-tennapel@uiowa.edu
Phone: 319-356-8286

Length of Course:

The course will run through out the fall and spring semesters. There will be approximately three hours of class per week. This course will closely follow the progress of Oncology and Pathology.

Grade Composition:

Each student's final grade will be based on the following items: Homework 40%; Exams 60%;

Calculation of Grades:

GRADING SYSTEM: Correlation between letter and numerical grades is:

GRADING SCALE		
100% - 95% = A	85% - 84% = B-	73% - 72% = D+
94% - 93% = A-	83% - 82% = C+	71% - 67% = D
92% - 91% = B+	81% - 77% = C	66% - 64% = D-
90% - 86% = B	76% - 74% = C-	63% - below = F

Radiation Therapy Program
University of Iowa Hospitals and Clinics
Oncology and Pathology Course

This course is designed to provide the student with an understanding of the concepts of cancer, its causes, effects on the human body and current treatments. There is an emphasis on the practical application of radiation therapy principles and their appropriate use in the clinical setting. The epidemiology, etiology, detection, diagnosis, patient condition, treatment and prognosis of neoplastic disease will be presented, discussed and evaluated in relationship to histology, anatomical site and patterns of spread. The Radiation Therapist's responsibility in the management of neoplastic disease will be examined and linked to the skills required to analyze complex issues and make informed decisions while appreciating the character of the profession.

Text: 1) Principles and Practices of Radiation Therapy Chapter 37: p 893-918
Washington and Leaver; Mosby

2) Radiation Therapy Planning, Second Edition Chapter 3: p. 53-54
Bentel, Gunilla; McGraw-Hill

3) Principles of Anatomy and Physiology, 11th Edition; Chapter 5: p. 145-170
G. Tortora and S. Grabowski.
Harper Collins College Publishers

4) Sectional Anatomy for Imaging Professionals; N/A
Kelley, Lorrie L. and Petersen, Connie M. Mosby

5) www.cancer.org Detailed guide for Skin Cancer – melanoma and Skin Cancer – nonmelanoma

6) Various Handouts

Instructor: Mindi TenNapel
E-mail: mindi-tennapel@uiowa.edu
Phone: 319-356-8286

Length of Course:
The course will run through out the fall and spring semesters. There will be approximately three hours of class per week. This course will closely follow the progress of Anatomy and Physiology.

Grade Composition:
Each student's final grade will be based on the following items: Unit papers 40%; Exams 50%; Class participation 10%.

Unit Papers:
The unit paper will be replaced by homework assignments for unit one. For the subsequent units a three to five page paper will be written before the end of that unit. The

paper should include, but not be limited to information regarding epidemiology, etiology, detection, diagnosis, treatment and prognosis of the histology that will be covered. The student may choose to find a patient with the diagnosis and present the above topics in relation to how that patient was treated.

The students are strongly encouraged to consult with the instructor if any problems or questions arise in general or concerning any information sources or if conflicting information is found.

The grading breakdown for the paper is as follows:

Organization and Flow	10 %
Grammar and Spelling	10 %
Presentation (Style, Clarity, Transitions)	20 %
Research, Content, and Application	60 %

Calculation of Grades:

GRADING SYSTEM: Correlation between letter and numerical grades is:

GRADING SCALE		
100% - 95% = A	85% - 84% = B-	73% - 72% = D+
94% - 93% = A-	83% - 82% = C+	71% - 67% = D
92% - 91% = B+	81% - 77% = C	66% - 64% = D-
90% - 86% = B	76% - 74% = C-	63% - below = F

Course Goals and Schedule:

Unit One – Introduction to Cancer **August-September**

- Historical Perspective of Radiation and Cancer Treatment
- Principles of Medical Oncology
- Cancer Biology
- Diagnostic Tools
  - Imaging
  - Nuclear Medicine
- Other treatments
  - Chemotherapy
  - Surgery
- Patient Education

The following units get into the individual cancers and the related anatomy. The goals for each of these individual units include:

- Epidemiology
- Etiology
- Anatomy and Physiology of associated region
- Benign pathology of associated region
- Clinical Presentation
- Detection and Diagnosis
- Histopathology
- Prognostic factors
- Routes of spread
- Treatment Techniques

Unit Two – Hemopoietic System & Leukemia

Unit Three – Lymphoreticular System

Unit Four – The Integumentary System & Skin Cancer – melanoma and non melanoma

Unit Five – The Central Nervous System

Unit Six – The Genitourinary System and Breast Cancer

Unit Seven – The Gastrointestinal and Respiratory System

Unit Eight - Head and Neck Cancers

Unit Nine – Male and Female Reproductive System

Unit Ten – Bone, cartilage and soft tissue sarcomas

Unit Eleven - Pediatric, Metastatic, Special Senses and Endocrine System

Radiation Oncology Medical Physics Lecture Series
2006-2007 for Residents and RTTs

Thursday's from 12:30-2:00 pm - Radiation Oncology Conference Room (SW164-13GH)

Lecture #	Date	Lecture Topic / Exam	Instructor
1	8/31	Atomic and nuclear structure (including decay and radioactivity)	JEB
2	9/7	Production of X-rays, photons, and electrons	JEB
3	9/14	Radiation interactions	JEB
4	9/21	Treatment machines and generators; simulators (including computed tomography)	TJW
5	9/28	Treatment machines and generators; simulators (including computed tomography)	TJW
6	10/5	Radiation beam quality and dose	JMM
7	10/12	Radiation measurement and calibration	JMM
8	10/19	Radiation measurement and calibration	JMM
9	10/26	Photons and X-rays (including concepts, isodoses, monitor unit, heterogeneities, field shaping, compensation, field matching)	ECP
10	11/2	Photons and X-rays (including concepts, isodoses, monitor unit, heterogeneities, field shaping, compensation, field matching)	ECP
11	11/9	Photons and X-rays (including concepts, isodoses, monitor unit, heterogeneities, field shaping, compensation, field matching)	ECP
12	11/16	Photons and X-rays (including concepts, isodoses, monitor unit, heterogeneities, field shaping, compensation, field matching)	ECP
-	11/23	THANKSGIVING	
13	11/30	Monitor Unit calculations - Software Applications	ECP
-	12/7	Semester Review	
-	12/14	Semester Exam	
14	1/18	Electrons (including concepts, isodoses, monitor unit, heterogeneities, field shaping, field matching, etc.)	JEB
15	1/25	Electrons (including concepts, isodoses, monitor unit, heterogeneities, field shaping, field matching, etc.)	JEB
16	2/1	Electrons (including concepts, isodoses, monitor unit, heterogeneities, field shaping, field matching, etc.)	JEB
17	2/8	Electrons (including concepts, isodoses, monitor unit, heterogeneities, field shaping, field matching, etc.)	JEB
18	2/15	3D-CRT including ICRU concepts and beam-related biology	ACS
19	2/22	Imaging for radiation oncology: US, PET, CT, MRI	MM
20	3/1	Imaging for radiation oncology: US, PET, CT, MRI	MM
21	3/8	Imaging for radiation oncology: US, PET, CT, MRI	MM
-	3/15	SPRING BREAK	
22	3/22	Special procedures (including radiosurgery, TBI, etc.)	ECP

23	3/29	Special procedures (including radiosurgery, TBI, etc.)	ECP
24	4/5	External beam quality assurance, Radiation protection and shielding	ECP
25	4/12	Brachytherapy (including intracavitary, interstitial, HDR, etc.)	JMM
26	4/19	Brachytherapy (including intracavitary, interstitial, HDR, etc.)	JMM
27	4/26	Brachytherapy (including intracavitary, interstitial, HDR, etc.)	JMM
-	5/3	Semester Review	
-	5/10	Semester Exam	
28	5/17	Assessment of patient setup and treatment (including electronic portal imaging device, immobilization, etc.)	JEB
29	5/24	IMRT	JEB
30	5/31	IMRT	ACS
31	6/7	IGRT	JEB
32	6/14	Hyperthermia, Particle Therapy	TJW

Course Instructors

John E. Bayouth (coordinator)	10 lectures	15 lecture hoursR.
Alfredo C. Siochi	2 lectures	3 lecture hours
Joseph M. Modrick	6 lectures	9 lecture hours
Edward C. Pennington	8 lectures	12 lecture hours
Timothy J. Waldron	3 lectures	4.5 lecture hours
Manickam Muruganandham	3 lectures	4.5 lecture hours

Calculation of Grades

There will be a 10 min quiz given at the beginning of each lecture testing a major idea from the previous lecture. The quizzes will make up 40% of your grade. The quizzes will be designed to help you understand major points of emphasis and will help in preparing for the exams. The quizzes will begin promptly at 12:30 pm and end at 12:40 pm.

There will be two exams given throughout the year, each at the end of the academic semester, each worth 100 points. The tests for this semester make up 60% of your grade.

The final grade ranges will be:

≥90% A

90%>B ≥80%

80%>C≥70%

<70% fail.

All quizzes and exams must be written during their scheduled time, unless the instructor provides approval and arrangements prior.

Text

The quiz and exam questions will come from your text and lecture notes. The text for this class is: “The Physics of Radiation Therapy" 3rd edition, Faiz M. Khan, Lippincott Williams & Wilkins 2003

Course Description
This course is designed to help the student better understand the principles and application of physics in radiation therapy. By the end of the course the student should understand the following areas:

Atomic And Nuclear Structure 1. learn the structure of the atom, including types of nucleons, relation between atomic number and atomic mass, and electron orbits and binding energy. 2. be able to relate energy to wavelength and rest mass, and understand and describe an energy spectrum. 3. learn about radioactivity, including decay processes, probability, half life, parent-daughter relationships, equilibrium, and nuclear activation.
The Production Of Photons And Electrons 1. the concepts of beam production, including acceleration of electrons in diagnostic X-ray tubes, Bremsstrahlung, X-ray tube design, and characteristic radiation. 2. about the general design of a linear accelerator, including major components and their functions, steering, flattening filtration, and beam hardening.
Radiation Interactions 1. the physical description, random nature, and energy dependence of the five scatter and absorption interactions that X-ray photons undergo with individual atoms (coherent scatter, photoelectric effect, compton effect, pair production, and photonuclear disintegration). 2. definitions of the key terms such as attenuation, scatter, beam geometry, linear and mass attenuation coefficients, energy transfer, energy absorption, half-value layer, and how these terms relate to radiation scatter and absorption through the exponential attenuation equation. 3. the physical description and energy dependence of the elastic and inelastic collision processes in matter for directly and indirectly ionizing particulate radiation. 4. definitions of key terms such as linear energy transfer, specific ionization, mass stopping power, range, and how these terms relate to energy deposition by particulate radiation.
Treatment Machines And Simulators 1. the mechanics and delivery of radiation with respect to wave guides, magnetron vs. klystron for production. 2. the production and delivery of electrons by the electron gun, buncher, and scattering foil vs. scanning. 3. the production and delivery of photons including the target and flattening filter. 4. benefits and limitations of multileaf collimator (MLC) collimators and cerrobend and hand-block. 5. the production and collimation of superficial photons. 6. the production of low-energy X-rays for imaging. 7. the differences in film and other imaging modalities for simulation. 8. digitally reconstructed radiograph (DRR) production and use.
Photons And X-Rays 1. basic dosimetric concepts of photon beams. 2. how these concepts relate to calculation concepts. 3. basic calculation parameters. 4. how these parameters relate to one another and how to cross convert. 5. parameters used for calculations and their dependencies for source-to-skin distance (SDD) and source-to-axis distance (SAD) setups. 6. how beam modifiers affect beams and calculations. 7. basic treatment planning arrangements and strategies. 8. how beam shaping affects isodose maps. 9. surface and exit dose characteristics. 10. the effect and use of beam modifiers including bolus. 11. heterogeneity corrections and effects on isodoses. 12. beam matching techniques and understanding of peripheral dose. 13. special considerations for pacemaker, pregnant patients.
Electron Beams 1. the basic characteristics of electron beams for therapy, including components of a depth-dose curve as a function of energy, electron interactions, isodoses, oblique incidence, and electron dose measurement techniques. 2. the nature of treatment planning with electrons, including simple rules for selecting energy based on treatment depth and range, effect of field size, dose to skin and bolus, and effects of field shaping, especially for small fields. 3. about field matching with photons and other electron fields, internal shielding, backscatter, and the effects of inhomogeneities on electron isodoses.
External Beam Quality Assurance 1. the goals of a departmental quality assurance (QA) program, the staffing required to perform these QA activities, and the duties and responsibilities of the individuals associated with the QA program. 2. what is entailed in making equipment selections in radiation therapy and the content of equipment specification. 3. what is involved in

acceptance testing of a linear accelerator and in commissioning both a linear accelerator and a treatment planning system. 4. what linear accelerator quality assurance is required on a daily, monthly, and yearly basis and the acceptance tolerances associated with these tests.
Radiation Protection And Shielding 1. the general concept of shielding, including "As Low As Reasonably Achievable" (ALARA) and Federal regulations. 2. the units of personnel exposure, sources of radiation (manmade and natural), and means of calculating and measuring exposure for compliance with regulations. 3. components of a safety program, including Nuclear Regulatory Commission (NRC) definitions and the role of a radiation safety committee.),

Imaging For Radiation Oncology 1. the physical principles associated with good diagnostic imaging techniques. 2. the rationale behind taking port films, how port films are used in the clinic, and the response characteristics of common films used in the radiation therapy department. 3. the types of portal imaging devices that are available in radiation therapy, the operating characteristics of these various devices, and the clinical application of this technology in daily practice. 4. the physical principles of ultrasound, its utility and limitations as an imaging device, and its application to diagnosis and patient positioning. 5. the physical principles behind CT, magnetic resonance imaging (MRI), and positron emission tomography (PET) scanning, how these modalities are applied to treatment planning, and their limitations. 6. the advantages of one imaging modality over another for various disease and body sites. 7. image fusion, its advantage in treatment planning, the difficulties and limitations associated with image fusion, and how image fusion can be accomplished.),
Three-dimensional Conformal Radiation Therapy (3DCRT) Including International Commission on Radiation Units (ICRU) Concepts and Beam-Related Biology 1. the concepts, goals, and technologies needed for planning and delivering 3D-CRT compared with conventional RT. 2. concepts and definitions associated with 3D-CRT planning including optimization strategies, uniform vs. non-uniform tumor dose distributions, non-biologic and biologic models for computing dose-volume metrics, beam shaping techniques, and magnitudes, sources, and implications of day-to-day treatment variabilities. 3. ICRU definitions and reporting recommendations for tumor-related volumes such as gross tumor volume (GTV), clinical target volume (CTV), and planning target volume (PTV).
Assessment of Patient Setup and Verification 1. patient immobilization and positioning. 2. imaging methods for monitoring patient geometry in the treatment position and how such images can be used for correcting patient alignment and modifying the initial treatment plan via an adaptive planning strategy. Intensity-Modulated Radiation Therapy 1. details on the different delivery system including advantages, differences, and limitations. 2. the differences for simulation and positioning compared with conventional therapy. 3. principles of inverse planning and optimization algorithms. 4. systematic and patient specific quality assurance.
Special Procedures 1. the basis of stereotaxic frame systems. 2. the frame placement, imaging, and treatment logistics. 3. differences in the stereotactic radiosurgery (SRS) systems and accuracy requirements. 4. dosimetry of small-field irradiation. 5. Total Body Irradiation (TBI) techniques and large-field dosimetry. 6. Logistics and dosimetric considerations for Total Skin Electron Radiotherapy (TSET) and e-arc
Brachytherapy 1. characteristics of the individual sources: Half-life, photon energy, half-value layer shielding, exposure rate constant, and typical clinical use. 2. source strength units: Activity, apparent activity, air kerma strength, exposure rate, equivalent of mg h of radium, and National Institute of Science and Technology (NIST) standards for calibration. 3. High-dose rate vs. low-dose rate in terms of alpha/beta ratios, fractionation, dose equivalence. 4. Specification of linear and point sources. 5. Implant dosimetry for planar implants vs. volume implant, including Patterson-Parker, Quimby, Memorial, Paris, and computational optimizations and calculations. 6. Implantation techniques for surface and interstitial implants, the sources used, and how they are optimized. 7. Uterine cervix applicators: Fletcher-Suit applicators (tandem and ovoids), high-dose rate applicators (tandem and ovoids/ring), and vaginal cylinders, and the

treatment planning systems for each applicator. 8. Cervix dosimetry conventions: Milligram-h, Manchester system, bladder and rectum dose, and the ICRU system (point A and point B). 9. Radiation detectors used for calibration and patient safety. 10. Remote afterloading units, including dose rates and devices for delivery, safety concerns and emergency procedures, and shielding for patient and personnel. 11. Discuss NRC and state regulations regarding use, storage, and shipping of sources.),

Hyperthermia 1. basic physics of hyperthermia and how this applies clinically. 2. hyperthermia systems. 3. Thermometry.

Particle Therapy 1. basic physics of neutron and proton beams. 2. configurations of proton and neutron delivery systems. 3. treatment planning considerations for particle therapy.

Radiation Biology (77:103)

Course Outline; Fall 2006 (4 cr.), M, T, W, Th; 8:30 am

Instructors: PC Goswami, DR Spitz, FE Domann, KJ Dornfeld, F Ianzini, and J Bayouth

Textbook: *Radiobiology for the Radiologist (5th ed), EJ Hall*

Lecture #	***Date***	**Lecture Topic/Exam**	**Paper Due Dates**
1	M Aug 21	Introduction and Historical Perspective, (Scientific Method, Law of Bergonié and Tribondeau; Gerschman et al.) (PG)	
2	T Aug 22	Acute Radiation Effects on Whole Animals (syndromes, LD50) (DS)	
3	W Aug 23	Types of Ionizing Radiation, Particulate vs. Electromagnetic (atomic structure, origin and nature of ionizing radiation, Part 1) (JB)	
4	Th Aug 24	Types of Ionizing Radiation, Particulate vs. Electromagnetic (atomic structure, origin and nature of ionizing radiation, Part 2) (JB)	
5	M Aug 28	Introduction to Radiation Physics (units, dosimetry, interaction of radiation with matter) (JB)	
6	T Aug 29	Introduction to Radiation Chemistry (target theory, water radiolysis, free radical formation, direct vs. indirect effects) (RD)	
7	W Aug 30	Radiation Cell Killing (Survival curves in vivo, in vitro, sites of radiogenic damage, damage repair at the cellular level, RBE, LET, dose rate effects) (RD)	
8	Th Aug 31	Radiation Cell Killing continued (RD)	
**	M Sep 4	Holiday, no class	
9	T Sep 5	Radiation Cell Killing continued (RD)	
10	W Sep 6	Radiation Cell Killing continued (RD)	
11	Th Sep 7	Tumor Responses to Radiation (survival, hypoxic fraction, angiogenesis, and predictive assays)	

		(DS)	
12	M Sep 11	MR Imaging and Response to Radiation Therapy (JB)	
13	T Sep 12	Tumor Responses to Radiation continued (DS)	
**	W Sep 13	Student Presentation (Adam Case)	
14	Th Sep 14	Oxidative stress (DS)	
**	M Sep 18	Exam I (Lectures 1-14)	
15	T Sep 19	Radiation-induced changes in metabolic processes and initiation of signal transduction (DS)	
**	W Sep 20	Student Presentation	
16	Th Sep 21	Normal Tissue Responses to Radiation (early vs. late effects, intrinsic radiosensitivity, renewal vs. non-renewal systems, radiation-induced fibrosis, clinical responses of normal tissue) (DS)	
Lecture	**Date**	**Lecture Topic/Exam**	**Paper Due Dates**
17	M Sep 25	Normal Tissue Responses to Radiation (early vs. late effects, intrinsic radiosensitivity, renewal vs. non-renewal systems, radiation-induced fibrosis, clinical responses of normal tissue) (DS)	
**	T Sep 26	Student Presentation (Yueming Zhu)	
**	W Sep 27	Student Presentation (Emily Alden)	
18	Th Sep 28	Molecular techniques in Radiation Biology (PG)	
19	M Oct 2	Molecular techniques in Radiation Biology (PG)	
20	T Oct 3	Radiation effects on the cell cycle I (PG)	
**	W Oct 4	Student Presentation (Leena Chaudhuri)	
21	Th Oct 5	Radiation effects on the cell cycle II (PG)	
22	M Oct 9	Oxygen Effects (OER, tumor hypoxia, reoxygenation, SER, fractionation) (DS)	
23	T Oct 10	Radiation effects on the cell cycle III (PG)	
**	W Oct 11	Student Presentation (Kristy Powers)	
24	Th Oct 12	Oxygen Effects (OER, tumor hypoxia, reoxygenation, SER, fractionation) (DS)	
25	M Oct 16	Radiation Effects on DNA (nature of radiation-induced DNA damage) (FI)	
**	T Oct 17	Exam II (Lectures 15-24)	
**	W Oct 18	Student Presentation (Jenice Wang)	
26	Th Oct 19	Radiation Effects on DNA repair mechanisms, homologous recombination, non-homologous end joining (KD)	
27	M Oct 23	Genetic Effects of Radiation (chromosome and chromatid aberrations, radiation induced mutations, nature of radiogenic lesions in the	Due: first proposal submission

		genome) (KD)	
28	T Oct 24	Radiation Carcinogenesis (KD)	
**	W Oct 25	Student Presentation (Rumpa Ganguly)	
29	Th Oct 26	Radiation Carcinogenesis (definitions, stages, human data, malignancies) (KD)	
30	M Oct 30	Mechanisms of radiation-induced cell death (I) (apoptosis) (FI)	
31	T Oct 31	Student Presentation (Anna Warpinski)	
**	W Nov 1	Radiation Effects on Oncogenes and tumor suppressor genes (PG)	
32	Th Nov 2	Mechanisms of radiation-induced cell death (II) mitotic catastrophe) (FI)	
**	Nov 5-8	No Class, (Radiation Research and Astro Conferences)	
33	Th Nov 9	Low Dose Radiation Effects (PG)	
Lecture #	***Date***	**Lecture Topic/Exam**	**Paper Due Dates**
34	M Nov 13	Radiation Teratology (effects on developing embryo, fetus) (FI)	
35	T Nov 14	Radiation-induced changes in transcription factor activity (PG)	
**	Nov 15-17	No Class, SFRBM Conference	
**	Nov 20-24	No Class, Thanksgiving	
36	M Nov 27	Hyperthermia (DS)	
37	T Nov 28	Fractionation and BED Calculations: The Clinical Perspective (KD)	
**	W Nov 29	Exam III (Lectures 25-36)	
38	Th Nov 30	Antioxidant modulation of Radiation Response (DS)	
39	M Dec 4	Modulation of Radiogenic Damage (radiosensitizers and radioprotectors) (KD)	
40	T Dec 5	Gene therapy in radiobiology (PG)	
**	W Dec 6	Student Presentation (Peter Scarbrough)	Due: second submission of research proposal
41	Th Dec 7	Novel Approaches to Radiation and Adjuvant Therapies (BNCT, fast neutrons, protons) (FI)	
**	Th Dec 14	Final Exam (Lectures 37-40 24%; Comprehensive 76%)	

Name	Lectures
Spitz, DR	11
Domann, FE	5
Dornfeld, KJ	6

Goswami, PC	10
Ianzini, F	5
Bayouth J	4
Total	41

Grading

Each individual exam grade will contribute a percentage to the final course grade according to the following guidelines:

Exam I..................................15%
Exam II.................................15%
Exam III................................15%
Final Exam...........................25%

Oral and written student presentations will also contribute to the final course grade according to the following guidelines:

2 Research Proposal Papers 15% 1 Student Presentation 15%

The goal of student presentation is to develop the student's skills in oral presentation of scientific findings. Student presentations should consist of a brief formal introduction and survey of a particular topic (see suggestions below) in radiation biology, focusing on 2 to 3 peer-reviewed publications in a particular field of study. Papers of differing viewpoints are welcomed. A mandatory interactive discussion by all registrants for the remainder of the period will follow. Audience participation in these discussions is required, and the overall grade for oral presentations will reflect both the individual presentation and the extent of individual student participation in these discussions.

Written reports (see suggestions below) should consist of 10-15 pages (including references in standard journal format)* on a mock grant proposal derived from a specific topic directly related to radiation biology, focusing on peer-reviewed publications in a specific field. Integrating concepts between papers that may present different points of view to derive a testable hypothesis is encouraged. The style should follow the format used in a grant application, including hypothesis and aims, background and significance, preliminary results, and experimental designs aimed at testing the hypothesis. The topics can be chosen on your own or with the aid of the instructors. Some suggested topics are listed below and can overlap with the topic of the student presentation. The first submission of the written report will be critiqued by 3 faculty members and returned without a grade to the student for revisions. The second submission of the report will receive a grade that will represent the credit for the assignment.

Radiation chemistry
Radiation physics
Acute radiation syndromes
Radiation cytotoxicity
Oxygen effects
Radiosensitizers
Radioprotectors
Apoptosis
DNA Damage and Repair
Radiation effects on the cell cycle
Radiation effects on cellular metabolism
Radiation effects on signal transduction
Metabolic perturbations and Radiation Response
Radiation-induced mitotic catastrophe

Hyperthermia
Radiation mutagenesis
Radiation carcinogenesis
Radiation teratology

Bystander effects
Genomic instability
Radiation-induced adaptive responses
Modes of Cell Death

*Sample reference:
Sekhar KR, Spitz DR, Harris S, Nguyen TT, Meredith MJ, Holt JT, Guis D, Marnett LJ, Summar ML, and Freeman ML: Redox sensitive interaction between KIAA0132 and Nrf2 mediates indomethacin-induced expression of γ-glutamylcysteine synthetase. Free Radic. Biol. Med. 2002; 32:650-66

Appendix E – Applicant Ranking Sample

Candidate	Ranking	2nd Ranking	Comments	Reviewer
	Do	Do Siochi	Excellent candidate, CT research, particle physics education, MCV post doc Sounds like a fast learner, independent learner. Good interpersonal skills. Background is diagnostic, though he seems to want to go into therapy; has had some therapy background	Bayouth
	Do	Do Siochi	UF Med Physics graduate – mostly diagnostic dosimetry Excellent background. Motivated, eager, cheerful. Passed part I of ABR	Bayouth
	Do	Don't Bayouth	Quite possibly over qualified for our residency. Seems to me he applied for one of our faculty openings. Strange – a lot of experience in Med Phys research and plenty of opportunity for clinical exposure, but no pertinent supporting letters	Modrick
	Do	Undecided Bayouth	Very motivated. No clear background in medical physics. Personal statement reads like a medical resident's. Very strong recommendation letters. Professor in EE, bright and academically productive.	Modrick
	Do	Undecided Modrick	PhD from U Wisconsin in Diagnostic CT Med Phys. Great grades, strong letters Trained at UW Madison. PhD in Diagnostic Imaging. Started at UW year before I left. Remember his name, but do not recall him. Only radiotherapy experience appears to be graduate course work. Therapy grades ok.	Bayouth
	Don't		Language issues, no med physics contact, and no statement	Waldron
	Don't	Don't Modrick	Only half an application – no letters or Med Phys experience. No application form. No personal statement	Bayouth
	Don't	Don't Siochi	Poor undergrad grades (F), no clinical background. Missing letters of support. CV not very strong	Bayouth
	Don't	Don't Waldron	Post-doc in molecular/biophysics. No Med Phys exposure. No stated interest in clinically relevant activities. No exposure to medical physics.	Bayouth
	Undecided Bayouth	Don't	No real background in medical physics. Rather late in life career change. Physics professor, no medical background, solid references letters, well liked by students	Modrick
	Undecided Bayouth	Don't	Health Physics background. Theragenics R & D. 5 years. Recommendation letters not very enthusiastic. Theragenics physicist, 4 month as clinical medical physicist . Health physics training	Modrick
	Undecided Siochi	Don't	Physics student U Missouri, great grades, no letters of support, poor English. No reference letters. Poor written English. Appears to be more theoretical-questionable for the clinic	Bayouth

Appendix F – Interview Invitation Letter

Dear Name:

Thank you for applying for residency in the Medical Physics Residency Program in Radiation Oncology at the University of Iowa. I am pleased to invite you to interview for the July 2006 position. We will conduct interviews on the following days:

March 1, 2006
March 8, 2006

Please respond to our Residency Program Coordinator (Diane Crossett at diane-crossett@uiowa.edu) by January 30th, and indicate whether you will accept our invitation. Include in your response your first and second choice for interview dates, and we will try to accommodate your preference. We ask that you arrive the day of your interview at 7:15 AM and spend about a half day with us. An outline of your schedule is as follows:

7:15 Arrive at the University of Iowa Department of Radiation Oncology
7:30 – 8:30 Case Conference in the Radiation Oncology Conference Room
8:30 – 9:00 Orientation and tour of the department with Dr. John Bayouth, Physics Residency Program Director
9:00 – 12:30 Rotate through interviews with faculty and staff. Each interview will be approximately 20 minutes
12:45 – 1:45 Lunch with our current resident

If you accept our invitation, we will then send you a detailed agenda with area accommodation information. In May 2005 the Department opened a newly created Center of Excellence in Image Guided Radiation Therapy. This center combines state-of-the-art imaging and treatment delivery equipment into the same department: 4 new Siemens ONCOR Plus linear accelerators with megavoltage cone beam CT, 3T MAGNETOM Trio MRI scanner, Biograph PET/CT scanner, mobile C-arm for fluoroscopy and kV cone beam CT, and optical image guidance. In addition, being a major university with strong graduate and undergraduate programs in several disciplines of science, exposure to and education from other groups within the Department and University are plentiful. Our department has three divisions (Clinical, Medical Physics, and Free Radical and Radiation Biology), we currently have active collaborations with the Department of Electrical and Computer Engineering, Biomedical Engineering, the Lung Imaging Center, and Nuclear Medicine. To learn more about our facility and the University of Iowa, I encourage you to review our webpage at:

http://www.uihealthcare.com/depts/med/radiationoncology/index.html.

Again, thank you for your interest in our Radiation Oncology residency program, and congratulations for being selected to interview; we look forward to hearing from you soon. Please do not hesitate to contact me if you have any further questions about our program, or Diane regarding the logistics of your visit. Diane's email is diane-crossett@uiowa.edu, and her phone number is 319-384-6135.

Sincerely,

John E. Bayouth, PhD
Associate Professor and Director of Medical Physics
Department of Radiation Oncology
University of Iowa Hospitals and Clinics
200 Hawkins Dr
Iowa City, IA 52242

Candidate Name

Below is the agenda for March 1, 2006

7:15	**Arrival - Department of Radiation Oncology** Reception area, Lower Level, West Addition
7:30 – 8:30 a.m.	**Case Conference** Conference Room
8:30 – 8:50 a.m.	**Orientation and Facility Tour - with Dr. John Bayouth, Physics Residency Director** Continental breakfast will be served
9:00 – 1:00 p.m.	**Interview – approximately 20 minutes each** Dr. Buatti – Room 01626 Dr. Spitz – Room 01615 Dr. Smith – Room 01613 Dr. Modrick – Room 01604 Ed Pennington – Room 01602 Tim Waldron – Room 01606 Dolly Chesnut – Room ? Dr. Bayouth – Room 01622 Dr. Siochi – Room 01608 Darrin Pelland – Room 01623 Break
1:00 – 2:00	Lunch with our current resident – Melrose Café, 5th Floor PFP
1:00	Departure

Our interviewing team:

- John Buatti, MD, Professor and Head of the Department of Radiation Oncology
- Mark Smith, MD, Assistant Professor and Medical Residency Program Director
- John Bayouth, PhD, Director of Medical Physics and Medical Physics Residency Program Director
- Douglas Spitz, PhD, Associate Professor, Free Radical and Radiation Biology Graduate Program
- Frederick Domann, PhD, Associate Professor, Free Radical and Radiation Biology Graduate Program
- Joseph Modrick, PhD, Assistant Professor
- Tim Waldron, MS, Associate of Medical Physics
- Ed Pennington, MS, Associate of Medical Physics
- Alfredo Siochi, PhD, Assistant Professor
- Kathleen Anderson, RT(T), CMD, Dosimetrist
- Dolly Chesnut, R.T. (R)(T), Chief Therapist

Appendix G

Dear Applicant,

Thank you for your interest in our Medical Physics Residency. We received material from a surprising number of qualified applicants.

After careful review and consideration by the selection committee, we have offered invitations to those we wish to interview.

Your application will not be kept for future openings. You will need to go through the application process again if you plan to apply in the future.

We wish you the best in your career pursuits.

Sincerely,

John E. Bayouth, PhD
Medical Physics Residency Program Director

Appendix H

RESIDENT APPLICANT EVALUATION

JULY 2007 OPENING

NAME OF CANDIDATE

INTERVIEWER: **DATE**

Please rank each candidate on the following chart.

Unacceptable		Acceptable		Highly recommend
1	2	3	4	5

Comments:

Please return to Diane Crossett. Thank you.

Appendix I

Candidate	Ranking	Comments	Interviewer
#1	3	Experience in therapy with WA of accelerators. Didn't get a feeling of great excitement	Chesnut
#1	3.75	ABR board certified (step 1); demonstrates commitment. Good communication skills, comes highly recommended, good physics and engineering background. Is still considering medical school as a future option. Clearly committed to biomedical physics. Would be an acceptable candidate	Domann
#1	2		Pelland
#1	2	Eventually wants to get into medical school. Rambles on and on about himself…Passed ABR written, has been offered junior positions with NY state but wants to learn more first	Pennington
#1	3	Not sure how well he will get along with the group, clinical residency goals realistic, is he teachable?	Siochi
#1	2		Smith
#1	4	Strong accent, but otherwise good communication skills	Waldron
#1	4	Very knowledgeable and has a solid understanding of medical physics	Bayouth
#1	2.75	Not clear that he has the background and experiences that he does a very good job of talking about at great length. There was something about him that seemed very off to me.	Modrick
#1	3	Acceptable candidate. He is pleasant and engaging. He seems an intelligent individual and comes with a reasonable understanding of the role and duties of a clinical medical physicist. could probably get along well with clinical teams.	Sample
#2	4.5	Soft spoken. Seems like he would be easy to work with. Quite knowledgeable	Chesnut
#2	3	High energy particle physics – Fermi? Lab and UC-Irvine. Wants to be a clinical medical physicist. Has good post-doctoral experience; mostly constructing algorithms for XR-CT metal artifacts. Not exceedingly outgoing – good fit? Very eclectic training – from high-energy particle physics to correction of XRCT metal artifact… a quantum leap in interest…Seems acceptable, but not my first choice.	Domann
#2	3		Pelland
#2	4	Quiet. Audited a number of medical physics classes	Pennington
#2	4.5	Intelligent, communicates well, seems a little reserved, excellent researcher	Siochi
#2	3		Smith
#2	5	Excellent communication, conversant in therapy. Interested in 80% clinic/20% academic but would choose clinic if 100% choice was	Waldron

		needed	
#2	4	Great background in CT and CT research, little exposure to rad onc	Bayouth
#2	3.75	Experience primarily in imaging as post doc at VCU. Background in experimental particle physics at UC-Irving. Very little direct clinical therapy physics experience. Interested in academic career. Concerned about formal course work in our program. Seemed very reserved in his personal responses. Couldn't get a good read on how intereste in Iowa.	Modrick
#2	3	Acceptable candidate. He is a very pleasant individual with good interpersonal skills. He is very intelligent and comes with a good understanding of CT image reconstruction and image quality. could get along well with clinical teams. The only downsize is that he may not fully appreciate the role and normal routines of a clinical medical physics and may in the end find the work not to his liking.	Sample

Appendix J

	JB	FD	MS	JM	TW	EP	JEB	AS	DP	DC	DS	JS	Rank	STD
Candidate	5	5	5	4.25	5	5	5	5	4	5		5	4.84	0.4
Candidate	5		4	4	5	3	5	4.5	4	4	4.5	4.5	4.32	0.6
Candidate		4	5	4	4	5	3	4	4	4.5		5	4.25	0.6
Candidate		5	4	4	5	4	2	5	3	3		5	4.00	1.1
Candidate	5	5	4	4		3	5	4	2.8	4		2.5	3.93	0.9
Candidate		3	3	3.75	5	4	4	4.5	3	4.5		3	3.78	0.7
Candidate	3	3	3	3		3	3	4	3	3		3	3.10	0.3
Candidate		3.75	2	2.75	4	2	4	3	2	3		3	2.95	0.8
Candidate	2	3	3	3.75	4.5	2	2	3	2.5	3		2.5	2.84	0.8

Appendix K

January 23, 2006

Candidate name
Candidate address
Candidate address

Dear First name:

It is with great pleasure that we offer you a position as a resident in Medical Physics in the Radiation Oncology Department to begin on April 1, 2006. We are extremely enthusiastic about you joining our Department and feel that your contributions and our commitment to your resident training will be enjoyable and beneficial.

This is a two-year program. Your stipend will be $42, 012 for year one. Benefits are administered by the UIHC House Staff Affairs Office. I will arrange a meeting for you to discuss benefits with them after you arrive. You can review the information at their website:
http://www.uihealthcare.com/depts/graduatemedicaleducation/benefits/statement.html

I have included a description of the medical physics residency program. If you agree to this offer, sign and return this form.

Sincerely,

John Bayouth, PhD
Clinical Associate Professor and
Residency Program Director

I have read this offer and accept the terms of appointment described herein.

____

Signature of Candidate   Date

Appendix L – Recruitment Advertisement

Position Description

We are seeking applications for the Clinical Medical Physics Residency Program in Radiation Oncology at the University of Iowa Hospitals and Clinics. This 2-year training program is designed for candidates with masters or doctoral degrees in relevant physical sciences who are interested in careers as clinical medical physicists in radiation oncology. The program provides structured training and progress assessment in all aspects of clinical medical physics in radiation oncology, with direct supervision by the Medical Physics faculty. Training occurs in a large, state-of-the-art radiation oncology center, with additional exposure to a community based hospital. The curriculum provides comprehensive, mentored, hands-on experiences, and progressive responsibility providing the opportunity to work towards becoming fully independent by the time you complete the program.

Facility and Equipment

The successful applicant will join seven faculty physicists and two other Medical Physics residents, along with five dosimetrists, two programmers, and one imaging scientist in the growing Physics Division of the Department of Radiation Oncology. Our newly constructed facility opened in 2005, combining state-of-the-art imaging and treatment delivery equipment into the same department: 4 Siemens ONCOR linear accelerators with gating and megavoltage cone beam CT, 3T MAGNETOM Trio MRI scanner, 4-D Biograph PET/CT scanner, mobile C-arm for fluoroscopy and kV cone beam CT, optical image guidance, and an active and diverse brachytherapy program (HDR, prostate seed implants, eye plaque implants, etc.). Specialized equipment and/or features include the IMRT delivery, 4D imaging/treatment planning/ delivery, frame-based and frameless linac stereotactic radio-surgery/therapy with both cones and micro-multileaf collimator, and image guidance provided by multiple technologies. As the Medical Physics Division is actively involved in translational research, collaboration opportunities for our residents with basic scientists in Radiation Biology as well as scientists in Bioengineering, Electrical and Computer Engineering, and Radiology are plentiful.

Employer and Environment:

The University of Iowa Hospitals and Clinics provides tertiary care patient care in Iowa City, where the excitement and energy of a Big Ten University town is balanced with Midwest living. Interested applicants should complete our on-line application, which can be found at http://www.uihealthcare.com/depts/med/radiationoncology/residency/physicsresidency.html along with sending an official college and graduate school transcripts, three letters of recommendation, a curriculum vitae, and a personal statement to: John E. Bayouth , PhD, Clinical Medical Physics Residency Program Director
c/o Diane Crossett, Program Coordinator, Dept. of Radiation Oncology, University of Iowa Hospitals and Clinics, 200 Hawkins Drive, Lower Level, West Addition, Iowa City, IA 52242 TEL: 319-384-6135, FAX: 319-356-1530

Appendix M

University of Iowa Radiation Oncology Clinical Medical Physics Residency
Rotation Specific Evaluation Form

Medical Physics Training Evaluation – Written Report and Oral Exam

Resident____ Date:______________________

Rotation Topic____

Reviewer____

Written Report Grade_______________

Unsatisfactory				Satisfactory				Superior		
1	2	3		4	5	6		7	8	9

Comments____

____

____

Oral Exam Grade____________

Unsatisfactory				Satisfactory				Superior		
1	2	3		4	5	6		7	8	9

Comments____

____

____

Recommendations____

____

____

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

Remediation (if Conditional Pass)____

____

____

Signed____
Faculty Member

University of Iowa Radiation Oncology Clinical Medical Physics Residency
Mentor's Rotation Evaluation Form

Resident__________________________________ Date:___________________

Rotation Topic____

Mentor_____________________________

Written Report Grade_________________

Unsatisfactory				Satisfactory				Superior		
1	2	3		4	5	6		7	8	9

Comments____

____

____

Oral Exam Grade_________

Unsatisfactory				Satisfactory				Superior		
1	2	3		4	5	6		7	8	9

Comments____

____

____

Recommendations____

____

____

Rotation grade (Pass, Fail, or Conditional Pass)

Remediation (if Conditional Pass)____

____

____

Signed____
Faculty Member

University of Iowa 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

Radiation Oncology Clinical Medical Physics Resident Rotation - Year 1+ (13 months)

{months}	Primary Rotation	Mentor
0.5	Orientation	JEB
2	Dosimetric system acceptance testing/Commissioning/QA	JEB
2	Linear Accelerator Acceptance Testing / Commissioning / Annual QA	JM/TW
2	Brachytherapy	JM
2	Treatment machine calibration (TG51) & Monitor Unit Calculations	EP/AS
1.5	TPS Modeling / Acceptance / Commissioning /	JEB
2	Treatment Planning A&B	JEB
1	Vacation / Sick Leave / Family Leave / Conferences	

Radiation Oncology Clinical Medical Physics Resident Rotation - Year 2 (11 months)

{months}	Primary Rotation	Mentor
2	Intensity Modulated Radiation Therapy (IMRT)	AS
1	Treatment Simulation Process	TW

2	Stereotactic radiosurgery	EP
2	Special Procedures: Total Body Irradiation, Total skin electrons (TSE) & Intraoperative radiation therapy (IORT)	TW
1	Imaging for planning and treatment verification	JM
1	Image Guided Radiation Therapy (IGRT)	JEB
1	Shielding/Room Design/Radiation Protection Survey / Radiation Safety	EP
1	Vacation / Sick Leave / Family Leave / Conferences	

Appendix N - Staff Biographical Sketches and Primary Clinical Interest in alphabetical order

Name	*Primary Clinical Interest*
Bayouth, John	4D Radiotherapy, Multi-modality Treatment Planning
Modrick, Joseph	Brachytherapy, Portal Imaging
Muruganandham, Manickam	Multi-modality Simulation
Pennington, Edward	Stereotactic Radiosurgery, 3DCRT, Shielding
Siochi, R. Alfredo	IMRT, QA, Monitor Units
Waldron, Timothy	SRS, Brachy, Total Body Irradiation, Linac QA
Goswami, Prabhat	Free Radical and Radiation Biology
TenNapel, Mindi	Radiation Therapist Training

BIOGRAPHICAL SKETCH

NAME OF SPONSOR (CO-SPONSOR)	POSITION TITLE
John E. Bayouth	Associate Professor

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE (if applicable)	YEAR(s)	FIELD OF STUDY
Kansas State University, Manhattan KS	B.S.	1988	Physics
Kansas State University, Manhattan KS	M.S.	1991	Physics
University of Texas Health Science Center, Houston TX	Ph.D.	1993	Physics
University of Texas Health Science Center, Houston TX	Postdoctoral Fellow	1994	Radiation Physics

A. Positions and Honors

Positions and Employment

1988-1990	Graduate Research Assistant, Nuclear Engineering, Kansas State University, Manhattan KS
1988-1990	Consulting Engineer, Southwest Research Institute Center for Nuclear Waste Regulatory Analysis, San Antonio TX
1990-1993	Graduate Research Assistant, Radiation Physics, University of Texas, Anderson Cancer Center, Houston TX
1994-1996	Assistant professor, Department of Radiation Oncology, University of Pittsburgh Pittsburgh PA
1996-1999	Chief of Medical Physics, Division of Radiation Oncology, Shadyside Hospital, Pittsburgh PA
1999-2004	Assistant professor, Department of Radiation Oncology, The University of Texas, Houston TX
2004-current	Associate Professor (Clinical), Director of Medical Physics, Department of Radiation Oncology, The University of Iowa, Iowa City IA

Other Experience and Professional Membership

1997-1999	AAPM Penn-Ohio Chapter (President Elect, President)
1999-current	AAPM Southwest Chapter
2000-2003	AAPM – Task Group No. 67: Benchmark Datasets for Photon Beams (Co-chair)
2001-2003	AAPM Southwest Chapter (President Elect, President)
2001-2003	AAPM – Assessment of Technology Subcommittee (member)
2002-current	American Society for Therapeutic Radiology and Oncology
2002-current	European Society for Therapeutic Radiology and Oncology

2003-current	The American Society for Therapeutic Radiology and Oncology – Radiation Physics Committee (member)
2004-current	AAPM Missouri River Valley (President Elect, President)
2005-current	AAPM Workgroup on Treatment Planning (member)

Honors

1988	Outstanding College Students of America
1989	Knights of St. Patrick Honorary in Engineering
1989	INPO Fellowship in Nuclear Engineering
1991	Alpha Nu Sigma Honorary
1991	Robert J. Shalek Fellow in Medical Physics

B. Selected Peer-Reviewed Publications

1. Faw RE, Simons GG, Gianakon TA, Bayouth JE. Simulation of angular and energy distributions of the PTB beta secondary standard. Health Phys. 1990;59:311-324.
2. Bayouth JE, Macey DJ. Dosimetry considerations of bone-seeking radionuclides for marrow ablation. Med. Phys. 1993;20:1089-1096.
3. Rosenblum MG, Macey DJ, Podoloff DA, Kasi LP, Bayouth J, Cunningham J, Bhadkamkar V, Reieger P, Thompson LB, Cheung L, Pinsky C, Sharkey R, Murray JL. A phase I pharmacokinetic, toxicity and dosimetry study of 131I labeled IMMU-4 F(ab')2 in patients with advanced colorectal carcinoma. Antibody, Immunoconjugates and radiopharmceuticals 1993;6:239-255.
4. Bayouth JE, Macey DJ. Quantitative imaging of holmium-166 with an Anger camera. Phys. Med. Biol. 1994;39:265-279.
5. Bayouth JE, Macey DJ, Kasi LP, Fossella FV. Dosimetry and toxicity of samarium-153-EDTMP administered for bone pain due to skeletal metastases. J. Nucl. Med. 1994;35:63-69.
6. Bayouth JE, Macey DJ, Boyer AL, Champlin RE. Radiation dose distribution within the bone marrow of patients receiving holmium-166-labeled-phosphonate for marrow ablation. Med. Phys. 1995;22:743-753.
7. Bayouth JE, Macey DJ, Kasi LP, Garlich JR, McMillan K, Dimopoulos MA, Champlin RE. Pharmacokinetics, dosimetry and toxicity of holmium-166-DOTMP for bone marrow ablation in multiple myeloma. J. Nucl. Med. 1995;36:730-737.
8. Diaz M, Macey DJ, Kasi LP, Bayouth JE, Podoloff DA. Dispensing therapeutic amounts holmium-166 with a radionuclide calibrator. J. Nucl. Med. Technol. 1995;23:275-278.
9. Giap HB, Macey DJ, Bayouth JE, Boyer AL. Validation of a dose-point kernel convolution technique for internal dosimetry. Phys. Med. Biol. 1995;40:365-381.
10. Macey DJ, Grant EJ, Bayouth JE, Giap HB, Danna SJ, Sirisriro R, Podoloff DA. Improved conjugate view quantitation of I-131 by subtraction of scatter and septal penetration events with a triple energy window method. Med. Phys. 1995;22:1637-1643.
11. Bayouth JE, Morrill SM. MLC dosimetric characteristics for small field and IMRT applications. Med. Phys. 2003;30:2545-2552.
12. Bayouth JE, Wendt D, Morrill SM. MLC quality assurance techniques for IMRT applications. Med. Phys. 2003;30:743-750.
13. Culp LR, Pou AM, Jones DV, Bayouth J, Sanguineti G. A case of radiation recall mucositis associated with docetaxel. Head & Neck 2004;26:197-200.
14. Sanguineti G, Culp LR, Endres EJ, Bayouth JE. Are neck nodal volumes drawn on CT slices covered by standard three-field technique? Int. J. Radiat. Oncol. Biol. Phys. 2004;59:725-742.
15. Bayouth J. Investigating the Frontiers in Image Guided Radiation Therapy at the New Center of Excellence. ISTRO Spring Conference. Iowa City IA; 2005.
16. Cavey M, Bayouth JE, Endres EJ, Pena JM, Colman M, Hatch S. Dosimetric comparison of conventional and forward-planned intensity-modulated techniques for comprehensive locoregional irradiation of post-mastectomy left breast cancers. Med. Dosim. 2005;30:107-116.
17. Yao M, Dornfeld K, Buatti JM, Skwarchuk M, Tan H, Nguyen TT, Wacha J, Bayouth J, Funk GF, Smith RB, Graham SM, Chang K, Hoffman HT. Intensity modulated radiation treatment for head-

and-neck squamous cell carcinoma—the University of Iowa experience. Int. J. Radiat. Oncol. Biol. Phys. 2005;in press.

C. Research Support

Ongoing Support

None

Pending Research Support

None.

Completed Research Support

Development of an Inverse Treatment Planning System for Sterotactic Radiosurgery using Accuray Neurotron 1000 Cyberknife

Source:	Shadyside Hospital, Pittsburgh PA		
Direct Funds:	$8,000	Period of Funding:	1998
PI:	John E. Bayouth	% of Effort	

Development of an Image Processing System for Frameless Sterotactic Radiosurgery Using the Accuray Neurotron 1000 Cyberknife

Source:	Shadyside Hospital, Pittsburgh PA		
Direct Funds:	$8,000	Period of Funding:	1998
PI:	John E. Bayouth	% of Effort	

Hardware and Software – Tools for comparison of dose distributions

Source:	ADAC Laboratories, Milpitas CA		
Direct Funds:	$175,000	Period of Funding	2000
PI:	John E. Bayouth	% of Effort	

Development of IMRT

Source:	Siemens Medical Systems, Concord CA		
Direct Funds:	$30,000	Period of Funding	2002
PI:	John E. Bayouth	% of Effort	

Hardware and Software - IMRT Training Course

Source:	Philips Medical Systems		
Direct Funds:	$600,000	Period of Funding	2002
PI:	John E. Bayouth	% of Effort	

Software (IMFAST)

Source:	Siemens Medical Systems, Concord CA		
Direct Funds:	$46,000	Period of Funding	2002
PI:	John E. Bayouth	% of Effort	

IMRT Training Course

Source:	Philips Medical Systems		
Direct Funds:	$27,500	Period of Funding	2002
PI:	John E. Bayouth	% of Effort	

IMRT Training Course

Source:	Philips Medical Systems		
Direct Funds:	$27,500	Period of Funding	2003
PI:	John E. Bayouth	% of Effort	

Hardware and System Platform Upgrades – IMRT Training Course

Source:	Philips Medical Systems		
Direct Funds:	$115,000	Period of Funding	2003
PI:	John E. Bayouth	% of Effort	

ASTRO Training Grant for Medical Physics Residency

Source:	American Society for Therapeutic Radiology and Oncology		
Direct Funds:	$12,000	Period of Funding	2005

PI: John Bayouth

Siemens Research Grant Exhibit A: Clinical Evaluation of COHERENCE Physicist Workspace

Source:	Siemens Medical Solutions USA, Inc.		
Direct Funds:	$19,780	Period of Funding	2005

PI: John Bayouth

Siemens Research Grant Exhibit B: 4DCT in Radiotherapy: Image Acquisition, Planning, Verification, and Treatment Delivery

Source:	Siemens Medical Solutions USA, Inc.		
Direct Funds:	$91,000	Period of Funding	2005

PI: John Bayouth

Siemens Research Grant Exhibit C: On-line Image Guidance for Precision Therapy

Source:	Siemens Medical Solutions USA, Inc.		
Direct Funds:	$82,290	Period of Funding	2005

PI: John Bayouth

Consultant on SBIR Grant: Benchmark Datasets for Photon Beam Algorithm Verification

Source:	National Cancer Institute/Sun Nuclear Corporation		
Direct Funds:	$13,500	Period of Funding	2005

PI: John Bayouth

BIOGRAPHICAL SKETCH

Joseph M. Modrick	POSITION TITLE Assistant Professor

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE (if applicable)	YEAR(s)	FIELD OF STUDY
University of Northern Iowa, Cedar Falls IA	B.S.	1989	Physics
The University of Iowa, Iowa City IA	M.S.	1996	Physics
University of Wisconsin, Madison WI	M.S.	2000	Physics
University of Wisconsin, Madison WI	Ph.D.	2000	Medical Physics

A. Positions and Honors

Positions and Employment

1989-1996	Teaching Assistant, Department of Physics & Astronomy, The University of Iowa, Iowa City IA
1994-1996	Research Assistant, Department of Radiation Oncology, The University of Iowa, Iowa City IA
1996-2000	NIH NRSA Pre-doctoral trainee, Department of Medical Physics, University of Wisconsin, Madison WI
2000-2002	Research Clinical Physicist, Department of Radiation Oncology, The University of Michigan, Ann Arbor MI
2002-2005	Assistant Professor, Department of Radiation Oncology, The University of Iowa, Iowa City IA

Honors and Awards

1987 Elected member Sigma Pi Sigma (National Physics Honor Society)

Other Experience and Professional Membership

1994-2000	American Association of Physicists in Medicine – Student Member
1996-2000	American Association of Physicists in Medicine – North Central Chapter
2001-current	American Association of Physicists in Medicine – Full Member

B. Selected Peer-Reviewed Publications

1. Modrick JM, Thomadsen BR, Mackie TR. Photon dose kernels for brachytherapy source convolution dose calculation. Med. Phys. 1998;25:A170.
2. Modrick JM, Mackie TR, Thomadsen BR. Convolution/superposition dosimetry for diagnostic beam spectra. Med. Phys. 1999;26:1174.
3. Modrick JM, Mackie TR, Thomadsen BR. EGS4 Energy Deposition Kernels at Low Photon Energy Including the Molecular Coherent Scattering Form Factor. XIII ICCR 2000: Springer-Verlag; 2000.
4. Modrick JM, Mackie TR, Thomadsen BR. Energy Deposition Kernels at Low Photon Energy Including Coherent Scatter. World Congress on Medical Physics and Biomedical Engineering, IEEE; 2000.

5. Modrick JM, Mackie TR, Thomadsen BR. Generalized convolution/superposition algorithm for brachytherapy dosimetry. Med. Phys. 2001;28:1279.
6. Zhou C, Inanc F, Modrick JM. Distortions induced by radioactive seeds into interstitial brachytherapy dose distributions. Med. Phys. 2004;31:3393-3405.
7. Liu R, Wagner TH, Buatti JM, et al. Geometrically based optimization for extracranial radiosurgery. Phys. Med. Biol. 2004;49:987-996.

C. Research Support

Ongoing Support

None

Pending Research Support

None.

Completed Research Support

None

BIOGRAPHICAL SKETCH

Provide the following information for the key personnel in the order listed on Form Page 2.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME OF SPONSOR (CO-SPONSOR)	POSITION TITLE
Manickam Muruganandham	Clinical Assistant Professor

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
University of Madras, Madras India	BS	1983-1987	Physics
College of Engineering/Cancer Institute, Anna University, Madras, India	MS	1987-1989	Medical Physics
National Institute of Mental Health and Neuro Sciences, Bangalore University, India	MPhil	1989-1994	Biophysics
University of Delhi, Delhi India	PhD	1994-1999	Physics (Biomedical NMR)

A. Positions and Honors

Positions and Employment

1989-1992	Medical Physicist (Clinical Radiation Therapy), V.N. Cancer Center, GKNM Hospital, Coimbatore, TN, India
1992-1994	Fellow in Biophysics, Dept. of Biophysics, National Institute of Mental Health and Neuro
1995-2000	Senior Research Fellow, Dept. of Biocybemetics, Institute of Nuclear Medicine and Allied Sciences, University of Delhi, India
2000-2003	Post-Doctoral Research Fellow, Dept. of Medical Physics, Memorial Sloan-Kettering Cancer Center, New York
2003-2006	Instructor, Dept. of Medical Physics, Memorial Sloan-Kettering Cancer Center, New York NY
2006-present	Clinical Assistant Professor, Radiation Oncology, University of Iowa, Iowa City

Other Experience and Professional Membership

1998; 2000-present	International Society for Magnetic Resonance in Medicine
2005	Consultant: Aventis/Regeneron Pharmaceuticals DCE-MRI Expert Consensus Meeting, New York NY, August 24, 2004

Honors

1987	V.U. Chidambaranar's Educational Trust Prize for ranking college first in B. Sc. (Physics)
1989	Radiological Safety Officer (in Medical Institutions) Certification from Bhabha Atomic Research Centre Bombay, India
1990	Certificate of Participation in the Workshop-cum-Familiarization with Nucletron Treatment Planning System, held at Hyderabad, India

1992	Certificate of Participation in Brachytherapy Udate, Tata Memorial Centre (Golden Jubilee Scientific Celebrations), Bombay, India
1992	Post Graduate Diploma in Computer Applications, Bharatiya Vidya Vhavan, Bombay, India
1993	IISc-Continuing Education Credit Certification for proficiency in Programming and Data Structures in C. Indian Institute of Science, Bangalore, India
1998	ISMRM travel award, International Society for Magnetic Resonance in Medicine, Berkley CA
2002	ISMRM travel award, International Society for Magnetic Resonance in Medicine, Berkley CA

B. Selected Peer-Reviewed Publications

1. Sreenivasan R, **Muruganandham M**, Sharma M, Joshi PG, Joshi NB. Binding of monomeric and oligomeric porphyrins to human glioblastoma (U-87MG) cells and their photosensitivity. *Cancer Letters (120); 45-51: 1997.*

2. **Muruganandham M**, Kasi Viswanathan A, Jagannathan JR, Raghunathan, Jain PC, Jain V. Diltiazem enhances Tumor Blod Flow: A MRI study in a Murine tumor. *Int. J. Rad. Oncol. Biol. Phy. 43, 2, 413-421 1999.*

3. Zakian KL, Eberhardt S, Hricak H, Shukla-Dave A, Kleinman S, **Muruganandham M**, Sircar K, Kattan MW, Reuter VE, Scardino PT, Koutcher JA. Transition Zone Prostate Cancer: Metabolic Characteristics at ^{1}H MR Spectroscopic imaging – Initial Results. *Radiology 229(1):241-7, 2003.*

4. **Muruganandham M**, Koutcher JA, Pizzorno G, Quihong He. In Vivo Tumor Lactate Relaxation Measurements by Selective Multiple-Quantum-Coheren Transfer. *Magn Reson Med. 52(4): 902-906: 2004.*

5. **Shukla-***Dave A, Hricak H, Eberhardt S, Olgac S,* **Muruganandham M**, Scardino P, Reuter V, Koutcher JA, Zakian KL. Chronic Prostatitis: MR Imaging and ^{1}H MR Spectroscopic imaging – Initial Results. *Radiology 231(3): 717-24; 2004.*

6. Zakian KL, Sircar K, Hricak H, Chen H, Shukla-Dave A, Eberhardt S, **Muruganandham M**, Ebora L, Kattan MW, Reuter VE, Scardino PT, Koutcher JA. Correlation of Proton MR Spectroscopic Imaging with Gleason Score based on Step Section Pathology after Radical Prostatectomy. *Radiology 234(3): 804-14; 2005.*

7. **Muruganandham M**, Alfieri AA, Chen Y, Schemainda I, Hasmann M, Sukenick G, Saltz LB, Koutcher JA. Metabolic Signatures Associated with a NAD Synthesis Inhibitor-induced Tumor Apoptosis Identified by ^{1}H-decoupled- ^{31}P Magnetic Resonance Spectroscopy. *Clin Cancer Res 11(9): 3503-3513: 2005.*

8. **Danso M, Jarnagin WR, Muruganandham M**, Schwartz LH, Goen M, Haviland D, Blumgart L, D'Angelica MD, Dematteo R, Kemeny N. Hepatic arterial infusion therapy in patients with unresectable primary liver cancer. Use of dynamic contrast enhanced MRI to

evaluate response. *Journal of Clinical Oncology,* 2005 ASCO Annual Meeting Proceedings. Vol23, No 16S 2005: 4129.

9. *Zakian KL, Eberhardt S, Kleinman S, Shukla-Dave A,* **Muruganandham M**, Rueter V, Scardino P, Hricak H, Koucher JA. The Utility of ^{1}H MRSI in Detecting Cancer in the Prostate Transition Zone. *Proc. Intl. Soc. Mag. Reson.* Med. 10, 2002.

10. **Muruganandham M**, XuS, Kalderon N, Koutcher J. MRI Evaluation of the Onset of chronic inflammation after contusion injury in rat spinal cord. *Proc. Intl. Soc. Mag. Reson. Med. 10, 2002.*

11. **Muruganandham M**, Chen Y, Scheminda I, Hasmann H, Saltz L, Koutcher JA. The Effects of FK866 on Tumor Metabolism and Growth: ^{1}H-decoupled ^{31}P MRS Study. *Proc. Intl. Soc. Mag. Reson. Med. 10, 2002.*

12. **Muruganandham M**, Koutcher JA, Qiuhong He. T2 Relaxation measurements of Lactate in abundant Lipid Environment by Selective Multiple Quantum Coherence Transfer, *Proc. Intl. Soc. Mag. Reson. Med 10, 2002.*

13. Shukla-Dave JA, Koutcher JA, Eberhardt S, **Muruganandham M**, Sircar K, Scardino P, Rueter V, Hricak H, Zakian KL. ^{1}H MRSI findings in prostatitis. Proc. Intl. Soc. Mag. Reson. Med. 11, 2003.

14. **Muruganandham M**, Lupu M, Dyke JP, Matei C, Higgins B, Kolinsky K, Bachynsky M, Grace JU, Koutcher JA. Preclinical Evaluation of Anti-angiogenic agent Roche I by Dynamic Contrast Enhanced MRI at 1.5T. *Proc. Intl Soc Magn Reson Med 12, 2004.*

15. **Muruganandham M**, Schwartz LH, Kemeny NE, Jarnagin WR, Haviland D, Dyke JP, Koutcher JA. DCE-MRI Assessment of Hepatic Arterial Infusion Chemotherapy in Patients with Unresectable Primary Liver Cancer. *Proc. Intl Soc Magn Reson Med 13. 2005.*

C. Research Support

Ongoing Support

None

Pending Research Support

None.

Completed Research Support

RO1-CA076423 7/7/1999 – 4/30/2010

NIH

Role of imaging in pre-treatment risk assessment of prostate cancer patients
The main goal is to investigate magnetic resonance spectroscopic imaging; whether (MRSI) allows more accurate determination of tumor aggressiveness and indications of patient outcomes.

Co-Investigator

Hoffmann-LaRoche Inc., NJ, USA 2002-2003
Effects of anti-angiogenists agents evaluated by NMR
The main goal is to assess effects of anti tumor/anti-angiogeneric agent on tumor vascular function.
Co-Investigator

DAMD17-03-1-0474 7/1/2003 – 6/30/2006
US Army Breast Cancer Research Program
Multi-Parametric Magnetic Resonance Imaging of Angiogenesis in Breast Cancers
The main goal is to develop a multiparametric MR approach by combining lactate-specific MRSI and dynamic contours enhanced MRI (DCE-MRI) to study angiogenesis processes in Breast Cancer tumor models.
PI

1R01CA10454-01A1 7/1/2004 – 6/30/2008
NIH
Dynamic Magnetic resonance imaging in bone tumors
The main goal is to assess the value of dynamic contrast enhanced MRI in predicting bone tumor response to treatment and percent necrosis, as well as disease free survival.
Co-PI

2005 - 2008
NIH
MSKCC-Imaging Response Assessment Team (IRAT)
The main goal is to advance the role of imaging in assessment of response to therapy.
Co-Investigator

Aventis/Regeneron Pharmaceuticals 2003 - 2006
"Dynamic Contrast Enhanced MRI in assessing tumor response to anti-angiogenic agent VEGF Trap in patients with incurable, relapsed or refractory solid tumors or lymphoma in an open label, sequential cohort dose-escalation safety, tolerability and pharmacokinetic study – Phase I
The main goal is to evaluate the potential of DCE-MRI as an imaging biomarker to assess the effects of anti-angiogenesic therapy.
Co-Investigator

1P01CA115675 5/8/2006 – 3/31/2011
NIH
Tumor Hypoxia Imaging – Laboratory and Clinical Studies
The main goal is to develop and evaluate different non-invasive hypoxia imaging methods in laboratory and clinical studies.
Co-PI

BIOGRAPHICAL SKETCH

Edward C. Pennington	POSITION TITLE Associate

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE (if applicable)	YEAR(s)	FIELD OF STUDY
University of Nebraska: Lincoln NE	B.S.	1974-1978	Applied Physics
University of Texas Health Science Center: Houston TX and University of Texas: Arlington TX	M.S.	1978-1980	Medical Physics

A. Positions and Honors

Positions and Employment

1976-1978	Research Assistant, Partical Track Physics, University of Nebraska, Lincoln NE
1979	Radiation Safety Program Aide, University of Texas Health Science Center, Dallas TX
1980	Radiological Physics Assistant, Department of Radiology, Parkland Memorial Hospital, Dallas TX
1980-1985	Medical Physicist, Department of Radiation Oncology, St. Paul Medical Center, Dallas TX
1985-2001	Medical Physicist, Department of Radiation Oncology, The University of Iowa, Iowa City IA
2001-current	Associate, Department of Radiation Oncology, The University of Iowa, Iowa City IA

Other Experience and Professional Membership

1997	Medical Physics Journal Reviews
1995	Medical Dosimetry Journal Reviews
1995-current	Radiation Therapy Student Advisory Committee
1999	AAPM MRV Chapter: Member, Iowa Regulatory Review Committee
1985-current	American Association of Physicists in Medicine
1985-current	Iowa Chapter of AAPM

B. Selected Peer-Reviewed Publications

1. Katz R, Pennington EC. Radiobiologic aspects of supralinear photographic emulsions. Phys. Med. Biol. 1978.

2. Katz R, Pennington EC. Response of photographic emulsions to low energy x-rays. J Photo Sci 1978.

3. Jani SK, Hitchon PW, Vangilder JC, Pennington EC, Hussey DH. Choice of radioisotope in stereotactic interstitial radiotherapy of small brain tumors. Applied Neurophysiology 1987;50:295-301.

4. Jani SK, Pennington EC, Vigliotti AP, Hussey DH. Dosimetric aspects of a rotating beam splitter used in tangential field breast treatment. Med. Phys. 1987;14:879-883.

5. Jani SK, Pennington EC. Dosimetric aspects of a rotating beam splitter used in tangential field breast treatment - reply. Med. Phys. 1988;15:421-421.

6. Jani SK, Pennington EC, Wacha JE, Anderson KA. Effect of collimator setting on the output of rectangular fields from linear accelerators. Med. Dosim. 1988.

7. Jani SK, Pennington EC, Wacha JE, Hussey DH. Megavoltage radiation-field matching on uneven surface. Int. J. Radiat. Oncol. Biol. Phys. 1988;15:1247-1250.

8. Pennington EC, Jani SK, Wen BC. Leakage radiation from electron applicators on a medical accelerator. Med. Phys. 1988;15:763-765.

9. Jani SK, Pennington EC, Knosp BM. Dose anisotropy around an Au-198 seed source. Med. Phys. 1989;16:632-636.

10. Jani SK, Pennington EC, Knosp BM, Doornbos JF. Analysis of relative dose distribution around iridium-192 endobronchial implants. Endocurieth/Hyperth Onc 1989;5.

11. Pennington EC, Staples JS, Jani SK. A simple method for reducing ovarian dose during megavoltage irradiation of the breast. Med. Dosim. 1989.

12. Wen BC, Pennington EC, Hussey DH, Jani SK. Alopecia associated with unexpected leakage from electron cone. Int. J. Radiat. Oncol. Biol. Phys. 1989;16:1637-1641.

13. Jani SK, Pennington EC. Tissue compensators with use of vinyl lead sheets for head and neck portals on 4-mv x-rays. Med. Phys. 1990;17:481-482.

14. Ross CS, Hussey DH, Pennington EC, Stanford W, Doornbos JF. Analysis of movement of intrathoracic neoplasms using ultrafast computerized-tomography. Int. J. Radiat. Oncol. Biol. Phys. 1990;18:671-677.

15. Jani SK, Pennington EC. Depth dose characteristics of 24-mv x-ray-beams at extended ssd. Med. Phys. 1991;18:292-294.

16. Hussey DH, Pennington EC, Neeranjum WS, Wen BC, Doornbos JF, Mayr NA. "Experience with CT-simulation at the University of Iowa," International Symposium Proceedings: 3D Radiation Treatment Planning and Conformal Therapy, St. Louis, MO, 1993.

17. Pennington EC. Quality assurance aspects of a CT simulator system. In: Jani SK, editor. CT Simulation for Radiotherapy: Medical Physics Publishing; 1993.

18. Wen BC, Jani SK, Pennington EC. "Clinical Applications of a CT Simulator in Unconventional Radiation Therapy Techniques," Symposium on Current Perspectives in CT Simulation for Radiotherapy Treatment Planning, 1993.

19. Mellenberg DE, Pennington EC, Duhl RA. TBI diode cobalt reaction factors for the calculation of midline dose from surface readings. Med. Phys. 1994;21:974.

20. Mayr NA, Riggs CE, Saag KG, Wen BC, Pennington EC, Hussey DH. Mixed connective tissue disease and radiation toxicity - A case report. Cancer 1997;79:612-618.

21. Mellenberg DE, Pennington EC, Wen BC, Hitchon PW, Saw CB, Hussey DH. Measured accuracy of a replaceable sterotactic radiotherapy headframe system using sequential CT scanning. Med. Phys. 1997;24:1044.

22. Saw CB, Wen BC, Anderson KA, Pennington EC, Hussey DH. Dosimetric evaluation of water-bolus for irradiation of extremities in the management of Kaposi's sarcoma. Med. Phys. 1998;25:1577.

23. Mellenberg DE, Pennington EC. Pd103 loaded cartridge air KERMA strength verification. Med. Dosim. 1999;24:73-75.

24. Kaiser HK, Mayr NA, Adli M, Skwarchuk M, Paulino AC, Meeks SL, Pennington EC, Pelland D, Buatti JM. Usefulness of conformal radiation therapy with prone positioning in postoperative pelvic radiation for gynecologic malignancies. Int. J. Radiat. Oncol. Biol. Phys. 2001;51:219-220.

25. Ryken TC, Meeks SL, Pennington EC, Hitchon P, Traynelis V, Mayr NA, Bova FJ, Friedman WA, Buatti JM. Initial clinical experience with frameless stereotactic radiosurgery: analysis of accuracy and feasibility. Int. J. Radiat. Oncol. Biol. Phys. 2001;51:1152-1158.

26. Ryken TC, Meeks SL, Traynelis V, Haller J, Bouchet LG, Bova FJ, Pennington EC, Buatti JM. Ultrasonographic guidance for spinal extracranial radiosurgery: technique and applicaiton for metastatic spinal lesions. Neurosurg. Focus 2001;11:1-6.

27. Lopez J, Wahle A, Pennington EC, Meeks SL, Buatti JM, Braddy KC, Fox JM, Brennan TMH, Rossen JD, Sonka M. Is target dosing attained with intracoronary brachytherapy? An IVUS 3D reconstruction analysis. Circulation suppl. 2002.

28. Meeks SL, Buatti JM, Bova FJ, Friedman WA, Pennington EC, Wagner TH. Stereotactic radiosurgery with the Linac Scalpel. In: Schulder M, editor. Handbook of stereotactic neurosurgery. New York: Marcel Dekker, Inc.; 2002. pp. 191-215.

29. Meeks SL, Paulino AC, Pennington EC, Simon JH, Skwarchuk MW, Buatti JM. In vivo determination of extra-target doses received from serial tomotherapy. Radiother. Oncol. 2002;63:217-222.

30. Meeks SL, Ryken TC, Pennington EC, Bova FJ, Friedman WA, Buatti JM. Testing and initial experience with an image-guided system for frameless stereotactic radiosurgery. Radiosurgery 2002;4:251-261.

31. Meeks SL, Buatti JM, Bouchet LG, Bova FJ, Ryken TC, Pennington EC, Anderson KM, Friedman WA. Ultrasound-guided extracranial radiosurgery: technique and application. Int. J. Radiat. Oncol. Biol. Phys. 2003;55:1092-1101.

32. Wahle A, Lopez JJ, Pennington EC, Meeks SL, Braddy KC, Fox JM, Brennan TMH, Buatti JM, Rossen JD, Sonka M. Effects of vessel geometry and catheter position on dose delivery in intracoronary brachytherapy. IEEE Trans. Biomed. Eng. 2003;50:1286-1295.

C. Research Support

Ongoing Support

None

Pending Research Support

None.

Completed Research Support

None

BIOGRAPHICAL SKETCH

	POSITION TITLE
Ramon Alfredo C. Siochi	Assistant Professor

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE (if applicable)	YEAR(s)	FIELD OF STUDY
Ateneo de Mainila University, Quezon City, Philippines	B.S.	1985	Physics, Summa Cum Laude
Virginia Tech, Blacksburg, Virginia	M.S.	1988	Physics
Virginia Tech, Blacksburg, Virginia	Ph.D.	1990	Physics
University of Cincinnati, Cincinnati, Ohio	M.S.	1995	Medical Physics

A. Positions and Honors

Positions and Employment

1985	Instructor, Physics Department, Ateneo de Manila University, Quezon City, Philippines
1985-1990	Graduate Assistant, Physics Department, Virginia Tech, Blacksburg, Virginia
1991	Visiting Assistant Professor, Physics Department, Virginia Tech, Blacksburg, Virginia
1991-1993	Visiting Assistant Professor, Physics Department, Muskingum College, New Concord, Ohio
1994-1995	Graduate Student Assistant, University of Cincinnati, Barrett Cancer Center, Cincinnati, Ohio
1995-2002	Medical Physicist, Siemens Medical Systems, Oncology Care Systems, Concord, California
2002-2004	Assistant Member, St. Jude Children's Research Hospital, Memphis, Tennessee
2005-present	Assistant Professor, Department of Radiation Oncology, Iowa City, IA

Other Experience and Professional Membership

1997. U.S. Patent 5,663,999. Optimization of an intensity modulated field.
1998. U.S. Patent 5,724,403. Virtual compensator.
2000. U.S. Patent 6,052,430. Dynamic sub-space intensity modulation.
2000. U.S. Patent 6,097,787. System and method for calculating scatter radiation.
2000. U.S. Patent 6,108,400. System and method for using precalcuated strips in calculating scatter radiation.
2000. U.S. Patent 6,128,366. Dosimetry error reduction for optimized static intensity modulation.
2000. U.S. Patent 6,142,925. Microgradient intensity modulating multi-leaf collimator.
2000. U.S. Patent 6,167,114. System and method for calculating scatter radiation including a collimator thickness.
2001. U.S. Patent 6,240,161. Multi-leaf collimator constrained optimization of intensity modulated treatments.
2001. U.S. Patent 6,314,159. System and method for optimizing radiation treatment with an intensity modulating multi-leaf collimator.

2001. U.S. Patent 6,330,300. High definition intensity modulating radiation therapy system and method.
2002. U.S. Patent 6,349,129. System and method for defining radiation treatment intensity maps.
2002. U.S. Patent 6,353,655. System and method for calculating fluence contributions from a source plane.
2002. U.S. Patent 6,449,335. System and method for optimizing radiation treatment with an intensity modulating multi-leaf collimator.
2002. U.S. Patent 6,473,490. Intensity map reconstruction for radiation therapy with a modulating multi-leaf collimator.
2003. U.S. Patent 6,577,707. Edge extension of intensity map for radiation therapy with a modulating mult-leaf collimator.
2003. U.S. Patent 6,661,871. System and method for optimizing radiation treatment with an intensity modulating multi-leaf collimator by minimizing junctions.
2004. U.S. Patent 6,757,355. High-definition radiation treatment with an intensity modulating multi-leaf collimator.
2004. U.S. Patent 6,813,336. High definition conformal arc radiation therapy with a multi-leaf collimator.
2005. U.S. Patent 6,907,282. Intensity map resampling for multi-leaf collimator compatibility.
2005. U.S. Patent 6,968,035. System to present focused radiation treatment area.

Honors

2000 Siemens, Inventor of the Year

B. Selected Peer-Reviewed Publications

1. Siochi RA, Elson HR, Foster AE, Lamba MA. A self-collimating convolution backprojection algorithm for optimizing dose distributions of I-125 prostate implants. *Med. Phys.* 1997;24:241-249.

2. Siochi RAC. Requirements for manufacturer supplied data for Monte Carlo simulation: a BEAM perspective. In: Duggan JL, Morgan IL, editors. Proceedings of the Fifteenth International Conference on the Application of Accelerators in Research and Industry. Denton, TX; 1998. pp. 1060-1065.

3. Siochi RA. Minimizing static intensity modulation delivery time using an intensity solid paradigm. *Int. J. Radiat. Oncol. Biol. Phys.* 1999;43:671-680.

4. Siochi RAC. A fluence correction method for intensity modulation. In: Proceedings of the 38ieme Congres - Societe Francaise des Physiciens d'Hopital; 1999. pp. 5-15.

5. Siochi RAC. Optimized decomposition of virtual micro intensity maps. In: Schlegel W, Bortfeld T, editors. Proceedings of the 13th International Conference on the Use of Computers in Radiation Therapy. Heidelberg, Germany; 2000. pp. 300-302.

6. Siochi RAC. Simultaneous minimization of segments and junctions in virtual micro IMRT. In: Proceedings of the 22nd Annual International Conference of the IEEE. Vol 1; 2000. pp. 452-455.

7. Siochi RAC. Virtual micro-intensity modulated radiation therapy. *Med. Phys.* 2000;27:2480-2493.

8. Saw CB, Siochi RC, Ayyangar KM, Zhen W, Enke CA. Leaf sequencing techniques for MLC-based IMRT. *Med. Dosim.* 2001;26:199-204.

9. Azcona JD, Siochi RA, Azinovic I. Quality assurance in IMRT: importance of the transmission through the jaws for an accurate calculation of absolute doses and relative distributions. *Med. Phys.* 2002;29:269-274.

10. Potter LD, Chang SX, Cullip TJ, Siochi AC. A quality and efficiency analysis of the IMFAST segmentation algorithm in head and neck "step & shoot" IMRT treatments. *Med. Phys.* 2002;29:275-283.

11. Siochi RA. Modifications to the IMFAST leaf sequencing optimization algorithm. *Med. Phys.* 2004;31:3267-3278.

C. Research Support

<u>Ongoing Support</u>
<u>None</u>

<u>Pending Research Support</u>

None.

<u>Completed Research Support</u>

None

BIOGRAPHICAL SKETCH

Timothy J. Waldron	POSITION TITLE Associate

EDUCATION/TRAINING (Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)

INSTITUTION AND LOCATION	DEGREE (if applicable)	YEAR(s)	FIELD OF STUDY
Richard Stockton State College; Pomona NJ	B.S.	1981-1985	Applied Physics
University of Texas Health Science Center: Houston TX	M.S.	1990-1995	Medical Physics

A. Positions and Honors

Positions and Employment

1987-1990	Field Service Representative, Varian Associates, Radiation Division, Palo Alto CA
1990-1992	Accelerator Technician III, Department of Radiation Physics, University of Texas, M. D. Anderson Cancer Center, Houston TX
1995-1996	Physicist/dosimetrist, Savannah Oncology Center, Savannah GA
1996-1998	Medical Physicist, Fox Chase Cancer Center, Philadelphia PA
1998-2002	Medical Physicist/Supervisor of Accelerator Maintenance, M. D. Anderson Cancer Center, Houston TX.
2002-2004	Senior Medical Physicist, M. D. Anderson Cancer Center, Houston TX
2004-current	Associate, Medical Physics, Department of Radiation Oncology, The University of Iowa Hospital & Clinics, Iowa City, IA

Other Experience and Professional Membership

1984-2003	Medical Physics Journal Reviewer
2002-2003	Radiotherapy Service Engineers' Association –Board of Directors

B. Selected Peer-Reviewed Publications

1. Boyer AL, Ochran TG, Nyerick CE, Waldron TJ, Huntzinger CJ. Clinical dosimetry for implementation of a multileaf collimator. Med. Phys. 1992;19:1255-1261.

2. Bortfeld T, Boyer AL, Schlegel W, Kahler DL, Waldron TJ. Realization and verification of three-dimensional conformal radiotherapy with modulated fields. Int. J. Radiat. Oncol. Biol. Phys. 1994;30:899-908.

3. Bortfeld TR, Kahler DL, Waldron TJ, Boyer AL. X-ray field compensation with multileaf collimators. Int. J. Radiat. Oncol. Biol. Phys. 1994;28:723-730.

4. Desobry GE, Waldron TJ, Das IJ. Validation of a new virtual wedge model. Med. Phys. 1998;25:71-72.

C. Research Support

Ongoing Support

None

Pending Research Support

None.

Completed Research Support

None

I. BIOGRAPHICAL SKETCH

Provide the following information for the key personnel and other significant contributors in the order listed on Form Page 2.
Follow this format for each person. **DO NOT EXCEED FOUR PAGES.**

NAME Prabhat C. Goswami, Ph.D.	POSITION TITLE Assistant Professor, Department of Radiation Oncology
eRA COMMONS USER NAME pgoswami	

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, and include postdoctoral training.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
St. Anthony's College, Shillong, India	B.Sc. (Honors)	1974	Chemistry
Gauhati University, India	M.Sc.	1976	Chemistry
Gauhati University, India	Ph.D.	1983	Chemistry

Professional Experience

1978-1983	Pre-doctoral Fellow, Regional Research Laboratory, Jorhat, India
1984-1986	Research Associate, Department of Microbiology, St. Louis University, St. Louis, MO
1986-1988	Post-Doctoral Fellow, Department of Microbiology, Univ of Miami, Miami, FL
1988-1990	Research Associate, Department of Microbiology, St. Louis University, St. Louis, MO
1990-1992	Senior Research Associate, Radiation Oncology Center, Washington University, St. Louis, MO
1992-1994	Instructor, Radiation Oncology Center, Washington University, St. Louis, MO
1994-2000	Assistant Professor, Radiation Oncology Center, Washington Univ, St. Louis, MO
2000-2001	Research Scientist, Department of Radiology, University of Iowa, Iowa City, IA
2002-present	Assistant Professor, Free Radical and Radiation Biology Program, Department of Radiation Oncology, University of Iowa, Iowa City, IA
2003-present	Faculty, Interdisciplinary Molecular Biology Program, Univ of Iowa, Iowa City,IA

Honors and Awards

National Merit Scholarship (1974-1976), Awarded the Jawherlal Nehru Memorial prize (1974), Awarded best presentation certificate by the International Conference on Frontiers in Biotechnology (1997), RSNA study section member (2002-present), University of Iowa Research Committee member (2001-present), NIH (NIDDK) RFA DK-05-001 study section adhoc reviewer (2005), Susan G. Komen Breast Cancer Foundation reviewer (2004-present), Civilian Research & Development Foundation, scientific reviewer (2005), NIH (NIDDK) ZDK1 GRB-N (M1) LRP Study Section adhoc reviewer (2006), Department of Defense (USA) Breast Cancer Research Program (Molecular Biology and Genetics), scientific reviewer (2006), United States Israel Binational Science Foundation (BSF), scientific reviewer (2006), Department of Energy (USA), scientific reviewer (2006), NASA Radiation Health Panels, scientific reviewer (2006).

Invited Lectures

Cell Kinetics Annual Meeting (1995), Sixth Annual Meeting of the Oxygen Society (1999),

Radiation Research Society (2000), 7th Annual Meeting of the Oxygen Society (2000), Radiation Research Society (2001),
Gordon Research Conference (2002), 9th Annual Meeting of the Oxygen Society (2002), Wake Forest University (2002) Holden Comprehensive Cancer Center, University of Iowa (2002), Department of Bioengineering, University of Iowa (2003), Molecular Biology Interdisciplinary Program, University of Iowa (2003), Radiation Research Society (2004), International Conference on Free Radicals & Antioxidants in Health, Diseases and Radiation, Kolkata, India (2006), The fourth PCB workshop: Recent advances in the environmental toxicology and health effects of PCBs. Zakopane, Poland (2006), Roswell Park Cancer Institute, Department of Molecular & Cellular Biophysics & Biochemistry, Buffalo (2006).

Selected Publications (45 papers total; 18 papers published in last 3 yrs.)

Goswami PC and Goldenberg CJ: Intron sequences and the length of the downstream second exon affect the binding of hnRNP C proteins in an in vitro splicing reaction. ***Nucl. Acids Res***. 1988; 16:4995-5011.

Goswami PC, Higashikubo R, Tolmach LJ and Roti Roti JL: G1 shortening following unbalanced growth:
Specific vs. nonspecific effects. ***Cell Prolif.*** 1992; 25:251-260.

Goswami PC, Hill M, Higashikubo R, Wright WD and Roti Roti JL: The suppression of the synthesis of a nuclear protein in cells blocked in G2-phase: Identification of NP170 as Topoisomerase II. ***Radiat. Res.***
1992; 132:162-167.

Goswami PC, He W, Higashikubo R and Roti Roti JL: Accelerated G1-transit following transient inhibition of DNA replication is dependent on two processes. ***Exp. Cell Res.*** 1994; 214:198-208.

Goswami PC, Roti Roti JL and Hunt CR: The cell cycle coupled expression of Topoisomerase II-alpha during S-phase is regulated by mRNA stability and is disrupted by heat shock or ionizing radiation. ***Mol. Cell. Biol.,*** 1996, 16:1500-1508.

Diamond DA, Parsian A, Hunt CR, Lofgren S, Spitz DR, Goswami PC and Gius D: Redox factor-1 (Ref-1) mediates the activation of AP1 in HeLa and NIH 373 cells in response to heat shock. ***J. Biol. Chem.,*** 1999, 274:16959-16964.

Curry HA, Clemens RA, Shah S,m Bradbury CM, Botero A, Goswami P and Gius D: Heat shock inhibits radiation-induced activation of NF-kB via inhibition of I-kB kinase. ***J. Biol. Chem.,*** 1999, 274:23061-23067.

Goswami PC, Albee LD, Parsian A, Sheren J, Higashikubo R, Hunt CR and Spitz DR: Cell cycle coupled variation in Topoisomerase II-alpha mRNA is regulated by the 3'untranslated region: Possible role of redox sensitive protein binding in message accumulation. ***J. Biol. Chem.*** 2000; 275:38384-38392.

Wei SJ, Botero A, Hirota K, Bradbury CM, Markovina S, Laszlo A, Goswami PC, Spitz DR, Yodoi J, and Gius D: Thioredoxin nuclear translocation and interaction with redox factor-1 activates the AP-1 transcription factor in response to ionizing radiation. ***Cancer Res.*** 2000; 60:6688-6695.

Zoberi I, Bradbury CM, Curry HA, Bisht KS, Goswami PC, and Gius D. Radiosensitizing and Anti-Proliferative Effects of Resveratrol in Two Human Cervical Tumor Cell Lines. ***Cancer Letters.*** 2002, 175:165-173.

Chen MS, Goswami PC, and Laszlo A. Differential Accumulation of U14 snoRNA and HSC70 mRNA in CHO Cells after exposure to various stress conditions. ***Cell Stress & Chaperone.*** 2002, 7:65-72.

Goswami PC, Higashikubo R, and Spitz DR. Redox control of cell cycle coupled topoisomerase II alpha gene expression. ***Methods in Enzymology.*** 2002, 353:448-459.

Karimpour S, Lou J, Lin LL, Rene LM, Lagunas L, Ma X, Karra S, Bradbury CM, Markovina S, Goswami PC, Spitz DR, Hirota K, Kalvakolanu DV, Yodoi J, and Gius D. Thioredoxin reductase regulates AP-1 activity as well as thioredoxin nuclear localization via active cysteines in response to ionizing radiation. ***Oncogene.*** 2002, 21:6317-6327.

Menon SG, Sarsour EH, Spitz DR, Zhang H, Sturm M, and Goswami PC. Redox regulation of the G1 to S transition in the mouse embryo fibroblast cell cycle. ***Cancer Research*** 2003, 63:2109-2117.

He T, Weintraub NL, Goswami PC, Chatterjee P, Flaherty DM, Domann FE, and Oberley LW. Redox factor-1 required for platelet derived growth factor-induced progression from G0/G1 to S in vascular smooth muscle cells. ***American Journal of Physiology; Heart and Circulatory Physiol.*** 2003, 285(2):H804-12.

Wang HP, Schafer FQ, Goswami PC, Oberley LW, and Buettner GR. Phospholipid hydroperoxide glutathione peroxidase induced a delay in G1 of the cell cycle. ***Free Radical Research.*** 2003, 37:621-630

Delsite RL, Rasmussen LJ, Rasmussen AK, Kalen A, Goswami PC, and Singh K. Mitochondrial impairment is accompanied by impaired oxidative DNA repair in the nucleus. ***Mutagenesis*** 2003, vol. 18 (6): 497-503.

Zhao W, Goswami PC, and Robbins MEC. Radiation-induced upregulation of MMP-2 involves increased mRNA stability, redox modulation and MAPK activation. ***Radiation Research*** 2004, vol.161:418-429.

Menon SG, Coleman M, Walsh S, Spitz DR and Goswami PC. Differential Susceptibility of Nonmalignant Human Breast Epithelial Cells and Breast Cancer Cells to Thiol Antioxidant-Induced G_1-Delay. ***Antioxidants & Redox Signaling,*** 2005, 7:711-718.

Venkataraman S, Jiang X, Weydert C, Zhang Y, Zhang HJ, Goswami PC, Ritchie JM, Oberley LW, Buettner GR. Manganese superoxide dismutase overexpression inhibits the growth of androgen-independent prostate cancer cells. ***Oncogene*** 2005, 24:77-89.

Goswami PC and Singh KK. Oxidative Stress and Multistage Carcinogenesis. ***Oxidative Stress, Disease and Cancer*** 2006, Imperial College Press London.

Ridnour LA, Sim JE, Choi J, Dickinson DA, Forman HJ, Ahmad IM, Coleman MC, Hunt CR, Goswami PC, and Spitz DR. Nitric oxide-induced resistance to hydrogen peroxide stress is a glutamate cysteine ligase activity-dependent process. ***Free Radic. Biol. Med***. 2005, 38:1361-1371.

Sarsour EH, Agarwal M, Pandita TK, Oberley LW and Goswami PC. Manganese superoxide dismutase protects the proliferative capacity of confluent normal human fibroblasts. ***J. Biol. Chem.*** 2005, 280:18033-18041.

Kalen AL, Sarsour,EH, Venkataraman S, and Goswami PC. Mn-superoxide dismutase over expression enhances G2-accumulation and radioresistance in human oral squamous carcinoma cells. ***Antioxidants & Redox Signaling*** 2006, 8:1273-1281.

Li Hualei, Goswami PC, and Domann FE. AP2-g induces p21 expression, arrest cell cycle, and inhibits tumor growth of human cancer cells. ***Neoplasia*** 2006, 8(7):568-577.

Slane BG, Akyin-Burns N, Smith BJ, Kalen AL, Goswami PC, Domann FE, and Spitz DR. Mutation of succinate dehydrogenase subunit C (SDHC) results in increased O2•-, oxidative stress and genomic instability. ***Cancer Research*** 2006, 66(15):7615-7620.

Menon SG, and Goswami PC. A redox cycle within the cell cycle: Ring in the old with the new. ***Oncogene*** 1-9, 2006 (published on line August 21, 2006).

Research Projects Ongoing or Completed During the Last 3 Years

<u>Ongoing</u>:

Goswami (PI)

03/01/05 – 02/28/07

University of Iowa Carver College of Medicine Pilot Grant

“Antioxidant Enzymes 3-UTRs: Molecular Hotspots for Redox-based Therapy”
This research proposal is designed to test the hypothesis that intracellular antioxidant enzymes regulate radiation-induced activation of cell cycle checkpoint pathways thereby regulating tumor cells sensitivity to radiotherapy.

P01 CA066081-09 Oberley (PI), Goswami (Core B co-Investigator) 07/01/02 – 06/30/07
NIH
“Oxidative Events in Cancer Therapy” (overall title)
The major goal of the integrated projects in this Program is the discovery of novel mechanisms involved in tumor cell responses to cancer therapy based on an understanding of the tumor cell's altered oxidative metabolism.

Robertson (PI) Goswami (Project 2 Co-Leader) 04/01/06 - 03/31/11
NIEHS Superfund Basic Research Program – NIH
Semi-volatile PCBs: Sources, Exposures, Toxicities (overall title)
“Oxidative Stress and PCB Exposure in Mammalian Cells (Project 2)”
The purpose of this proposal is to study mechanisms of oxidative stress in PCB induced growth alterations in breast and prostate epithelial cells.

R01 CA111365-01 Goswami (PI)
04/01/06 - 03/31/11
NIH

“Antioxidant Enzymes and Cell Cycle Checkpoint Pathways”
The overall objective of this proposal is to investigate the hypothesis that intracellular redox environment modulate cell cycle progression both under nonoxidative and oxidative growth conditions via cell cycle checkpoint pathways.

<u>Completed</u>:
University of Iowa Goswami (PI)
10/01/04 - 09/30/05
Environmental Health Sciences Research Center
“Polychlorinated Biphenyls, Intracellular Antioxidants and Cellular Proliferation”
Principal Investigator: Prabhat C. Goswami

P20 CA091709; Graham (PI), Goswami (Core Director) 06/01/01 - 05/31/04

NIH
“Molecular Imaging of Responses to Cancer Therapy”
The objective of this research project was to develop methods for tumor imaging.

RO1 HL051469, Spitz (PI), Goswami (Co-Investigator) 02/01/99 - 01/31/04
NIH
“Nitric Oxide-Induced Cell Injury: Molecular Mechanisms”
The objective of this research project was to investigate the molecular mechanisms of nitric oxide induced cellular toxicity.
American Cancer Society Institutional Research Grant; Goswami (PI) 12/01/02 - 11/30/03
“Redox Imbalance-Induced Tumor Cell Radiosensitivty”
The objective of this research project was to determine whether transient over expression of antioxidant enzymes sensitizes tumor cells radiosensitivity.

BIOGRAPHICAL SKETCH

NAME	POSITION TITLE
Mindi J. TenNapel	Program Director, Radiation Therapy Technologist Program

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	YEAR(s)	FIELD OF STUDY
University of Iowa Hospitals and Clinics, Iowa City, IA	RT(T)	1997	Radiation Therapy
University of Iowa, Iowa City, IA	B.S.	2001	Radiation Sciences
University of Iowa, Iowa City, IA	M.B.A.	2004	Business Administration

Positions and Honors

Positions and Employment

2001 –	Program Director, Radiation Therapy Technologist Program, University Clinics, Iowa City IA
2005 –	Adjunct Faculty, Kirkwood Community College, Cedar Rapids IA
1995-1996	Physicist/dosimetrist, Savannah Oncology Center, Savannah GA
1997 – 2001	Radiation Therapist, Iowa City Cancer Treatment Center & University of Iowa Hospitals & Clinics, Iowa City IA

Awards and Activities

2005	Management Orientation Program (MOP), University of Iowa Hospital
2005	Certificate of Completion, Human Participant Protections Education for National Cancer Institute
	Continuing Education Lecturer – Radiation Protection:
2003	Iowa Society of Radiologic Technologists Annual Meeting
2004	Mammography Conference, ISRT
2005	South Dakota Society of Radiologic Technologists Annual Meeting
2006	Department of Orthopedics

Awards and Activities

City of Coralville Fire Department; President of Association and Volunteer Firefighter
Boy Scout's of America; Pancake Breakfast Volunteer
Christian Reformed Church; SERVE project

Appendix O – Compensation and Benefits

2006-2007 Stipends for the Fiscal Year

House Staff Level	**Annual Stipend**
House Staff I	$43,300
House Staff II	$44,100
House Staff III	$45,300
House Staff IV	$46,800
House Staff V	$48,200
House Staff VI	$49,600
House Staff VII	$51,100

Benefits

See the following web page for full details:
http://www.uihealthcare.com/depts/graduatemedicaleducation/benefits/statement.html

Health Care Benefits – Medical and Dental
Counseling Services
Disability Insurance
Liability Protection
Life Insurance
G.I. Bill
Pharmacy Services

Vacation

15 working days per year

Travel and Academic support $300.00 and one annual meeting during residency

Book allowance $500/year

Appendix P - Letters of Invitation and Institutional Commitment

August 1, 2005

John E. Bayouth, Ph.D.
Associate Professor
Director of Medical Physics
Department of Radiation Oncology

Dear John:

The Department of Radiation Oncology and the University of Iowa Hospitals and Clinics will provide significant support for the Medical Physics residency program. Stipend and benefits are paid for each resident. This is provided at a level equal to the physician residents within the institution. An individual computer and desk are provided, as well as a stipend for text books. Library and conference room space is available for study and lectures. Travel to the AAPM meeting is paid for by the department as part of the residents' professional development. Secretarial support is available for the residents for issues related to travel, immigration, benefits, scheduling or any other University process issues. The salary and wages of all faculty that instruct the medical physics resident are paid by the department or hospital.

Sincerely,

Laurie Smith, M.B.A.
Administrator

Appendix Q - Documentation of Institutional Accreditation

October 14, 2005

John E. Bayouth, Ph.D.
Associate Professor,
Director of Medical Physics,
Department of Radiation Oncology

Dear John,

Thank you for meeting with me recently to clarify remaining educational and structural issues related to your proposal to establish a new medical physics residency program. Subsequently, I was able to discuss your proposal with Donna Katen-Bahensky and the University of Iowa Hospitals and Clinics endorses the educational rationale to establish the program.

In addition to the educational approval, UIHC will also support your residents' healthcare benefits. As we discussed, financial support for your residents' stipends will need to be borne by the Department of Radiation Oncology. Because your residents will be non-physicians, their employment contracts will need to be arranged through your department. After this occurs, you can direct the new residents to the Graduate Medical Education Office to learn about their healthcare benefits.

I appreciate your patience during this application process and I look forward to hearing about the future successes of your new educational program. Please do not hesitate to contact me if I may be of assistance in the future.

Sincerely,

Mark C. Wilson MD

Mark C. Wilson, M.D., M.P.H.
Professor, Internal Medicine
Director, Graduate Medical Education
Associate Director, Internal Medicine Residency Program

cc: Dr. Keith Carter, Chair, GMEC
Cindy Geyer, Administrative Director, GME
Dr. John Buatti, Head, Dept of Radiation Oncology

Appendix R – CAMPEP Invitation

UNIVERSITY of IOWA
HOSPITALS & CLINICS
University of Iowa Health Care

Department of Radiation Oncology

Department of Radiation Oncology
200 Hawkins Dr. / LL West Addition PFP
Iowa City, IA 52242-1009
319-356-2699 ***Tel***
319-356-1530 ***Fax***
www.uihealthcare.com

December 11, 2006

To: Commission on Accreditation for Medical Physics Educational Programs
Fm: Shane Cerone, Senior Assistant Director, UIHC
Laurie Smith, MBA, Administrator, Department of Radiation Oncology
Re: CAMPEP evaluation of Medical Physics Residency Program

On behalf of The University of Iowa Hospitals and Clinics and the Department of Radiation Oncology we would like to invite CAMPEP to our institution for a review of our Medical Physics residency program.

We understand that we are required to abide by the decision of the CAMPEP Board of Directors. We welcome your review and are anxious to demonstrate the quality of our program.

The Department of Radiation Oncology graduated its first medical physics resident in October of 2006. Currently there are two other individuals participating in this active training program and we are currently receiving applications for the July 2007 position. We have been very pleased with the quality of applicants we have received and view accreditation by CAMPEP as the next important step in the program's growth.

Please feel free to contact us with questions.

Sincerely,

Shane Cerone
Senior Assistant Director
University of Iowa Hospitals and Clinics

Laurie Smith, MBA
Administrator
Department of Radiation Oncology
University of Iowa Hospitals and Clinics