Rosalind Franklin University of Medicine and Science
College of Health Professions

MEDICAL PHYSICS CLINICAL SKILLS WORKBOOK

FOR THERAPY PHYSICS

Online Version, Revised October 23, 2012

Welcome to the Online Version of our Medical Physics Clinical Skills Workbook!

While this workbook was developed as a guide for medical physics master's degree students in a clinical practicum course, we feel strongly that it can be very useful to medical physics residents as well. This workbook can easily serve as a companion text for any beginning medical physicist who is new to the clinical setting and whose objective is to learn to safely, competently, and appropriately practice clinical medical physics.

Instead of telling the students how to do things, the workbook serves as a framework for what things should be understood and mastered in the clinic. The workbook poses many questions and outlines various exercises for each topic. The goal of these questions and exercises is to help the student learn how to think like a medical physicist.
Our expectation is that the student will discuss the answers to these questions with their clinical preceptors; this step is essential to a correct and in-depth understanding of the material.

The workbook includes a competency list. We employed this list as a mechanism for preceptor evaluation of the student's progress at the end of every quarter. In addition, we asked the students to each keep a "composite" competency list to summarize their total learning over multiple quarters. The course syllabus is included as an appendix.

This workbook and structured clinical practicum course together merited an award for "Excellence in Educational Innovation" at the 2010 AAPM national meeting in Philadelphia.

We are very anxious to share this tool for learning clinical skills with a wider audience.

This Medical Physics Clinical Skills Workbook was written by Mary Ellen Smajo, Ph.D., DABR, Instructor and Director of Clinical Education and edited by Alex Markovic, Ph.D., DABR, Director and Assistant Professor in the Medical Radiation Physics Department, College of Health Professions, Rosalind Franklin University of Medicine and Science, 3333 Green Bay Road, North Chicago, IL 60064, over the years 2008-2012. This work has accompanied our Medical Physics Clinical Practicum course for Master's Degree students, typically taken for 6 consecutive quarters, but it can also be very useful for residency education. It is based in part on the following guidance documents of the American Association of Physicists in Medicine (AAPM):

- AAPM Report No. 90, "Essentials and Guidelines for Hospital-Based Medical Physics Residency Training Programs, Report of the Subcommittee on Residency Training and Promotion of the Education and Training of Medical Physicists Committee of the AAPM Education Council", August 2006,

- AAPM Report No. 197, "Academic Program Recommendations for Graduate Degrees in Medical Physics, Report of the Education and Training of Medical Physicists Committee", April 2009, and

- AAPM Report No. 79, "Academic Program Recommendations for Graduate Degrees in Medical Physics, A Report of the Education and Training of Medical Physicists Committee", November 2002.

Questions or comments regarding this workbook can be addressed to:

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CLINICAL SKILLS WORKBOOK
DEPARTMENT OF MEDICAL RADIATION PHYSICS
ROSALIND FRANKLIN UNIVERSITY OF MEDICINE AND SCIENCE
COLLEGE OF HEALTH PROFESSIONS

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Use of the Clinical Skills Workbook:

The goal of a clinical practicum is to become proficient with medical physics responsibilities in a radiation oncology department. The student is expected to participate in and become involved with all medical physics activities. Because immediate preceptor guidance may not always be available due to the physicists' time demands in the clinic, the workbook is structured in such a way as to provide activities that can be done independently, and reviewed with the preceptor at a later time. For certain tasks, if that task is not performed during a specified quarter, or if certain equipment is not available in the clinic to which the student is assigned, it may be possible to instead research and write a detailed description of how the task would be accomplished if the equipment were available. It may also be possible to observe the task or equipment at another facility, or to work with example data in place of actual new measured data.

It is important that the student never be idle during clinical time. One can always see what is going on in the clinic and ask to help or observe, read reference materials suggested in the workbook, expand logbook entries (procedures), list questions for the preceptor, lead therapist, or physician, or work on a clinical presentation.

Performance of workbook tasks and the keeping of a Medical Physics Student Logbook will be a requirement for all physics students. This logbook will:

1) be a summary of the activities performed while at the clinical sites,
2) serve as a detailed "how-to" reference guide for the student in their future work,
3) include answers to the questions listed with various workbook tasks and
4) enable the clinical preceptor to determine how well the student understands the material and whether they will be able to perform satisfactorily in a clinical setting.

Many of the projects in this workbook are rather extensive and will require a significant amount of time to complete. The student must budget their time in order to complete the workbook topics over the 6 quarters allotted. The student's first source of information should be the list of references given at the start of each workbook unit. In addition, various books and reference materials are typically available at each clinical site. **Students should check with their preceptor before using any materials which belong to the clinical site; do not remove any references form the clinical site without first asking the medical physics staff.** If questions concerning the workbook material remain after consulting the references, the student should ask their preceptor where this information can be obtained.

Student Responsibilities:

- Time commitment: at least 2 full days per week actively participating in the clinic; additional time is expected in the summer quarter, participating as close to full-time as possible (typically at least 4 full days per week);
  missed time should be made up: the student should arrange for this with the preceptor;
- Completion of workbook tasks & associated reading;
- Attendance sheet (summary) & logbook entries (procedures and detailed information) for work completed;
- Clinical presentation for the therapists (1 per quarter; student attends to all details);
- Final oral practical exam (one per quarter);
- Regular meetings with the Director of Clinical Education (DCE).

Preceptor Responsibilities:

- Time commitment: meet with the student for at least 3 30-minute sessions per week;
- Space commitment: have a work-space for each student; keep a file for each student (including their immunization record, pre-rotation checklist, etc.)
- Grading: ("A", "B", or "F")
  - Clinical Tasks in Workbook: 40% : Preceptor
  - Completeness of Logbook: 20% : Preceptor
  - Clinical Presentation: 10% : Preceptor
  - Final Practical Exam: 30% : Program Director & Staff
  - Professionalism: (Pass/Fail): Preceptor, DCE, and Program Director
- Regular meetings with the DCE;
- Regular phone conversations with the DCE;
- All responsibility for the correctness of actual patient work remains with the preceptor.

Typical Learning Process:

- The preceptor shows the student how to perform the task (the student is expected to take detailed notes);
- The student performs the task under the preceptor's direct supervision;
- The student practices performing the task without direct supervision (while the preceptor still reviews the work done);
- For tasks that may not be done frequently at a particular clinical site, the student should approach the task as if they were asked by their chief physicist or physician to be ready to do that procedure in the next few weeks. The student should review the literature, find information from the vendor(s), determine what measurements would need to be made and how to make them, write up their proposed procedure and review it with their preceptor.

Clinical Conduct and Professional Guidelines

- Treat everyone with respect, regardless of position or title.
- Cultivate good working relationships with everyone in the clinic; be kind and considerate.
- Remember that your clinical work is important and has consequences. It needs to be correct. Never be afraid to ask for help.
- Pay attention to what is being taught; it is very likely that you will need to do this task independently one day.
- Take notes.
- Ask questions, but be aware of circumstances, and possibly hold your question until the immediate patient task is completed (to avoid distracting anyone). Jot questions down so you won't forget them. Similarly, try not to interrupt a therapist while they are treating a patient; talk with the therapist after the treatment is completed to avoid possible errors.
- If the clinic staff does not introduce you to the patient you are working with, introduce yourself, and explain that you are a Medical Physics student.
- Confidentiality: The HIPAA regulations protect the privacy of patient information. Do not discuss identifying patient information in public areas. Only access patient information which you need to complete your work. For example, if you are checking charts and discover that your neighbor has been under treatment, you cannot mention it to them or tell anyone in your family. Or, if you discover that a famous person has been treated at your clinic, you should not access their records to learn more about them unless it is directly related to your current clinical task.
- Be cautious when speaking in front of patients. Always inspire confidence, but never pretend to know things that you don't. Get help if needed. (i.e."You know, I'm a student, but let me find out for you.") Watch how experienced personnel interact with the patients and listen to their choice of language. Remember that patients are watching and listening even when you are not speaking directly to them, so be careful with in-the-hall conversations. Also remember that many patients are preoccupied and afraid, and may misunderstand what is said.

- Examples of ways to avoid common mistakes made when speaking to other staff in front of patients:
    - Instead of saying directly "I don't know how to do that" ask your colleague, "Could you please give me a hand?"
    - Instead of saying "I don't think that's correct" ask "Could we step out for a minute?" and address your concerns out of earshot of the patient.
    - Don't say things like, "Wow, that Linac is so unreliable! Service has been here every day this week!" where patients may overhear.
    - If you must ask about one patient in front of another, do not speak the patient's name, but say something like, "You know the breast patient we were discussing earlier?" or "For the 1:00 PM patient,….", or show the other staff member the chart: "on this patient, did you want me to ….."
    - Imagine that each patient is your family member or close friend: how would you want them treated? How would you want them to feel?

- Never have "idle time", except during your lunch break. For example, if you are unable to move forward with the workbook task you are completing until you are able to speak with your preceptor, you can:

    - See what is going on in the clinic and ask if you can observe;
    - Ask if there is something you can help with;
    - Read reference materials suggested in the workbook;
    - Expand your logbook entries (this will be a how-to reference for you for the future);
    - List things that you must do next, or list questions for the Preceptor, Lead Therapist, or Physician;
    - Work on your clinical presentation.

- While it can be good to get to know one's co-workers, do not chit-chat. It may prevent others from doing their work, or may distract someone who is listening in, and a mistake can be made. This is especially important during patient treatments, i.e. at the linac.

- If internet access is provided to you, use the internet for work-related items only.

- Do not use cell phones.

- Wear your ID badge and lab-coat at all times while in clinical areas.

- Dress Code: Dress should be professional, i.e. how one dresses should convey respect for the clinical setting and for one's patients and co-workers. Personal appearance should not be distracting.

- Ethical Practice: Review the RFUMS College of Health Professions Student Handbook (accessible online) and the AAPM Code of Ethics found on the AAPM website. Students are responsible for adhering to these ethical norms.

- Students are expected to meet all requirements as noted in the course syllabus. For example, failing to meet regularly with the DCE, failing to bring the required items to the meeting for review, or disrespectful behavior or emails can be seen as unprofessional behavior and may result in failure of the clinical practicum course.

List of Modules

Module I: **Basic Clinical Skills in Radiotherapy**
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- Unit 4: Chart Checking
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Module II: **Quality Assurance in Radiation Oncology**
- Unit 1: Linear Accelerator Quality Assurance
- Unit 2: Acceptance Testing and Commissioning
- Unit 3: Measurement Equipment QA
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- Unit 5: Portal Imaging and kV X-ray Imaging QA
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- Unit 7: PET-CT QA
- Unit 8: HDR QA
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Module III: **Treatment Planning**
- Unit 1: Prerequisites for Treatment Planning
- Unit 2: Mark and Start Cases
- Unit 3: 3D-Conformal Planning
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- Unit 7: Block Cutting
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Module IV: **Special Procedures**
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- Unit 2: LDR Brachytherapy
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Module V: **Health Physics**
Unit 1: Radiation Safety
Unit 2: Instrumentation for Health Physics Measurements
Unit 3: Shielding Calculations
Unit 4: Isotope Procedures

Agreement

Clinical Practicum HMRP 616 Student Agreement
In signing this document, I acknowledge that the Clinical Skills Workbook, most current approved version, has been presented to me by the Medical Radiation Physics Director of Clinical Education (DCE). I have reviewed the Workbook Table of Contents, List of Modules, and Clinical Competency List, as well as the Syllabus for this course, and understand that I am responsible for the contents therein.

I also understand that, while each student's wishes will be taken into consideration, the final decision of which clinical site will be assigned to which student will remain with the DCE in consultation with the program director and preceptors. I may be required to commute up to 2 hours each way in the interests of gaining valuable clinical experience and mentoring.

_____
Student Name (Print)

_____
Student Signature

_____
Date

Clinical Student Pre-Rotation Checklist:

This form is provided to ensure that students have all needed materials prior to beginning each quarter's rotation. Thus, a new form will be needed whenever the student goes to a new facility, or minimally at the start of each academic year. The student is responsible for ensuring that all requirements are met. A copy of 1.) this completed form, 2.) all inoculation records, and 3.) an updated Composite Competency Checklist should be given to the preceptor and kept on file at the clinical site; the student should also retain copies for their own records.

Name:_____

Clinical Site:_____

Preceptor:_____

Quarter:_____

Item	Date Submitted	Preceptor Initials	Comments
Inoculation Records			
Identification Form/Badge			
Hospital Orientation Sheet			
Radiation Safety In-service			
Updated Competency Checklist			
Clinical Skills Workbook (CSW)			
Attendance Sheet			
Lab coat			
Parking (if necessary)			

Clinical Student Attendance Sheet:

This form is provided to be filled out after each day spent at the clinical site. This form will serve as a summarized reference of daily tasks. All absences and make-up days must also be documented. This sheet will be reviewed and initialed weekly by the preceptor, and reviewed periodically with the DCE.

Duplicate this form as needed.

Name:

Date/Site	Preceptor Initials	Tasks performed	Comments

Clinical Competency List

The following list is provided as a learning guide, to be filled out and initialed by the preceptor as soon as each item may be evaluated. At the end of each quarter, the student should give the DCE

- an updated preceptor-signed competency list which reflects the learning that occurred during that quarter;
- a composite competency list detailing everything learned since the first quarter of the course.

Students should strive to complete each item with a score of "3" or "4" prior to graduation. In order to graduate,

- Every item must have a score of at least "1";
- no more than 20% of the items may have scores of "1" or "2";
- "Core concepts", designated by an asterisk, **must** be completed with a score of "3" or "4".

	Skill Level
1	Observation Only
2	Needs Improvement
3	Competent w/ Supervision
4	Competent

Skill / Competency

Basic Skills:		**Preceptor Initials / Date**
* Demonstrates Good Communication Skills	Needs Improvement	Satisfactory
* Demonstrates Respect / Collegiality	Needs Improvement	Satisfactory
* Understands the Clinical Environment	Needs Improvement	Satisfactory
* Demonstrates Appropriate Clinical Conduct	Needs Improvement	Satisfactory
* Understands Interactions with Other Departments	Needs Improvement	Satisfactory
* Demonstrates Inter-professionalism	Needs Improvement	Satisfactory
Familiarity with Items in the Paper Chart	1 2 3 4	
Paper Chart Checking	1 2 3 4	
Familiarity with Immobilization Devices	1 2 3 4	
Familiarity with the CT-Simulation Process	1 2 3 4	
CT-Simulation Start-Up and Shut-Down	1 2 3 4	
CT-Sim Warm-Up	1 2 3 4	
* Basic Radiation Safety Concepts	1 2 3 4	
Record and Verify Systems:		
* Familiarity with Items in the Electronic Chart	1 2 3 4	
Patient / Treatment Field Manual Entry	1 2 3 4	
Treatment Plan Import	1 2 3 4	
DRR Import / Association / Registration	1 2 3 4	
* Port Film Review	1 2 3 4	

	Preceptor Initials / Date
* Electronic Chart Checking	1 2 3 4
Electronic Billing	1 2 3 4
Quality Assurance:	
Linac QA	
* Daily Checks	1 2 3 4
* Monthly Checks	1 2 3 4
* Quarterly Checks	1 2 3 4
* Annual Checks	1 2 3 4
RPC Linac Checks with TLD's	1 2 3 4
MLC QA	1 2 3 4
Portal Imager QA	1 2 3 4
OBI QA	1 2 3 4
Cone-beam CT QA	1 2 3 4
CT-Simulator QA	
* Daily Checks	1 2 3 4
Annual Checks	1 2 3 4
HDR QA	
* Day-of-treatment Checks	1 2 3 4
* Monthly Checks	1 2 3 4
Source Exchange	1 2 3 4
Annual Checks	1 2 3 4
PET-CT QA	1 2 3 4
Measurement Equipment QA	1 2 3 4
Chamber Intercomparison	1 2 3 4
Familiarity with regulations, ADCL's	1 2 3 4
Software System QA	
* Treatment Planning System QA	1 2 3 4
Record & Verify System QA	1 2 3 4
Secondary-MU-Check Software QA	1 2 3 4
Prevention of Technology-Related Errors	1 2 3 4
Contouring for Treatment Planning:	
* Brain	1 2 3 4
* Head and Neck	1 2 3 4
* Thorax	1 2 3 4
* Breast	1 2 3 4
* Abdomen	1 2 3 4

	Preceptor Initials / Date
* Pelvis	1 2 3 4
* Spine	1 2 3 4
External Beam Treatment Planning:	
* Image Fusion	1 2 3 4
* Familiarity with Organ Tolerances	1 2 3 4
Familiarity with TCP, NTCP, Radiobiology Concepts	1 2 3 4
Mark-and-Start Cases	
APPA Shoulder	1 2 3 4
PA Spine	1 2 3 4
Whole Brain	1 2 3 4
Hip Replacement: Heterotopic Bone	1 2 3 4
Extended SSD Femur	1 2 3 4
3-D Conformal Treatment Planning	
Brain with Vertex Field	1 2 3 4
* Head and Neck (Initial, Off-Cord w/ matched electrons)	1 2 3 4
* Lung (Initial, Off-Cord, and Boost)	1 2 3 4
* Breast (Tangents, 1-Point w/ SCV, IM nodes, PAB, FIF)	1 2 3 4
Electron Breast Boost	1 2 3 4
Mantle with Para-aortics	1 2 3 4
Abdomen	1 2 3 4
* Prostate	1 2 3 4
Pelvis (with & without hip prosthesis)	1 2 3 4
* Spine	1 2 3 4
Feet-first Femur	1 2 3 4
IMRT Treatment Planning	
* Head and Neck	1 2 3 4
* Prostate	1 2 3 4
Breast	1 2 3 4
Lung with Motion-averaged Target Volume	1 2 3 4
* IMRT QA Plans	1 2 3 4
* IMRT QA Execution and Analysis	1 2 3 4
Familiarity with RTOG, QARC, ECOG, etc.	1 2 3 4
Beam Data Collection	1 2 3 4
Beam Modeling / Commissioning	1 2 3 4
CT-to-ED file measurement, input, & testing	1 2 3 4

	Preceptor Initials / Date
Secondary MU Checks:	
* Hand Calculations	1 2 3 4
* Computer Calculations (i.e. RadCalc)	1 2 3 4
Secondary MU Check Software Set-up & Testing	1 2 3 4
Blocking / Tissue Compensation:	
Fabrication of Photon Blocks	1 2 3 4
Fabrication of Electron Blocks	1 2 3 4
Electron Cut-Out Measurements	1 2 3 4
Familiarity with Compensators	1 2 3 4
Diodes / TLD's:	
Diode Hand Calcs	1 2 3 4
* Diode Computer Calcs	1 2 3 4
* Diode Calibration / Check	1 2 3 4
* Diode Action Levels	1 2 3 4
Diode measurements with electons vs photons	1 2 3 4
Familiarity with TLD / other patient dosimeters	1 2 3 4
Special Radiation Oncology Procedures:	
Intracranial Radiosurgery (Gamma Knife, Cyberknife, Novalis)	1 2 3 4
Extracranial Body Radiosurgery	1 2 3 4
TBI Electrons	1 2 3 4
TBI Photons	1 2 3 4
IGRT Methods (Fiducial-based systems, Respiratory Gating)	1 2 3 4
Tomotherapy	1 2 3 4
Proton Therapy	1 2 3 4
Brachytherapy:	
* Brachytherapy Source Decay Calculations	1 2 3 4
* Brachytherapy Radiation Safety Procedures	1 2 3 4
LDR Brachytherapy (planning and treatment):	
Interstitial Iridium Ribbons	1 2 3 4
* Cesium Tandem and Ovoids	1 2 3 4
Cesium Vaginal Cylinder	1 2 3 4
Prostate Seed Implants	1 2 3 4
Ultrasound Volume Study	1 2 3 4
* Pre-Plan for Seed Implants	1 2 3 4

		Preceptor Initials / Date
Seed Assay / Auto-radiograph	1 2 3 4	
Post-Plan for Seed Implants	1 2 3 4	
HDR Brachytherapy (planning and treatment):		
* Breast (Mammosite, Savi, Contoura)	1 2 3 4	
* Tandem and Ovoids	1 2 3 4	
* Vaginal Cylinder	1 2 3 4	
Intra-bronchial	1 2 3 4	
Prostate	1 2 3 4	
Eye Plaque	1 2 3 4	
Superficial Brachytherapy	1 2 3 4	
Familiarity with Equipment / Software:		
* Ion Chambers	1 2 3 4	
* Electrometers	1 2 3 4	
* Cables	1 2 3 4	
* QA Phantoms	1 2 3 4	
* Water Phantoms	1 2 3 4	
Diode Arrays (i.e. MapCheck)	1 2 3 4	
Ion Chamber Arrays (i.e. PTW)	1 2 3 4	
* Film Processing / H&D Curves	1 2 3 4	
* Film Scanning and Analysis Software (i.e. RIT)	1 2 3 4	
* GAF-Chromic Film	1 2 3 4	
Portal Dosimetry QA Software	1 2 3 4	
How to select new equipment or software	1 2 3 4	
How to acceptance-test new equipment	1 2 3 4	
How to acceptance-test new software	1 2 3 4	
How to commission new equipment	1 2 3 4	
How to commission new software	1 2 3 4	
Health Physics:		
Radiation Safety		
* Exposure Limits	1 2 3 4	
Oncogenesis / Risk	1 2 3 4	
Fetal Dose Estimations	1 2 3 4	
Instrumentation	1 2 3 4	
* Shielding Calculations	1 2 3 4	
Spill Clean-Up	1 2 3 4	
Patient Surveys / Background Checks	1 2 3 4	

		Preceptor Initials / Date
Room Surveys	1 2 3 4	
Waste Surveys (storage / disposal)	1 2 3 4	
Isotope Procedures		
I-131	1 2 3 4	
Gliasite	1 2 3 4	
Metastron / Quadramet	1 2 3 4	

MODULE I: BASIC CLINICAL SKILLS IN RADIOTHERAPY

To be completed by the end of the first quarter of clinical work.

Unit 1: The Clinical Environment

References:

1. Bruce Thomadsen, et. al., American Association of Physicists in Medicine Statement on the Role of a Physicist in Radiation Oncology, the Report of Task Group 1 of the Professional Information and Clinical Relations Committee, (American Institute of Physics, New York, NY, 1993). http://www.aapm.org/pubs/reports/rpt_38.pdf

2. Richard L. Morin, et. al., ACR Guide to Medical Physics Professional Practice (2004-2009): http://www.acr.org/SecondaryMainMenuCategories/BusinessPracticeIssues/FeaturedCategories/GroupPractice/guide_medphys.aspx

3. ACR Practice Guideline for Radiation Oncology: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/radiation_oncology.aspx

4. Robert G. Parker, et. al., Radiation Oncology in Integrated Cancer Management, Report of the Inter-Society Council for Radiation Oncology, (Un-numbered AAPM Reports, 1991). http://www.aapm.org/pubs/reports/BLUEBOOK.pdf

5. J.R. Williams and D.I. Thwaites, editors, Radiotherapy Physics in Practice, (Oxford University Press Inc., New York, NY, 1993).

6. Ann E. Wright and Arthur L. Boyer, editors, AAPM Monograph Number 9, Advances in Radiation Therapy Treatment Planning, (American Institute of Physics, New York, NY, 1983).

Objectives:

1) Describe the general flow of work in a radiation oncology department, the staff involved, and the equipment used.
2) Describe the role that physicists and other staff members play in each step of the treatment process.
3) Demonstrate facility with the nomenclature / vocabulary of Radiation Oncology Physics.

Task 1: The Clinical Process

Here is an Overview of the Radiotherapy External Beam Treatment Process in a particular clinic:

1. *Patient Registration*
2. *Physician Consultation*
3. *RN teaching and ongoing support*
4. *Patient Simulation*
5. *External Beam Treatment Planning*
6. *Plan Approval*
7. *Transfer of the Approved Plan from the Treatment Planning System to the Record & Verify System / Treatment Delivery System*
8. *Physics Billing*
9. *If IMRT, Patient-specific Quality Assurance*
10. *Set-up / Port Films ("Block Verification Sim")*
11. *Beginning of Treatment*
12. *Chart Checks / Port-Film Review / On-going Quality Assurance*
13. *Weekly patient checks (MD, RN)*
14. *End of Treatment*
15. *Scheduling of Follow-Up Appointments*
16. *Following of the patient by Tumor Registry*

Staff that may be involved:

- *Radiation Oncologist*
- *Radiation Therapists*
- *Dosimetrists*
- *Medical Physicists*
- *Nurses*
- *Clerical Staff*

A. Observe and, if possible, participate in each step listed in the Overview outlined above for External Beam Radiotherapy in your assigned clinic. Some clinical sites may put these steps in a different order or include additional steps; adjust the steps as needed and arrange them in the order in which they occur at your clinical site.

B. For each step in the Overview, complete the form on page 26 (duplicate as needed). If some steps are omitted at your clinical site, describe in writing what would have occurred at that step and the rationale for its omission.

(Later on in the Workbook, as you come to new topics, you will be asked to outline the steps involved in other Radiation Oncology procedures, i.e. LDR / HDR Brachytherapy, Stereotactic Radiosurgery, and other Radiation Oncology procedures performed at your clinical site. You will be asked to evaluate how the process is modified compared with the process for External Beam Radiotherapy, to note what is different about the roles & responsibilities, whether there are additional personnel involved, i.e. personnel outside of the Radiation Oncology Department, and to create an Outline similar to the one for External Beam Radiotherapy and answer the questions in "a" through "n" below for each step of the process.)

EXTERNAL BEAM RADIOTHERAPY

Step in the clinical process:
a) What is done during this step in the process?
b) What is the most important thing that must be accomplished in this step?
c) List which staff members are involved.
d) Describe the roles and responsibilities of each person.
e) Who is the primary staff member responsible for this step?
f) What is the patient's involvement in this step of the process?
g) What information is needed before this step can begin?
h) What equipment and / or software is used for this step?
i) How is that equipment / software used to support the process?
j) What documentation is generated at this step?
k) How / where is this information stored / accessed?
l) How is the information which will be needed for the next step communicated?
m) What are important things to consider during this stage of the radiotherapy process?
n) What would the consequences be if this step were omitted or if there were a mistake made during this part of the process?

Task 2: Nomenclature

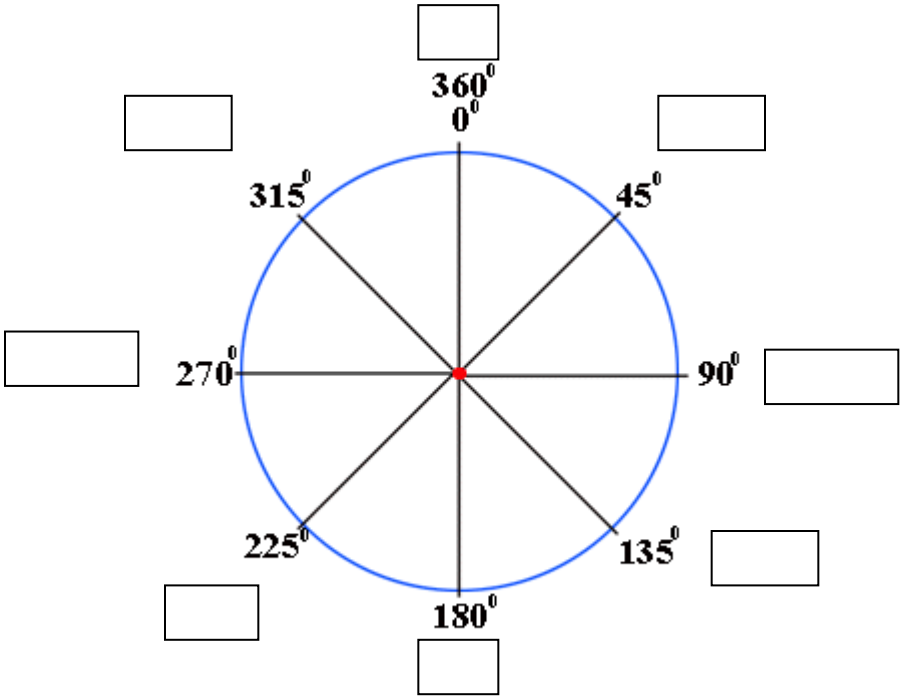
The following are terms and acronyms commonly used in the clinical setting. You are expected to be familiar with these terms as they refer to the clinic. Written definitions should be reviewed with your preceptor by the end of the quarter.

Linac	Mark and Start	3D Conformal	Oblique
Acceptance	Couch	GTV	Vertex
Commissioning	Couch Lateral	CTV	LAO
Clinical Mode	CouchLongitudinal	PTV	LPO
Service Mode	Couch Vertical	Diode	RAO
High Voltage	Head-First	Dosimeter	RPO
Isocenter	Feet-First	Film Badge	RPSO
Isodose	Supine	TLD	LPSO
Gantry	Prone	QA	RASO
Gantry Stand	SSD	Compensator	LASO
Gantry Head	SAD	Electron Cut-out	RPIO
Hand Pendant	Interest Point	Electrometer	LPIO
PV Image Arm	Weight Point	Ion chamber	RAIO
EPID	Brachytherapy	R & V System	LAIO
Collimator	LDR	Fluoroscopy	MU
Field Size	HDR	C-Arm	TPR
MLC	FOV	Mammography	TMR
Jaws	OBI	Seeds	TAR
Electron Cone	CT	Shielding	Sc
Block Tray	US	ALARA	Sp
Solid Block Tray	Cone-beam CT	Electrons	PDD
Slotted Block Tray	PET	Photons	IDL (isodose line)
Custom Blocks	PET-CT	Protons	TF (tray factor)
Electron Cut-Out	MRI	Neutrons	WF (wedge factor)
Anterior	SPECT	Alpha	OAR
Posterior	IMRT	Beta	Inverse square
Transverse/Axial	IGRT	x-rays	Rem
Sagittal	Intra-Op RT	gamma-rays	Rad
Coronal	Radio-surgery	DRR	cGy
Simulation	Intra-Cranial	DICOM	Gy
Immobilization	Extra-Cranial	AP	NTCP
Image Fusion	TBI	PA	TCP
Sim and Treat	TSET	Lateral	GM detector

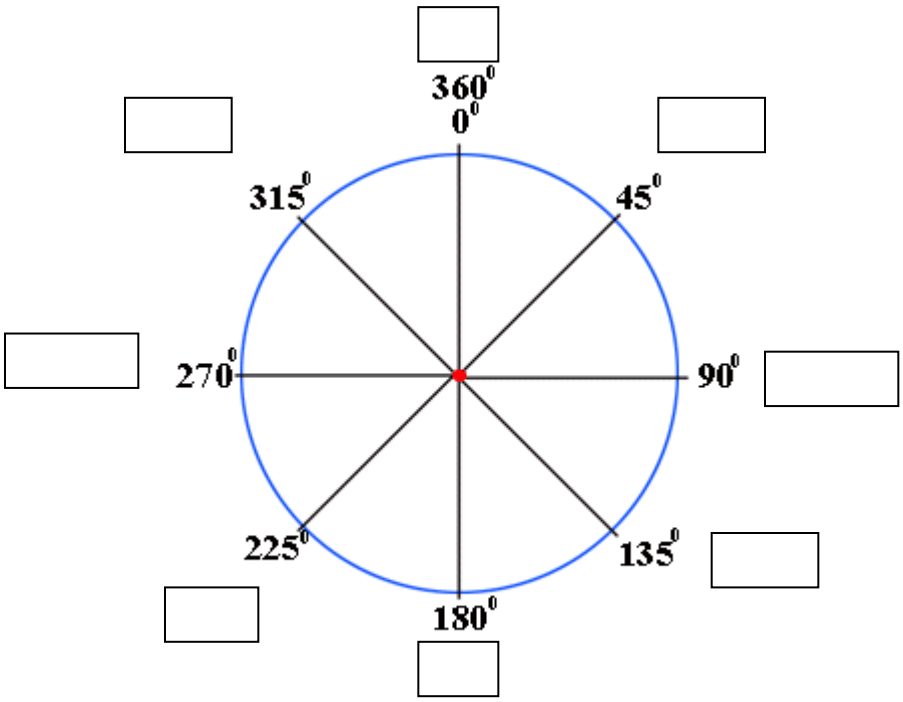
Task 3: Gantry Vocabulary

Please anatomically describe the following beam orientations, i.e. AP, vertex, Rt Lat, LAO, etc. Verify with your clinical site's linear accelerator.

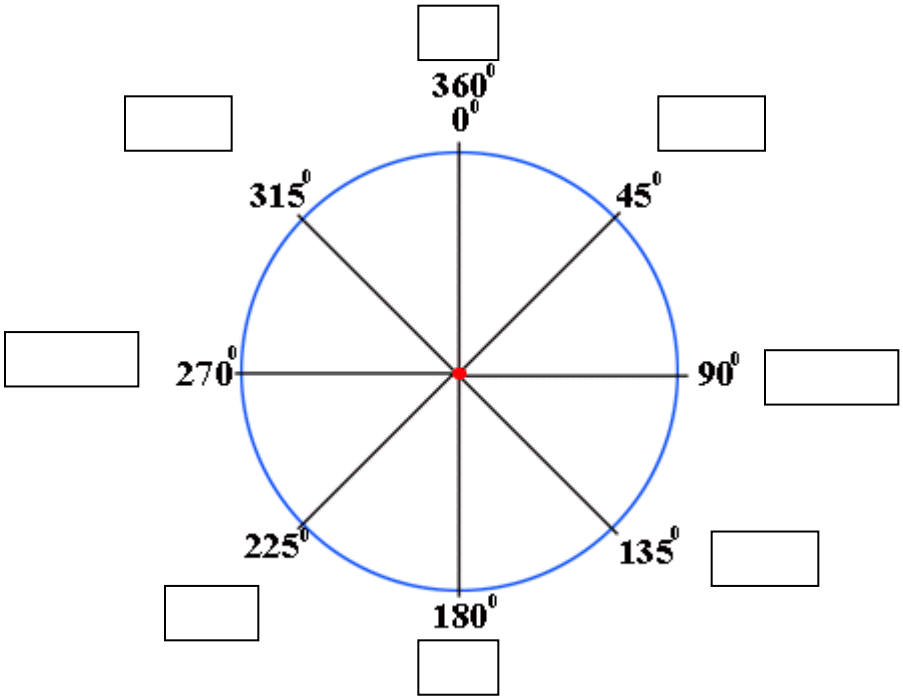
Patient is:
Supine
Head First
No Couch Kick



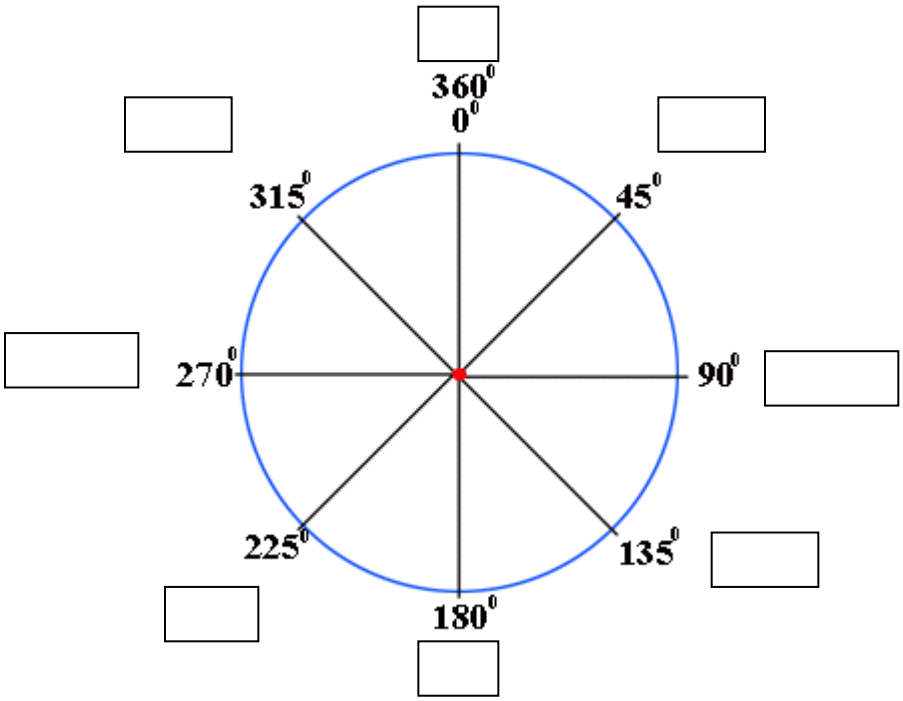
Patient is:
Prone
Head First
No Couch Kick



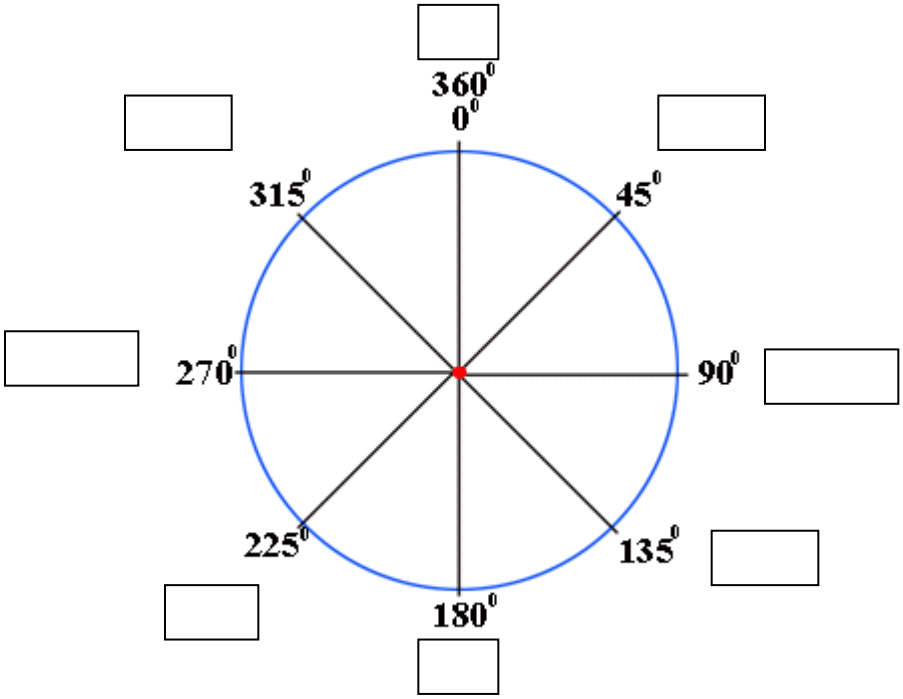
Patient is:
Supine
Feet First
No Couch Kick



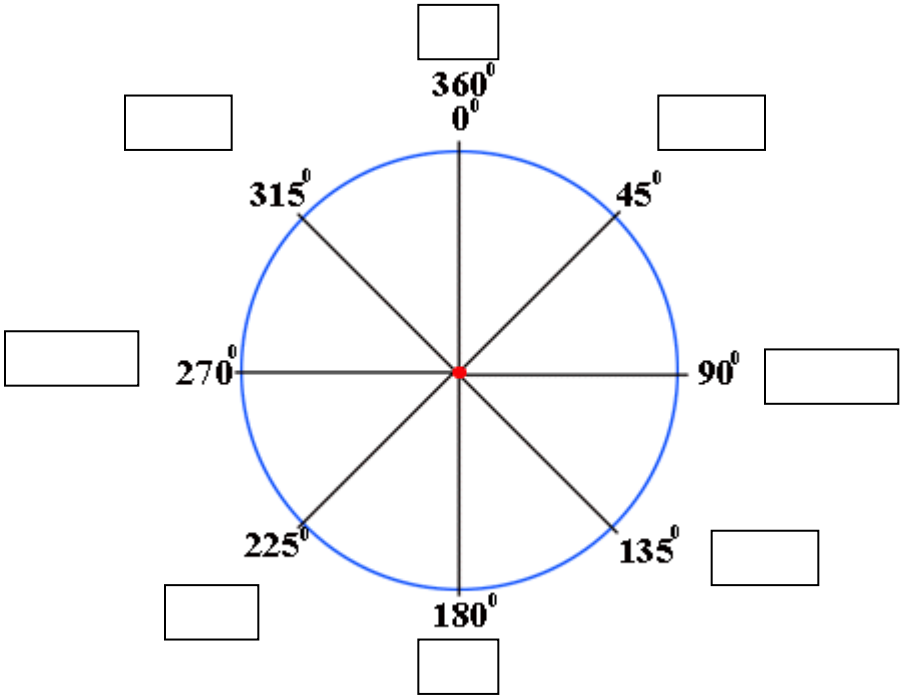
Patient is:
Supine
Head First
Couch Kick 270 Deg



Patient is:
Prone
Head First
Couch Kick 90 Deg



Patient is:
Supine
Head First
Couch Kick 45 Deg



Unit 2: Simulation

References:

1. J.R. Williams and D.I. Thwaites, editors, Radiotherapy Physics in Practice, (Oxford University Press Inc., New York, NY, 1993).

2. G. C. Bentel, Radiation Therapy Planning, (McGraw-Hill Health Professions Division, New York, NY, 1996).

3. S. Mutic, et. al., 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), 2762-2792 (2003). http://www.org/Pubs/Reports/Rpt_83.Pdf

Objectives:

1) Demonstrate warming up and shutting down the CT-Simulator in use at your clinical site, including performance of any daily QA measurements.
2) Analyze and explain the simulation process, including immobilization, for several types of external beam treatments.
3) Demonstrate the process of successfully transferring images from the CT-Simulator to the Treatment Planning System.
4) Perform a CT simulation on a phantom patient.
5) Summarize the inter-relationships between CT parameters, image quality, and patient dose.
6) Recognize common CT artifacts that can occur, explain how they might affect treatment planning, and describe what can be done to minimize them.

Task 1: CT-Simulator Warm-Up and Shut-Down

A. Observe the CT-Sim therapist powering on and warming up the CT-Simulator; document the steps of this process, including any daily quality assurance. Review these steps with your preceptor or with the CT-Sim therapist.

B. Observe the CT-Sim therapist shutting down the CT-Simulator; document the steps of this process. Review these steps with your preceptor or with the CT-Sim therapist.

C. With the CT-Sim therapist or your preceptor present, shut down the CT-Simulator, then power it on again and go through the warm-up procedure, including daily quality assurance.

Task 2: Observation of Patient Simulations

A. Observe 10 actual patient simulations; be sure to observe as diverse a range of immobilizations and anatomic sites as possible in your clinic (i.e. head & neck, breast, lung, pelvis, cranio-spinal, brain, pediatric case, etc). Pay special attention to measures that are taken to insure reproducibility in patient set-up, as well as things done to enhance patient comfort and cooperation. Fill out the Simulation Worksheet (see next page) for each case observed. Some of the needed information may be obtained through discussion with the patient's Radiation Oncologist. The sheet must be reviewed and signed by the radiation therapist doing the sim ("CT-Sim RT" on form).

B. Discuss your observations of simulations with your preceptor: what are the most important things to ensure a "good sim"?

Task 3: Transfer of Images from the CT-Simulator

A. Observe the CT-Sim therapist sending images from the CT-Sim to the Treatment Planning System. Document the steps of this process; review them with your preceptor or with the CT-Sim therapist.

B. With the CT-Sim therapist or your preceptor present, transfer images to the Treatment Planning System. Verify that the images successfully arrived.

Task 4: CT-Simulation of a Phantom Patient

Under the guidance of your preceptor or the CT-Sim therapist, perform a CT-Simulation on a phantom patient. Describe in writing how you performed your test-simulation.

Simulation Worksheet (duplicate as needed):

Date		Patient Initials/Age	
Disease		Site to be Scanned	
Planned Treatment Technique: Initial Treatment		Planned Treatment Technique: Boost Treatment (Re-Sim for Boost?)	
Patient's Anatomical Orientation		Locations of Patient's Skin Markers	
Immobilization Devices or Accessories employed		Comfort / Cooperation Measures employed	
Slice Thickness		Scan Length	
kV/mA		Prescription Dose	
Other Important Factors:	Any previous radiation dose (and when was this dose received): Alternative or concomitant therapies (if available): Patient's presenting symptoms: Potential side effects of this treatment: What may change between simulation and treatment? What information must be communicated to Dosimetry prior to planning? How will the patient's position be replicated at treatment?		
Comments:			
CT-Sim RTT:			

Task 5: CT-Simulator Questions

Please write descriptive answers to the following questions, and review them with your preceptor:

A. Document the steps of the CT simulation process from start to finish. Identify all equipment and accessories used, and the purpose of each item. Include devices used to position the patient or to ensure reproducible patient positioning, and describe how each is employed.

B. Explain the roles of the CT-Sim therapist and medical physicist with regard to the simulation process. How might the actions/duties of the physicist affect the therapist, and vice versa?

C. Where and how do the therapists tattoo or mark patients? How are BB's and other radio-opaque markers used in the Sim? What purpose can these marks serve during Treatment Planning? What happens if a new isocenter is determined during the Treatment Planning process (after the Sim is completed and the patient has gone home)?

D. What are the advantages and disadvantages of contouring and setting up fields in the Sim, rather than in Dosimetry?

E. What is a clinical set up (i.e. a "mark and start") and when would it occur?

F. What is the purpose of the daily QA done for CT Simulators? What is measured during these tests? What is the tolerance level for each test? What would be the effect of having the lasers out of alignment?

G. Which lasers are considered to be more stable in the CT (room lasers vs. CT-Sim internal lasers), i.e. which should one rely on if there is a discrepancy? How would one verify the accuracy of the lasers? How would one adjust the lasers if they are out of alignment?

H. Explain how the following variables affect CT image quality and patient dose:
    a. kV
    b. mA
    c. slice thickness
    d. slice spacing
    e. scan time
    f. scan length
    g. field of view

I. Compare and contrast axial vs. helical scans. Explain when each should be used (i.e. for which anatomical sites or treatment techniques) and discuss the advantages and disadvantages of each technique. What is done at your clinical site?

J. What is considered a "good image"? Name sources of artifacts and poor image quality and discuss how to minimize these problems. How could CT-image artifacts adversely affect a patient's treatment plan?

Unit 3: Clinical Conduct

References:

1. "Clinical Conduct and Professional Guidelines" as outlined in this Workbook, pp 9-11;

2. American Association of Physicists in Medicine, Code of Ethics http://www.aapm.org/org/policies/details.asp?id=260&type=PP&current=true) and http://www.aapm.org/pubs/reports/RPT_109.pdf

3. Rosalind Franklin University of Medicine and Science, Student Handbook, sections on Ethical Standards http://www.rosalindfranklin.edu/DNN/Portals/25/documents/Biomed/CHPStudentHandbook.pdf

4. P.A. Griffiths, et. al., On Being a Scientist: Responsible Conduct in Research, 2nd ed. (National Academy Press, Washington, DC, 1995).

5. ACR Practice Guideline for Communication: Radiation Oncology: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/comm_radiation_oncology.aspx

6. ACR Practice Guideline on Informed Consent: Radiation Oncology: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/informed_consent.aspx

7. Health Insurance Portability and Accountability Act (HIPAA) Regulations http://www.hipaa.org/

8. Rachel E. Spector, Cultural Diversity in Health and Illness, 7th ed. (Pearson Prentice Hall, Upper Saddle River, New Jersey, 2009).

9. ABR/ACR/RSNA/AAPM/ASTRO/ARS Online Modules on Ethics and Professionalism: http://ep.rsna.org/default.asp

Objectives:

1. Professionalism: recognize and outline the ethical and behavioral standards to which Medical Physicists are held, and explain the importance of and reasons for these standards.
2. Multi-cultural awareness: recognize and describe how cultural background can affect patient care, effective communication, interactions between staff members, etc.
3. Inter-professionalism:
    a. Demonstrate respectful ways to communicate with patients, staff, and colleagues.
    b. Discuss the interactions of Medical Physicists with staff in other hospital departments.

Task 1: Professionalism

A. After reviewing the references listed above, imagine (or observe in your clinic) and then describe in writing 3 clinical situations in which an ethical determination must be made by a Medical Physicist. Write a summary of each case, outlining possible courses of action and the rationale for each. Explain ethical and unethical choices in each scenario; using the references listed above, cite reasons to support making the most ethical choice. Describe what consequences might be expected for the persons involved if a poor ethical choice were made. Note possible costs / hardships to the Physicist for choosing the most ethical course of action. Discuss these scenarios with your preceptor; does the preceptor have any real-life examples to share?

B. HIPAA regulations are very important in healthcare today; describe in writing how these regulations will impact your work as a Medical Physicist, and discuss the ramifications of failing to follow HIPAA practices for the patient, their family members, and other affected individuals. What does your preceptor think?

Task 2: Multi-cultural Awareness

A. Imagine (or observe in your clinic) and then describe in writing a situation in which a lack of multi-cultural awareness resulted in a lack of good communication. What could have been done to improve communication in this instance?

B. Consider a patient with cultural restrictions to care, i.e. special needs for privacy, cleanliness, same-gender interactions, etc; how would you address these needs if you were the Medical Physicist interacting with this patient? Describe in writing a possible problem and solution. (An example might be an in-house LDR OB-GYN patient with radiation safety precautions.)

C. Ask your preceptor about multi-cultural situations they may have encountered, and how they handled them, as well as to review your answers to A & B above.

Task 3: Inter-professionalism

(Some of the material in this section is based upon the University of Toronto Centre for Interprofessional Education's IPE flexible activities, April 2010).

A. The interactions of all the members of the Radiation Oncology team may be considered a form of Inter-professional practice. In Unit 1, Task 1 on "The Clinical Process", you had the opportunity to shadow various team members and reflect in detail on the workings of the clinical environment. Consider again your observations and experiences, this time in light of teamwork. Did your observations of team interactions match your expectations? From your observations, give examples of effective communication, attentive listening, and appropriate responses to feedback from other team members. Give examples of poor communication, poor listening, and poor responses to feedback from others. What factors enhance working as a team? What factors hinder it? How do power and hierarchy influence team interactions? How are effective working relationships established and maintained? How can team members support one another in their roles? What effect can reflection have on inter-professional practice? Write your thoughts and discuss them with your preceptor.

B. Observe how the Radiation Therapists interact with the patients, what they say, how they say it. Discuss with them what they feel are the best ways to interact with patients. What should be done? What should not be done? How do they decide the best way to discuss issues with patients and patient's family members? Write what you have learned, and discuss this with your preceptor.

C. Observe how the physics and dosimetry staff interacts with the Radiation Oncology physicians. Describe in writing ways to foster collegiality. Describe in writing effective and respectful ways to handle conflict situations, where there may be disagreement regarding what is best for a particular patient. Discuss your answers with your preceptor.

D. How do Medical Physicists interact with other departments in the medical center, i.e. Biomedical Engineering, Information Systems, Capital Equipment Purchasing, Design and Construction, Administration, Housekeeping, Nurses working on the patient floors? Consider these interactions in light of your reflections on inter-professional practice in A above. How can a team approach benefit everyone in each of these cases? How would you go about fostering a team approach? Write your answers, and review them with your preceptor.

E. If your site participates in hospital-wide Quality Improvement meetings and / or Radiation Safety meetings, ask if you can attend and observe. Who from your department routinely attends, and what is their role? If you were asked to serve on such a committee, what contributions would you make? How could you benefit from the contributions of others? How can the hospital benefit from the workings of such an Interprofessional team?

Unit 4: Chart Checking

Reference:

1. G. J. Kutcher, et. al., Comprehensive QA for Radiation Oncology : Report Of The AAPM Radiation Therapy Committee Task Group No. 40, Med. Phys. **21** (4), 581-618 (1994). http://www.aapm.org/pubs/reports/rpt_46.PDF

Objectives:

1) Identify the main sections in a patient chart.
2) Demonstrate the process of weekly chart review.
3) Practice identifying possible errors.

One of the core responsibilities of a physicist is checking patient charts. The purpose of chart-checking is to ensure that a patient is receiving consistent and proper treatment. Physicists verify that the information in a patient's chart is correct and that it corresponds to the information in the treatment planning system, record and verify system, and/or treatment delivery system, as well as that the physician's prescription is being carried out correctly. During this Unit, the focus will be on checking the paper record, but the same principles apply to checking the electronic record in a paperless (or duplicated paper and electronic) environment. If your clinical site is completely paperless, or duplicated paper/electronic, work through Unit 5 on the Record and Verify System in conjunction with Unit 4.

Task 1: Review of TG-40

Review the chart-check sections of TG-40; what items does the AAPM recommend be checked? Who should perform these checks, and how often should they be performed? Summarize these recommendations in your logbook.

Task 2: Familiarity with Your Site's Treatment Charts

Choose a typical chart from your clinical site, and identify each of the items in the following list:

Patient charts often contain the following items:

i. Registration information
ii. Consent to treatment/billing
iii. MD Consultation Report / Treatment Summary:
    1. Primary Diagnosis
    2. Staging
    3. Present Illness
    4. Past Medical History (includes previous RT)
    5. Surgical History
    6. Allergies
    7. Medications
    8. Family History
    9. Social History
    10. Review of Systems
    11. Records of Physical Exams
    12. Physician Recommendations
iv. Pathology Report - report of pathologic diagnosis
v. Laboratory Work
vi. Nursing Notes (initial teaching and weekly visits)
vii. MD Simulation Note
viii. MD Treatment Planning Note
ix. MD Weekly Visit Notes
x. MD Completion Note
xi. Follow-up Notes
xii. PHYSICS INFORMATION:
    1. Physician's Prescription
    2. Simulator / set-up sheet
    3. Treatment Plan from the TPS
        a. Isodose lines superimposed on CT image (in at least 1 plane)
        b. Beam Data Sheet from the TPS (lists isocenters & beam parameters)
        c. MU's
        d. DVH graph
        e. DVH data page
        f. 3D view with isodose surface
        g. BEV's for each field
        h. Fluence pattern printouts for IMRT
    4. Independent MU Calcs (hand-calcs or secondary-check-software calcs)
    5. Expected / actual diode reading (or TLD other QA-dosimeter reading)
    6. IMRT QA
    7. Billing checklist
    8. Treatment Card (paper treatment card or electronic record) (see below)

Items typically found in the **TREATMENT CARD** include:

1) Physician's Prescription
    a. Total Dose
    b. Daily Dose
    c. Number of Fractions
    d. Beam Energy
    e. Treatment Technique
    f. MD signature
2) Set-up instructions, diagrams
3) For each field:
    a. Beam name/number and anatomic designation/orientation
    b. Beam energy
    c. Field size / jaw settings
    d. Gantry / couch / collimator settings
    e. Custom blocks / MLC
    f. Wedges (with orientation)
    g. Bolus (with thickness)
    h. SSD / depth
    i. Intended cGy / MU
4) Date of last treatment
5) Fraction number
6) Therapist's initials
7) Delivered cGy & MU per field
8) Total dose delivered to date
9) Any prescription modifications

Task 3: Chart-check Questions

For each of the following, write your answers and then discuss with your preceptor:

A. At your clinical site, who performs chart checks, and how often?

B. How are new starts handled at your clinical site? Patients who are finishing?

C. What is the billing process for chart checks at your clinical site?

D. For each of the items in the list of Physics Information and Treatment Card Information above, explain what harm would be done if there were a mistake made in that item; consider how that mistake might go undetected; how could you guard against failing to catch that mistake?

E. If you have checked a chart the week before, and you are re-checking the chart today, would you check everything with the same thoroughness as when you first reviewed the chart? If not, what aspects of the chart you focus on during re-checking? What would you omit? Discuss with your preceptor.

Task 4: Your Preceptor's Chart-Check Methodology

Different physicists have different methods for chart checking, and different ways of attempting to insure that mistakes are caught. Sit with your preceptor during chart checking, and ask them to explain their thought process as they check a chart; perhaps they will have additional items to add to the list of items to check on the Treatment Card, or helpful hints for chart checking. Try to understand their chart-check methodology and the rationale behind it. Document this methodology.

Task 5: Checking Charts for Practice

Use the example form on the next page to check 10 charts (duplicate form as needed). In addition to using this form, create whatever other form / list may be helpful to you in following your preceptor's chart-check methodology, and use them both. For liability reasons, your check must not be the only check of that chart; thus the charts you check must also be checked by the responsible physicist, either before or after your practice-check. Remember that as a student you may not initial the chart. If you discover any discrepancies or errors, bring them to the attention of your preceptor. Verify the completeness and accuracy of the physics information and treatment-card items in the chart. Look at the physician's prescription, treatment plan, paper chart, record and verify system and/or treatment delivery system to make sure everything is consistent and correct. Remember to review isocenters and compare portal images with DRRs. Step back and think: "Does everything make sense?" Completed chart-check forms should be reviewed with your preceptor by the end of the first quarter.

Task 6: Chart Rounds

(Some of the material in this section is based upon the University of Toronto Centre for Interprofessional Education's IPE flexible activities, April 2010).

If your clinical site has a weekly chart review conference and/or planning conference, attend as frequently as you are able. Observe what is presented and discussed, and how the participants interact. Consider your observations in light of your reflection on inter-professional practice in Unit 3, Task 3 above.

What are the objectives of chart rounds? Who attends, and what are their roles and responsibilities? How does the team function, i.e. do various individuals serve as leader, facilitator, mediator, clarifier, recorder, etc.? How do team members behave, communicate, solve problems, make decisions, provide and respond to feedback, address conflict, etc.? How would you describe the relationship between how the team functions and effective patient care? How would you describe the relationship between how the team functions and team member satisfaction? What factors effect team collaboration? How might your observations and reflections effect how you participate in teams?

Document your attendance, along with any important insights, in your logbook.

Example Chart-Checking Worksheet

Patient's Name:		**Field Parameters**							
		Field #	Field Name	cGy/MU	gant/coll/ couch	X1/LW X2/RW	Y1/LL Y2/UL	accessory	SSD/Wt fan SSD
Anatomic site of disease									
Type of disease/ diagnosis									
Prescription (total dose/ # of fractions)									
Dose per fraction									
Beam energy/ dose rate/ depth of dmax									
Treatment technique/ patient position									
Is isocenter correct?									
# fractions completed/ date of last fraction									
Do BEV& MLC in R&V = TPS BEV?									
If IMRT, Step thru leaf motion in R&V BEV:ok?									
Look at Portal Images: ok w/ DRRs?									
Items missing from chart?									
Notes / any errors or problems									

*all items above need to be included for both main course and boost if applicable (fill out a new worksheet for boost)

**make sure both hand-calcs and TPS data are checked against a secondary-check program (i.e. RadCalc)

***sanity check- Does everything make logical sense? (i.e. don't just check numbers against numbers)

Unit 5: Record and Verify Systems

References:

1. Software Documentation for the Record and Verify system in use at your clinical site (ask your preceptor where this can be found);

2. Vendor websites / online documentation for this system;

3. ‘‘Health Information Technology for Economic and Clinical Health Act’’ or the ‘‘HITECH Act’’: http://waysandmeans.house.gov/media/pdf/111/hitech.pdf

4. “CMS EHR Meaningful Use Overview”: https://www.cms.gov/EHRIncentivePrograms/30_Meaningful_Use.asp#TopOfPage

5. “Electronic Health Records and Meaningful Use”: http://healthit.hhs.gov/portal/server.pt?open=512&objID=2996&mode=2

Objectives:

1) Outline the purpose of and describe the working of a Record and Verify System for patient treatments in Radiation Oncology.
2) Explain how the Record and Verify System acts as an Electronic Medical Record (EMR).
3) Practice doing necessary clinical tasks within the Record and Verify System.
4) Practice using the Record and Verify system to check charts.

Task 1: The Purpose of a Record and Verify System

For each of the following, please write descriptive answers and discuss them with your preceptor:

A. By reviewing the references listed above, by observing patient treatments at the linear accelerator, and by watching the flow of information through the clinical site, describe the purposes of the Record and Verify (R&V) System. Does / how does the R&V interact with the treatment planning computer, with the linac, with the simulator, with the portal imaging device? What does the R&V control? When does the R&V give warnings? Does / when does the R&V prohibit treatment? Can the R&V be over-ridden? If so, under what circumstances? Is it prudent or appropriate to over-ride the R&V, even if it is possible to do so?

B. What was done before R&V systems were created? Can / should treatments be given outside of the R&V? If so, under what circumstances should this be allowed? What is done at your clinical site?

C. Is the R&V ever "wrong"? What errors might occur? How can these be guarded against? What is done at your clinical site to ensure the accurate delivery of patient treatments?

D. Imagine (or observe) and describe a situation in which a patient receives an incorrect treatment despite the use the R&V system. Could this error have been prevented? What adjustments could one make to the treatment process to prevent this error in the future?

E. What regulations affect the use of an electronic medical record, i.e. what is the HITECH Act of 2009? What is "meaningful use", and how is it demonstrated? How do the HITECH act and "meaningful use" affect the practice of medical physics and radiation oncology? Are there other regulations, recommendations, or guidelines that pertain to EMRs? If so, what are they and how do they affect the practice of medical physics and radiation oncology?

Task 2: Familiarity with Items in the Electronic Chart

For each of the following, please write descriptive answers and discuss them with your preceptor:

A. Review the electronic chart in use at your clinical site. What information is stored in the electronic chart? How does that information get there? Who is responsible for inputting data at each stage of the treatment process? Who is responsible for reviewing that data for accuracy?

B. Does your site also maintain a paper chart? If so, is every item duplicated, or only some items? What are the motivations behind these choices?

C. Who is allowed access to which items in the electronic chart? How is this access controlled? Are some items available in a read-only format for certain staff members? Why would this be done? Who decides issues of access at your clinical site? What factors guide these decisions?

D. Is any part of the electronic chart accessible outside of the immediate department (i.e. other hospital departments, or affiliated external clinical sites)? For the information to be accessible outside of the immediate department, safeguards would need to be in place to maintain the integrity of the data; how is this typically done?

E. Medical physicists often are able to access EMR systems outside of the radiation oncology department and beyond the scope of the R&V system (i.e. hospital registration and billing systems, or hospital-wide electronic charting systems). What are examples of patient

information that should NOT be accessed because it is beyond the scope of your current clinical task, in light of the HIPAA regulations?

Task 3: Manual Entry of a New Patient / New Treatment Field

For each of the following, please write descriptive answers and review them with your preceptor:

A. Observe the creation of a new patient in the R&V system. Document the steps required and, with your preceptor's permission, create a practice patient for your use.

B. For clinical set-ups (i.e. mark-and-start cases), there is no treatment plan done, only a hand-calc. Observe and document the steps required to create a new treatment field. At your clinical site, are parameters imported from the linac? Is this possible with the R&V and linac currently in use? When would this be a prudent thing to do? Are there circumstances under which it should be avoided? Note arguments for and against.

C. How would a second field be created? Document the steps required. With your preceptor's permission, create opposing fields following the manual method for your practice patient.

Task 4: Importing a Plan from the Treatment Planning System

For the following questions, please write your answers and review them with your preceptor:

A. For most R&V systems, once the patient is created, treatment fields can be imported directly from the treatment planning system. Observe this process, and document the steps required. During importation, what is checked, by whom, and when? Are there additional checks that occur prior to treatment? Who is responsible for these checks? When do they occur?

B. With your preceptor's permission, import a test plan for your practice patient.

Task 5: DRR Import / Association / Registration

For the following questions, please write your answers and review them with your preceptor:

A. For most R&V systems, there is a method of importing the DRRs for each treatment field from the treatment planning system. Observe and document this process. Do the images need to be manually associated with each treatment field, or does this happen automatically? Do the images need to be registered or scaled manually? What insures that the correct DRR belongs to each field? Who is responsible for checking this, and when?

B. With your preceptor's permission, import DRRs for your practice patient.

Task 6: Portal Image Review

A. Most R&V systems include ways to easily compare portal images (either EPID images or scanned-in films) with the corresponding BEV DRR's sent from the Treatment Planning System. Observe and document this process, and review the steps with your preceptor.

B. For the chart checks performed in Unit 4, check that the portal images and BEV DRRs are consistent with one another. Also check whether or not the portal images have been reviewed by the physician; do you agree with the physician's decisions regarding portal-image acceptability? Ask your preceptor's opinion of how best to handle a circumstance where you might disagree with a physician's acceptance or rejection of a portal-image.

Task 7: Electronic Chart Checking

For the following questions, please write your answers and discuss them with your preceptor:

A. Compare and contrast the process of chart checking in a paper-only environment, electronic-only environment, and duplicated paper/electronic environment. What are advantages/disadvantages of each system? If you were asked to make a recommendation to the department manager and physicians, which method would you advocate and why?

B. For an IMRT plan, learn how the expected leaf motions can be viewed over the BEV DRRs. For the chart checks performed in Unit 4, review the leaf motion for any IMRT patients.

Task 8: Electronic Billing

A. Learn how physics billing is performed in the R&V system at your clinical site. Document the process, and review the steps with your preceptor.

B. With your preceptor's permission, practice billing typical physics and dosimetry procedures for your practice patient; be sure to delete the charges before they cause confusion to the clerical staff.

Unit 6: Basic Radiation Safety

References:

1. Michael G. Stabin, Radiation Protection and Dosimetry: an Introduction to Health Physics, (Springer Science & Business Media, New York, NY, 2008).

2. Herman Cember, editor, Radiation Instruments, Health Physics Society Summer School 2001, (Medical Physics Publishing, Madison, WI, 2001).

3. Faiz M. Khan, The Physics Of Radiation Therapy, 3rd ed. (Lippincott Williams & Wilkins, Philadelphia, PA, 2003).

4. Herman Cember, Introduction to Health Physics, (Pergamon Press, London, 1969).

5. Bruce Thomadsen, ed., Radiotherapy Safety, American Association of Physicists in Medicine Symposium Proceedings No. 4, (American Institute of Physics, New York, NY, 1982).

6. NCRP Report 116, Limitation Of Exposure To Ionizing Radiation (National Council on Radiation Protection & Measurements, Bethesda, MD, 1993).

7. NCRP Report 107, Implementation of the Principle of As Low As Reasonably Achievable (ALARA) for Medical and Dental Personnel (National Council on Radiation Protection & Measurements, Bethesda, MD, 1990).

Objectives:

1) Recognize and distinguish between types of radiation warning signs.
2) Describe the concept of ALARA and explain its implementation.
3) Describe how time, distance, and shielding can be used to minimize one's exposure to radiation.
4) Explain the purpose and working of a radiation badge.
5) Demonstrate the proper use of a survey meter to check radiation levels.
6) Describe methods for the safe handling of radioactive materials.
7) Discuss allowed exposure levels for radiation workers and the general public.

Answer the following questions in writing, and review with your preceptor:

A. Locate the radiation warning signs posted at your clinical site. What prompted the need for signage in that location? Is more than one type of sign in use in your clinic? If yes, why? Are there other types of signs that may be used in different circumstances? If yes, what are these circumstances?

B. What signs / labels are used for the charts of patients undergoing radionuclide therapies or LDR brachytherapy? When is which type of label used?

C. Explain the concept of ALARA. How does this concept apply to your work as a medical physicist? Describe ways of implementing the ALARA concept.

D. Explain how time, distance, and shielding can be used to minimize your radiation exposure. If one were to double the time, double the distance, or double the thickness of the shield, which of these factors would have the greatest effect? Why?

E. What is the purpose of the radiation badge? How does the badge work? How often is your badge exchanged? Who monitors the readings from these badges? When and where is this information available, and to whom?

F. Learn where radiation meters are stored at your clinical site, and what types of meters are available to you there. Learn how to operate the most-frequently-used meters. What is a check-source reading? Why is it important?

G. If you were assisting with a prostate seed implant, what meter would you use to locate a missing seed? What meter would you use to survey an I-131 therapy patient? What meter would you use to survey an arriving package of radioactive material?

H. If a cesium source were to fall on the floor, how would you safely retrieve it? What about an I-125 seed?

I. Where are radioactive sources stored at your clinical site? How is access controlled? How are the sources shielded?

J. How are radioactive packages handled at you clinical site?

K. What are the allowed radiation exposure levels for radiation workers? For members of the general public? For pregnant radiation workers? How were these levels determined? Why might patients be allowed to exceed these levels?

MODULE II: QUALITY ASSURANCE IN RADIATION ONCOLOGY

In this Module you will be performing tests to assess the performance of medical equipment used in radiotherapy. Initially, you will perform these tests under the supervision of your clinical preceptor. Once you become familiar with the tests, you will be expected to repeat these tests multiple times to gain competence and acquire a better understanding of each test. The most important thing, however, is to gain an in-depth understanding of the reasons behind each test and the role of these tests and others like them in keeping patients safe.

This module should typically be completed during the second and third quarters of the Clinical Practicum course, along with Module III, Treatment Planning.

Unit 1: Linear Accelerator Quality Assurance

References:

Text: Constantinou, C. (1993). Protocol And Procedures For Quality Assurance Of Linear Accelerators (Brockton Hospital, Radiation Oncology Department, Brockton, MA, 1993).

1. Klein, Eric E., et. al., AAPM Report No. 142: Task Group 142 Report: Quality Assurance of Medical Linear Accelerators, Med. Phys. **36** (9), 4197-4212, 2009: http://www.aapm.org/pubs/reports/RPT_142.pdf

2. AAPM Radiation Therapy Committee Task Group 40 Report (1994): Comprehensive QA For Radiation Oncology: Http://www.aapm.Org/pubs/reports/rpt_46.pdf

3. Almond, Peter, et. al, AAPM Report No. 67: AAPM's TG-51 protocol for clinical reference dosimetry of high-energy photon and electron beams, Med. Phys. **26** (9), 1847-1870, 1999: http://www.aapm.org/pubs/reports/RPT_67.pdf (If you would like a copy of the Worksheets in Microsoft Word, they are available here.)

4. Zhu, Timothy, et. al., AAPM Report No. 97: Report of AAPM Therapy Physics Committee Task Group 74: In-air output ratio, Sc, for megavoltage photon beams, Med Phys. **36** (11), 5261-5291, 2009: http://www.aapm.org/pubs/reports/RPT_97.pdf

5. AAPM Code of Practice for Radiotherapy Accelerators: http://www.aapm.org/pubs/reports/rpt_47.pdf

6. Pai, Sujatha, et. al., AAPM Report No. 216: TG-69: Radiographic film for megavoltage beam dosimetry, Med. Phys. **34**, 2228-2258, 2007: http://www.aapm.org/pubs/reports/RPT_216.pdf

7. U.S. NRC Part 35: Medical Use of Byproduct Material: http://www.nrc.gov/reading-rm/doc-collections/cfr/part035/index.html

8. Illinois Emergency Management Agency (IEMA) Part 335: Medical Use of Radioactive Material: http://www.state.il.us/iema/legal/pdf/32_335.pdf

9. Illinois Emergency Management Agency (IEMA) Part 340: Standards for Protection Against Radiation: http://www.state.il.us/iema/legal/pdf/32_340.pdf

10. Illinois Emergency Management Agency (IEMA) Part 360: Use of X-Rays in the Healing Arts Including Medical, Dental, Podiatry, and Veterinary Medicine: http://www.state.il.us/iema/legal/pdf/32_360.pdf

Objectives:

1) Document and perform daily, weekly, monthly and annual quality assurance tests on linear accelerators
2) Explain the purpose each test
3) Explain and evaluate the results of each test
4) Explain the tolerances for each test
5) Demonstrate safe and appropriate use of equipment
6) Identify reasons for deviations in tests results
7) Compose a clear and detailed summary of test results
8) Demonstrate an understanding of troubleshooting techniques

Task 1: Rationale and Process for Daily Linac Quality Assurance

A. Review the references listed above, particularly Chapter 2 in the text, TG-142, and TG-40, as well as any other applicable references, articles, and guidance documents. Pay special attention to understanding the rationale behind daily linac QA measurements. Discuss what you learn with your preceptor.

B. Observe and practice the methods for performing daily linac QA as done at your clinical site. Create procedures documenting the steps involved, and ask your preceptor to review your work to be sure that your procedures are correct.

C. In addition to performing daily linac QA by the methods used at your clinical site, perform the tests for daily linac quality assurance following the methods described in the text. Fill out the forms in Appendix 2 of the text to document your work, and note any key insights in your logbook. Discuss with your preceptor.

D. What are the tolerances for each of the tests performed for daily linac QA? Where do these tolerances come from? If the results of the quality assurance tests are outside of the tolerances, what action(s) should be taken? List possible causes for the discrepancies; how could you determine the actual reasons? Discuss your answers with your preceptor.

E. For each of the following questions, please write your answers, and discuss them with your preceptor.

1. Do the tests and tolerances recommended in the text, in the other references, and in any applicable supplementary guidance documents agree with one another? Do they differ from what is done at your site? Summarize any discrepancies, and list possible reasons behind any differences. Can all of these methods be correct? Why or why not?

2. What equipment is used to acquire data for these tests at your particular clinical site? Are there other devices that could be used to make these measurements? How would you learn about the features of other devices? If the lead physicist were to ask your recommendations about purchasing new equipment, what QA devices would you recommend for these tests, and why?

3. What forms and / or software programs are used to record and analyze data for these tests at your particular clinical site? Where did these forms and software programs come from?

4. Design your own form / software program for these tests. Compare and contrast the features of your form / program with the ones in use at your clinical site, and in the text. What other commercial forms / software programs exist that could be used for these purposes? How would you learn about the features of these commercially available products?

5. Considering the items in E1 through E4 above, if the lead physicist were to ask your recommendations regarding the best, most efficient, safest method to perform these tests, what would you say? Be prepared to defend your answer to your preceptor.

Task 2: Rationale and Process for Weekly Linac Quality Assurance

A. Review the references listed above, particularly Chapter 3 in the text, TG-142, and TG-40, as well as any other applicable references, articles, and guidance documents. Pay special attention to understanding the rationale behind weekly linac QA measurements. Discuss what you learn with your preceptor.

B. Observe and practice the methods for performing weekly linac QA as done at your clinical site. Create procedures documenting the steps involved, and ask your preceptor to review your work to be sure that your procedures are correct.

C. In addition to performing weekly linac QA by the methods used at your clinical site, perform the tests for weekly linac quality assurance following the methods described in the text. Fill out the forms in Appendix 3 of the text to document your work, and note any key insights in your logbook. Discuss with your preceptor.

D. What are the tolerances for each of the tests performed for weekly linac QA? Where do these tolerances come from? If the results of the quality assurance tests are outside of the tolerances, what action(s) should be taken? List possible causes for the discrepancies; how could you determine the actual reasons? Discuss your answers with your preceptor.

E. For each of the following questions, please write your answers, and discuss them with your preceptor.

1. Do the tests and tolerances recommended in the text, in the other references, and in any applicable supplementary guidance documents agree with one another? Do they differ from what is done at your site? Summarize any discrepancies, and list possible reasons behind any differences. Can all of these methods be correct? Why or why not?

2. What equipment is used to acquire data for these tests at your particular clinical site? Are there other devices that could be used to make these measurements? How would you learn about the features of other devices? If the lead physicist were to ask your recommendations about purchasing new equipment, what QA devices would you recommend for these tests, and why?

3. What forms and / or software programs are used to record and analyze data for these tests at your particular clinical site? Where did these forms and software programs come from?

4. Design your own form / software program for these tests. Compare and contrast the features of your form / program with the ones in use at your clinical site, and in the text. What other commercial forms / software programs exist that could be used for these purposes? How would you learn about the features of these commercially available products?

5. Considering the items in E1 through E4 above, if the lead physicist were to ask your recommendations regarding the best, most efficient, safest method to perform these tests, what would you say? Be prepared to defend your answer to your preceptor.

Task 3: Rationale and Process for Monthly Linac Quality Assurance

A. Review the references listed above, particularly Chapter 4 in the text, TG-142, and TG-40, as well as any other applicable references, articles, and guidance documents. Pay special attention to

understanding the rationale behind monthly linac QA measurements. Discuss what you learn with your preceptor.

B. Observe and practice the methods for performing monthly linac QA as done at your clinical site. Create procedures documenting the steps involved, and ask your preceptor to review your work to be sure that your procedures are correct.

C. In addition to performing monthly linac QA by the methods used at your clinical site, perform the tests for monthly linac quality assurance following the methods described in the text. Fill out the forms in Appendix 4 of the text to document your work, and note any key insights in your logbook. Discuss with your preceptor.

D. What are the tolerances for each of the tests performed for monthly linac QA? Where do these tolerances come from? If the results of the quality assurance tests are outside of the tolerances, what action(s) should be taken? List possible causes for the discrepancies; how could you determine the actual reasons? Discuss your answers with your preceptor.

E. For each of the following questions, please write your answers, and discuss them with your preceptor.

1. Do the tests and tolerances recommended in the text, in the other references, and in any applicable supplementary guidance documents agree with one another? Do they differ from what is done at your site? Summarize any discrepancies, and list possible reasons behind any differences. Can all of these methods be correct? Why or why not?

2. What equipment is used to acquire data for these tests at your particular clinical site? Are there other devices that could be used to make these measurements? How would you learn about the features of other devices? If the lead physicist were to ask your recommendations about purchasing new equipment, what QA devices would you recommend for these tests, and why?

3. What forms and / or software programs are used to record and analyze data for these tests at your particular clinical site? Where did these forms and software programs come from?

4. Design your own form / software program for these tests. Compare and contrast the features of your form / program with the ones in use at your clinical site, and in the text. What other commercial forms / software programs exist that could be used for these purposes? How would you learn about the features of these commercially available products?

5. Considering the items in E1 through E4 above, if the lead physicist were to ask your recommendations regarding the best, most efficient, safest method to perform these tests, what would you say? Be prepared to defend your answer to your preceptor.

Task 4: Rationale and Process for Annual Linac Quality Assurance

A. Review the references listed above, particularly Chapter 5 in the text, TG-142, TG-40, and TG-51, as well as any other applicable references, articles, and guidance documents. Pay special attention to understanding the rationale behind annual linac QA measurements. Discuss what you learn with your preceptor.

B. Observe and practice the methods for performing annual linac QA as done at your clinical site. Create procedures documenting the steps involved, and ask your preceptor to review your work to be sure that your procedures are correct.

C. In addition to performing annual linac QA by the methods used at your clinical site, perform the tests for annual linac quality assurance following the methods described in the text. Fill out the forms in Appendix 5 of the text to document your work, and note any key insights in your logbook. Discuss with your preceptor.

D. What are the tolerances for each of the tests performed for annual linac QA? Where do these tolerances come from? If the results of the quality assurance tests are outside of the tolerances, what action(s) should be taken? List possible causes for the discrepancies; how could you determine the actual reasons? Discuss your answers with your preceptor.

E. For each of the following questions, please write your answers, and discuss them with your preceptor.

    1. Do the tests and tolerances recommended in the text, in the other references, and in any applicable supplementary guidance documents agree with one another? Do they differ from what is done at your site? Summarize any discrepancies, and list possible reasons behind any differences. Can all of these methods be correct? Why or why not?

    2. What equipment is used to acquire data for these tests at your particular clinical site? Are there other devices that could be used to make these measurements? How would you learn about the features of other devices? If the lead physicist were to ask your recommendations about purchasing new equipment, what QA devices would you recommend for these tests, and why?

    3. What forms and / or software programs are used to record and analyze data for these tests at your particular clinical site? Where did these forms and software programs come from?

    4. Design your own form / software program for these tests. Compare and contrast the features of your form / program with the ones in use at your clinical site, and in the text. What other commercial forms / software programs exist that could be used for these purposes? How would you learn about the features of these commercially available products?

5. Considering the items in E1 through E4 above, if the lead physicist were to ask your recommendations regarding the best, most efficient, safest method to perform these tests, what would you say? Be prepared to defend your answer to your preceptor.

Unit 2: Acceptance Testing and Commissioning

References:

1. Das, Indra J., et. al., AAPM Report No. 106: Accelerator beam data commissioning equipment and procedures: Report of the TG-106 of the Therapy Physics Committee of the AAPM, Med. Phys. **35** (9), 4186-4215, 2008: http://www.aapm.org/pubs/reports/RPT_106.pdf

2. Klein, Eric E., et. al., AAPM Report No. 142: Task Group 142 Report: Quality Assurance of Medical Linear Accelerators, Med. Phys. **36** (9), 4197-4212, 2009: http://www.aapm.org/pubs/reports/RPT_142.pdf

3. AAPM Radiation Therapy Committee Task Group 40 Report (1994): Comprehensive QA For Radiation Oncology: Http://www.aapm.Org/pubs/reports/rpt_46.pdf

4. Almond, Peter, et. al, AAPM Report No. 67: AAPM's TG-51 protocol for clinical reference dosimetry of high-energy photon and electron beams, Med. Phys. **26** (9), 1847-1870, 1999: http://www.aapm.org/pubs/reports/RPT_67.pdf (If you would like a copy of the Worksheets in Microsoft Word, they are available here.)

5. Zhu, Timothy, et. al., AAPM Report No. 97: Report of AAPM Therapy Physics Committee Task Group 74: In-air output ratio, Sc, for megavoltage photon beams, Med Phys. **36** (11), 5261-5291, 2009: http://www.aapm.org/pubs/reports/RPT_97.pdf

6. AAPM Code of Practice for Radiotherapy Accelerators: http://www.aapm.org/pubs/reports/rpt_47.pdf

7. Pai, Sujatha, et. al., AAPM Report No. 216: TG-69: Radiographic film for megavoltage beam dosimetry, Med. Phys. **34**, 2228-2258, 2007: http://www.aapm.org/pubs/reports/RPT_216.pdf

8. Ezzell, Gary A., et. al., AAPM Report No. 119: IMRT commissioning: Multiple institution planning and dosimetry comparisons, a report from AAPM Task Group 119, Med. Phys. **36** (11), 5359-5373, 2009: http://www.aapm.org/pubs/reports/RPT_119.pdf (Note: A test suite of mock clinical cases for IMRT planning and QA measurements can be accessed here.)

9. Recommendations for clinical electron beam dosimetry: Supplement to the recommendations of Task Group 25, 2009: http://www.aapm.org/pubs/reports/RPT_99.PDF

10. AAPM Report No. 32: Clinical Electron Beam Dosimetry, 1991: http://www.aapm.org/pubs/reports/RPT_32.pdf

11. AAPM Report No. 39: Specification and Acceptance Testing of Computed Tomography Scanners, 1993: http://www.aapm.org/pubs/reports/RPT_39.pdf

Objectives:

1) Compare and contrast "acceptance testing" and "commissioning" as applied to radiation oncology equipment.
2) Outline acceptance test and commissioning procedures for linear accelerators.
3) Describe acceptance test and commissioning procedures for other radiation oncology equipment.

All equipment introduced into the radiation oncology clinical environment must first be tested to ensure that it performs as expected and in accordance with the manufacturer's claims. This applies to everything from linear accelerators to chambers and electrometers, and should encompass both software and hardware aspects of the devices. In addition, any baseline measurements needed to make the devices ready for clinical implementation must be taken and documented, and procedures for routine use and on-going quality assurance of the devices should be developed. All of these things are the responsibility of the clinical medical physicist.

In this section, however, the discussion will be limited to a general understanding of the principles involved in acceptance testing and commissioning hardware. The special considerations pertaining to treatment planning systems are addressed in Module 3, Unit 9.

For the following questions, write your answers and discuss them with your preceptor.

A. Review the references above and any other pertinent references, articles, and guidance documents on the topics of acceptance testing and commissioning in radiation oncology. What is the difference between acceptance testing and commissioning? What does each include? Do they overlap, or does one include the other? Explain your answers.

B. Imagine that your clinic is about to install a new linear accelerator. Outline the steps involved in linear acceptance testing and commissioning.

C. Review the acceptance testing and commissioning documents for radiation oncology equipment in use at your clinical site. Pay special attention to the documents for linear accelerators. Compare these with recommendations found in the guidance documents. Are there things recommended in the guidance documents that were not done when this equipment was acceptance tested or commissioned at your site? Are there things done by your site that are not

described in the guidance documents? List any inconsistencies, and discuss possible reasons for any discrepancies. Explain when and why it may be permissible to deviate from acceptance testing or commissioning procedures outlined in a guidance document.

D. Who is responsible for deciding what needs to be done to acceptance test and commission new equipment? Who decides how much testing is sufficient? How does one know whether or not the equipment is safe for patient use in a particular clinical setting?

E. If you were asked by the lead physicist to prepare to acceptance test and commission a new radiation oncology device for your department, how would you plan this task? Create an example plan, and review it with your preceptor.

F. If possible, participate in acceptance testing and/or commissioning at your clinical site. Document your work in your logbook (i.e. by writing procedures).

Unit 3: Measurement Equipment QA

References:

1. Instrumentation Requirements Of Diagnostic Radiological Physicists http://www.aapm.org/pubs/reports/rpt_60.pdf

2. The Calibration and Use of Plane-Parallel Ionization Chambers for Dosimetry of Electron Beams http://www.aapm.org/pubs/reports/rpt_48.pdf

3. Radiological Physics Center Website: http://rpc.mdanderson.org/rpc/

4. Accredited Dosimetry Calibration Laboratory Website: http://uwmrrc.wisc.edu/index.php?option=com_content&task=view&id=27&Itemid=54

5. National Institute of Standards and Technology (NIST) website: http://www.nist.gov/index.html

6. U.S. NRC Part 35: Medical Use of Byproduct Material: http://www.nrc.gov/reading-rm/doc-collections/cfr/part035/index.html

7. Illinois Emergency Management Agency (IEMA) Part 335: Medical Use of Radioactive Material: http://www.state.il.us/iema/legal/pdf/32_335.pdf

8. Illinois Emergency Management Agency (IEMA) Part 340: Standards for Protection Against Radiation: http://www.state.il.us/iema/legal/pdf/32_340.pdf

9. Illinois Emergency Management Agency (IEMA) Part 360: Use of X-Rays in the Healing Arts Including Medical, Dental, Podiatry, and Veterinary Medicine: http://www.state.il.us/iema/legal/pdf/32_360.pdf

10. Diode In Vivo Dosimetry For Patients Receiving External Beam Radiation Therapy http://www.aapm.org/pubs/reports/rpt_87.pdf

11. Reft, C. S. And Kuchnir, F. T. (1994). "A Comparison Of Methods For Calibrating Parallel-Plate Chambers", Med. Phys. 21(12), 1953-1957.

12. Pai, Sujatha, et. al., AAPM Report No. 216: TG-69: Radiographic film for megavoltage beam dosimetry, Med. Phys. **34**, 2228-2258, 2007: http://www.aapm.org/pubs/reports/RPT_216.pdf

Objectives:

1) Describe quality assurance tests for QA test equipment
2) Demonstrate safe and appropriate use of test equipment
3) Describe the role of outside checks for measurement equipment

In radiation oncology physics, it is obviously important to know whether or not the equipment is working correctly. Often a second device is used as a double check, but how can one be certain if the second device is working correctly and hence can provide an accurate confirmation? How can one be sure that the data one obtains are reliable? That is the subject of this section.

Review the references above, and any other sources pertinent to the quality assurance of measurement equipment and devices.

For each of the following questions, please write your answers and discuss them with your preceptor.

A. List measurement equipment in use in the radiation oncology department at your clinical site.
    a. What equipment should be checked daily (or just prior to use)? How is this done?
    b. What equipment is checked periodically, or annually? How is it checked, and who checks it?
    c. Are there regulations or guidance documents to help determine the appropriate frequency of checks, or what checks to perform? Who determines the frequency of checks?
    d. What tolerances are employed? Where do these tolerances come from?
    e. What might the consequences be if the test equipment were not working properly?
    f. What safeguards or procedures are in place to ensure that the equipment is performing as expected?

B. When considered broadly, measurement equipment can include things like radiographic film, GAF-Chromic film, water phantoms, scanners, readers, etc. Many of these depend on the proper functioning of software to provide accurate information.
    a. How can various types of film be used in radiation oncology measurements? How is information obtained from the film?
    b. What is an H&D curve? How is an H&D curve obtained? What effect can variations in film processing have on an H&D curve, and hence on the accuracy of the information from film? Is an H&D curve necessary for relative measurements?
    c. What other factors should be considered for reliable film measurements besides obtaining a correct H&D curve? What factors may affect radiographic film, GAF-Chromic film, other types of film? How would you determine which film is appropriate for measurements at various radiation doses?

d. How would you determine whether or not the devices used to obtain information from film (i.e. scanners, readers, etc) are performing correctly? What should be done to test the software of scanners, readers, water phantoms, etc?

C. With regard to measurement equipment, what is the role of an Accredited Dosimetry Calibration Laboratory (ADCL)? What is the role of the Radiological Physics Center (RPC)? What is the role of the National Institute of Standards and Technology (NIST)?

D. What equipment in your department is sent to an outside organization for periodic checks? How frequently is this done? Who is responsible for making sure the equipment is sent out in a timely way? What records should be kept, and where?

E. What is a "chamber inter-comparison"? How and when is it performed? Why might it be useful?

F. At your clinical site, observe the quality assurance of any measurement equipment. Document QA procedures, and, if possible, perform these procedures under the guidance of your preceptor.

Unit 4: CT Simulator QA

References:

1. Comprehensive Methodology for the Evaluation of Radiation Dose in X-Ray Computed Tomography, Report of AAPM Task Group 111: The Future of CT Dosimetry, 2010: http://www.aapm.org/pubs/reports/RPT_111.pdf

2. Quality Assurance For Computed-Tomography Simulators And The Computed tomography-Simulation Process: Report Of The AAPM Radiation Therapy Committee Task Group No. 66, 2003: http://www.aapm.org/Pubs/Reports/Rpt_83.Pdf

3. The Measurement, Reporting, and Management of Radiation Dose in CT http://www.aapm.org/pubs/reports/RPT_96.pdf

Objectives:

1) Document and perform daily and annual quality assurance tests on CT simulators
2) Explain the purpose each test
3) Explain and evaluate the results of each test
4) Explain the tolerances of each test
5) Demonstrate safe and appropriate use of equipment
6) Identify reasons for deviations in tests results
7) Compose a clear and detailed summary of test results
8) Demonstrate an understanding of troubleshooting techniques

A. Review the references listed above, as well as any other applicable references, articles, and guidance documents. Pay special attention to understanding the rationale behind daily and annual QA measurements for CT simulators. Discuss what you learn with your preceptor.

B. Observe and practice the methods for performing daily and annual CT simulator QA as done at your clinical site. Create procedures documenting the steps involved, and ask your preceptor to review your work to be sure that your procedures are correct.

C. What are the tolerances for each of the tests performed for CT simulator QA? Where do these tolerances come from? If the results of the quality assurance tests are outside of the tolerances, what action(s) should be taken? List possible causes for the discrepancies; how could you determine the actual reasons? Discuss your answers with your preceptor.

D. For each of the following questions, please write your answers, and discuss them with your preceptor.

1. Do the tests and tolerances recommended in the references and in any other applicable guidance documents agree with one another? Do they differ from what is done at your site? Summarize any discrepancies, and list possible reasons for any differences. Can all of these methods be correct? Why or why not?

2. What equipment is used to acquire data for these tests at your particular clinical site? Are there other devices that could be used to make these measurements? How would you learn about the features of other devices? If the lead physicist were to ask your recommendations about purchasing new equipment, what QA devices would you recommend for these tests, and why?

3. What forms and / or software programs are used to record and analyze data for these tests at your particular clinical site? Where did these forms and software programs come from?

4. Design your own form / software program for these tests. Compare and contrast the features of your form / program with the ones in use at your clinical site. What other commercial forms / software programs exist that could be used for these purposes? How would you learn about the features of these commercially available products?

5. Considering the items in E1 through E4 above, if the lead physicist were to ask your recommendations regarding the best, most efficient, safest method to perform these tests, what would you say? Be prepared to defend your answer to your preceptor.

Unit 5: Portal Imaging and kV X-Ray Imaging QA

References:

1. Clinical use of electronic portal imaging: Report of AAPM Radiation Therapy Committee Task Group 58, 2001: http://www.aapm.org/pubs/reports/RPT_75.pdf

2. AAPM Report No. 104: The Role of In-Room kV X-Ray Imaging for Patient Setup and Target Localization, 2009: http://www.aapm.org/pubs/reports/RPT_104.pdf

3. AAPM Report No. 24: Radiotherapy Portal Image Quality, Task Group No. 28, 1987: http://www.aapm.org/pubs/reports/RPT_24.pdf

Objectives:

1) Describe the purpose of portal imaging and kV X-ray imaging (such as on-board-imaging - OBI)
2) Discuss imaging dose
3) Document and perform quality assurance tests on portal imaging and kV X-ray imaging devices
4) Explain the purpose each test
5) Explain and evaluate the results of each test
6) Explain the tolerances of each test
7) Demonstrate safe and appropriate use of equipment
8) Identify reasons for deviations in tests results
9) Compose a clear and detailed summary of test results
10) Demonstrate an understanding of troubleshooting techniques

A. Explain the differences and similarities between traditional port films, portal imaging using flat-panel detectors (i.e. amorphous silicon), and kV X-ray imaging (i.e. OBI). What is the purpose of taking these images? How can these images contribute to patient safety?

B. Do these images result in dose to the patient? If yes, what is the magnitude of this dose? Describe methods of measuring or calculating the imaging dose. Is the imaging dose typically accounted for in the patient's chart? Why or why not?

C. Review the references listed above, as well as any other applicable references, articles, and guidance documents. Pay special attention to understanding the rationale behind QA measurements for portal imaging and OBI devices. Discuss what you learn with your preceptor.

D. Observe and practice the methods for performing portal imaging and OBI QA as done at your clinical site. Create procedures documenting the steps involved, and ask your preceptor to review your work to be sure that your procedures are correct.

E. What are the tolerances for each of the tests performed for portal imaging and OBI QA? Where do these tolerances come from? If the results of the quality assurance tests are outside of the tolerances, what action(s) should be taken? List possible causes for the discrepancies; how could you determine the actual reasons? Discuss your answers with your preceptor.

F. For each of the following questions, please write your answers, and discuss them with your preceptor.

1. Do the tests and tolerances recommended in the references and in any other applicable guidance documents agree with one another? Do they differ from what is done at your site? Summarize any discrepancies, and list possible reasons for any differences. Can all of these methods be correct? Why or why not?

2. What equipment is used to acquire data for these tests at your particular clinical site? Are there other devices that could be used to make these measurements? How would you learn about the features of other devices? If the lead physicist were to ask your recommendations about purchasing new equipment, what QA devices would you recommend for these tests, and why?

3. What forms and / or software programs are used to record and analyze data for these tests at your particular clinical site? Where did these forms and software programs come from?

4. Design your own form / software program for these tests. Compare and contrast the features of your form / program with the ones in use at your clinical site. What other commercial forms / software programs exist that could be used for these purposes? How would you learn about the features of these commercially available products?

5. Considering the items in E1 through E4 above, if the lead physicist were to ask your recommendations regarding the best, most efficient, safest method to perform these tests, what would you say? Be prepared to defend your answer to your preceptor.

Unit 6: Cone-beam CT QA

References:

1. AAPM Report No. 104: The Role of In-Room kV X-Ray Imaging for Patient Setup and Target Localization, 2009: http://www.aapm.org/pubs/reports/RPT_104.pdf

2. A Quality Assurance Procedure to Evaluate Cone-beam CT Image Center Congruence with the Radiation Isocenter of a Linear Accelerator: http://jacmp.org/index.php/jacmp/article/view/3297/2020

3. A Quality Assurance Program for Image Quality of Cone-beam CT Guidance in Radiation Therapy: http://online.medphys.org/resource/1/mphya6/v35/i5/p1807_s1?isAuthorized=no

Objectives:

1) Describe the purpose of cone-beam CT and discuss cone-beam CT dose
2) Document and perform quality assurance tests for cone-beam CT
3) Explain the purpose each test
4) Explain and evaluate the results of each test
5) Explain the tolerances of each test
6) Demonstrate safe and appropriate use of equipment
7) Identify reasons for deviations in tests results
8) Compose a clear and detailed summary of test results
9) Demonstrate an understanding of troubleshooting techniques

A. What is the purpose of using cone-beam CT? How can these images contribute to patient safety?

B. Does cone-beam CT result in dose to the patient? If yes, what is the magnitude of this dose? Describe methods of measuring or calculating the imaging dose. Is the imaging dose typically accounted for in the patient's chart? Why or why not?

C. Review the references listed above, as well as any other applicable references, articles, and guidance documents. Pay special attention to understanding the rationale behind QA measurements for cone-beam CT. Discuss what you learn with your preceptor.

D. Observe and practice the methods for performing cone-beam CT QA as done at your clinical site. Create procedures documenting the steps involved, and ask your preceptor to review your work to be sure that your procedures are correct.

E. What are the tolerances for each of the tests performed for cone-beam CT QA? Where do these tolerances come from? If the results of the quality assurance tests are outside of the tolerances, what action(s) should be taken? List possible causes for the discrepancies; how could you determine the actual reasons? Discuss your answers with your preceptor.

F. For each of the following questions, please write your answers, and discuss them with your preceptor.

1. Do the tests and tolerances recommended in the references and in any other applicable guidance documents agree with one another? Do they differ from what is done at your site? Summarize any discrepancies, and list possible reasons for any differences. Can all of these methods be correct? Why or why not?

2. What equipment is used to acquire data for these tests at your particular clinical site? Are there other devices that could be used to make these measurements? How would you learn about the features of other devices? If the lead physicist were to ask your recommendations about purchasing new equipment, what QA devices would you recommend for these tests, and why?

3. What forms and / or software programs are used to record and analyze data for these tests at your particular clinical site? Where did these forms and software programs come from?

4. Design your own form / software program for these tests. Compare and contrast the features of your form / program with the ones in use at your clinical site. What other commercial forms / software programs exist that could be used for these purposes? How would you learn about the features of these commercially available products?

5. Considering the items in E1 through E4 above, if the lead physicist were to ask your recommendations regarding the best, most efficient, safest method to perform these tests, what would you say? Be prepared to defend your answer to your preceptor.

Unit 7: PET-CT QA

References:

1. AAPM Task Group 126 in progress: http://www.aapm.org/org/structure/default.asp?committee_code=TG126

2. IAEA Human Health Campus: Quality Assurance for PET and PET/CT Systems: http://nucleus.iaea.org/HHW/NuclearMedicine/QualityPractice/QualityAssurancePET/Quality_Assurance_for_PET_and_PETCT_Systems/index.html

3. IAEA Scientific and Technical Publications: Quality Assurance for PET and PET/CT Systems, 2009: http://www-pub.iaea.org/books/IAEABooks/8002/Quality-Assurance-for-PET-and-PET-CT-Systems

4. Lei Xing: Quality Assurance of PET/CT for Radiation Therapy: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2600917/

Objectives:

1) Describe the purpose of PET-CT and discuss PET-CT dose
2) Document and perform quality assurance tests for positron emission tomography CT (PET-CT) scanners
3) Explain the purpose each test
4) Explain and evaluate the results of each test
5) Explain the tolerances of each test
6) Demonstrate safe and appropriate use of equipment
7) Identify reasons for deviations in tests results
8) Compose a clear and detailed summary of test results
9) Demonstrate an understanding of troubleshooting techniques

A. What is the purpose of using PET-CT? How are PET-CT images typically employed in radiation oncology? What advantages might PET-CT have compared with separate PET images and CT images?

B. Do these images result in dose to the patient? If yes, what is the magnitude of this dose? Describe methods of measuring or calculating the imaging dose.

C. Review the references listed above, as well as any other applicable references, articles, and guidance documents. Pay special attention to understanding the rationale behind QA measurements for PET-CT. Discuss what you learn with your preceptor.

D. Observe and practice the methods for performing PET-CT QA as done at your clinical site. Create procedures documenting the steps involved, and ask your preceptor to review your work to be sure that your procedures are correct.

E. What are the tolerances for each of the tests performed for PET-CT QA? Where do these tolerances come from? If the results of the quality assurance tests are outside of the tolerances, what action(s) should be taken? List possible causes for the discrepancies; how could you determine the actual reasons? Discuss your answers with your preceptor.

F. For each of the following questions, please write your answers, and discuss them with your preceptor.

1. Do the tests and tolerances recommended in the references and in any other applicable guidance documents agree with one another? Do they differ from what is done at your site? Summarize any discrepancies, and list possible reasons for any differences. Can all of these methods be correct? Why or why not?

2. What equipment is used to acquire data for these tests at your particular clinical site? Are there other devices that could be used to make these measurements? How would you learn about the features of other devices? If the lead physicist were to ask your recommendations about purchasing new equipment, what QA devices would you recommend for these tests, and why?

3. What forms and / or software programs are used to record and analyze data for these tests at your particular clinical site? Where did these forms and software programs come from?

4. Design your own form / software program for these tests. Compare and contrast the features of your form / program with the ones in use at your clinical site. What other commercial forms / software programs exist that could be used for these purposes? How would you learn about the features of these commercially available products?

5. Considering the items in E1 through E4 above, if the lead physicist were to ask your recommendations regarding the best, most efficient, safest method to perform these tests, what would you say? Be prepared to defend your answer to your preceptor.

Unit 8: HDR QA

References:

1. High dose-rate brachytherapy treatment delivery: Report of the AAPM Radiation Therapy Committee Task Group No. 59 http://www.aapm.org/pubs/reports/rpt_61.pdf

2. Code of practice for brachytherapy physics: Report of the AAPM Radiation Therapy Committee Task Group No. 56 http://www.aapm.org/pubs/reports/rpt_59.pdf

3. U.S. NRC Part 35: Medical Use of Byproduct Material: http://www.nrc.gov/reading-rm/doc-collections/cfr/part035/index.html

4. Illinois Emergency Management Agency (IEMA) Part 335: Medical Use of Radioactive Material: http://www.state.il.us/iema/legal/pdf/32_335.pdf

5. Illinois Emergency Management Agency (IEMA) Part 340: Standards for Protection Against Radiation: http://www.state.il.us/iema/legal/pdf/32_340.pdf

6. Illinois Emergency Management Agency (IEMA) Part 360: Use of X-Rays in the Healing Arts Including Medical, Dental, Podiatry, and Veterinary Medicine: http://www.state.il.us/iema/legal/pdf/32_360.pdf

Objectives:

1) Document and perform day-of-treatment, monthly, annual and source-exchange quality assurance tests on HDR units
2) Explain the purpose each test
3) Explain and evaluate the results of each test
4) Explain the tolerances of each test
5) Demonstrate safe and appropriate use of equipment
6) Identify reasons for deviation in tests results
7) Compose a clear and detailed summary of test results
8) Demonstrate an understanding of troubleshooting techniques
9) Demonstrate proper radiation safety practices
10) Outline and demonstrate emergency procedures

A. Review the references listed above, as well as any other applicable references, articles, and guidance documents. Pay special attention to understanding the rationale behind QA measurements for HDR. Discuss what you learn with your preceptor.

B. What regulations have a bearing on HDR? What role does the hospital's radioactive materials license play in HDR procedures? Is there a difference between QA methods for devices which contain radioactive materials versus QA methods for radiation-producing devices? If yes, please explain. Discuss with your preceptor.

C. Observe and practice the methods for performing HDR QA as done at your clinical site. Be sure to include day-of-treatment, monthly, annual and source-exchange quality assurance tests on HDR units. Create procedures documenting the steps involved, and ask your preceptor to review your work to be sure that your procedures are correct.

D. What are the tolerances for each of the tests performed for HDR QA? Where do these tolerances come from? If the results of the quality assurance tests are outside of the tolerances, what action(s) should be taken? List possible causes for the discrepancies; how could you determine the actual reasons? Discuss your answers with your preceptor.

E. Observe, document and practice radiation safety procedures for HDR at your clinical site. Are there guidance documents for best radiation safety practices? Where did the procedures in use at your clinical site come from? Are there things you would suggest adjusting in these procedures for added safety? Discuss your observations and analysis with your preceptor.

F. Observe, document and practice emergency procedures for HDR at your clinical site. Are there guidance documents for best emergency practices? Where did the emergency procedures in use at your clinical site come from? Are there things you would suggest adjusting in these procedures for added safety? Discuss your observations and analysis with your preceptor.

G. For each of the following questions, please write your answers, and discuss them with your preceptor.

    1. Do the tests and tolerances recommended in the references and in any other applicable guidance documents agree with one another? Do they differ from what is done at your site? Summarize any discrepancies, and list possible reasons for any differences. Can all of these methods be correct? Why or why not?

    2. What equipment is used to acquire data for these tests at your particular clinical site? Are there other devices that could be used to make these measurements? How would you learn about the features of other devices? If the lead physicist were to ask your recommendations about purchasing new equipment, what QA devices would you recommend for these tests, and why?

3. What forms and / or software programs are used to record and analyze data for these tests at your particular clinical site? Where did these forms and software programs come from?

4. Design your own form / software program for these tests. Compare and contrast the features of your form / program with the ones in use at your clinical site. What other commercial forms / software programs exist that could be used for these purposes? How would you learn about the features of these commercially available products?

5. Considering the items in G1 through G4 above, if the lead physicist were to ask your recommendations regarding the best, most efficient, safest method to perform these tests, what would you say? Be prepared to defend your answer to your preceptor.

Unit 9: Software System QA

References:

1. Klein, Eric E., et. al., AAPM Report No. 142: Task Group 142 Report: Quality Assurance of Medical Linear Accelerators, Med. Phys. **36** (9), 4197-4212, 2009: http://www.aapm.org/pubs/reports/RPT_142.pdf

2. B. Fraass, et. al., American Association of Physicists in Medicine Radiation Therapy Committee Task Group 53: Quality assurance for clinical radiotherapy treatment planning, (American Institue of Physics, New York, NY, 1998). http://www.aapm.org/pubs/reports/rpt_62.pdf

3. Daniel Miller, et. al., AAPM Report No. 55: Radiation Treatment Planning Dosimetry Verification, Task Group 23 of the Radiaiton Therapy Committee, (American Institute of Physics, New York, NY, 1995): http://www.aapm.org/pubs/reports/rpt_55.pdf

4. Gerald J. Kutcher, et. al., AAPM Report No. 46: Comprehensive QA For Radiation Oncology, Report of Task Group No. 40, Radiation Therapy Committee, AAPM (American Association of Physicists in Medicine, College Park, MD,1994): http://www.aapm.Org/pubs/reports/rpt_46.pdf

5. AAPM Report No. 166: The use and QA of biologically related models for treatment planning: Short report of the TG-166 of the therapy physics committee of the AAPM: http://www.aapm.org/pubs/reports/RPT_166.pdf

Objectives:

1) Describe and practice appropriate methods of treatment planning system QA.
2) Describe and practice appropriate methods of record & verify system QA.
3) Describe and practice appropriate methods of secondary MU check software QA.

Task 1: Treatment Planning System QA

A. What recommendations exist for treatment planning system QA? Review guidance documents and other information found in the literature or available from the vendors. Compile a list of recommendations and their sources. What is done at your clinical site for treatment planning system QA? If you were a lead physicist at some site, what recommendations would you make regarding treatment planning system QA procedures and the frequency of these procedures?

B. What is the distinction between acceptance testing a new software system and routine QA? When is it appropriate to test a planning system using standard data versus test the planning system with one's own beam data? What standard data is available? Why might tests with standard data be necessary or helpful?

C. How are software upgrades handled? What must be checked following an upgrade to insure that the software is functioning correctly and is ready for clinical use? Create detailed lists of test plans and test calculations that you could use in such a circumstance. Review these with your preceptor.

D. Practice doing some of the tests advocated for treatment planning system QA. Note your observations in your logbook and discuss them with your preceptor.

Task 2: Record & Verify System QA

A. What recommendations exist for record & verify system QA? Review guidance documents and other information found in the literature or available from the vendors. Compile a list of recommendations and their sources. What is done at your clinical site for record & verify system QA? If you were a lead physicist at some site, what recommendations would you make regarding record & verify system QA procedures and the frequency of these procedures?

B. What is the distinction between acceptance testing a new software system and routine QA? When is it appropriate to test a record & verify system using standard data versus test the record & verify system with one's own data? What standard data is available? Why might tests with standard data be necessary or helpful?

C. How are software upgrades handled? What must be checked following an upgrade to insure that the software is functioning correctly and is ready for clinical use? Create detailed lists of test plans and test calculations that you could use in such a circumstance. Review these with your preceptor.

D. Practice doing some of the tests advocated for record & verify system QA. Note your observations in your logbook and discuss them with your preceptor.

Task 3: Secondary-MU-Check Software QA

A. What recommendations exist for secondary MU check software QA? Review guidance documents and other information found in the literature or available from the vendors. Compile a list of recommendations and their sources. What is done at your clinical site

for secondary MU check software QA? If you were a lead physicist at some site, what recommendations would you make regarding secondary MU check software QA procedures and the frequency of these procedures?

B. What is the distinction between acceptance testing a new software system and routine QA? When is it appropriate to test a secondary MU check software system using standard data versus test the system with one's own data? What standard data is available? Why might tests with standard data be necessary or helpful?

C. How are software upgrades handled? What must be checked following an upgrade to insure that the software is functioning correctly and is ready for clinical use? Create detailed lists of test plans and test calculations that you could use in such a circumstance. Review these with your preceptor.

D. Practice doing some of the tests advocated for secondary MU check software QA. Note your observations in your logbook and discuss them with your preceptor.

Unit 10: Prevention of Technology-Related Errors

References:

1. James A. Purdy, et. al., AAPM Report No. 56: Medical Accelerator Safety Considerations, Report of AAPM Nuclear Medicine Task Group 35, (American Institute of Physics, New York, NY, 1996): http://www.aapm.org/pubs/reports/rpt_56.pdf

2. H.I. Amols, New Technologies in Radiation Therapy: Ensuring Patient Safety, Radiation Safety and Regulatory Issues in Radiation Oncology, Health Physics **95** (5), 658-65 (2008).

3. IAEA power-point on the Therac-25 issues: http://rpop.iaea.org/RPOP/RPoP/Content/Documents/TrainingAccidentPrevention/Lectures/AccPr_2.03_Accelerator_software_problems_USA_Canada_WEB.ppt#449,62

4. AAPM Virtual Library Presentations on errors (protected content: must be an AAPM member): click on link below; then sign in, and then in the left-hand column go to "Annual Meetings", "2007", "Symposia", "Professional Course Series"; several of these are useful; Peter Dunscombe gives error examples; http://live.blueskybroadcast.com/bsb/client/CL_DEFAULT.asp?Client=1&PCAT=485&CAT=496

5. Glasgow error: http://www.dailymail.co.uk/news/article-412992/Human-error-responsible-cancer-girls-19-radiation-overdoses.html

6. New York MLC error: http://www.health.state.ny.us/environmental/radiological/radon/radioactive_material_licensing/docs/berp2005_1.pdf

7. NRC website: http://www.nrc.gov/materials/miau/med-use.html, http://www.nrc.gov/site-help/search-select.cfm?q=medical+events&sa=Search&cof=FORID%3A11&cx=01431102830282974089 9%3Agsojhkka504#927

8. Walt Bogdanich series of articles on Medical Physics errors in the New York Times (beginning in June 2009): http://topics.nytimes.com/top/reference/timestopics/people/b/walt_bogdanich/index.html?offset=0&s=newest

Objectives:

1.) Describe safety concerns in Radiation Oncology.
2.) Discuss the types of errors that can occur with new technology.
3.) List methods to prevent clinical and safety errors.
4.) Outline ways to learn from errors that may occur in the clinic, and to put procedures in place to help avoid them in the future.

Review the documents cited above and other safety-related documents in the literature. For each of the following, write your answers and review them with your preceptor:

A. What safety concerns are important in Radiation Oncology? What impact does the increasing reliance on technology have on the type and frequency of errors? What concerns exist when new technology is introduced into the clinic? What can be done to minimize these concerns?

B. Review error cases that have been reported and analyzed in the literature. Are there factors that several of these cases have in common? How were each of these cases resolved? For each of these cases, are there additional steps that you would advocate to help ensure that the error would not recur?

C. Is there a consensus in the literature for the definition of a "radiation misadministration"? Does the definition of misadministration include linac errors as well as radionuclide errors? What is the difference between a "reportable" event and a "recordable" event?

D. What types of errors have occurred at your clinical site? How were these errors caught? How were these errors addressed? What mechanisms, policies, or procedures have been put in place to try to prevent these errors in the future? What other mechanisms could be put in place to help catch and prevent errors? Is there a defined method for communicating information about errors or suspected errors at your clinical site?

E. What is the best way to approach an error investigation? Should error-investigation be a team endeavor? How would you ensure that errors are reported? How would you create a climate of trust and mutual support where the truth is paramount? How would you create a climate where everyone is alert and checks each-other's work for the benefit of the patient, rather than a climate where everyone is looking to blame and not to be blamed? How could you enforce appropriate consequences without shaming an individual? How can a clinical site (and possibly other clinical sites) benefit from the analysis and resolution of an error? What is your preceptor's point of view on these issues?

MODULE III: TREATMENT PLANNING

This module should typically be completed during the second and third quarters of the Clinical Practicum course.

Unit 1: Prerequisites for Treatment Planning

References:

1. JCAHO website: http://www.jointcommission.org/PatientSafety/UniversalProtocol/up_faqs.htm

2. ICRU information: http://jicru.oxfordjournals.org/cgi/content/extract/4/1/25

3. QUANTEC data: http://www.aapm.org/pubs/QUANTEC.asp

4. Eric J. Hall and Amato J. Giaccia, Radiobiology for the Radiobiologist, 6th edition, (Lippincott Williams and Wilkins, Philadelphia, PA, 2005).

5. Ann E. Wright and Arthur L. Boyer, editors, AAPM Monograph Number 9, Advances in Radiation Therapy Treatment Planning, (American Institute of Physics, New York, NY, 1983).

6. B. Emami, et. al, Tolerance of Normal Tissue to Therapeutic Radiation, Int. J. Radiat. Oncol. Biol. Phys. 21 (1), 109-22 (1991). http://www.ncbi.nlm.nih.gov/pubmed/2032882?dopt=Abstract, http://en.wikibooks.org/wiki/Radiation_Oncology/Normal_tissue_tolerance

7. Lorrie L. Kelly and Connie Peterson, Sectional Anatomy for Imaging Professionals, 2nd edition, (Mosby/Elsevier, Philadelphia, PA, 2007).

8. Faiz M. Khan, The Physics Of Radiation Therapy, 3rd ed. (Lippincott Williams & Wilkins, Philadelphia, PA, 2003.

9. AAPM Report No. 166: The use and QA of biologically related models for treatment planning: Short report of the TG-166 of the therapy physics committee of the AAPM: http://www.aapm.org/pubs/reports/RPT_166.pdf

Objectives:

1) Explain the Joint Commission's emphasis on "correct patient, correct treatment, correct site", and how this standard is met in your clinic.
2) Review the ICRU volumes and various radiobiology concepts as applied to the thought process behind treatment planning.
3) Describe and practice the process of image fusion.
4) List normal-tissue tolerances and explain their impact on treatment planning.
5) Observe and practice contouring for several anatomical sites.

Task 1: Anatomical Site Verification

It is an important JCAHO safety consideration to verify that the correct patient receives the correct treatment to the correct anatomical site (see Joint Commission link, above). What is done in your clinic to ensure this with regard to radiation procedures? When beginning a plan, is it a routine practice for the planner to review the chart and double-check that the correct area is going to be planned? What is done to prevent image sets from being imported into the wrong patient? What is done to prevent the completed plans from being incorrectly associated in the record and verify or treatment delivery system? Can you think of other areas that may be of concern, or additional safeguards that could be put into practice? Please write descriptive answers to these questions, and review them with your preceptor.

Task 2: The ICRU Volumes

Review the definitions of the GTV, CTV, PTV, etc; how are these delineated at your clinic? Which are drawn by the physician, and which are defined expansions depending on the anatomical site? What are the rules for these expansions at your clinic or in the literature, and what is the basis for these rules? Please write your answers, and review them with your preceptor.

Task 3: TCP, NTCP, and Radiobiology Concepts

Review the concepts of TCP, NTCP, dose-response, re-oxygenation, repopulation, repair of sub-lethal damage, re-assortment of cells within the cell cycle, and the effects of time, dose, and fractionation. Are / how are these concepts employed in your clinic? If they are not used directly in the treatment planning process in your clinic at this time, how might they be in the future? Is TCP or NTCP used in plan evaluation / comparison? Please write your answers, and review them with your preceptor.

Task 4: Image Fusion / Image Registration

A. Why might an image fusion be performed? In your clinic, who decides if an image fusion should be done for a particular patient? What are the reasons behind these decisions? List possible benefits from image fusion, as well as circumstances when one should not spend the time to perform an image fusion. When might it be of benefit to perform multiple fusions on the same patient with different modalities (i.e. CT, MRI, PET)? Please write your answers, and review them with your preceptor and radiation oncologist.

B. Using your clinic's CT-Sim workstation or treatment planning system, observe, learn, and practice the method by which CT-Sim images are fused with previous CT images (i.e. images taken prior to surgery), PET images, and MRI images. If possible, review the documentation provided by the software manufacturer for the image fusion process. Write detailed steps for these procedures; include image import methods (both from the network and from CD or DVD). Ask your preceptor to review your process steps.

C. How are the images aligned if the scans were taken with the patient in different positions (i.e. arms up over the head vs. arms at sides)? Who makes the final determination that the images are fused properly prior to contouring? Please write your answers, and review them with your preceptor.

D. Do at least 3 image fusions on your own for practice (at least one CT-CT, one CT-PET, and one CT-MRI). Ask your preceptor or physician to check your work.

Task 5: Organ Tolerances

Become familiar with published normal tissue tolerance tables (i.e. Emami, et. al., QUANTEC data, etc.), and with common normal tissue complications (i.e. ref. 4, chapter 1). What organ tolerances are in use at your clinic? Document them. Are these tolerances physician-specific, or is there a consensus for the physician's group at your clinical site? When might treatment be allowed to proceed even if the customary tolerances are violated? Are there certain limits that should never be exceeded, no matter what? Write your answers, and discuss with your preceptor and radiation oncologist.

Task 6: Contouring for Practice

For each anatomical site given in the contouring section of the Clinical Competency List on p. 15,

A. List the organs at risk for this anatomical site.

B. Cite typical dose tolerances for each of these structures.

C. Practice contouring in the method employed by your clinical site, i.e. using the CT-Sim or the Treatment Planning Computer. Ask your preceptor to review your contours for accuracy. In your clinic, who is responsible for the correctness of the contours? Is there a second check?

Document your work in your logbook.

Unit 2: Mark-and-Start Cases (Clinical Set-Ups)

Objectives:

1) Describe the rationale for performing Mark-and-Start cases.
2) Participate in Mark-and-Start cases for various anatomic sites.

In certain situations, the patient is set up on the treatment couch and treated immediately, without having a CT-Sim or treatment plan. This is often referred to as a "clinical set-up" or a "mark-and-start" case.

Task 1: The Rationale for Clinical Set-Ups

For each of the following questions, please write your answers, and discuss them with your preceptor and/or radiation oncologist.

A. What factors might motivate the decision to do a clinical set-up rather than a simulation and treatment plan? Who decides?

B. Are there circumstances when a CT-Sim may be done the next day (or later), even though the patient has started treatment? What might these circumstances be?

C. If a treatment plan is done later, does the plan typically reflect the treatments done clinically? If one wanted to create such a plan, what factors would need to be taken into account to accurately portray the initial treatments on the plan?

D. What happens in your clinic for after-hours or week-end treatments? When a patient begins treatment over the weekend, what are the responsibilities of physics/dosimetry on Monday with regard to this patient?

E. Describe the differences between mark-and-start cases and sim-and-treat cases. What is the difference between a sim-and-treat case and a 3-D conformal case? Why are certain patients treated as mark-and-start cases, others as sim-and-treat cases, and still others with 3D-conformal or IMRT? List pro's and con's for each type of treatment.

Task 2: Performing Clinical Set-Ups

A. Observe, participate in, and document the steps for each of the Mark-and-Start cases given in the Clinical Competency List, as well as for any other anatomical sites treated in this fashion in your clinic. Note the roles and responsibilities of each member of the Radiation Oncology team in delivering the treatment in an efficient and timely way.

   Pay attention to such factors as:

   - How is the patient immobilized?
   - How is the field size determined?
   - What is done to ensure that the correct area is treated?
   - How is the set-up documented?
   - How are the depth and SSD determined?
   - What parameters are needed in order to calculate the monitor units?
   - Will the patient be treated through a support or table? If so, is this taken into account in the monitor unit calculation?
   - How is the monitor unit calculation performed? How is it verified?
   - Is a second MU check performed prior to treatment or after the treatment is delivered? What is the rationale for this decision in your clinic?
   - Are blocks used for Mark-and-Start cases?
   - If blocks are to be used, how are they created? How are they placed? How is the block position verified? Are they standard blocks used for multiple patients, or blocks specific to this patient?

   Please write your answers and review them with your preceptor.

B. Serve as the physicist in as many mark-and-start cases as possible (with your preceptor or another designated responsible physicist available to observe and check your work). Note your observations and insights in your logbook.

Unit 3: 3D-Conformal Planning

References:

1. ACR-ASTRO Practice Guideline for 3D External Beam Radiation Planning and Conformal Therapy: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/3d_external_beam.aspx

2. Ann E. Wright and Arthur L. Boyer, editors, AAPM Monograph Number 9, Advances in Radiation Therapy Treatment Planning, (American Institute of Physics, New York, NY, 1983).

3. G. C. Bentel, Radiation Therapy Planning, (McGraw-Hill Health Professions Division, New York, NY, 1996).

4. Faiz M. Khan, The Physics Of Radiation Therapy, 3rd ed. (Lippincott Williams & Wilkins, Philadelphia, PA, 2003.

5. Chester Reft, et. al., Dosimietric Considerations for Patients with Hip Prostheses Undergoing Pelvis Irradiation, Report of the AAPM Radiation Therapy Committee Task Group 63, Med. Phys. **30** (6) 1162-1182, (2003). http://www.aapm.org/pubs/reports/rpt_81.pdf

6. J.R. Marbach, et. al., Management of Radiation Oncology Patients with Implanted Cardiac Pacemakers, Report of AAPM Task Group 34, (American Institute of Physics, New York, N.Y., 1994). http://www.aapm.org/pubs/reports/rpt_45.pdf

7. Radiotherapeutic and surgical management for newly diagnosed brain metastasis/es: An American Society for Radiation Oncology evidence-based guideline (2012): https://www.astro.org/Clinical-Practice/Guidelines/Brain-metastases.aspx

Objectives:

1) Explain the importance of understanding the physician's goals in the treatment planning process.
2) Observe, document, and practice doing 3-D conformal treatment plans for various anatomical sites.
3) Document and practice the process of sending these plans to the record and verify system / treatment delivery system.

Task 1: Physician Communication

The first step in treatment planning is often learning what the physician has in mind. In trying to create a plan that meets the physician's goals and constraints, it is a good idea to first run a plan that follows the physician's stated preferred beam arrangement. As a physicist, it is also important to consider what other beam arrangements or treatment techniques may better meet the physician's goals, or may spare more normal tissue. Be sure to run plans that you think may be better than the plan the physician originally requested, and compare them with the plan that follows the physician's preferred beam arrangement. Consider what you might vary to improve the plan. Compare plans using dose volume histograms and any other tools your treatment planning system may offer. Discuss your treatment plans with the physician, showing him/her the best alternatives you have created.

As you work through each of the plans in this section, keep the following questions in mind; write descriptive answers, and review them with your preceptor:

- What information is needed before you can begin the treatment plan?
- How is this information obtained?
- What strategies work best for learning what the physician has in mind?
- What strategies work best for presenting plans to the physician?
- What criteria lead the physician to select the plan that ultimately is chosen?

Task 2: Creating 3D-Conformal Treatment Plans

A. Observe, write detailed how-to procedures, and create treatment plans for each of the 3-D conformal cases given in the Clinical Competency List, as well as for any other anatomical sites treated in this fashion in your clinic. At least three plans are required for each of the following sites: breast, pelvis, and lung. At least one plan is required for each of the other sites/cases listed, but the more practice you have in doing treatment planning the more skill you will acquire: work on as many patients as you possibly can.

   As you work through this section, discuss each of the cases with one of the physicians at your clinical site, and document their responses. For each of the plans you do, keep a copy (with identifying patient information removed) for your future reference (and for your preceptor to review).

B. What is the process for sending a completed 3D-Confromal plan to the record and verify system / treatment delivery system? Document the steps involved, and ask your preceptor to review

them. If possible, practice sending completed and approved plans, under the guidance of your preceptor.

C. What is the role of bolus in treatment planning? When and how is bolus used? How is the necessary bolus thickness determined? Is / how is bolus modeled in the treatment planning system? Is the use of bolus shown or noted on the treatment plan printout? How is the use of bolus documented and communicated to the therapists? Discuss your responses with your preceptor.

Unit 4: IMRT Planning

References:

1. ACR-ASTRO Practice Guideline for Intensity Modulated Radiation Therapy (IMRT): http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/imrt.aspx

2. Gary A. Ezzell, et al., Guidance document on delivery, treatment planning, and clinical implementation of IMRT: Report of the IMRT subcommittee of the AAPM radiation therapy committee, Med. Phys. **30** (8), 2089-2115 (2003). http://www.aapm.org/pubs/reports/rpt_82.pdf

3. Jatinder R. Palta and T. Rockwell Mackie, editors, AAPM Monograph Number 29, Intensity Modulated Radiation Therapy: The State of the Art, (Medical Physics Publishing, Madison, WI, 2003).

Objectives:

1) Describe the rationale for IMRT vs. 3D-Conformal treatments.
2) Observe, document, and practice doing IMRT treatment plans for various anatomical sites.
3) Document and practice the process of sending these plans to the record and verify system / treatment delivery system.
4) Observe, document, and practice the methods of IMRT QA in use at your clinical site. Compare these with other IMRT QA methods that might be implemented.

Task 1: IMRT vs. 3D-Conformal

As you work through each of the plans in this section, keep the following questions in mind; write descriptive answers, and review them with your preceptor:

- How is IMRT planning different from 3D-Conformal Planning?
- What are the differences in how you approach the problem?
- What might you vary to create a better treatment plan?
- What criteria lead the physician to select the plan that ultimately is chosen?
- Why did the physician prefer the IMRT plan to a 3D-Conformal plan? Could a 3D-Conformal plan have met the physician's goals just as well?

- Is the process of sending an IMRT plan to the record and verify system / treatment delivery system different from the process for sending a 3D-Confromal plan? If so, document any differences.

Task 2: Creating IMRT Treatment Plans for Head and Neck, Prostate, and Breast

A. Observe, write detailed how-to procedures, and create IMRT treatment plans for head and neck, prostate, and breast cases, as well as for any other anatomical sites treated in this fashion in your clinic (lung with motion-averaged target volumes will be addressed in the next section). At least three plans for each site are required, but the more practice you have in doing planning the more skill you will acquire: work on as many patients as you possibly can.

   As you work through this section, discuss each of the cases with one of the physicians at your clinical site, and document their responses. For each of the plans you do, keep a copy (with identifying patient information removed) for your future reference (and for your preceptor to review).

B. What is the process for sending a completed IMRT plan to the record and verify system / treatment delivery system? Document the steps involved, and ask your preceptor to review them. If possible, practice sending completed and approved plans, under the guidance of your preceptor.

Task 3: Creating IMRT Treatment Plans for Lung with Motion-Averaged Target Volumes

There are several image-guided methods for taking respiratory motion into account during the treatment of lung lesions (i.e. fiducial-based systems, respiratory gating methods, etc). These will be investigated in detail in the Special Procedures Module. A simple method to be sure that the entire lung target volume is treated involves fusing CT images taken during different parts of the respiratory cycle and constructing a target volume large enough to encompass the lesion's entire trajectory.

For each of the following, please write your answers, and discuss with your preceptor:

A. Why might using a motion-averaged target volume be preferable to treating the patient based on a CT scan taken at one particular phase of the respiratory cycle?

B. What might be the negative aspects of using a motion-averaged target volume?

C. If one free-breathing CT scan is taken with an old single-slice scanner, is the effect of respiratory motion accounted for sufficiently?

D. How does your physician determine margins for lung treatments? Are there guides or standards-of-practice in the literature?

E. How are lung IMRT treatments done at your clinical site? (If your site does not use IMRT for lung, check the literature to see how other clinics have been doing this). Detail the steps of this process.

F. If possible, create an IMRT plan for lung based on a motion-averaged target volume. (If such a target is not possible at your site, create an imaginary example target on a CT set used for a 3D-Conformal lung treatment, and use this to try creating an IMRT lung plan for practice.) As with the other plans you have done, discuss it with the physician, keep a copy of the plan, and ask your preceptor to review it.

Task 4: IMRT QA: Planning, Execution, and Analysis

With a non-IMRT plan, one can perform a hand calculation to independently verify that the monitor units are correct. With an IMRT plan, patient-specific measurements are typically made to ensure that the plan will be delivered correctly.

A. For each of the following, please write your answers, and discuss them with your preceptor:

   a. What recommendations / guidelines can you find in the literature as to how IMRT QA ought to be performed? What measurements / calculations are recommended? How much QA is enough? What are the recommended tolerances? List them. Do they vary for different anatomical sites? What should be done if the QA fails?

   b. How is IMRT QA performed at your clinical site? Document each step of the process: creating the QA plan, performing the measurements, and analyzing the results. If this clinic's process differs from the recommendations you found in the literature, why is the process in use at your clinic judged to be a good one?

   c. Is IMRT QA done for every patient and every anatomical site in your clinic? If not, why not? Are there situations in which IMRT QA may not be necessary? If so, what might those circumstances be?

d. When is / when should IMRT QA be performed in relation to the start of the patient's treatment? What is the rationale for this? What consequences might result if the QA were not performed in a timely way?

e. Often, while a QA plan is created for comparison, it is the actual patient plan that is delivered for the QA measurements. Is / when is it acceptable to deliver the QA plan for the QA measurements? Discuss pros / cons / possible pitfalls.

f. Can thorough, diligent, and frequent MLC QA substitute for patient-specific IMRT QA? If yes, what tests would be required? If no, what makes MLC QA an inadequate substitute for IMRT QA? Are there other tests that could be done in place of patient-specific QA?

g. Even if the IMRT QA shows that everything is within tolerance, should this give us confidence that the patient's IMRT plan will be correctly delivered every time?

h. Investigate and describe other methods of IMRT QA that are not in use in your clinic but that might be implemented in other clinical sites, i.e. using different phantoms, different QA devices, different QA software, etc. (Mapcheck, PTW Ion Chamber Array, RIT, Vidar, Portal Image Dosimetry, etc). What are the advantages / disadvantages of each method? If you were to create an IMRT QA program at a clinical site, what equipment / methods would you recommend and why?

B. Perform the entire IMRT QA process as it is done in your clinic. Do at least one QA for each of the anatomical sites treated there with IMRT; as with treatment planning, the more QA's you do, the easier and faster it will be. Work on as many IMRT QA's as you possibly can. Document your work by keeping copies of the QA plans and data analysis for each QA that you do, and review them with your preceptor.

Unit 5: Protocols

References:

1. Arthur J. Olch, et. al., Quality Assurance for Clinical Trials: A Primer for Physicists, AAPM Report No. 86, (Medical Physics Publishing, Madison, WI, 2004). http://www.aapm.org/pubs/reports/rpt_86.pdf

2. Radiation Therapy Oncology Group (RTOG) website: http://www.rtog.org/index.html

3. Eastern Cooperative Oncology Group (ECOG) website: http://ecog.dfci.harvard.edu/

4. Children's Oncology Group (COG) website: http://www.childrensoncologygroup.org/

5. Gynecologic Oncology Group (GOG) website: http://www.gog.org/

6. National Surgical Adjuvant Breast and Bowel Project (NSABP) website: http://foundation.nsabp.org/

7. National Cancer Institute (NCI) website: http://www.cancer.gov/

8. Quality Assurance Review Center (QARC) website: http://www.qarc.org/

9. Cancer Trials Support Unit (CTSU) website: https://www.ctsu.org/

10. Advanced Technology Consortium (ATC) website: http://atc.wustl.edu/

11. Radiological Physics Center (RPC) website: http://rpc.mdanderson.org/rpc/

Objectives:

1) Describe the purpose of cooperative groups in Radiation Oncology.
2) Demonstrate how to submit protocol-related materials for patient cases.
3) Explain the purpose of and demonstrate the execution of benchmark studies prior to participation in cooperative groups.

Take some time to peruse the websites listed above. Use the information found there to help you to answer the following questions. Write your answers, and review them with your preceptor.

A. State the primary purpose of each of the cooperative groups or clinical trial support organizations listed above. Why are there so many? Who typically participates in each one?

B. Is there a benefit to the Radiation Oncology Center for participating in clinical trials? Is it likely that patients will select a Medical Center based on their participation in a certain clinical trial? Is there a cost or a remuneration for participating, either to the hospital or the patient (i.e. for RTOG)?

C. Are there any protocol patients currently being planned or treated at your clinical site? What protocols have been used most at your clinical site? How is the decision made to enter a patient into a protocol?

D. Select a protocol used recently at your site (or select any protocol from the RTOG as an example). Look up the protocol on-line. What are the physics requirements? What data will need to be submitted, and when? What physics summary forms will need to be filled out?

E. At your clinical site, who is typically responsible for gathering the necessary information and submitting it? If your site has recently entered a patient into this protocol, review that patient's chart and submission forms/data. When the patient was submitted, were alterations required by the reviewers at the protocol office? What documentation was (or would have been) required to confirm that these modifications had taken place?

F. From the QARC website, the "RT Forms" link, locate and print out the "RT1 Dosimetry Summary Form" and "RT2 Radiotherapy Total Dose Record". Practice filling out these forms for an example (or actual) patient.

G. Benchmark studies or "dry runs" must often be submitted prior to a clinical site's participation in protocols. What is the purpose of these benchmark studies? Who is responsible for deciding if an institution passes these benchmarks? What can be done if the institution's benchmark study does not pass?

H. On the QARC website, review some of the benchmark cases described. Select one or two of the benchmarks, and do them as if you were required to submit them for review. Review them with your preceptor.

I. How do the QARC benchmarks differ from the RPC credentialing process? Which cooperative groups require QARC benchmarks and which require RPC credentialing? Which require ATC involvement? Why do some protocols require submission of phantom studies and others

require submission of only a treatment plan? When would RPC test cases (including measurements) be useful apart from preparing for participation in clinical trials?

J. On the RPC website, locate the information on the anthropomorphic phantoms that are available. For any two of these, look up what would need to be measured, and how it would be done. Discuss with your preceptor: which has he/she submitted? How has participation in this RPC process benefitted the clinical site?

Unit 6: Secondary Monitor Unit (MU) Checks

References:

1. Stern, Robin, et. al., AAPM Report No. 114: Verification of monitor unit calculations for non-IMRT clinical radiotherapy: Report of AAPM Task Group 114, Med. Phys. **38** (1), 504-530, 2011: http://www.aapm.org/pubs/reports/RPT_114.pdf

2. Gerbi, Bruce, et. al., AAPM Report No. 99: Recommendations for clinical electron beam dosimetry: Supplement to the recommendations of Task Group 25, Med. Phys. **36** (7), 3239-3279: http://www.aapm.org/pubs/reports/RPT_99.PDF

3. Gerald J. Kutcher, et. al., AAPM Report No. 46: Comprehensive QA For Radiation Oncology, Report of Task Group No. 40, Radiation Therapy Committee, AAPM (American Association of Physicists in Medicine, College Park, MD,1994): http://www.aapm.Org/pubs/reports/rpt_46.pdf

4. Harold E. Johns and J. R. Cunningham, The Physics of Radiology, 4th ed., (Charles C. Thomas Publisher, Springfield, IL, 1983).

5. Ponnunni K. I. Kartha and Phyllis Thompson, Dosimetry Workbook, (Year Book Medical Publishers, Inc, Chicago, IL, 1982).

6. Faiz M. Khan, The Physics Of Radiation Therapy, 3rd ed. (Lippincott Williams & Wilkins, Philadelphia, PA, 2003.

Objectives:

1) Explain the rationale for and describe the process of secondary MU checks.
2) Review the use of hand calculations for secondary MU checks.
3) Describe the proper use, implementation, and testing of secondary MU check software programs.

Task 1: Rationale and Process for Secondary MU Checks:

A. Review the requirements and recommendations outlined in TG 40 and any other guidance documents available in the literature regarding secondary monitor unit calculations. Summarize these recommendations in your logbook.

B. For the following questions, write your answers and then discuss them with your preceptor:

1. Why are secondary MU checks (either by hand or using a secondary-check software program) important? What errors could one reasonably expect to catch or prevent by performing a secondary check?

2. For a patient about to begin treatment, when should the secondary check be performed? Should the check be done prior to treatment, or within a certain number of treatments? If "within a certain number of treatments", within how many treatments? Is this spelled out in the guidance documents, or is it up to the lead physicist in each clinic?

3. Who should perform the secondary monitor unit check? Who should review the secondary check, and when or how often should it be reviewed? Under what circumstances would a new calculation be needed (i.e. what things might change that would warrant a new calculation)?

4. Does your clinical site have a written procedure specifying how, when, and by whom the secondary check should be performed? Do the guidance documents require or recommend the creation of such a policy? What are the advantages / disadvantages of having such a policy?

5. What tolerance is permitted if there is a discrepancy between the initial calc and the secondary check? If you observe a discrepancy larger than the permitted tolerance, what should be done? Which monitor units are considered "more correct", and why? Which MU's should be used for treatment?

6. Are there differences in the definition of acceptable tolerances depending on the type of calculation, i.e. IMRT vs. 3D conformal? What should be done if the calc is not within the specified tolerance?

7. When / how are inhomogeneities considered in the calculation? Should inhomogeneities be considered? Why or why not?

8. If the actual depth read on the patient's skin at the time of treatment is not in agreement with the depth for which the calc was performed, what should be done? What tolerances in depth are typically allowed? What should be done if the depth/SSD should change during the course of treatment? How would such a change in depth be known? Would / when would a new treatment plan be required?

C. Review and document the secondary monitor unit check methods employed by your clinical site, especially with regard to the questions posed in B1-8 above. Compare and contrast the recommendations of TG 40 and any other guidance documents that you found with your clinic's methods. If there are discrepancies, why is the method used by your clinical site deemed appropriate? If you were the lead medical physicist in a particular clinic, would you do anything differently with regard to secondary checks, and if so, why?

Task 2: Review of Hand Calculations

Review the methods of performing hand calculations from your course notes and texts and/or from the texts listed above.

A. What calculations are typically checked using a hand-calc vs. using a computer calc? How are IMRT calcs checked, and why, i.e. can IMRT calcs be checked by hand? Why or why not? Discuss with your preceptor.

B. Practice doing hand calcs for at least 5 patients treated in your clinic. Review your work with your preceptor. How does your calculation compare with the MU's being used for treatment? If there is a discrepancy, should the treatment MU's be changed? Why or why not? Discuss with your preceptor.

Task 3: Secondary Check Software

A. Learn to use the secondary monitor unit calculation software employed by your clinic. Document the steps of the process. Practice using the software for at least 5 monitor unit calculations. Be sure to do at least one quick-calc check, i.e. for a clinical set-up, at least one 3-D conformal plan check, and at least one IMRT calc check. Review your work with your preceptor.

B. For the following questions, write your answers and then discuss them with your preceptor:

1. How is data transferred from the treatment planning system to the secondary check software? What process is in place to ensure that the data transfers correctly?

2. What algorithm or algorithms does your secondary check software program use for its calculations? Is there a choice of algorithm? What algorithms are available in the treatment planning system? How would you expect the results from the secondary check software algorithm to compare with the results from the treatment planning system algorithm, based on how these algorithms work / what factors they take into account / each algorithm's strengths and weaknesses? Which would you expect to be "more correct"? Which MU's should be used for treatment, and why?

3. Are (or how are) inhomogeneities handled by the secondary-check software? How will this affect the comparison with the treatment planning software's calculation? What affect will this have on allowable tolerances?

4. Review your site's documentation regarding the installation of this secondary check program. How was the software set up? What data was needed? Where did this data come from? Was the data input by the vendor or by the physicists on site? How was the secondary check software tested prior to clinical implementation?

5. What requirements / guidelines are there regarding regular QA for secondary check software? What regular QA is performed at your clinical site? If you were the lead medical physicist in a particular clinic, would you do anything differently with regard to QA for the secondary check software, and if so, why?

6. If you were to implement an upgrade of the secondary check software, what tests would you need to perform following the installation of the new software to ensure that the program was behaving correctly and could be put back into clinical service?

7. Look up websites for several vendors of secondary check software. What are the pros and cons of each vendor's product? How would you determine which product to advocate purchasing for a new radiation oncology site?

Unit 7: Block Cutting

References:

1. G. C. Bentel, Radiation Therapy Planning, (McGraw-Hill Health Professions Division, New York, NY, 1996): Chapter 8.

1. Huestis Medical website: http://www.huestismedical.com/HuestisMed/productpgs/products_rad.html

3. Ann E. Wright and Arthur L. Boyer, editors, AAPM Monograph Number 9, Advances in Radiation Therapy Treatment Planning, (American Institute of Physics, New York, NY, 1983), "Design of Compensating Filters".

Objectives:

1) Describe and practice the fabrication of photon and electron blocks.
2) Describe and practice the measurement of electron cutout factors.
3) Describe various methods of tissue compensation.

Task 1: Photon and Electron Blocks

A. For each of the following, please write your answers and discuss them with your preceptor:

1. When might hand blocks be used for patient treatment? Are (or when are) hand blocks used in your clinic? Do hand blocks typically have divergence? Is (or when is) this important? Why or why not? When hand blocks are used, what is done to be sure that they are placed correctly?

2. When are custom photon blocks used in your clinic? Are photon blocks ever used along with MLC's? If so, give examples. Who is responsible for making photon blocks? When custom blocks are used, what is done to be sure that they are correct?

3. Observe the process of making photon blocks; document the steps for this process. Is divergence important? Why or why not? If divergence is important, what would happen if the divergence were incorrect? How much would it matter?

4. What are photon transmission blocks? When might they be used? How are they fabricated? How would one determine if a transmission block has been made correctly? What are the expected transmissions for MLC's, linac jaws, and cerrobend for 6MV and 10MV photons?

5. When are custom electron cutouts used in place of standard electron cutouts? Who is responsible for making these electron blocks? In your clinic, are electron cutouts made from the treatment planning system or drawn clinically? What is the process of clinically drawing an electron cutout? (Observe this if it is done at your clinical site.)

6. Observe the process of making electron cutouts; document the steps for this process. Is divergence important? Why or why not? If divergence is important, what would happen if the divergence were incorrect? How much would it matter?

7. How is the process of making electron blocks different from the process of making photon blocks?

8. Who is responsible for measuring electron cutout factors? Observe and document the steps for measuring electron cutout factors.

9. How should the ion chamber be oriented to measure a long thin cutout? What would happen if the ion chamber were in another orientation?

10. Does the size of the ion chamber used to measure an electron cutout have an effect on the measurement? If so, how?

B. Practice making at least one photon block (including a Mantle block).

C. Practice making at least one electron cutout.

D. Practice measuring at least 2 electron cut-out factors; review your work with your preceptor.

Task 2: Compensators

Look up compensating filters in the literature. Describe various methods of tissue compensation, including Ellis filters and commercially milled filters. Is tissue compensation routinely done in your clinic? Why or why not? Describe circumstances where tissue compensation could be especially helpful. Can compensators be used in place of MLC's to do IMRT? If yes, list the pros and cons of this method. Discuss with your preceptor.

Unit 8: Diodes / TLD

References:

1. Ellen Yorke, et. al., AAPM Report No. 87, Diode In Vivo Dosimetry For Patients Receiving External Beam Radiation Therapy, Report of Task Group 62 of the Radiation Therapy Committee, (medical Physics Publishing, Madison, WI, 2005). http://www.aapm.org/pubs/reports/rpt_87.pdf

2. Landauer website: OSL detectors: http://www.osldosimetry.com/introduction/

3. Radiological Physics Center (RPC) Website: http://rpc.mdanderson.org/rpc/

Objectives:

1) Explain the use of diodes for patient dose verification in Radiation Oncology.
2) Describe and practice diode calculations.
3) Describe and practice calibrating a diode.
4) List the steps involved in selecting and setting up a new diode system.
5) Compare and contrast diodes with other patient dosimeters, i.e. TLD, OSL dosimeters, etc.

Task 1: The Clinical Use of Diodes

For each of the following, write your answers and review them with your preceptor.

A. From your previous texts, from the references listed above, or from the literature, review the workings of a diode detector.

B. How are diodes used for patient dose verification at your clinical site? Document this process. Review AAPM guidelines and any recommendations in the literature for the use of diodes. What is the rationale for making in vivo measurements? If you were the lead physicist at this particular clinic, are there any diode practices that you would alter or implement, and if so, why?

C. Do billing considerations have any impact on the use or frequency-of-use of diodes? If yes, how?

D. Are diodes typically used for both photons and electrons? Can the same diode be used for both? Why or why not? Should different diodes be used for different energy beams? Why or why not?

E. Do diodes typically exhibit a directional dependence? If yes, can (or how can) this be measured in the clinical setting? If there is a directional dependence, how would one avoid having this influence a patient dose verification measurement?

F. Are there particular set-ups or treatment conditions where diode in-vivo dose verification would require special instructions on diode placement for the therapists?

G. From your previous texts, review the methods of doing diode calculations by hand. Observe and practice these calculations in your clinic.

H. Does the secondary check software program in use at your clinical site produce a diode calculation or an expected value for comparison? How is this calculation performed? Review and understand the software's calculation method: be sure to understand where each number it uses comes from, and any expectations the software may have regarding diode calibration. Does the software give the same result as your hand calculation? If not, why not?

I. If a diode reading is not as expected, what would you check in the diode hand calculation and/or secondary-check-software calculation? What would you check in the original monitor unit calculation? At your clinical site, what is the procedure for dealing with diode readings that are out of tolerance?

J. What factors can influence a clinical diode dose verification measurement? If you were to ask the therapists to repeat a diode reading, are there special considerations to which you would ask them to be especially attentive? How would you be certain that the diode was positioned correctly? How would you know if the SSD and depth were correct?

K. What can or should be done if the SSD on the day the diode measurement is taken is not the same as the SSD used for the original calculation? How much variability in SSD is acceptable for a diode measurement to be valid?

L. What tolerances are appropriate under what circumstances for diode measurements, and why? What action levels are in use at your clinical site? Are there recommended action levels?

M. What would you do if a diode reading was not within tolerance, you checked the calculation and it was fine, the therapists repeated the diode reading with you present and the set-up was correct, but the repeated diode reading was still out of tolerance?

N. Do the diodes in use at your clinical site have a limited lifetime? How would one ascertain whether or not a diode is nearing end-of-life?

Task 2: Diode Calibration

A. Research methods of calibrating diodes, concentrating on the diode system in use at your clinical site: check the manufacturer's website and any manuals available in the department. Also consider the requirements of the secondary check software in use in the department. How would you calibrate the diodes at your clinical site?

B. Observe and document the steps actually performed to calibrate the diode system at your clinical site. Why is this calibration method used? How often are the diodes checked or recalibrated, and why? Are there circumstances under which you would recommend that they be checked more or less frequently?

C. Perform a diode calibration with the guidance of your preceptor.

Task 3: Diode System Selection / Acceptance

A. Imagine that you were given the task of recommending a new diode system for your clinical site. What other diode systems are available? What considerations would be important? How would you go about comparing one system against another?

B. Imagine that you were given the task of installing, testing, and calibrating a new diode system. Document the steps that you would follow. How would you be sure that the system was performing correctly and was ready for clinical use? If possible, review the documentation of the acceptance test performed for the diode system currently in use at your clinical site.

Task 4: Other Patient Dosimeters

A. Review the use of TLDs, and the steps involved in making accurate TLD measurements. Contrast this with the use of diodes (list pros and cons).

B. Review the use of OSL dosimeters; contrast this with the use of diodes (list pros and cons).

C. When would a TLD or an OSL dosimeter be better suited for patient dose verification than a diode?

D. If you needed to obtain TLD or OSL dosimeters for a particular patient measurement in the near future, what would need to be done? Describe how you would go about obtaining the necessary dosimeters and how you would be certain that the doses recorded are correct.

E. What alternatives exist to maintaining a TLD program at your clinical site, i.e. can TLD's be read off-site? If so, how does this process work? What would you do if you were asked to get TLD's for a total skin electron patient who will begin treatment soon? What is the turn-around time for off-site TLD services, i.e. how long before you would know the TLD results?

F. Check the internet and/or review the current literature: what other dosimeters are available besides TLD or OSL? Are any in use in your clinic? Are there any that you would recommend instead of a new diode system, and why or why not?

G. Why does the RPC choose to use TLD or OSL for its remote monitoring program?

Unit 9: Beam Data Collection, Modeling, and Commissioning

Special thanks to Jerry Soen, M.S., DABR, FACR whose presentation on this topic contributed significantly to this section.

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6. AAPM Report No. 166: The use and QA of biologically related models for treatment planning: Short report of the TG-166 of the therapy physics committee of the AAPM: http://www.aapm.org/pubs/reports/RPT_166.pdf

7. Varian documentation for Eclipse (this may be a printed manual or this may be electronic but password-protected: in either case, the information should be accessible through your clinical site)

8. Elekta / CMS documentation for XiO (this may be a printed manual or this may be electronic but password-protected: in either case, the information should be accessible through your clinical site)

Objectives:

1) Describe the requirements and process of beam data collection, beam modeling, beam commissioning, and preparing a treatment planning system for clinical use.
2) Practice the skills involved in beam data collection, beam modeling, beam commissioning, and preparing a treatment planning system for clinical use.

For a medical physicist, an important aspect of using a computerized treatment planning workstation is knowing how to input the correct information so that the computer's output will reflect the reality of your particular linear accelerator. Even if the beam data is taken or modeled by a colleague or by the vendor, it is the responsibility of the physicist on site to verify the correctness of the data and the proper working of the treatment planning system. In the following exercises, work with your preceptor and the treatment planning system's vendor-supplied documentation to understand and practice the concepts outlined. You may be able to work with example data (BE CAREFUL NOT TO MODIFY ANY BEAMS CURRENTLY IN CLINICAL USE unless this is the express desire of your preceptor). Prepare detailed how-to procedures for yourself, so that you will be able to do this on your own in the future.

A. Review AAPM and other guidance documents pertaining to beam data collection, modeling, acceptance testing and commissioning. What is the definition / scope of each of these terms?

B. Review the vendor-supplied documentation for your treatment planning system, as well as other pertinent documents in the literature.

   1. What algorithms are available? What algorithms are / will be in use at your clinical site? What are the differences between these algorithms? What are the advantages and disadvantages of each algorithm? Does (or how does) each algorithm model inhomogeneities? Is (or how is) scatter taken into account? What about missing tissue? How accurate is the dose in the penumbra, in the area outside of the beam, or in the build-up region? Where does the algorithm fail? Discuss with your preceptor.

   2. In what clinical situations would each algorithm be best, and why? Which algorithm(s) would you expect your clinic would use most often? How would you explain the differences between the algorithms or advocate for one algorithm over another for a particular clinical case if you wanted to convince your Radiation Oncologist? How would the "new" algorithm's dose compare with what he/she is used to seeing? Which is more real? Which better reflects the standard of care / historical prescribing method? Would the differences observed when using the different algorithms cause your Radiation Oncologist to prescribe differently? Discuss these things with your preceptor and Radiation Oncologist.

C. Review the vendor-supplied documentation for your treatment planning system in order to determine what beam data must be acquired. Pay special attention to vendor recommendations regarding data acquisition methods.

1. What equipment will be needed? Is this equipment available at your clinical site? If not, how could you go about obtaining it, or is there comparable equipment available at your site that could be used?

2. Create a detailed data acquisition plan that you or a colleague could follow to efficiently and comprehensively collect beam data. Review this document with your preceptor.

3. Consider what additional data would be needed in order to verify the accuracy of the modeled beams. Create a detailed data acquisition plan for this data as well, and review it with your preceptor. In your plan, include how each measurement would be made, what comparisons should be done, what tolerances would be acceptable, etc.

4. Also consider what data would be required for input into the secondary monitor unit check software. Create a detailed acquisition plan for this data, too, including appropriate tests, comparisons, and tolerances, and review it with your preceptor.

5. Become familiar with all of the equipment that will be needed for beam data collection and for obtaining the verification data. For example, what are the peculiarities of your particular scanning system, what chambers will be used, etc?

6. If possible, participate in beam data collection and in the collection of whatever additional data would be needed to verify the accuracy of the final modeled beams and the secondary check software.

D. With your newly-acquired beam data, or with demo data or previous data obtained from your preceptor, follow the data manipulation and input process as advocated in the vendor documentation. CAUTION: DO NOT ADJUST ANY BEAMS THAT HAVE BEEN USED CLINICALLY unless you are doing this under the direct guidance of your preceptor! If your clinical site will not allow the input of new data, research and document the process that would have been followed if you were able to perform this step.

E. Following the guidelines provided in the vendor documentation and by your preceptor, practice the process of beam fitting. What parameters are adjusted? How do these adjustments affect the results? Be aware of compromises that may need to be made during the beam-fitting process. Discern the reasons behind these compromises, i.e. are these compromises a function of the algorithm, the vendor implementation of the algorithm, vendor-imposed limitations on certain parameters, etc? What work-arounds, if any, would the vendor recommend or could you devise in order to get a better fit for a broader range of data? Is it important to fit a broad range of data? What does the vendor consider acceptable? What are the limits of the algorithm? If compromises need to be made, is the resulting discrepancy clinically significant? Discuss with your preceptor.

F. In the final step of beam fitting, when the beams are "validated" in XiO or "calculated" in Eclipse, what is the computer actually doing? What is happening during these calculations?

G. Before the treatment planning system can be used to calculate doses with inhomogeneity correction, information regarding the CT numbers corresponding to known electron densities will need to be determined and this data will need to be input into the treatment planning computer. How should these measurements be made? What equipment will be needed? Will this need to be done for each CT and PET/CT which will send images to the treatment planning computer? If images arrive from an outside scanner, i.e. from another hospital, can the CT-to-ED file created for one of your CT scanners be used? What discrepancy would this cause, if any? Are CT-to-ED files required in order to calculate and display DRRs? Practice acquiring and inputting the necessary CT-to-ED data following the recommendations of your treatment planning system vendor. Review your work with your preceptor.

H. After the beams have been modeled, perform as many as possible of the tests you listed above to determine if the planning system's output matches reality. Include tests for the secondary check software. For each of these measurements, what range of errors would you expect? Would you expect the errors to oscillate about a mean? Are the beams now ready for clinical use? Do adjustments need to be made to the fitting? Discuss with your preceptor.

I. What records should be kept to properly document the process of beam data collection, beam modeling, and commissioning? How / where should this information be stored? Why is it important to keep such data? Will this data be useful when software upgrades occur, or when the annual checks are done? Are there recommendations for these things in the guidance documents? What is your preceptor's point of view on these things?

J. What other tests would need to be performed before the system is ready for actual clinical use, i.e. image transfer, connectivity with the record & verify system, printer output accuracy, image and printer scaling, digitizer scaling, etc? How would you test these aspects? Practice performing several of these tests. What would you do if you find problems? How would you resolve them? Discuss with your preceptor.

MODULE IV: SPECIAL PROCEDURES

Unit 1: Radiosurgery

References:

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Objectives:

1) Explain the rationale for radiosurgery.
2) Describe "stereotactic radiosurgery" (SRS), "stereotactic radiotherapy" (SRT), and "stereotactic body radiotherapy" (SBRT).
3) Compare and contrast the different radiosurgery methods available.
4) Outline typical dose and fractionation schemes, margins, and tissue tolerances for several radiosurgery treatment sites and methods.
5) Observe, document, and practice radiosurgery techniques.

Task 1: The Rationale for Radiosurgery

Consult the current literature in order to answer the following questions. Write your answers, and discuss them with your preceptor and radiation oncologist.

A. What anatomical sites can be treated or are typically treated with radiosurgery (intra/extra cranial)?

B. In what circumstances would radiosurgery be preferable to external beam radiation, or to ordinary surgery?

C. What are the advantages and disadvantages of radiosurgery compared with conventional external beam radiation?

D. What are the advantages and disadvantages of radiosurgery compared with ordinary surgery?

E. What are the differences between "stereotactic radiosurgery" (SRS), "stereotactic radiotherapy" (SRT), and "stereotactic body radiotherapy" (SBRT)? In what circumstances and for what reasons would each of these be performed?

F. What dose and fractionation schemes are typically employed for each anatomical site listed in "A" above? Are these different from the dose and fractionation schemes used in conventional radiotherapy for these sites? Why or why not?

G. Do dose and fractionation schemes for radiosurgery depend on whether the treatment is SRS versus SRT? Why or why not? If yes, please describe.

H. What margins are typically employed for each anatomical site listed in "A" above? Are these different from the margins used in conventional radiotherapy for these sites? Why or why not?

I. Do margins for radiosurgery depend on whether the treatment is SRS versus SRT? Why or why not? If yes, please describe.

J. For each of the sites listed in "A" above, what are the adjacent normal tissues of concern? What are typical tolerance limits for these structures? Do these limits depend on whether the treatment is SRS versus SRT? Why or why not? If yes, please describe.

K. Who is typically involved in treatment planning for radiosurgery? Is this usually a dosimetry responsibility or a physics responsibility, and why? (Consider such factors as time, expertise, etc.) What is the role of non-radiation-oncology physicians?

Task 2: Radiosurgery Methods

Compare and contrast the various methods of performing radiosurgery, i.e. linac-based methods (for example, Brainlab and Radionics), Gamma Knife, CyberKnife, and any others. Write your answers, and review them with your preceptor.

A. What are the advantages and disadvantages of each of these methods in terms of precision, accuracy, patient comfort, staff involvement, anatomical sites that can be treated, how the radiation is produced, how the radiation is delivered, etc?

B. How do these methods differ with regard to treatment of intra-cranial sites? How do these methods differ with regard to treatment of extra-cranial sites?

C. Do dose and fractionation schemes, margins, and tissue tolerances vary for these different methods? Why or why not? If yes, please describe.

D. What quality assurance is needed for each of these methods? Create an outline of the quality assurance procedures that are required for each method, including the frequency of each test, and when it should be performed with regard to the day and time of treatment. What are the

acceptable tolerances for each test? Where do these tolerances come from? What should be done if the test fails?

E. How is the treatment planning different or similar for each of these methods? What imaging studies are typically performed prior to planning? How are these studies used, i.e. for target localization, image fusion, other applications? How is the quality of the plan assessed? Do inherent differences between radiosurgery methods imply that certain methods will produce a better plan in certain circumstances or for certain types of cases? Give examples.

F. In each of these methods, how is the patient's proper positioning assured? How is motion controlled / curtailed / accounted for in each of these methods? Which methods employ imaging to check patient position? Is the imaging done prior to treatment or during treatment? How does the imaging system work, and what quality assurance is done to ensure that the imaging system is functioning properly? What level of accuracy and precision should be expected from each of these fixation methods or imaging methods?

G. Why might the consequences of an error in a radiosurgery treatment be greater than for conventional external beam radiotherapy? What broader measures can or should be put in place to ensure that patients are treated safely and correctly, and the possibility of an incorrect treatment is reduced?

H. If you were asked to recommend a radiosurgery process/device for a new Radiation Oncology center, what would you advocate, and why? What arguments would you use to convince the lead physician to agree with you? Outline costs versus benefits, including considerations such as your patient population and anatomical sites that can be treated, shielding requirements, quality assurance requirements, treatment delivery time and required staff involvement, patient comfort and cooperation, and accuracy and precision of patient positioning and treatment delivery.

Task 3: The Radiosurgery Process: Observation and Practice

At the start of Module I you were given an overview of the clinical process for external beam radiotherapy and were asked to observe, participate in, and analyze each step. Research, observe, and participate in as many of the radiosurgery methods described above as possible. For each radiosurgery method, create an outline of its clinical process analogous to the outline for external beam radiotherapy. For steps that are modified compared with the process of external beam radiotherapy, complete a sheet like the one on page 26 (duplicated below) to analyze each step in detail. Include QA, imaging studies, head-ring placement or mask fabrication, treatment planning, and any other steps that distinguish radiosurgery from other treatment modalities. Pay attention to differences in roles and responsibilities and the involvement of additional personnel. Discuss your answers with your preceptor.

STEREOTACTIC RADIOSURGERY METHOD: _____

Step in the clinical process:
a) What is done during this step in the process?
b) What is the most important thing that must be accomplished in this step?
c) List which staff members are involved.
d) Describe the roles and responsibilities of each person.
e) Who is the primary staff member responsible for this step?
f) What is the patient's involvement in this step of the process?
g) What information is needed before this step can begin?
h) What equipment and / or software is used for this step?
i) How is that equipment / software used to support the process?
j) What documentation is generated at this step?
k) How / where is this information stored / accessed?
l) How is the information which will be needed for the next step communicated?
m) What are important things to consider during this stage of the process?
n) What would the consequences be if this step were omitted or if there were a mistake made during this part of the process?

Unit 2: LDR Brachytherapy

References:

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Objectives:

1) Explain the rationale for LDR ("Low Dose Rate") brachytherapy.
2) Describe various LDR brachytherapy methods / isotopes / applicators.
3) Compare and contrast LDR brachytherapy with external beam methods.
4) Demonstrate proficiency in LDR brachytherapy treatment techniques, including LDR treatment planning and plan evaluation.

Task 1: The Rationale for LDR Brachytherapy

Consult the literature and the various guidance documents listed above in order to answer the following questions. Write your answers, and discuss them with your preceptor and radiation oncologist.

A. What anatomical sites can be treated or are typically treated with LDR brachytherapy? What anatomical sites were typically treated with LDR brachytherapy 10 years ago? 25 years ago? Is LDR brachy less or more common now than in the past? Why might this be?

B. In what circumstances would LDR brachytherapy be preferable to other treatment methods? What are the advantages and disadvantages of LDR brachytherapy compared with external beam radiation (consider both photons and electrons)? When does LDR brachytherapy involve a temporary implant, and when does it involve a permanent implant?

C. What dose and fractionation schemes are / have been typically employed for each anatomical site listed in "A" above? Are these different from the dose and fractionation schemes used in conventional external beam radiotherapy for these sites? Why or why not? Is LDR brachytherapy ever used in conjunction with external beam or other therapies? If yes, for what anatomic sites? How would the dose and fractionation schemes be affected if concomitant therapies are employed?

D. Who is typically involved in LDR brachytherapy procedures? Who is typically responsible for treatment planning / treatment time calculations? For prescribing the dose? For putting the source(s) in position? For ensuring that proper radiation safety procedures are in place and are followed? For speaking with the patient and their family members about radiation safety concerns / precautions? For communicating with other hospital personnel (i.e. in-patient nursing, OR staff, etc.) about radiation safety precautions and time limits for patient care?

E. If there are limits on the amount of time any one staff member may spend caring for the patient, how can the staff ensure that the patient receives excellent care and the attention they need while still obeying the time limits? How would such time limits be calculated? On what are they based? Practice such a calculation for a cesium GYN implant patient.

Task 2: Radioactive Materials / LDR Applicators

Compare and contrast common isotopes and applicators historically employed for LDR brachytherapy. Write your answers, and discuss them with your preceptor.

A. What radioactive isotopes are / have been typically employed for each anatomical site listed in "Task 1-A" above?
    a. What factors influence the choice of a particular isotope for a particular procedure, e.g. when / why would one choose I-125 vs. Pd-103, etc?
    b. What isotopes are typically kept at the hospital? For these isotopes, what radiation precautions / safeguards should be in place? Do radiation precautions / safeguards differ for these different isotopes? If yes, how?
    c. What isotopes are typically ordered for particular procedures? How are these isotopes most often utilized (i.e. in ribbons, loose seeds, etc)? For isotopes that need to be ordered, how is the amount of activity determined? For these isotopes, what radiation precautions / safeguards should be in place? Do radiation precautions / safeguards differ for these different isotopes? If yes, how?
    d. How are the radioactive materials stored / transported within the hospital? Are there special tests on the sources, i.e. are the materials assayed / wipe tested / etc? If yes, how is this done, when, and by whom?
    e. What happens to the radioactive materials after they have been used in a patient procedure? Are they stored for use for a future patient, stored for decay, disposed of, returned to the vendor, etc? If they are disposed of, how is this done? If they are

returned to the vendor, how is this done? What radiation safety procedures and practices are involved in safely handling materials that have been used in a patient procedure (consider biological hazard precautions as well as radiation safety precautions)?

B. What applicators / devices are typically used for each anatomical site listed in "Task 1-A" above? How are these applicators / devices used / put in place on / in the patient, when, and by whom? Are the sources / applicators removed from the patient after a certain time, or do they remain in the patient? If the sources / applicators are removed from the patient, how is this done, when, and by whom? Do the applicators require special handling? How are they cleaned / maintained? Are there checks that need to be done to be sure they are safe to use? If yes, what are these checks? Who would perform these checks, and when?

C. What are interstitial planar implants? Volume implants? Surface applicators? Syed template interstitial implants? How are / were these used? How do these implants compare with the treatments given by superficial x-ray units? Electron beams? Electronic brachytherapy?

D. Review source decay calculations. Practice decay calculations for a Cs-137 source and for I-125 seeds, i.e. what will the activity be 1 week from now? Express this activity as a percentage of today's activity.

E. Review the units used to describe activity and source strength. What are these units, and how do they relate to one another?

F. When / how are portable shields used in LDR? Are lead aprons helpful, and if so, in what circumstances?

Task 3: LDR Brachytherapy Methods

Compare and contrast the various methods of performing LDR brachytherapy, e.g. interstitial iridium ribbons, syed template interstitial implants, cesium tandem and ovoids, cesium vaginal cylinders, prostate seed implants, eye plaques, strontium eye applicators, and any others. Write your answers, and review them with your preceptor.

A. What are the advantages and disadvantages of each LDR method in terms of dose delivery, dose fall-off, patient comfort, staff involvement, anatomical sites that can be treated, the treatment process, radiation safety procedures, etc?

B. Do dose and fractionation schemes vary for these different methods, or are dose and fractionation schemes dependent only on the anatomical site? Please explain.

C. For each anatomical site, how and where is the dose prescribed?

D. What quality assurance is needed for each of these methods? Create an outline of the quality assurance procedures that are required for each method, including the frequency of each test, and when it should be performed with regard to the day and time of treatment.

E. For each of these methods, what imaging studies are typically performed prior to planning? How are these studies used? Is / how is CT used for planning? If CT is used, what difficulties may be encountered, and why? Can / how can these difficulties be overcome?

F. How is the treatment planning different or similar for each of these methods? Is planning done in advance, or after the applicator(s) / sources are in place? How does one determine the activity needed to deliver the prescribed dose? If sources are to be removed, how does one determine the treatment time? How is a secondary check of the planning calculations performed for each treatment?

G. In each of these methods, how are the sources placed? How is proper source positioning assured? Is / how is the source placement verified? Is the patient able to / allowed to move, and if so, would this affect the source positioning? What limits (if any) need to placed on patient movement? How would one determine whether or not the source position has shifted?

H. What radiation safety procedures are needed for each of these methods? Create an outline of the radiation safety procedures that are required for each method, including what should be done, when, and by whom.

I. For prostate seed implants:
    a. What is a volume study? How is it done, when, and by whom? How is it used?
    b. What is a pre-plan? How is it done, when, and by whom? How is it used?
    c. What is a post-plan? How is it done, when, and by whom? How is it used?
    d. What are real-time delivery / planning methods? How do they differ from pre-planning methods? How are seeds ordered for real-time methods?
    e. What is a Mic applicator? When / how / by whom is it used?
    f. What are pre-loaded seeds?
    g. Are seeds assayed? If yes, how is this done, when is this done, and by whom? What is the AAPM recommendation regarding vendor-supplied assays?
    h. What is an auto-radiograph? How does it apply in this context? What is the AAPM recommendation regarding vendor-supplied auto-radiographs?
    i. What ultrasound QA is recommended for prostate seed implants? When / how / by whom / how frequently should this performed?
    j. What radiation safety procedures should be followed in the OR? What precautions are typically taken to prevent lost seeds?
    k. What radiation safety instructions are given to the patient before they are discharged from the hospital? Who typically explains these to the patient and his family?

l. Are these patients typically given documentation which describes their implant for the purpose of aiding the airport security screening process? Why or why not?
m. For left-over seeds, is it better to return them to the vendor or store them for decay? Why? What should be done with seeds removed from the bladder / urethra?
n. How is a new source created in the treatment planning system? What information is needed to do this? How can one be sure that it is done correctly?

J. For tandem and ovoid implants:
   a. What are points A & B? What is their significance with respect to anatomy? With respect to dose prescription?
   b. How are orthogonal radiographs used in treatment planning? How is magnification determined? What happens if the 2 films are not at the same magnification? Do the 2 films need to be exactly AP and Lateral? What happens if they are close to AP and Lateral? Can non-orthogonal films be used? Please explain.
   c. What radiation safety instructions are given to the nurses taking care of the patient while she is in the hospital, or to the patient and her family members? Who typically explains these instructions, and when?

Task 4: The LDR Brachytherapy Process: Observation and Practice

At the start of Module I you were given an overview of the clinical process for external beam radiotherapy and were asked to observe, participate in, and analyze each step. Research, observe, and participate in as many of the LDR brachytherapy methods listed above as possible. For each LDR brachytherapy method, create an outline of its clinical process analogous to the outline for external beam radiotherapy. For steps that are modified compared with the process of external beam radiotherapy, complete a sheet like the one on page 26 (duplicated below) to analyze each step in detail. Include imaging, planning, ordering sources and/or calculating the time for the sources to be in place, radiation safety considerations, and any other steps that distinguish LDR brachytherapy from other treatment modalities. Pay attention to differences in roles and responsibilities and the involvement of additional personnel. Discuss your answers with your preceptor.

LDR BRACHYTHERAPY METHOD: _____

Step in the clinical process:
a) What is done during this step in the process?
b) What is the most important thing that must be accomplished in this step?
c) List which staff members are involved.
d) Describe the roles and responsibilities of each person.
e) Who is the primary staff member responsible for this step?
f) What is the patient's involvement in this step of the process?
g) What information is needed before this step can begin?
h) What equipment and / or software is used for this step?
i) How is that equipment / software used to support the process?
j) What documentation is generated at this step?
k) How / where is this information stored / accessed?
l) How is the information which will be needed for the next step communicated?
m) What are important things to consider during this stage of the process?
n) What would the consequences be if this step were omitted or if there were a mistake made during this part of the process?

Unit 3: HDR Brachytherapy

References:

1. Glenn P. Glasgow, et. al., AAPM Report No. 41: Remote Afterloading Technology, A Report of AAPM Task Group No. 41, (American Institute of Physics, New York, NY, 1993): http://www.aapm.org/pubs/reports/rpt_41.pdf

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5. ACR-ASTRO Practice Guideline for the Performance of High-Dose-Rate Brachytherapy: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/high_dose_rate_brachytherapy.aspx

6. ACR Practice Guideline for the Performance of Coronary Vascular Brachytherapy (CVBT): http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/coronary_vascular_brachytherapy.aspx

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8. Xoft Axxent Website: http://www.xoftinc.com/

9. Varian VariSource and GammaMedPlus Website: http://www.varian.com/us/oncology/brachytherapy/brachytherapy_products.html

Objectives:

1) Explain the rationale for HDR ("High Dose Rate") brachytherapy.
2) Describe various HDR brachytherapy methods/devices/applicators.
3) Compare and contrast conventional HDR Brachytherapy with LDR brachytherapy, electronic brachytherapy, and external beam methods.
4) Demonstrate proficiency in HDR brachytherapy techniques, including HDR treatment planning and plan evaluation.

Task 1: The Rationale for HDR Brachytherapy

Consult the literature and the various guidance documents listed above in order to answer the following questions. Write your answers, and discuss them with your preceptor and radiation oncologist.

A. What distinguishes HDR brachytherapy from LDR brachytherapy?

B. What anatomical sites can be treated or are typically treated with conventional HDR brachytherapy? With electronic brachytherapy? What effect has the development of HDR and electronic brachytherapy had on LDR brachytherapy? On other treatment modalities (i.e. for breast cancer)?

C. In what circumstances would HDR brachytherapy be preferable to other treatment methods? What are the advantages and disadvantages of HDR brachytherapy compared with LDR brachytherapy or external beam radiation (photons or electrons)?

D. What dose and fractionation schemes are / have been typically employed for each anatomical site listed in "B" above? Are these different from the dose and fractionation schemes used in conventional radiotherapy or LDR brachytherapy for these sites? Why or why not? Is HDR brachytherapy ever used in conjunction with external beam or other therapies? If yes, for what anatomic sites? How would the dose and fractionation schemes be affected if concomitant therapies are employed?

E. Who is typically involved in HDR brachytherapy procedures? Who is typically responsible for treatment planning/treatment time calculations? For prescribing the dose? For putting the source(s) in position? For ensuring that proper radiation safety procedures are in place and are followed? For speaking with the patient and their family members or with hospital personnel about radiation safety concerns/precautions? What personnel need to be present when an HDR treatment is performed?

Task 2: HDR Units / Devices / Applicators

Write your answers to the following questions, and discuss them with your preceptor.

A. What radioactive isotope(s) are/have been typically employed for HDR? Why this / these? How does this compare with electronic brachytherapy in terms of dose delivery, dose fall-off, patient comfort, staff involvement, anatomical sites that can be treated, the treatment process, radiation safety procedures, etc?

B. What is a source exchange? How is it performed, and by whom? What checks need to be done? How is the source strength determined? What is a typical range for source strength values from the time the new source is delivered to the end of its useful life? Is the new source wipe tested? Why or why not? If possible, participate in a source exchange at your site, and document the procedure.

C. What checks are typically done on the day of treatment? How are these performed, and by whom? If possible, participate in day-of-treatment checks for your site's HDR unit, and document the procedure.

D. What are the emergency procedures for HDR? What radiation safety precautions should be taken? How often should HDR emergency procedures be practiced?

E. What HDR applicators / devices are typically used for each anatomical site listed in "Task 1-B" above? Do / how do HDR applicators differ from LDR applicators? How are these HDR applicators / devices used / put in place on / in the patient, when, and by whom? How are they removed from the patient, when, and by whom? Do they require special handling? How are they cleaned / maintained? Are there checks that need to be done to be sure they are safe to use? If yes, what are these checks? Who would perform these checks, and how frequently?

F. Practice decay calculations for an Ir-192 source, i.e. what will the activity be 1 week from now? Express this activity as a percentage of today's activity.

G. When / how are portable shields used in HDR? Are lead aprons helpful, and if so, in what circumstances?

H. Are there any shielding requirements for HDR brachytherapy? If yes, please describe. What rooms in Radiation Oncology would be most appropriate for HDR procedures, and why?

I. What is "intravascular brachytherapy" or "coronary vascular brachytherapy"? What devices / isotopes have been used / are currently used? When is this therapy employed? If it is not used frequently now, why not? Was there a time when intravascular was especially popular, and if so, why was that, and what happened to decrease its popularity? What radiation safety procedures

should be followed? When / how are portable shields used in intravascular brachytherapy? Are lead aprons helpful, and if so, in what circumstances?

Task 3: HDR Brachytherapy Methods

Compare and contrast the various methods of performing HDR brachytherapy, e.g. partial breast irradiation (SAVI, Contura, Mammo Site, etc), tandem and ovoids, vaginal cylinder, prostate, intra-bronchial, and any others. Write your answers, and review them with your preceptor.

A. What are the advantages and disadvantages of each HDR method in terms of dose delivery, dose fall-off, patient comfort, staff involvement, anatomical sites that can be treated, the treatment process, radiation safety procedures, etc? How do these differ from LDR, where isotopes with varying characteristics can be chosen for different anatomical sites?

B. Do dose and fractionation schemes vary for these different methods, or are dose and fractionation schemes dependent only on the anatomical site?

C. For each anatomical site, how and where is the dose prescribed?

D. What quality assurance is needed for each of these methods? Create an outline of the quality assurance procedures that are required for each method, including the frequency of each test, and when it should be performed with regard to the day and time of treatment.

E. How is the treatment planning different or similar for each of these methods? What imaging studies are typically performed prior to planning? How are these studies used? Is planning done in advance, or after the applicator / source is in place? How does one determine the time needed to deliver the prescribed dose? What independent secondary checks should be employed, if any, for the plan and for the treatment time?

F. In each of these methods, how is proper source positioning assured? Is the patient able to / allowed to move, and if so, would / how would this affect the source positioning?

G. What radiation safety procedures are needed for each of these methods? Create an outline of the radiation safety procedures that are required for each method, including what should be done, when, and by whom. Include a discussion of any radiation safety information given to patients, patient's family members, and staff (especially staff members who are pregnant).

H. How can one be certain that the HDR source has retracted properly and is not left inside the patient? What equipment and which measuring devices are used for this purpose?

I. How is the HDR source created / characterized in the treatment planning system? What information is needed to do this? How can one be sure it is done correctly? Should the planning system information be updated at the time of a source exchange, and if so, in what way?

J. For breast HDR, compare and contrast the various catheters available, outlining the strengths and weaknesses of each. If your lead physician asked you to recommend one, which would you advocate, and why?

K. For tandem and ovoid implants:
   a. Is the definition and significance of points A and B the same as for LDR brachytherapy?
   b. Can orthogonal radiographs used in treatment planning in place of a CT scan? If yes, how is this done?

Task 4: The HDR Brachytherapy Process: Observation and Practice

Research, observe, and participate in as many of the HDR brachytherapy methods listed above as possible. For each HDR brachytherapy method, create an outline of its clinical process analogous to the outline for external beam radiotherapy. For steps that are modified compared with the process of external beam radiotherapy, complete a sheet like the one on page 26 (duplicated below) to analyze each step in detail. Include imaging, planning, treatment delivery, radiation safety considerations, and any other steps that distinguish HDR brachytherapy from LDR and from other treatment modalities. Pay attention to differences in roles and responsibilities and the involvement of additional personnel. Discuss your answers with your preceptor.

HDR BRACHYTHERAPY METHOD: _____

Step in the clinical process:
a) What is done during this step in the process?
b) What is the most important thing that must be accomplished in this step?
c) List which staff members are involved.
d) Describe the roles and responsibilities of each person.
e) Who is the primary staff member responsible for this step?
f) What is the patient's involvement in this step of the process?
g) What information is needed before this step can begin?
h) What equipment and / or software is used for this step?
i) How is that equipment / software used to support the process?
j) What documentation is generated at this step?
k) How / where is this information stored / accessed?
l) How is the information which will be needed for the next step communicated?
m) What are important things to consider during this stage of the process?
n) What would the consequences be if this step were omitted or if there were a mistake made during this part of the process?

Unit 4: TBI Electrons and Photons

References:

1. ACR-ASTRO Practice Guideline for the Performance of Total Body Irradiation: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/total_body_irradiation.aspx

2. J. Van Dyk, et. al., AAPM Report No. 17: The Physical Aspects of Total and Half Body Photon Irradiation, A Report of Task Group 29, Radiation Therapy Committee, American Association of Physicists in Medicine, (American Institute of Physics, New York, NY, 1986): http://www.aapm.org/pubs/reports/RPT_17.pdf

3. C. J. Karzmark, et. al., AAPM Report No. 23: Total Skin Electron Therapy: Technique and Dosimetry, Report of Task Group 30, Radiation Therapy Committee, American Association of Physicists in Medicine, (American Institute of Physics, New York, NY, 1987): http://www.aapm.org/pubs/reports/RPT_23.pdf

Objectives:

1) Explain the rationale for TBI (total body irradiation) with electrons and with photons.
2) Outline recommended methods for performing TBI with electrons and with photons, including any special physics measurements / procedures.

Task 1: The Rationale for TBI

Consult the literature and the various guidance documents listed above in order to answer the following questions for both TBI electrons and TBI photons. Write your answers, and discuss them with your preceptor and radiation oncologist.

A. What is the purpose of TBI electrons? Of TBI photons? What total dose and dose/fractionation scheme is typical for each?

B. Are these therapies used in conjunction with other treatments? If so, how does TBI fit into the total treatment regimen?

C. For TBI, where is the dose prescribed? How uniform can the dose be expected to be? Are there things that can be done to increase dose uniformity if the dose is found to not be sufficiently uniform? If yes, what are they?

D. Are there other treatment methods that are sometimes used in place of TBI? If yes, in what circumstances would TBI be preferable to those other treatment methods? Outline the advantages/disadvantages of each method.

E. Who is typically involved in TBI procedures? Who is typically responsible for treatment planning / treatment time calculations? For prescribing the dose? For measuring / calculating / verifying the dose and dose rate? Who should be present during the first treatment? Subsequent treatments?

Task 2: TBI Measurements / Devices / Methods

Write your answers to the following questions for both TBI electrons and TBI photons, and discuss them with your preceptor.

A. How is TBI different from other external beam treatments? What measurements need to be made prior to patient treatments? How are these performed? How can the dose and dose-rate be measured / verified? Are any checks needed on the day of treatment or at intervals during the treatments? Why or why not? Create procedures which document how to perform any necessary measurements.

B. Is treatment planning done for TBI, and if so, how is it done? If a treatment planning system is used, what data need to be input to the system for the calculations to be correct? How would you verify the correctness of the treatment planning system's result?

C. Is QA needed for TBI treatments? If yes, what needs to be checked, and how is this QA performed? Document these procedures.

D. What devices would need to be available or to be fabricated for TBI treatments?
What is a beam spoiler? How is it used? What are transmission blocks? Are blocks typically needed for TBI, and if yes, how are they made, and where / how are they positioned? Are other types of shields ever employed? If yes, what are these for and how are they made, and by whom? Where / how are they positioned?

E. How is the patient positioned for TBI treatments? How is that position reproduced day-to-day? Do the patients typically have any special needs during TBI? If yes, could these affect the positioning / reproducibility? How?

F. For TBI, is the dose typically measured during the treatment? If yes, how / when / how often is this done? What is the role of TLD and OSL dosimeters in TBI? What are the advantages / disadvantages of each? Which would you recommend for your site, and why? Are there other ways to measure the dose that might be preferable? If you needed to order dosimeters, when / how would you go about it?

G. How is the treatment time calculated for TBI? How is a secondary check performed? Practice doing a hand calc for TBI.

H. Are there special settings on the linac that should be used for TBI treatments? If yes, what are they?

I. Is / how is documentation different for TBI charts vs. typical external beam charts? If possible, review treatment charts for patients previously treated with TBI at your clinical site.

Task 3: The TBI Process: Observation and Practice

For both TBI electrons and TBI photons, create an outline of the clinical process analogous to the outline for external beam radiotherapy. For steps that are modified compared with the process of external beam radiotherapy, complete a sheet like the one on page 26 (duplicated below) to analyze each step in detail. Pay attention to differences in roles and responsibilities and the involvement of additional personnel. Discuss your answers with your preceptor.

If possible, observe and participate in TBI cases at your clinical site.

TBI METHOD: _____

Step in the clinical process:
a) What is done during this step in the process?
b) What is the most important thing that must be accomplished in this step?
c) List which staff members are involved.
d) Describe the roles and responsibilities of each person.
e) Who is the primary staff member responsible for this step?
f) What is the patient's involvement in this step of the process?
g) What information is needed before this step can begin?
h) What equipment and / or software is used for this step?
i) How is that equipment / software used to support the process?
j) What documentation is generated at this step?
k) How / where is this information stored / accessed?
l) How is the information which will be needed for the next step communicated?
m) What are important things to consider during this stage of the process?
n) What would the consequences be if this step were omitted or if there were a mistake made during this part of the process?

Unit 5: IGRT Methods

References:

1. Yin, Fang-Fang, et. al., AAPM Report No. 104: The Role of In-Room kV X-Ray Imaging for Patient Setup and Target Localization, Report of AAPM Task Group 104, (American Association of Physicists in Medicine, College Park, MD, 2009): http://www.aapm.org/pubs/reports/RPT_104.pdf

2. Keall, Paul J., et. al., AAPM Report No. 91: The Management of Respiratory Motion in Radiation Oncology, Report of AAPM Task Group 76, (American Association of Physicists in Medicine, College Park, MD, 2006): http://www.aapm.org/pubs/reports/RPT_91.pdf

3. Murphy, Martin J., et. al., AAPM Report No. 95: The Management of Imaging Dose During Image-guided Radiotherapy: Report of the AAPM Task Group 75, Med. Phys. **34** (10), 4041-4063, 2007: http://www.aapm.org/pubs/reports/RPT_95.pdf

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5. ACR–ASTRO Practice Guideline for Image-Guided Radiation Therapy (IGRT): http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/IGRT.aspx

6. ACR Technical Standard for Medical Physics Performance Monitoring of Image-Guided External Beam Radiation Therapy (IGRT): http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/med_phys/monitor_IGRT.aspx

7. Klein, Eric E., et. al., AAPM Report No. 142: Task Group 142 Report: Quality Assurance of Medical Linear Accelerators, Med. Phys. **36** (9), 4197-4212, 2009: http://www.aapm.org/pubs/reports/RPT_142.pdf

Objectives:

1) Outline the rationale for IGRT ("Image Guided Radiotherapy") for various anatomical sites.
2) Compare and contrast recommended methods for performing IGRT.
3) Discuss any additional patient dose that may be contributed by IGRT techniques, and describe methods of measuring or calculating that dose and accounting for that dose in the patient's chart.
4) If possible, observe and participate in IGRT procedures.

Task 1: The Rationale for IGRT

Consult the literature and the various guidance documents listed above in order to answer the following questions. Write your answers, and discuss them with your preceptor and radiation oncologist.

A. What is the purpose of IGRT? For which anatomical sites could IGRT provide an advantage? For which anatomical sites is image guidance (beyond weekly portal images) less important? For which anatomical sites is IGRT most necessary and why? For which anatomical sites has the use of IGRT become the "standard of care"?

B. For each anatomical site where IGRT could provide an advantage, what difficulties are involved in performing IGRT treatments? What might be difficult for the patient to tolerate? In what circumstances might the benefits of IGRT not out-weigh the difficulties?

C. For which anatomical sites is IGRT used in conjunction with 3-D conformal treatments, IMRT treatments, or other types of treatments in your clinic?

D. How do the tasks for IGRT differ from the tasks for 3-D conformal treatments or for IMRT treatments? What additional steps are required? Who is typically involved in IGRT procedures, and what are their roles?

Task 2: IGRT Methods

Compare and contrast the various methods of performing IGRT for the anatomical sites where IGRT could provide an advantage. Be sure to include cone beam CT methods (discuss both MV & kV technologies), fiducial marker methods (e.g. Acculoc, Calypso, etc.), ultrasound methods, various methods used to manage respiratory motion (discuss breath-hold techniques, motion-encompassing techniques, abdominal compression techniques, motion management through gating & coaching, and tumor tracking techniques), and any others. Write your answers, and review them with your preceptor.

A. What are the advantages and disadvantages of each IGRT method in terms of accuracy and precision of dose delivery, margin reduction compared with non-IGRT treatments, patient comfort, staff involvement, anatomical sites that can be treated, the treatment planning and delivery process, etc? In each of these methods, what immobilization devices are typically employed to better facilitate reproducible patient positioning?

B. Do dose and fractionation schemes vary for different IGRT methods, or are dose and fractionation schemes dependent only on the anatomical site? Does (when does) IGRT allow dose escalation?

C. What quality assurance is needed for each of these methods? Create an outline of the quality assurance procedures that are required for each method, including the frequency of each test, and when it should be performed with regard to the day and time of treatment.

D. How is the treatment planning done for each of these IGRT methods? How does it differ from the planning for non-IGRT techniques? What imaging studies are typically performed prior to planning, and how are these studies used? What secondary checks are employed, if any?

E. Some IGRT methods rely on images of the patient immediately prior to treatment. For these techniques, under what circumstances would it be prudent to interrupt the treatment to re-image (to be certain that nothing has moved)? (One example might be a prostate treatment with a multi-field long-delivery-time IMRT plan: consider the effects of bladder filling and bowel motion on tumor location.)

F. Imagine a case where images taken prior to treatment indicate that a large shift should be made in the table position. How big of a shift is "too big"? When would one need to re-calculate because the SSD's no longer match the treatment plan (i.e. when and by what percentage would the dose change)?

G. For each IGRT technique considered above, discuss any additional patient dose that may be contributed by IGRT techniques. Describe methods of measuring and/or calculating that dose, as well as methods of accounting for that dose.

    a. Is there a standard practice for accounting for the dose? Is it prudent to include the IGRT dose as part of the patient's prescription dose? Why or why not?

    b. How do doses from IGRT compare with doses from standard port films / portal images? Are / how are these doses typically handled in radiation oncology?

    c. Does the IGRT dose present any added risk to the patient (whether or not it is taken into account)? If yes, describe the magnitude and nature of the risk. If there is a risk, how does one decide if this risk is outweighed by the benefits of IGRT? Who makes this decision?

    d. What is done to measure or calculate and account for IGRT dose at your clinical site? If you were the lead physicist at a particular clinic, what would you advocate should be done regarding the idea of accounting for IGRT dose? How would you present your argument to the lead physician?

Task 3: The IGRT Process: Observation and Practice

Research, observe, and participate in as many of the IGRT methods listed above as possible. For each IGRT method, create an outline of its clinical process analogous to the outline for external beam radiotherapy. For steps that are modified compared with the process of external beam radiotherapy, complete a sheet like the one on page 26 (duplicated below) to analyze each step in detail. Include imaging, planning, treatment delivery, determining and accounting for any additional dose contributed by the IGRT method, and any other steps that distinguish IGRT from non-IGRT techniques. Pay attention to differences in roles and responsibilities and the involvement of additional personnel. Discuss your answers with your preceptor.

IGRT METHOD: _____

Step in the clinical process:
a) What is done during this step in the process?
b) What is the most important thing that must be accomplished in this step?
c) List which staff members are involved.
d) Describe the roles and responsibilities of each person.
e) Who is the primary staff member responsible for this step?
f) What is the patient's involvement in this step of the process?
g) What information is needed before this step can begin?
h) What equipment and / or software is used for this step?
i) How is that equipment / software used to support the process?
j) What documentation is generated at this step?
k) How / where is this information stored / accessed?
l) How is the information which will be needed for the next step communicated?
m) What are important things to consider during this stage of the process?
n) What would the consequences be if this step were omitted or if there were a mistake made during this part of the process?

Unit 6: Rotational Therapy

References:

1. TomoTherapy Website: http://www.tomotherapy.com/

2. Varian RapidArc Website: http://www.varian.com/us/oncology/treatments/treatment_techniques/rapidarc/

3. Elekta Volumetric Modulated Arc Therapy Website: http://www.elekta.com/healthcare_us_press_release_20070178.php

Objectives:

1) Describe the rationale for rotational therapy (such as TomoTherapy, RapidArc, and VMAT).
2) Discuss the differences and similarities between rotational therapy and conventional radiotherapy.
3) Discuss the differences and similarities between the various methods of delivering rotational therapy.
4) If possible, observe and participate in rotational therapy treatments.

Task 1: TomoTherapy

Consult the current literature and vendors' websites in order to answer the following questions. Write your answers, and then discuss them with your preceptor and radiation oncologist.

A. What is the rationale for TomoTherapy?

B. How does TomoTherapy differ from conventional linac-based treatments? Consider such factors as treatment machine design, shielding requirements, treatment delivery, treatment evaluation, quality assurance, dose and fractionation schemes, the treatment planning process, record-and-verify, patient comfort and compliance, etc.

C. What are the advantages and disadvantages for TomoTherapy compared with conventional linac-based treatments?

D. What anatomical sites are best suited to TomoTherapy? What sites would be difficult to treat with TomoTherapy?

E. What is "adaptive radiotherapy"? Is adaptive radiotherapy performed at your clinical site? If yes, how? Under what circumstances would adaptive radiotherapy be most important? Is TomoTherapy better suited than conventional radiotherapy for performing adaptive radiotherapy? If yes, how?

F. What quality assurance procedures are needed for TomoTherapy? How do these processes differ from linac QA and from linac IMRT QA? What QA devices are typically employed? From where could these devises be obtained? Write a comprehensive set of QA procedures for a new TomoTherapy facility.

G. How would the acceptance testing and commissioning of a TomoTherapy unit differ from the acceptance testing and commissioning of a linac? What data would be required? What equipment would be needed to make the measurements? How would the measurements be performed?

H. Does the commissioning of the TomoTherapy treatment planning system differ from commissioning the treatment planning systems discussed in Module III? If yes, how? Write detailed data acquisition plans similar to those you worked on in Module III, Unit 9, including any data you would need to verify the accuracy of the modeled beams.

I. Can secondary check software be used to verify TomoTherapy monitor unit calculations? If yes, also consider what data would be required to set up and verify the secondary check software. Include these measurements in your data acquisition plan.

J. If you were asked to plan for a TomoTherapy Unit for a new site that your clinic plans to open, how would you go about it? What recommendations would you make? What budget would be appropriate? (Be sure to include any ancillary items that would be necessary for successful patient treatments, i.e. QA devices, phantoms, chambers, scanners, immobilization devices, etc.) Write an outline of your proposal, detailing the steps involved.

K. If possible, observe and participate in TomoTherapy treatments and quality assurance measurements. Document your observations in your logbook.

Task 2: Linac-based Rotational Therapy

Consult the current literature and vendors' websites in order to answer the following questions. Write your answers, and then discuss them with your preceptor and radiation oncologist.

A. What is the rationale for linac-based rotational therapy (i.e. RapidArc or VMAT)? Does this differ from the rationale for TomoTherapy? If yes, how?

B. How do linac-based rotational therapy treatments differ from conventional linac treatments? How do they differ from TomoTherapy treatments? Consider such factors as treatment machine design, shielding requirements, treatment delivery, treatment evaluation, quality assurance, dose and fractionation schemes, the treatment planning process, record-and-verify, patient comfort and compliance, etc.

C. What are the advantages and disadvantages for linac-based rotational therapy compared with conventional linac-based treatments? Compared with TomoTherapy?

D. What anatomical sites are best suited to linac-based rotational treatments? What sites would be difficult to treat with linac-based rotational treatments?

E. What quality assurance procedures are needed for linac-based rotational treatments? How do these processes differ from conventional linac QA and from conventional linac IMRT QA? What QA devices are typically employed? From where could these devises be obtained? Write a comprehensive set of QA procedures for a new rotational therapy installation.

F. How would the acceptance testing and commissioning for linac-based rotational treatments differ from the acceptance testing and commissioning already performed for the linac itself? What data would be required? What equipment would be needed to make the measurements? How would the measurements be performed?

G. Do additional measurements need to be made in order to commission rotational therapy in the treatment planning system? If yes, what would need to be done? Write detailed data acquisition plans similar to those you worked on in Module III, Unit 9, including any data you would need to verify the accuracy of the modeled beams.

H. Can secondary check software be used to verify the monitor unit calculations for linac-based rotational treatments? If yes, also consider what data would be required to set up and verify the secondary check software. Include these measurements in your data acquisition plan.

I. If you were asked to plan for a rotational therapy upgrade to an existing linac at your site, how would you go about it? What recommendations would you make? What budget would be appropriate? (Be sure to include any ancillary items that would be necessary for successful

patient treatments, i.e. QA devices, phantoms, chambers, scanners, immobilization devices, etc.) Write an outline of your proposal, detailing the steps involved.

J. If possible, observe and participate in both RapidArc and VMAT treatments and quality assurance measurements. Document your observations in your logbook.

Unit 7: Proton Therapy

Objectives:

1) Describe the rationale for Proton Therapy.
2) Explain the general methods of Proton Therapy.

Consult the current literature and vendors' websites in order to answer the following questions. Write your answers, and discuss them with your preceptor and radiation oncologist.

A. What is the rationale for Proton Radiotherapy?

B. What are the advantages and disadvantages compared with photon and electron radiotherapy?

C. How is Proton Radiotherapy currently performed? What clinical sites are actively treating patients? What vendors exist? How do the various proton systems differ from one another?

D. What quality assurance procedures are needed for Proton Therapy? What QA devices are typically employed? From where could these devises be obtained? How are these different from / similar to the QA methods for photon and electron radiotherapy?

E. If you were asked to plan a proton facility for a new site that your clinic plans to open, how would you go about it? What recommendations would you make? What budget would be appropriate? (Be sure to include in your budget any ancillary items that would be necessary for successful patient treatments, i.e. QA devices, phantoms, chambers, scanners, immobilization devices, etc.) Write an outline of your proposal, detailing the steps involved.

MODULE V: HEALTH PHYSICS

Unit 1: Radiation Safety

References:

1. U.S. NRC Part 35: Medical Use of Byproduct Material: http://www.nrc.gov/reading-rm/doc-collections/cfr/part035/index.html

2. U.S. NRC Part 20: Standards for Protection Against Radiation: http://www.nrc.gov/reading-rm/doc-collections/cfr/part020/full-text.html

3. Illinois Emergency Management Agency (IEMA) Part 335: Medical Use of Radioactive Material: http://www.state.il.us/iema/legal/pdf/32_335.pdf

4. Illinois Emergency Management Agency (IEMA) Part 340: Standards for Protection Against Radiation: http://www.state.il.us/iema/legal/pdf/32_340.pdf

5. Illinois Emergency Management Agency (IEMA) Part 360: Use of X-Rays in the Healing Arts Including Medical, Dental, Podiatry, and Veterinary Medicine: http://www.state.il.us/iema/legal/pdf/32_360.pdf

6. Illinois Emergency Management Agency (IEMA) Part 400: Notices, Instruction and Reports to Workers; Inspections: http://www.state.il.us/iema/legal/pdf/32_400.pdf

7. Radiation Emergency Assistance Center / Training Site:
   a.) Main Page:
   https://orise.orau.gov/reacts/default.aspx
   b.) Guidance for Radiation Accident Management:
   http://orise.orau.gov/reacts/guide/guidesitemap.htm
   c.) Guidance for Hospital Medical Management:
   http://orise.orau.gov/reacts/guide/emergency.htm
   d.) The Medical Aspects of Radiation Incidents:
   https://orise.orau.gov/reacts/resources/radiation-accident- management.aspx

8. World Heath Organization "Radiation Accidents and Emergencies" http://www.who.int/ionizing_radiation/a_e/en/

9. IAEA Safety Report No. 4: "Planning the Medical Response to Radiological Accidents": http://www-pub.iaea.org/MTCD/publications/PDF/Pub1055_web.pdf

10. U.S. Environmental Protection Agency: "Radiation Health Effects": http://epa.gov/radiation/understand/health_effects.html

11. AAPM Report No. 18: "A Primer on Low-Level Ionizing Radiation and its Biological Effects": http://www.aapm.org/pubs/reports/rpt_18.pdf

12. AAPM Report No. 50: "Fetal Dose from Radiotherapy with Photon Beams": http://www.aapm.org/pubs/reports/rpt_50.pdf

13. Health Physics Society: "Radiology and the Pregnant Patient": http://hps.org/physicians/radiology_pregnant_patient_qa.html

14. Michael G. Stabin, Radiation Protection and Dosimetry: an Introduction to Health Physics, (Springer Science & Business Media, New York, NY, 2008).

15. Eric J. Hall and Amato J. Giaccia, Radiobiology for the Radiobiologist, 6th edition, (Lippincott Williams and Wilkins, Philadelphia, PA, 2005).

16. Louis K. Wagner, Richard G. Lester and Luis R. Saldana L. Exposure of the Pregnant Patient to Diagnostic Radiations: a Guide to Medical Management. 2nd edition, (Medical Physics Publishing, Madison, WI, 1997).

17. NCRP Report No. 160: Ionizing Radiation Exposure of the Population of the United States: http://www.ncrppublications.org/Reports/160

18. Health Physics Society discussion on NCRP Report No. 160: http://hps.org/media/documents/NCRP_Report-People_Exposed_to_More_Radiation_from_Medical_Exams_9Mar.pdf

19. NCRP Report 116, Limitation Of Exposure To Ionizing Radiation: http://www.ncrppublications.org/Reports/116

20. NCRP Report 107, Implementation of the Principle of As Low As Reasonably Achievable (ALARA) for Medical and Dental Personnel: http://www.ncrppublications.org/Reports/107

21. AAPM Position Statement on Radiation Risks from Medical Imaging Procedures: http://www.aapm.org/org/policies/details.asp?id=318&type=PP&current=true#06

22. Image Gently: http://www.pedrad.org/associations/5364/ig/

23. Image Wisely: http://www.imagewisely.org/

24. Faiz M. Khan, The Physics Of Radiation Therapy, 3rd ed. (Lippincott Williams & Wilkins, Philadelphia, PA, 2003).

Objectives:

1) Discuss radiation exposure limits for radiation workers and for the general public.
2) Outline radiation safety procedures and responsibilities, including personnel monitoring.
3) Describe the radiation risk associated with various radiation exposure levels and types of exposures.
4) Describe methods to estimate fetal dose.

Task 1: Radiation Exposure Limits and Monitoring

Consult the references listed above, as well as any other applicable references, articles, and guidance documents, in order to answer the following questions. Write your answers, and discuss them with your preceptor.

A. Review radiation exposure limits. What are the allowed radiation exposure levels for radiation workers? For members of the general public? For pregnant radiation workers? How were these levels determined? How are these levels monitored, and how is compliance ensured?

B. Discuss the procedures for personnel monitoring at your site. How are badges distributed and collected, and by whom? Who reviews the badge reports and communicates with employees about any unexpected readings? Are there requirements that this be done within a certain time period? How are unexpected readings investigated? Where and when are badge readings posted? Why are readings posted? Where are badges kept, and why was that location selected? Is it ok for badges to be taken home, or to other facilities, with the employee? Why or why not?

C. Who is the Radiation Safety Officer (RSO) at your site? What are the requirements for becoming an RSO? What does the RSO do? Who works in the Radiation Safety Office? What are their responsibilities? How do these responsibilities relate to regulations? To best practices?

D. Review the radioactive materials license for your clinical site. What things are specified in the license? If the license requirements differ from the regulations, which should be followed, and why? How is a newly-employed medical physicist added to the license? What does it mean for someone to be listed on the license?

Task 2: Oncogenesis / Risk

Consult the references listed above, as well as any other applicable references, articles, and guidance documents, in order to answer the following questions. Write your answers, and discuss them with your preceptor.

A. What are the risks associated with exposure to ionizing radiation? Why do we go through the effort of things like personnel monitoring, checking for contamination, etc.? How do the risks change with the magnitude of the exposure received? How do the risks change with the time over which the exposure is received? How do the risks change with the age of the person at the time of the exposure? How do the risks change with the type / energy / LET of the radiation? How do the risks change if the radioactive material can be inhaled / can be ingested / can contaminate the skin / can get onto the bottom of a shoe?

B. Define, compare and contrast the following terms:
   - Dose
   - Effective dose
   - Dose equivalent
   - Committed dose

   How do these concepts apply to the discussion of radiation risk? What is the quality factor, and how is it used?

C. Imagine that you were giving a radiation in-service to the nursing staff on the oncology floor. How would you explain radiation levels and risk? What is the level of background radiation in Chicago? In Denver? What is a typical dose from a chest x-ray? From a CT-scan? From a flight across the U.S.? How do these levels compare with exposures typically encountered in radiation oncology? How do occupational risks from radiation exposure compare with occupational risks in other professions, i.e. “safe industries” such as working in an office or store?

D. How does radiation induce cancers? How long would it typically be between exposure and effect for various radiation doses? Describe stochastic and non-stochastic effects. Does radiation exposure always result in cancer? Why or why not? What is radiation hormesis?

E. Is there a difference between exposure from radiation-producing equipment and exposure from radioactive materials? What additional precautions should be taken when handling radioactive materials, and why? What happens if radioactive material is ingested or inhaled?

F. What is your site's plan for handling a radiation accident, i.e. a "dirty bomb" at a nearby shopping center? How will patients be triaged? How will contamination be contained? How will the risk of late complications be assessed? Consider how you might advise a hospital spokesperson who plans to address the media regarding the disaster. What can be done to decrease the likelihood of hospital resources being overwhelmed by people who are fearful but un-injured and not contaminated?

Task 3: Fetal Dose Estimations

Consult the references listed above, as well as any other applicable references, articles, and guidance documents, in order to answer the following questions. Write your answers, and discuss them with your preceptor.

A. Imagine that a patient in radiation oncology discovers that she is pregnant. How would you assess the dose that the fetus has already received? How would you determine whether or not continuing her therapy might put the fetus at risk? What might happen to the fetus, i.e. what are possible outcomes for various fetal doses, and what is the likelihood of each outcome? In such a circumstance, who would counsel the patient? If you were explaining the situation to her physician, what would you say? In these cases, should the physicist make any recommendations, or just present the facts in an unbiased manner? Defend your answer. If you were to make recommendations, what course of action would you advocate, and why?

B. Imagine that a staff member in the cardiac catheterization lab discovers that she is pregnant. How would you calculate the dose that the fetus has already received? How would you determine whether or not she can continue her duties? How would you monitor the dose to the fetus for the rest of the pregnancy? What would you do if you determine that the fetus has already received a high dose? In such a circumstance, who would counsel the staff member? If you were explaining the situation to her supervisor, what would you say? In these cases, should the physicist make any recommendations, or just present the facts in an unbiased manner? Defend your answer. If you were to make recommendations, what course of action would you advocate, and why?

C. Review previous fetal dose calculations made at your clinical site, and the recommendations made. Consider the differences between external beam procedures, HDR procedures, and radio-isotope procedures.

D. Practice at least two example fetal dose calculations, and review them with your preceptor.

Unit 2: Instrumentation for Health Physics Measurements

References:

1. U.S. NRC Part 35: Medical Use of Byproduct Material: http://www.nrc.gov/reading-rm/doc-collections/cfr/part035/index.html

2. Illinois Emergency Management Agency (IEMA) Part 335: Medical Use of Radioactive Material: http://www.state.il.us/iema/legal/pdf/32_335.pdf

4. Herman Cember, editor, Radiation Instruments, Health Physics Society Summer School 2001, (Medical Physics Publishing, Madison, WI, 2001).

5. Michael G. Stabin, Radiation Protection and Dosimetry: an Introduction to Health Physics, (Springer Science & Business Media, New York, NY, 2008).

6. Faiz M. Khan, The Physics Of Radiation Therapy, 3rd ed. (Lippincott Williams & Wilkins, Philadelphia, PA, 2003).

7. Harold E. Johns and J. R. Cunningham, The Physics of Radiology, 4th ed., (Charles C. Thomas Publisher, Springfield, IL, 1983).

Objectives:

1) Describe the various instrumentation employed in Health Physics. Outline the distinguishing features and explain the capabilities of each instrument.
2) Identify the best uses for each instrument. Support your answers by discussing the reasons for choosing an instrument for a particular application.
3) Observe and participate in the use of Health Physics instrumentation.

Consult the references listed above, as well as any other applicable references, articles, and guidance documents, in order to answer the following questions. Write your answers, and discuss them with your preceptor.

A. Describe various instruments typically employed in Health Physics measurements. Be sure to include Geiger-Mueller counters, proportional counters, ionization chambers, scintillation detectors, liquid scintillation counters, alpha counters, beta counters, neutron detectors, and any other devices that may be used in Health Physics measurements in your clinic. What are the distinguishing features and capabilities of each instrument? What checks, if any, should be performed on each device prior to using it to make a measurement?

B. What is the best use for each of the instruments described in "A" above? Explain your reasons for choosing a particular instrument for a particular application.

C. Which instrument would you select for each of the following tasks, and why:
   a. Surveying a newly-received shipment of radioactive materials?
   b. Wipe-testing the box?
   c. Locating a lost 1-125 seed?
   d. Assaying an I-125 seed?
   e. Measuring the activity of a cesium source?
   f. Surveying the HDR unit?
   g. Surveying an HDR patient?
   h. Surveying an I-131 patient to see if they can be released?
   i. Surveying the OR after a prostate seed implant has taken place?
   j. Surveying an I-125 prostate seed implant patient to see if he can be released?
   k. Surveying a cesium GYN implant patient just after the sources are placed?
   l. Surveying a cesium GYN implant patient and room after the sources are back in the pig at the conclusion of the treatment?
   m. Surveying a Gliasite patient?
   n. Surveying a Metastron or Quadramet patient?
   o. Surveying items to be removed from a Gliasite patient's room?
   p. Surveying items to be removed from an I-131 patient's room?
   q. Surveying the patient room after an I-131 patient has been discharged?
   r. Wipe-testing the patient room after an I-131 patient has been discharged?
   s. Surveying a lab where tritium is used?
   t. Surveying the Nuclear Medicine Department?
   u. Wipe-testing the Nuclear Medicine Department?
   v. Surveying items that have been stored for decay to see if they can now be put back into use or put in the regular (non-radioactive) trash?

D. Review the statistics of isotope counting, resolving time, and loss of counts. How do these concepts apply to the use of the Health Physics instruments listed in "A" above?

E. How are survey meters calibrated? Can this be done in-house using, for example, a cesium source? Why or why not? If it can be done, under what circumstances should it be done, by whom, and when? What procedures should be followed and why?

F. Spend time with personnel from your clinic's Radiation Safety Office and the Radiation Oncology Department when they are using the equipment outlined in "A" above, ideally doing some of the tasks listed in "C" above. If possible, make these measurements yourself and practice using the different devices.

Unit 3: Shielding Calculations

References:

1. NCRP Report No. 151: "Structural Shielding Design and Evaluation for Megavoltage X- and Gamma-Ray Radiotherapy Facilities": http://www.ncrppublications.org/Reports/151

2. NCRP Report No. 147: "Structural Shielding Design for Medical X-Ray Imaging Facilities": http://www.ncrppublications.org/Reports/147

3. Patton H. McGinley, Shielding Techniques for Radiation Oncology Facilities, (Medical Physics Publishing, Madison, WI, 1998).

4. Michael G. Stabin, Radiation Protection and Dosimetry: an Introduction to Health Physics, (Springer Science & Business Media, New York, NY, 2008).

5. Faiz M. Khan, The Physics Of Radiation Therapy, 3rd ed. (Lippincott Williams & Wilkins, Philadelphia, PA, 2003).

Objectives:

1) Describe shielding requirements for radiation oncology and diagnostic radiology.
2) Describe key concepts in shielding design.
3) Perform example shielding calculations for radiation oncology and diagnostic radiology.

Consult the references listed above, as well as any other applicable websites, references, articles, and guidance documents, in order to answer the following questions. Write your answers, and discuss them with your preceptor.

A. What considerations are important for shielding design for radiation oncology? For diagnostic radiology? Are there regulations which govern shielding design? If yes, where can these regulations be found?

B. Describe the concepts of "occupancy", "work load", "primary barrier", and "secondary barrier" as they apply to shielding calculations.

C. Imagine that your radiation oncology department is hoping to budget for a new linac in the next fiscal year, and you have been asked to perform preliminary shielding calculations for this

treatment unit. The energies of the preferred machine will be 6x and 20x, with several electron energies ranging from 4e to 20e. The current plan is to fit the new linac into a large existing vault by replacing an old 6x machine, keeping the gantry orientation unchanged. This existing room is just below a patient waiting area. There is a 2nd existing linac vault to the right of this room, a CT-Simulator to the left of this room, the linac control area in front, and the parking lot outside the building behind. What additional shielding would be required for this new machine? Will the door require any additional shielding? How much would you estimate it will cost to upgrade the shielding for the existing vault? Review your calculation with your preceptor.

D. Imagine that administration has reviewed your preliminary figures and feels that the medical center would benefit more from purchasing a CyberKnife Radiosurgery unit. They would plan to add a new vault for this machine, in the parking area adjacent to the radiation oncology department. Perform a preliminary shielding calculation and cost estimate for the CyberKnife unit, making whatever assumptions you need, but being sure to note any assumptions you make on your design. Review your calculation with your preceptor.

E. You have been asked to calculate the shielding required for a suite of new radiographic units and a CT scanner to be added to a free-standing center owned by your hospital system. What information would you need to accurately perform these calculations? For the time being, perform a preliminary calculation, making whatever assumptions you need, but being sure to note these assumptions on your design. Review your calculation with your preceptor.

Unit 4: Isotope Procedures

References:

1. U.S. NRC Part 35: Medical Use of Byproduct Material: http://www.nrc.gov/reading-rm/doc-collections/cfr/part035/index.html

2. Illinois Emergency Management Agency (IEMA) Part 335: Medical Use of Radioactive Material: http://www.state.il.us/iema/legal/pdf/32_335.pdf

3. ACR-ASTRO Practice Guideline for the Performance of Therapy with Unsealed Radiopharmaceutical Sources: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/unsealed_radiopharmaceuticals.aspx

4. ACR-ASTRO-SIR Practice Guideline for Radioembolization with Microsphere Brachytherapy Device (RMBD) for Treatment of Liver Malignancies: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ro/RMBD.aspx

5. NCRP Report No. 155: "Management of Radionuclide Therapy Patients": http://www.ncrppublications.org/Reports/155

6. Michael G. Stabin, Radiation Protection and Dosimetry: an Introduction to Health Physics, (Springer Science & Business Media, New York, NY, 2008).

Objectives:

1) Describe the rationale for isotope procedures such as I-131 therapy, Gliasite, Metastron, Quadramet, and SIR-Spheres.
2) Outline the radiation safety procedures associated with each of these, including spill clean-up and patient release levels and instructions.

Consult the references listed above, as well as any other applicable websites, references, articles, and guidance documents, in order to answer the following questions. Write your answers, and discuss them with your preceptor.

A. Explain the rationale for isotope procedures such as I-131 therapy, Gliasite, Metastron, Quadramet, SIR-Spheres, and any other such procedures performed at your clinical site. What

anatomical sites does each one of these seek to treat? What dose is typically given? Are these procedures fractionated, and if so, describe the typical fractionation methods?

B. Are these procedures typically used in conjunction with other therapies, or do they substitute for other therapies? Compare and contrast these procedures with external beam radiation, brachytherapy, and other more conventional treatment procedures.

C. For each of the isotope procedures noted above, briefly outline the treatment process, and create a detailed outline of the radiation safety steps that should be performed. Be sure to note whether the procedure can be done on an out-patient basis, or if the patient must remain at the medical center (if either case is possible, list what factors are important in making this determination).

D. With regard to your outlines created in "C" above, who is responsible for each step? What is the medical physicist's involvement and responsibility in this procedure? Who is typically responsible for prescribing the dose? For assaying the dose? For administering the isotope? For ensuring that proper radiation safety procedures are in place and are followed? For speaking with the patient and their family members about radiation safety concerns / precautions? For communicating with other hospital personnel (i.e. in-patient nursing, OR staff, etc.) about radiation safety precautions and time limits for patient care?

E. If there are limits on the amount of time any one staff member may spend caring for the patient, how can the staff ensure that the patient receives excellent care and the attention they need while still obeying the time limits? How would such time limits be calculated? On what are they based? Practice such a calculation for an I-131 therapy patient.

F. In the use of unsealed radioactive materials (as opposed to sealed brachytherapy sources), what additional considerations are important from a radiation safety point of view? In each of the isotope procedures noted above, how is the radioactive material accounted for? How are spills prevented / contained? How is contamination prevented? Is special clothing recommended (i.e. shoe covers or gowns)? How are these items disposed of, and where? What should be done if a spill does occur?

G. What procedures should be in place with regard to visitors for the radioactive in-patient? How are these directives communicated to the visitors? Are these directives different when un-sealed sources are used, compared with the directives when sealed sources are used? If yes, summarize these differences.

H. In each of the isotope procedures noted above, what happens to any left-over isotope? How is it transported, stored, and / or returned to the vendor?

I. For each of the isotope procedures noted above, are there restrictions on what items can or should be brought into the patient's room / treatment room? Are items allowed to leave the area

where the radiation is administered, and if so, must they be checked first? If items need to be checked, how would this be done, and by whom? What governs whether or not an item can leave the area?

J. With regard to the isotope procedures noted above, should the patient's room / treatment room receive routine housekeeping services? Why or why not? If not, how is the room kept sufficiently clean? Are there special procedures regarding what should be done with any housekeeping supplies that are brought into the room? If yes, what are these procedures, and what is their purpose?

K. Are radiation shields typically used in these procedures? Why or why not? If they are used, how are they employed, and for what purpose?

L. What happens to any waste generated in these procedures, and why? What process should be followed with regard to surveys and wipe tests at the completion of the procedure? How is waste stored and eventually discarded? Who is responsible for managing this process?

M. For each of these procedures, what are the steps involved in releasing the patient from the medical center? What are the regulations regarding radiation levels at which patients may be released? How is the level of radioactivity assessed and documented at the time of discharge? Are there times when patients may be released with certain restrictions? If so, what are these restrictions?

N. For each type of procedure, what radiation-specific discharge instructions are given to the patients when they are released? Who is responsible for creating and updating the content of these instructions? Who is responsible for discussing these instructions with the patient and / or their family? Does HIPPA allow one to discuss these matters with the patient's family? Are there any other documents related to this procedure that are typically given to the patient at discharge, i.e. cards that can be presented at an airport when one is going through security, etc?

O. Do the patient's belongings need to be surveyed or wipe-tested before they can be sent home with the patient? If yes, how is this done, and by whom? What should be done if any of the patient's belongings are found to be highly radioactive?

P. What are the regulations and procedures for releasing the radioactive in-patient's room to housekeeping after the patient has been discharged? How is the status of the room communicated to hospital staff at the nursing station on the in-patient floor? What consequences could result if this communication is ineffective or incorrect?

APPENDIX:

HMRP 616 Course Syllabus

Rosalind Franklin University of Medicine and Science
Department of Medical Radiation Physics

Clinical Practicum HMRP 616

5 – 7 Units of Credit

Course Description
The purpose of the clinical practicum is to give the student clinical experience and exposure to the hospital environment in which the medical physicist participates. In collaboration with a faculty advisor (the "Director of Clinical Education"), the student is given a rotation schedule in the departments of radiation therapy in one or more of a number of affiliated hospitals. During this time the student works under the direct supervision of an experienced clinical physicist, their "Clinical Preceptor". **While at the clinical site, students are required to follow all of the rules, regulations, and policies designated by the facility, and behave in a professional, ethical, and thoughtful manner.** This class is taken for six consecutive quarters, beginning with the student's second quarter in the program.

Instructors **Assigned Clinical Preceptor:** To Be Determined
Director of Clinical Education: Mary Ellen Smajo, PhD
Program Director: Alex Markovic, PhD

Prerequisites
HMRP 607 – *Introduction to the Radiation Oncology Clinic*, enrollment and program director approval

Teaching Methods
Following the List of Modules and Clinical Competency List in the Clinical Skills Workbook, students are expected to work toward mastering tasks commonly performed by a medical physicist in the hospital setting. Techniques will be applied to real-life patient cases which are treated at the clinical site. The students will be required to perform each task, create how-to documentation for themselves in their logbooks, and answer questions pertaining to various topics as outlined in the Clinical Skills Workbook. Performance will be evaluated by the Preceptor, Director, and staff.

Course Objectives
Upon completion of all six quarters of this course, the student should be able to:
- Discuss and explain each of the topics listed in the Clinical Competency List (CCL) of the Clinical Skills Workbook
- Display competence in each of the CORE CONCEPTS in the CCL (either independently or with supervision)

- Display competence in at least 80% of ALL skills in the CCL (either independently or with supervision)

Course Schedule

The student should be present and actively participating in the clinic at least 2 full days per week. In Summer Quarter, the student is expected to put in additional time, typically 4 days per week. The more time the student is able to devote to the clinic, the more opportunity the student will have to learn. However, schedules must be coordinated with the Clinical Preceptor at each site, as some Preceptors may not be able to host a student more than 2 days per week.

Clinical Tasks/Workbook

The student is expected to complete the Tasks in Module I of the Workbook by the end of the first quarter in the clinic. Modules II and III should be completed by the end of the third quarter in the clinic (i.e. they are typically done concurrently, but one may be undertaken in the second quarter and the other in the third quarter). The remaining Modules/Tasks can be done in any order.

Clinical Presentations: *required every quarter*

These talks are meant to give students skills in organizing, preparing, and delivering presentations to the radiation oncology staff and physicians. Students are required to give one talk per quarter at their clinical site. The topic of each presentation will be agreed upon by the student, Director of Clinical Education, Clinical Preceptor, and Lead Therapist. The subject matter of the talk should be of interest to radiation therapists and should be relevant to the treatments being delivered at the clinical site. The students are responsible for:

1) Preparing the talk on power-point;
2) Providing handouts for staff;
3) Reserving the conference room and AV equipment;
4) Coordinating the date with the lead therapist at least 2 weeks before the talk will be given;
5) Providing the talk outline and the presenter's CV to the lead therapist at least 2 weeks before the talk will be given;
6) Printing and posting the talk flyer at least 2 weeks before the talk;
7) Distributing and collecting evaluation forms following the presentation.

Logbook

Students are required to keep a log of their clinical work in a single notebook which is turned in for review. This book will include detailed how-to procedures, notes, data, results, etc. It may also include answers to workbook questions. It must be kept neat and organized, with dates and headings so that the clinical preceptor can review it. The procedures documented by the student should serve as a reference for the student's future work.

Final Practical Exam

This is an oral exam (which may include hands-on work) and will cover the module or clinical work that the student has been involved with during that quarter. It will not cover the clinical talks.

Required Readings
References listed in the Clinical Skills Workbook.

Attendance
Excused absences due to illness or medical emergency are to be properly documented. The Clinical Preceptor, as well as the Department of Medical Radiation Physics, must be notified. Planned absences should be discussed with the Preceptor well ahead of the scheduled clinical days. Any missed time is expected to be made up; arrangements must be made with the Clinical Preceptor.

Director of Clinical Education Meetings
Students are expected to meet with the Director of Clinical Education regularly (typically every 4 to 6 weeks) to review their progress. The student should bring their logbook / how-to procedures, workbook answers, attendance sheets, Competency Lists, and any other information which will assist the Director of Clinical Education in evaluating the student's progress. The Director of Clinical Education serves as a resource for both students and Preceptors.

Field Trips
From time to time, additional learning opportunities ("field trips") may be offered to the students. These opportunities may include presentations, lectures, demonstrations, and tours. The purpose of the field trips is to acquaint students with topics or equipment that they may not have the opportunity to become familiar with at their current clinical site. Also, the field trips will often help to satisfy items in the Clinical Competency List. Participation in these field trips to various institutions is expected, unless special arrangements are made in advance with the Director of Clinical Education. Students are expected to take notes and to create procedures based on the presented material for their future work.

In addition, quizzes on the field trip material may be administered. Often these will be take-home open-book/open-notes format. In the spirit of self-assessment and life-long learning emphasized by the AAPM and ABR, the answer key will be provided to the student after the quizzes are submitted, and the quiz grade, while not added into the quarter grade, may be used by the Director of Clinical Education in helping to assess the student's overall performance in the clinical practicum course. Prior field trip topics have included "OBI & Cone-beam CT QA", "Beam Modeling & Commissioning", "Cyberknife", and "GammaKnife".

Thought Experiments
For tasks that may not be done frequently at a particular clinical site, students are advised to approach these topics as if they were asked by their chief physicist or physician to be ready to perform that procedure in the next few weeks. The student should review the literature, contact the vendor(s), determine what measurements would need to be made and what methods would need to be followed, write up a proposed procedure, and, finally, review it with their preceptor. The procedure should typically be no more than 3 pages and should take no more than a few hours to research and write. Performing such a "thought experiment" can earn at most a score of "competent with supervision".

Evaluation Methods for each quarter

Grading Breakdown:

Clinical Tasks in Workbook (Preceptor)	40%
Completeness of Logbook (Preceptor)	20%
Clinical Presentation (Preceptor)	10%
Final Practical Exam (Program Director & Staff)	30%

Grading Criteria:

Letter Grade	Percentage Grade
A	90-100
B	80-89
F*	<80%

*Graduate Students are expected to achieve B or better in MRP coursework.

Professionalism Component

In addition to satisfying the grading criteria as specified above, the student must pass a professionalism component in order to successfully pass this course. This component will be evaluated by the clinical preceptor, Director of Clinical Education, and Program Director on a "pass/fail" basis. Criteria to be evaluated in the professionalism component are outlined in the Clinical Skills Workbook.

Evaluation Methods for course completion

Students should strive to complete each item in the Clinical Competency List with a score of "3" ("competent with supervision) or "4" ("competent) prior to graduation. In order to graduate,

1) Every item must have a score of at least "1" ("observation only");
2) No more than 20% of the items may have scores of "1" or "2"("needs improvement");
3) "Core concepts", designated by an asterisk, **must** be completed with a score of "3" or "4".