Johns Hopkins University
Department of Radiation Oncology
Clinical Medical Physics Residency

Guidelines for Clinical Rotations

The core of the medical physics residency program is a series of ten rotations designed to cover the educational objectives of the program. The training goals for each rotation are outlined below.

The resident will have a mentor for each rotation who is a faculty or staff physicist who regularly works in the clinical area for that rotation. The mentor interacts regularly with the resident, usually daily, and serves as the primary person that the resident goes to with questions relating to that rotation. Successful completion of each rotation will include the completion of the guidelines and clinical activities outlined below and as seen appropriate by the rotation mentor.

The mentor will provide ABR style examinations throughout the rotation as needed. At the end of each rotation the resident will be examined and evaluated on the material in that rotation. This evaluation consists of a one-hour presentation by the resident in front of senior physicists with questions. Following this presentation the mentor is responsible for providing a written evaluation of the resident.

Rotation 1: Clinic Introduction (4 weeks)

Mentor: Todd McNutt and Khadija Sheikh

Training Objective: Provide the resident an understanding of clinic workflow. The resident will observer and participate in CT simulation and treatment delivery. During this rotation the resident will observe cases in all of the major disease sites and all of the immobilization devices used in the clinic. Clinical disease sites include the following: head and neck, brain, craniospinal, breast, lung, pancreas, prostate. They will follow patients through from simulation to treatment and will observe treatment setup, imaging and delivery. They will gain experience with all of the external beam delivery devices available in the clinic. The resident will also observe and participate in quality assurance.

Didactic Activities:

a. Review safety policy and procedures
b. Attend orientation and understand clinical used software: Mosaiq (understand the Record and Verify system), Pinnacle and Raystation (Treatment Planning Software)
c. Attend site specific chart reviews
d. Observe and learn how to use Elekta linacs
e. Understand and learn immobilization devices used in clinic and site specific set-ups
f. Develop an understanding of the differences between CT simulators and diagnostic CTs.
g. Develop an understanding of image guidance techniques at the machine
h. Review ICRU Report 50 to understand tumour localization and target definitions

Clinical Activities:

a. Observe and understand patient set-up (i.e. BBs, lasers, placement of isocenter) and CT simulations for the following sites:
    i. Prostate
    ii. Supine and prone breast
    iii. Brain
    iv. Spine
    v. Head and neck

vi. Abdomen and pelvis cases
vii. Extremity
viii. CSI*

b. Observe dosimetrists
   i. Understand Mosaiq and Quality Check Lists
   ii. Understand treatment schedule and machine schedules
c. Observe treatment delivery and understand concepts of patient set-up and workflow:
   i. Observe 10 cases on Versa machines (sites outlined in schedule below)
   ii. Observe patient set-up on CyberKnife
d. Shadow physicist of the day to understand clinical workflow
e. Observe quality assurance tasks:
   i. Observe morning QA
   ii. Observe patient specific QA
   iii. Observe external beam monthly QA
   iv. The resident will have the option to visit the proton center for 1-2 days to observe treatment and QA

Reading list

1. The Physics of Radiation Therapy, F. Kahn, Pub: Lippincott Williams & Wilkins, 4th Ed., 2009. Chapter 4 (linacs, etc)
2. Treatment Planning in Radiation Oncology, F. M. Khan, Pub: Lippincott Williams & Wilkins, 2nd Ed. 2006. Chapters 1-3.
3. Task Group 142 report: Quality assurance of medical accelerators (2009)
4. Verification of monitor unit calculations for non-IMRT clinical radiotherapy: Report of AAPM Task Group 114
5. Monitor unit calculations for external photon and electron beams: Report of the AAPM Therapy Physics Committee Task Group No. 71
6. MPPG 8A (AAPM Medical Physics Practice Guideline 8.a.: Linear accelerator performance tests)
7. MPPG 10A (AAPM medical physics practice guideline 10.a.: Scope of practice for clinical medical physics)

Evaluation

The resident should be able to discuss the workflow of the clinic, use Mosaiq, and feel comfortable working with the linacs. Resident will be evaluated to see if he/she is able to perform patient specific QA independently.

The resident must observe at minimum simulations and treatments for 10 cases. The resident must meet with mentor(s) at least twice during this rotation to review progress.

Sample Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Meet with Residency director and department tour	Orientation, safety policy and procedures	Orientation, safety policy and procedures	Orientation, safety policy and procedures	Sit with physicist to go over department workflow
Week 2	Observe CT simulations Review ICRU 50 and 62 Review MPPG 10a	Observe CT simulations Review ICRU 50 and 62 Review MPPG 10a	Observe CT simulations Review ICRU 50 and 62 Review MPPG 10a	Observe CT simulations Review ICRU 50 and 62 Review MPPG 10a	Meet with advisor
Week 3	Mosaiq tutorial Review TG 142 Review MPPG 8a	Pinnacle tutorial Review TG 142 Review MPPG 8a	Practice whole brain case Schedule machine time with physicist	Sit at machine with RTTs	Sit at machine with RTTs
Week 4	Review MU calcs Shadow IMRT QA	7-8am: Thoracic peer review 8-9am: Breast peer review	8-9am: CNS/HN peer review 9-10am: GI/Peds peer review 4:30-5:30pm: GU/Gyn peer review	Review MU calcs Shadow IMRT QA	Meet with advisor; mock oral covering first month and grad school topics

Simulations
- ☐ Prostate
- ☐ Breast
- ☐ Brain
- ☐ Spine
- ☐ Pelvis
- ☐ Head and Neck
- ☐ Extremity
- ☐ CSI*

Treatments
- ☐ Prostate
- ☐ Breast
- ☐ Brain
- ☐ Spine
- ☐ Pelvis
- ☐ Head and Neck
- ☐ Extremity
- ☐ CSI*

QA
- ☐ Observe DailyQA
- ☐ Observe IMRT QA
- ☐

Readings
- ☐ MPPG8a
- ☐ MPPG10a
- ☐ TG 71
- ☐ TG 114
- ☐ TG 142

Rotation 2: Treatment planning I for EBRT (12 weeks)

Mentor(s): Todd McNutt, Rachel Ger, and Dosimetry Team

Training Objective: The objective of this rotation is for the resident to gain experience with basic conformal radiotherapy planning and simple IMRT/VMAT, including a self-proficient use of the Pinnacle planning system and Mosaiq. The resident will be mentored by a senior staff physicist along with help from the dosimetry group, with a primary point of contact within the dosimetry group that will help assist in ensuring rotation goals are met. The resident will complete practice plans and clinical plans with guidance from medical dosimetrists during the treatment planning process of multiple anatomical sites.. Additionally, the resident will develop an understanding of the different 3-D photon beam dose algorithms, electron beam dose algorithms, non-dosimetric calculations performed by the planning system (e.g., DRRs, contouring tools, etc.) and dose evaluation tools.

Overview:
To begin the rotation, the resident will meet with the primary preceptor to go over the expectations of the rotation.

The resident will meet weekly with the primary preceptor and a primary point of contact within dosimetry. This meeting will be to check in on the progress of the resident in meeting the minimum treatment planning goals and on their understanding of the treatment planning material. This meeting does not replace reviewing plans directly with the dosimetrist overseeing the clinical treatment plan the resident is working on.

The minimum expected number of treatment plans for each site are listed below in the Evaluation section. Each patient is considered as one treatment plan in this tally even if different iterations of plans or plan types are completed unless these are different sequences of the plan (e.g., initial breast photon plan and electron breast boost shall be counted separately) or replans (i.e., change in patient anatomy requires replanning). For each treatment site, the resident will first complete a practice plan before picking up clinical plans. All practice plans should be completed within the first two weeks of the residency. Each practice plan is expected to be completed by the next business day and reviewed with dosimetry at that time. While completing practice plans, the resident will observe and help dosimetry in finalizing current plans in order to learn the process and better transition to working on clinical plans.

For all clinical plans, the resident will pick up the plan alongside a dosimetrist. The resident is to work with this dosimetrist for all steps of this given plan. On clinical plans, it is expected that the resident will learn the treatment planning workflow, communication within the dosimetry group, communication with physicians, and the plan finalization process. For plans to count towards the minimum expected case count, the resident is expected to complete all steps in the treatment planning process from beginning through finalization.

The primary concentration of this rotation is on 3D plans. If time allows, given the resident's progress, simple IMRT and VMAT cases will also be completed in this rotation.

Several didactic lectures will be given by the physics preceptors of the rotation on topics pertinent to treatment planning, such as different dose calculation methods. Additionally, two ABR-style exams will be given during the course of the rotation: one about the middle of the rotation and one at the end of the rotation.

A sample calendar is given below in the Sample Schedule section. This does not need to be followed exactly by the day, just to give an idea of how the resident should be proceeding during this rotation.

Learning Objectives:

1. Learn how to use the clinical treatment planning system
2. Understand DICOM and DICOM RT interfaces between CT, PACS and Treatment Planning
3. Interface between treatment planning and treatment management system (MOSAIQ)
4. MOSAIQ treatment and image guidance scheduling
5. Develop an understanding of beam properties for photons and electrons
6. Develop an understanding of beam modifiers (e.g., bolus, compensators, and wedges)
7. Understand plan evaluation (e.g., dose volume histogram)
8. Understand dose limits to sensitive structures
9. Attend site specific peer review once a week
10. The resident will be given practice ABR part 2 style exams during this rotation to complete on their own time which will include hand calculations to prepare the resident for the second part of the ABR certification.

Reading List

1. The Physics of Radiation Therapy, F. Khan, Pub: Lippincott Williams & Wilkins, 4th Ed., 2009. Chapters 9-14.
2. Treatment Planning in Radiation Oncology, F. M. Khan, Pub: Lippincott Williams & Wilkins, 2nd Ed. 2006. Chapters 4, 6, 17, 20, 23
3. Oelfke, U and Scholz, C. Dose Calculation Algorithms. 2006.
4. Verification of monitor unit calculations for non-IMRT clinical radiotherapy: Report of AAPM Task Group 114
5. AAPM TG 329
6. MPPG 11a
7. Ford Chapters 10, 11, 12, 13, 15

Evaluation

The resident's performance will be evaluated based on his/her understanding and confidence of treatment planning 3D conformal sites. Two ABR-style exams will be given by the primary preceptor of the rotation. Additionally, the evaluation document for this specific rotation will be used to determine if the rotation is passed. This document specifies the minimum expected number of treatment plans per site as shown in the table below.

Sites	**Practice Cases**	**Real Cases (minimum)**	**Details**	**Resident Completed Practice Cases Count**	**Resident Completed Real Cases Count**
Whole Brains	2	2			

AP/PA	1+1*	7	Sites may include: (1) Spine (1) Hip (1) obscure site (1) extended SSD* (1) multi iso (1) re-treatment spine (1) composite plan * may be practice case More than one of these may be covered by a single case (e.g., hip and composite plan may be a single case, this still only counts as one towards the case tally though)		
Obliques	1	3	Sites may include: (1) Spine (1) Ribs (1) Hip (1) Eye		
Breast (Supine)	3	4	One of each must be completed in practice and real cases: (1) Tangents only (1) Chest wall w. SCV, PAB (1) Breast w. SCV, PAB (1) Bolus Bolus may be incorporated with a chest wall case, this will only count as one towards the case tally though		
Breast (Prone)	1	1	(1) Tangents only		

Electrons	1	3	Sites may include: (1) Breast boost (1) Keloids (1) Bolus-any site		
Wedges	1	1	Types of plans/sites may include: (1) 3 fields (1) rectal/sacrum		
Four Field Box	1*	1	(1) practice or real case* *Only one case is needed, preferably a real case but if one does not happen during the resident's rotation time, then a practice case may be completed instead		
Simple IMRT (if time allows)	1+1*	3	(1) brain not near OARs (1) prostate* (1) PBI *may be practice case		
TOTAL	**11**	**22**			

Sample Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Lecture with advisor about traditional planning techniques	Practice plans: whole brain, spine, hip and extremity	Practice plans: whole brain, spine, hip and extremity	Practice plans: whole brain, spine, hip and extremity	Meet with dosimetry about plans
Week 2	Practice plans: breast, electrons	Practice plans: breast, electrons	Practice plans: breast, electrons	Practice plans: 4 field box pelvis cases	Meet with advisor
Week 3	Review MPPG11a Go over plan documentation with dosi	Paired with dosimetry to pick up 3DCRT cases	Paired with dosimetry to pick up 3DCRT cases	Paired with dosimetry to pick up 3DCRT cases	Paired with dosimetry to pick up 3DCRT cases

Week 4	Paired with dosimetry to pick up 3DCRT cases Observe MonthlyQA	7-8am: Thoracic peer review 8-9am: Breast peer review Paired with dosimetry to pick up 3DCRT cases	8-9am: CNS/HN peer review Paired with dosimetry to pick up 3DCRT cases	Paired with dosimetry to pick up 3DCRT cases Observe MonthlyQA	Meet with advisor
Week 5	Lecture with advisor about traditional correction based dose calculation methods	8-9am: Breast peer review Act as dosimetrist for 3DCRT	8-9am: CNS/HN peer review Act as dosimetrist for 3DCRT	Act as dosimetrist for 3DCRT	Act as dosimetrist for 3DCRT
Week 6	Act as dosimetrist for 3DCRT	8-9am: Breast peer review Act as dosimetrist for 3DCRT	8-9am: CNS/HN peer review Act as dosimetrist for 3DCRT	Act as dosimetrist for 3DCRT	Meet with advisor
Week 7	Lecture with advisor about optimization and general IMRT planning	Practice plans: prostate VMAT, brain IMRT	Practice plans: prostate VMAT, brain IMRT	Practice plans: prostate VMAT, brain IMRT	Meet with dosimetry about plans
Week 8	Act as dosimetrist for 3DCRT and simple VMAT	8-9am: Breast peer review Act as dosimetrist for 3DCRT and simple VMAT	8-9am: CNS/HN peer review Act as dosimetrist for 3DCRT and simple VMAT	Act as dosimetrist for 3DCRT and simple VMAT	Meet with advisor
Week 9	Paired with dosimetry to pick up easy Observe MonthlyQA	8-9am: Breast peer review Paired with dosimetry to pick up easy cases	8-9am: CNS/HN peer review Paired with dosimetry to pick up easy cases	Paired with dosimetry to pick up easy cases Observe MonthlyQA	Paired with dosimetry to pick up easy cases
Week 10	Act as dosimetrist for 3DCRT and simple VMAT Observe IMRTQA	8-9am: Breast peer review Act as dosimetrist for 3DCRT and simple VMAT	8-9am: CNS/HN peer review Act as dosimetrist for 3DCRT and simple VMAT	Act as dosimetrist for 3DCRT and simple VMAT Observe IMRTQA	Meet with advisor
Week 11	Act as dosimetrist for	8-9am: Breast peer review	8-9am: CNS/HN peer review	Act as dosimetrist for	Act as dosimetrist

	3DCRT and simple VMAT	Act as dosimetrist for 3DCRT and simple VMAT	Act as dosimetrist for 3DCRT and simple VMAT	3DCRT and simple VMAT	for 3DCRT and simple VMAT
Week 12	Act as dosimetrist for 3DCRT and simple VMAT Independent on IMRTQA	8-9am: Breast peer review Act as dosimetrist for 3DCRT and simple VMAT	8-9am: CNS/HN peer review Act as dosimetrist for 3DCRT and simple VMAT	Act as dosimetrist for 3DCRT and simple VMAT Independent on IMRTQA	Meet with advisor

Rotation 3: Treatment planning II for EBRT (12 weeks)

Mentor(s): Todd McNutt, Rachel Ger, and Dosimetry Team

Training Objective: This rotation builds on and extends treatment planning #1. During this rotation the resident will perform more complex plans including: IMRT and VMAT plans for a variety of sites.

Overview
To begin the rotation, the resident will meet with the primary preceptor to go over the expectations of the rotation.

The resident will meet weekly with the primary preceptor and a primary point of contact within dosimetry. This meeting will be to check in on the progress of the resident in meeting the minimum treatment planning goals and on their understanding of the treatment planning material. This meeting does not replace reviewing plans directly with the dosimetrist overseeing the clinical treatment plan the resident is working on.

The minimum expected number of treatment plans for each site are listed below in the Evaluation section. Each patient is considered as one treatment plan in this tally even if different iterations of plans or plan types are completed unless these are different sequences of the plan on separate CT scans (e.g., initial plan and cone down planned off of a later CT scan) or replans (i.e., change in patient anatomy requires replanning). For each treatment site, the resident will first complete a practice plan before picking up clinical plans. For each treatment site, except TBI, the resident will first complete a practice plan before picking up clinical plans. For all practice plans, the resident is expected to check in the next business day to update the progress on the plan. For all clinical cases picked up by the resident, they are responsible for all involved steps including any replans.

For all clinical plans, the resident will pick up the plan alongside a dosimetrist. The resident is to work with this dosimetrist for all steps of this given plan. On clinical plans, it is expected that the resident will learn the treatment planning workflow, communication within the dosimetry group, communication with physicians, and the plan finalization process. For plans to count towards the minimum expected case count, the resident is expected to complete all steps in the treatment planning process from beginning through finalization.

If the resident feels comfortable in IMRT planning during the rotation, in a weekly meeting with the primary preceptor and primary point of contact within dosimetry, they may ask if they can skip some practice cases. This is up to the discretion of the primary preceptor and dosimetry if this is allowed for the given resident.

For three patients that the resident completes the clinical treatment plan for, they must attend several fractions at the machine. For patients that are film only to start, the resident must attend the first two fractions of the patient's treatment and one additional fraction while the patient is under treatment. For patients that are film and treat to start, the resident must attend the first fraction and two additional fractions while the patient is under treatment.

Residents are encouraged to pick up at least one insurance comparison case. If possible, the resident should join the physician if peer to peer is required for the insurance approval process.

The primary concentration of this rotation is on IMRT plans. Additionally, two special procedures, TBI and CSI, are covered in this rotation.

Several didactic lectures will be given by the physics preceptors of the rotation on topics pertinent to treatment planning, such as different dose calculation methods. Additionally,

two ABR-style exams will be given during the course of the rotation: one about the middle of the rotation and one at the end of the rotation.

Learning Objectives:

1. Complete a didactic session with Todd McNutt and develop an understanding of step-and-shoot and sliding window IMRT, IMRT/VMAT optimization and QA
2. Attend site specific peer review once a week
3. Better understand normal tissue contouring – observe medical resident

Reading List

1. Treatment Planning in Radiation Oncology, F. M. Khan, Pub: Lippincott Williams & Wilkins, 2nd Ed. 2006
2. Principles and Practice of Radiation Therapy, C.M. Washington & D.T. Leaver, Pub: Mosby, 3rd Ed. 2009

Evaluation

The resident's performance will be evaluated based on his/her understanding and confidence of treatment planning IMRT and VMAT sites. Two ABR-style exams will be given by the primary preceptor of the rotation. Additionally, the evaluation document for this specific rotation will be used to determine if the rotation is passed. This document specifies the minimum expected number of treatment plans per site as shown in the table below.

Sites	**Practice Cases**	**Real Cases (minimum)**	**Details**	**Resident Completed Practice Cases Count**	**Resident Completed Real Cases Count**
Brain around critical structures	2	2			
Breast	1*	1	*If PBI practice done in TP1, instead do 2 real **If no PBI, can replace with IMRT breast		
Sarcoma	1	2			

Lung/Esophagus/Pancreas	2	3	(1) ABC (1) 4D		
Abdomen/Pelvis	1	2	(1) Gyn		
Prostate	2	3	Practice: (1) Prostate and nodes (1) Prostate bed Real: (1) Prostate and nodes (1) Prostate bed and nodes (1) Prostate SIB		
Head and neck	1	2	(1) Unilateral SIB (1) Bilateral		
TBI	0	2			
CSI	1	0			
TOTAL	**11**	**17**			

Sample Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	Lecture with advisor reviewing simple IMRT and introducing VMAT/IMRT	Practice plans: brain around critical structures	Practice plans: Sarcoma	Practice plans: thorax, pancreas	Meet with dosimetry about plans
Week 2	Practice plans: abdomen, pelvis	Practice plans: prostate with nodes	Practice plans: head and neck	Practice plans: head and neck	Meet with advisor
Week 3	Paired with dosimetry to	Paired with dosimetry to	Paired with dosimetry to	Paired with dosimetry to	Paired with dosimetry to

	pick up VMAT/IMRT cases	pick up VMAT/IMRT cases	pick up VMAT/IMRT cases	pick up VMAT/IMRT cases	pick up VMAT/IMRT cases
Week 4	Paired with dosimetry to pick up VMAT/IMRT cases Go to machine and watch day 1 of cases planned	7-8am: Thoracic peer review 8-9am: Breast peer review Paired with dosimetry to pick up VMAT/IMRT cases	8-9am: CNS/HN peer review Paired with dosimetry to pick up VMAT/IMRT cases	Paired with dosimetry to pick up VMAT/IMRT cases Observe VMAT/IMRT setups treatments	Meet with advisor
Week 5	Lecture with advisor	8-9am: Breast peer review Act as dosimetrist	8-9am: CNS/HN peer review Act as dosimetrist	Act as dosimetrist	Act as dosimetrist
Week 6	Act as dosimetrist	8-9am: Breast peer review Act as dosimetrist	8-9am: CNS/HN peer review Act as dosimetrist	Act as dosimetrist	Meet with advisor
Week 7	Lecture with advisor on TBI and read TG 29	Act as dosimetrist	Act as dosimetrist	Act as dosimetrist	Meet with dosimetry about plans
Week 8	Act as dosimetrist	8-9am: Breast peer review Act as dosimetrist	8-9am: CNS/HN peer review Act as dosimetrist	Act as dosimetrist	Meet with advisor
Week 9	Review TG 148 Review TG 176	8-9am: Breast peer review Act as dosimetrist	8-9am: CNS/HN peer review Act as dosimetrist	Act as dosimetrist	Act as dosimetrist
Week 10	Review chart check for VMAT/IMRT plans	8-9am: Breast peer review Act as dosimetrist	8-9am: CNS/HN peer review Act as dosimetrist	Act as dosimetrist	Meet with advisor
Week 11	Lecture with advisor on CSI	8-9am: Breast peer review	8-9am: CNS/HN peer review	Act as dosimetrist	Act as dosimetrist

		Practice CSI case with dosimetry	Practice CSI case with dosimetry		
Week 12	Act as dosimetrist	8-9am: Breast peer review	8-9am: CNS/HN peer review	Act as dosimetrist	Meet with advisor

Rotation 4: Stereotactic radiosurgery (SRS) and fractionated radiosurgery (FSR) (12 weeks, optional to 16 weeks)

Mentor(s): Stereotactic physicist and stereotactic and CyberKnife dosimetry team

Training objective: Understand the all major aspects of SRS, FSR, and SBRT. The resident will observe and participate in planning and treatment with the CyberKnife and with cone-beam CT-guided stereotactic brain, spine, lung and pancreas etc. The resident will observe and then participate in all aspects of planning and treatment. The resident will participate in each step of the cone-beam CT (CBCT)-guided LINAC based stereotactic spine and brain radiosurgery (SRS), fractionated radiosurgery and radiotherapy (FSR and SRT).

Didactic Activities:

1. Meet with mentor once a week to go over reading list
2. Understand small field planning, optimization and QA
3. Understand organ motion and organ-motion corrected methods
4. Understand image guided radiotherapy equipment and techniques (i.e. planar MV, CBCT)
5. Attend CNS chart rounds every week

Clinical Actitivies:

1. Understand CyberKnife workflow:
    a. Observe immobilization and orthogonal KV image guidace and understand the considerations involved.
    b. Oberve MRI, CT and angiography images and understand the considerations involved.
    c. Observe, practice and then perform treatment planning and treatment for the full variety of disease indications treated with the CyberKnife.
    d. Participate in daily and monthly QA
2. Complete the following CyberKnife plans:
    a. Multiple metastasis
    b. Post-op FSR boost
    c. SRT plan for benign tumor (pituitary, optical meninigioma etc.)
    d. Spine SRS plan
    e. SRS plan for benign tumor/symptom (Acoustic Neuroma, AVM etc.)
3. Perform both conformal and IMRT based stereotactic plans on different types of brain and spine tumor. The objective is to understand the specific consideration and planning techniques in stereotactic planning including margin setup, non-coplanar beam arrangement and different isodose normalization. The following plans need to be completed:
    a. Spine SRS plan
    b. Pancreas SBRT plan
    c. Lung SBRT plan
    d. Other SBRT plans if cases show up
    e. Single or Multi isocenter brain metastasis
4. The resident will participate stereotactic treatments and understand various specifics of stereotactic treatment including: CBCT guidance, inter- and intra-fraction motion monitoring and management, using of 6-degree freedom couch to correct patient setup uncertainty, etc.
5. The resident will perform patient specific treatment QA and stereotactic treatment devices QA routinely during this rotation.

Reading List:

1. AAPM TG 42 report: Stereotactic Radiosurgery
2. AAPM TG 101: Stereotactic body radiation therapy
3. AAPM TG 76: Motion Management
4. AAPM TG 135: Quality assurance for robotic radiosurgery

5. MPPG 9A: Medical Physics Practical Guideline 9a for SRS-SBRT
6. TG 235: Radiochromic Film Dosimetry: An update to TG-55
7. TG 155: Megavoltage photon beam dosimetry in small fields and non-equilibrium conditions
8. TRS 493: Dosimetry of small static fields used in external beam radiotherapy
9. TG179: QA of CT-Based IGRT

Evaluation

The resident's performance will be evaluated based on his/her understanding and confidence of treatment planning SRS and SBRT sites. An oral examination will be taken by the mentor and/or other staff physicist worked with the resident in this rotation.

Rotation 5: Quality Assurance for EBRT (ongoing)

Mentor: Assigned Machine Physicist

Training objective: Become self-proficient in all aspects of EBRT quality assurance. In this rotation the resident learn how to perform and evaluate quality assurance (QA) tests of patient-specific IMRT plans, regular monthly and annual QA of linacs, and QA of simulators.

Didactic Training:

1. Observe assigned machine physicist during monthly and annual QA
2. One on one session with machine physicist to understand basics of linacs
3. Develop an understanding of beam scanning systems and dose measuring systems

Clinical Training:

The specific rotation expectations:

1. Perform patient-specific IMRT QA routinely through out the entire residency. The QA includes patient-specific measurement, result analysis and report generation.
2. Perform regular monthly QA of Linac through out the whole residency. The QA will rotate through different LINACs at JHH including Elekta and TOMO machines.
3. The resident will perform regular monthly QA of Simulators through out the whole residency.
4. Perform regular annual QA of Linac through out the whole residency. The QA will rotate through different LINACs at JHH including Elekta and TOMO machines.
5. The resident is expected to fully understand the EBRT dosimetric calibration protocols for photon and electron beams.

Reading List:

1. AAPM TG 142: The QA of linear accelerators
2. AAPM TG 106: Accelerator beam data commissioning equipment and procedures.
3. AAPM TG 51 report: AAPM's TG-51 protocol for clinical reference dosimetry of high energy photon and electron beams
4. AAPM TG 21 report: A protocol for the determination of absorbed dose from high energy photon and electron beams
5. AAPM TG 39 report: The Calibraton and Use of Plane-Parallel Ionization Chambers for Dosimetry of Electron Beams
6. AAPM TG 40 report: Comprehensive QA for Radiation Oncology
7. AAPM TG 45 report: AAPM Code of Practice for Radiotherapy Accelerators

Evaluation

The resident's performance will be evaluated based on his/her understanding and confidence on using the linacs. The resident will be observed to see if he/she can complete patient specific and monthly QA independently.

Over the course of the 24 month clinical rotations the resident will have completed at minimum:

External Beam	Imaging	Brachytherapy
□ Versa Monthy (4x) □ Versa Annual (2x) □ CyberKnife Monthly (1x) □ CyberKnife Annual (1x) □ Observed Proton QA □ Patient QA (2x/month)	□CT Monthly (2x) □CT Annuals (1x) □MRI Monthly (1x) □PET/CT QA (optional)	□ Source Exchange (2x) □ Daily QA (3x)

Rotation 6: Linear accelerator acceptance testing and commissioning (10 weeks)

Mentor: Machine Physicist

Training objective: The resident will commission a new linear accelerator for treatment. Working with a staff physicist they will be responsible for all aspects of the acceptance testing and commissioning measurements. The resident may complete this rotation at the proton therapy center.

Didactic Training:

1. Meet one-on-one with physicist to understand linac acceptance test and commissioning project.
2. Develop an understanding of beam data acquisition and management
3. Develop an understanding of beam modelling

Clinical Training:

1. Perform mechanical tests
4. Conduct system calibration, performance evaluations and quality control, safety and compliance tests, including vendor specifications, under supervision of a qualified physicist
    a. Megavoltage photons
    b. Megavoltage electrons
    c. Small field systems (SRS,SBRT)
    d. Beam scanning systems
    e. External beam dose measuring systems
    f. 3D external beam treatment planning workstations
    g. Total body irradiation (TBI)
    h. In-vivo dosimetry (e.g. diodes, thermoluminescent dosimeters (TLDs), optically stimulated luminescence dosimeters (OSLDs))
2. Image quality tests of the imaging system
3. Beam output determination with TG51
4. Leakage determination and surveying
5. Beam data acquisition
    a. Photon Beam Data within acceptance parameters
    b. Electron Beam Data within acceptance parameters
    c. Dose Repeatability Test
    d. Output, flatness, symmetry with gantry angle
    e. Output and dose rate linearity
6. Treatment Planning System Commissioning
    a. Modeling of Beam data in TPS (Pinnacle, RayStation, or other)
    b. Verification measurements for a variety of clinically relevant fields.
7. Setup accelerator for future QA and use
    a. Establish a daily and monthly QA program
    b. Develop hand calculation tables for use with second check programs or hand calculations.

Reading Materials:

1. AAPM TG 142: The QA of linear accelerators
2. AAPM TG106: Accelerator beam data commissioning equipment and procedures.
3. AAPM TG10: Code of Practice for radiotherapy accelerators
4. AAPM TG 51 report: AAPM's TG-51 protocol for clinical reference dosimetry of high energy photon and electron beams
5. AAPM TG 21 report: A protocol for the determination of absorbed dose from high energy photon and electron beams
6. AAPM TG 39 report : The Calibraton and Use of Plane-Parallel Ionization Chambers for Dosimetry of Electron Beams

7. AAPM TG 40 report: Comprehensive QA for Radiation Oncology
8. AAPM TG 45 report: AAPM Code of Practice for Radiotherapy Accelerators
9. AAPM TG53 report: QA for clinical radiation therapy treatment planning
10. A Primer on Theory and Operation of Linear Accelerators in Radiation Therapy, C.J. Karzmark, R.J. Morton, Pub: Medical Physics Publishing Corporation, 2nd Ed. 1997
11. The Physics of Radiotherapy X-Rays from Linear Accelerators, P. Metcalfe, T. Kron, P. Hoban, Pub: Medical Physics Publishing Corporation, 1st Ed., 1997
12. The Q Book: The Physics of Radiotherapy X-Rays Problems and Solutions, P. Metcalfe, T. Kron, P. Hoban, Pub: Medical Physics Publishing Corporation, Workbook Edition, 1998

Evaluation:

An oral examination will be taken by the mentor and/or other staff physicist worked with the resident in this rotation.

Rotation 7: Brachytherapy (12 weeks, optional to 16 weeks)

Mentor: Michael Roumeliotis and Brachytherapy team

Training Objective: The objective of the brachytherapy rotation is to educate and train physicists to a competency level sufficient to practice brachytherapy physics independently. To accomplish this goal, the residents will be exposed to a multitude of clinical tasks and didactic education. The objective of this facet is to learn the steps involved in preparation of materials and equipment for procedures using LDR sources and HDR sources. This aspect of the clinical throughput involves treatment planning by dosimetrists and/or physicists as well as quality assurance with radiation therapists, physicians, and physicists.

Didactic Training:

1. Meet one-on-one with lead brachytherapy physicist once a week
2. Attend brachytherapy specific chart rounds
3. Develop an understanding of the different types of brachytherapy implants and their clinical value to patients
4. Develop an understanding of the clinical trials that have led to routine standard of care, which outline prescriptions, dose constraints, planning strategies, post-implant analysis, and patient outcomes
5. Review radioactive decay relevant to institutional radiopharmaceutical therapies

Clinical Training:

1. Observe and perform the following procedures:
    a. 3+ Prostate LDR cases
    b. Gynecological procedures including treatment planning:
        i. 3+ Single Channel Vaginal Cylinder
        ii. 2+ Multi Channel Vaginal Cylinder
        iii. 3+ Template Interstitial
        iv. 3+ Venezia Applicator
        v. 1+ Tandem and Ring
    c. 2+ Eye plaques
    d. 1+ Brain seed (if possible)
    e. 3+ IORT cases
    f. 3+ Xofigo (alpha emitter)
    g. 3+ TheraSphere (beta emitter)
2. Perform quality assurance & radiation safety:
    a. Remote afterloader quarterly QA (Flexitron & Microselectron)
    b. LDR Source QA (prostate & ocular)
    c. HDR Daily QA
    d. HDR Annual QA
    e. Pre- and post-treatment radiation processes for Xofigo & TheraSphere procedures

D. Reading List:

1. AAPM TG 43: Dosimetry of Interstitial Brachytherapy Sources
2. AAPM TG 59: HDR Treatment Delivery
3. AAPM TG 128: Quality assurance tests for prostate brachytherapy ultrasound systems
4. AAPM TG 137: Recommendationson Dose Prescription and Reporting Methods for Permanent Interstitial Brachytherapy for Prostate Cancer
5. ICRU 89: Prescribing, Recording, and Reporting Brachytherapy for Cancer of the Cervix
6. ABS Guidelines: Consensus for Guidelines for Interstitial Brachytherapy for Vaginal Cancers
7. ABS Guidelines: Consensus Guidelines for High-Dose-Rate Prostate Brachytherapy

Evaluation:

An oral examination will be taken by the mentor and/or other staff physicist worked with the resident in this rotation.

Sample Schedule

	Monday	Tuesday	Wednesday	Thursday	Friday
Month 1	Learn Oncentra; Learn survey meter; Daily QA; theraspheres	Eye plaques; Attend GYN meetings	Gyn Cases	IORT; Prostate Cases	Meet with advisor weekly; eye plaques; xofigo
Month 2	Learn source exchange; theraspheres	Eye plaques; Attend GYN meetings	Gyn Cases	IORT; Prostate Cases	Meet with advisor weekly; eye plaques; xofigo
Month 3	Theraspheres Be independent on basic HDR and LDR plans	Eye plaques; Attend GYN meetings	Gyn Cases	IORT; Prostate Cases	Meet with advisor weekly; eye plaques; xofigo

Cases

- 5 Prostate Cases
- 3 Gyn per applicator
- 5 Eye plaque cases
- 5 IORT Cases
- 1 Brain LDR
- 5 Xofigo
- 3 Theraspheres

Projects

- Secondary dose check
- Worflow improvement projects

QA

- Daily QA
- Source exchange
- Annual QA
- Wipe tests
- Inventory

Readings

- TG 43 and update
- TG 56
- GEC-ESTRO
- TG 137
- TG 64
- TG 59
- TG 128
- TG 129
- TG 186
- TG 221

Rotation 8: Radiation Safety (4 weeks)

Mentor: Radiation Safety Officer and Radiation Safety Office

Training objective: Gain experience with aspects of radiation safety including exposure risk evaluation and monitoring, surveying and shielding. This rotation will also include training in the patient safety improvement efforts of the department. The resident will also spend a week in the Radiation Safety department.

Didactic Training:

1. Complete radiation safety orientation with Rob Hobbs and go over personnel dosimetry
2. Complete one-on-one lecture with Carl in Radiation Safety to understand different detectors and policies of the hospital
3. Understand the material in NCRP report 151 and 103
4. Understand national and state regulations
5. Understand radiation exposure to the public
6. Understand failure mode effects analysis (FMEA) principles and applications
7. Understand reporting requirements for medical events
8. Understand sealed source storage, safety and protection
9. Understand patient release criteria following radionuclide therapy
10. Understand neutron shielding

Clinical Training:

1. Perform at least one shielding calculation for a new linear accelerator facility and for a diagnostic room. If none are under construction at the time of the training, example plans will be used.
2. Perform package acceptance, shipping, and source disposal at the Radiation Safety Department
3. Perform sealed source packaging and transportation
4. Perform sealed source inventory
5. Perform exposure, contamination, and facility radiation surveys
6. Perform root cause analysis (RCA)

Reading list:

1. The Physics of Radiation Therapy, F. Khan, Pub: Lippincott Williams & Wilkins, 4th Ed., 2009
2. Shielding Techniques for Radiation Oncology Facilities, P.H. McGinley, Pub: Medical Physics Publishing Corporation, 2nd Ed., 2002
3. NCRP Report Number 151
4. ICRP Report Number 103
5. NUREG 10 CFR Part 20: Standards for protection against radiation
6. NUREG 10 CFR Part 35: Medical use of byproduct material

Evaluation

The resident's performance will be evaluated based on the shielding calculations. An oral examination will be taken by the mentor and/or other staff physicist worked with the resident in this rotation.

Rotation 9: Imaging (6 weeks)

Mentor: Junghoon Lee

Training objective: Understand the basic aspects of medical physic imaging including: CT, cone-beam CT, ultrasound, MR, PET/CT and SPECT. This 6 week rotation will focus on the practical aspects of medical physics imaging as related to the practice of radiation oncology. This is meant as an addition to the standard didactic background in medical physics imaging as outlined above.

Didactic Training:

1. Spend one-on-one with physicist to understand DICOM standards, DICOM RT and data management
2. Develop an understanding of image registration, fusion, and segmentation
3. Develop an understanding of validation of imported images
4. Develop an understanding of the information acquired from PACS

Clinical Training:

1. Perform quality assurance of the department MR simulator, CT simulator, cone-beam CT devices, and brachytherapy ultrasound devices.
2. Spend at least one week in a rotation with radiology which will include physics aspects of MRI and PET/CT. Our physics contacts in radiology will act as laisons for this rotation.
3. Observe SPECT, PET or PET CT scanner QC procedure in radiology department. This procedure may include rod source normalization, 20 cm phantom measurement for transmission and emission test. Make sure understand the basic principles of PET imaging, including image resolution, etc.
4. Perform daily imaging physicist tasks such as image and plan fusions:
    a. Multi-modality image fusion for contouring and target definition.
    b. Treatment plan fusion with deformation for dose compositing and replanning

Reading List:

1. TG 132: Use of Image Registration and Data Fusion Algorithms and Techniques in Radiotherapy Treatment Planning
2. TG 66: Quality assurance for computed-tomography simulators and the computed-tomography-simulation process: Report of the AAPM Radiation Therapy Committee Task Group No. 66 (2003)
3. The Essentials of Physics of Medical Imaging, J.T. Bushberg, J.A. Seibert, E.M. Leidholdt, J.M. Boone, Pub: Lippincott Williams & Wilkins, 3rd Ed., 2012
    a. Image Quality: Chapter 4
    b. Tubes and X-ray Production: Chapter 6
    c. Radiography (CR Plates, CCD, flat panel imagers): Chapter 7
    d. Mammography: Chapter 8
    e. Fluoroscopy: Chapter 9
    f. Computed Tomography: Chapter 10
    g. MRI: Chapters 12-13
    h. Ultrasound: Chapter 14
    i. Nuclear Medicine: Section 3 of Bushberg
    j. PET and SPECT: Chapter 19

Evaluation

An oral examination will be taken by the mentor and/or other staff physicist worked with the resident in this rotation.

Rotation 10: Physicist of the Day Rotation (12 weeks)

Mentor: Physicist of the day

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

Didactic Activities:

a. Review ROTA, Oncobrowser white board.
b. Review functionality of clinical software programs: Mosaiq, RadCalc, and Sun Nuclear's Daily QA3.
c. Review in-vivo dosimetry (i.e. diodes, thermoluminscent dosimeters [TLDs], optically stimulated luminescence dosimeters [OSLDs])

Clinical Activities:

The resident will work with the designated physicist of the day on the activities listed below:
Under the supervision of the senior physicist, assist with clinical issues that arise during the treatment day, as needed.

1. Daily Quality Assurance: Review morning machine quality assurance data for all treatment units and identify any parameters outside of specification.
2. Complete 25 initial treatment plan/chart checks
    a. Check patient prescription in Mosaiq compared to the physician approved treatment plan
    b. Check second MU calculations (generated in RadCalc)
    c. Provide treatment day physics assistance
    d. Perform final physics chart checks
3. Complete 50 weekly treatment plan/chart checks
    a. Overall check of chart for completeness & signatures
    b. Check fractions treated & dose site summary
    c. Check the tolerance table values in Mosaiq compared those found in the treatment chart.
    d. For applicable plans, review diode measurements to ensure readings are within the expected range and transcribed into Mosaiq.
4. Complete 25 final treatment plan/chart checks
    a. Work through Final Physics Checks assessment
    b. Become familiar with process of billing (senior physicist is responsible for billing)

Reading list

1. AAPM TG 275 Report: Strategies for Effective Physics Plan and Chart Review in Radiation Therapy.
2. AAPM TG 100 Report: The report of Task Group 100 of the AAPM: Application of risk analysis methods to radiation therapy quality management.
3. AAPM TG 203 (TG 34) Report: Management of radiotherapy patients with implanted cardiac pacemakers and defibrillators.
4. C. Hurkmans, J. Knegjens, et al. Management of radiation oncology patients with a pacemaker or ICD: A new comprehensive practical guideline in The Netherlands. Radiation Oncology 2012, 7:198.

Evaluation:

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

Rotation 11: Proton Therapy (Optional 4-8 weeks)

Mentor: Proton Therapy Physics Team

Training Objective: Provide the resident resident an overview of the proton therapy physics and treatment techniques. The resident will learn through observation and direct participation in the clinical physics activities. The resident will participate in technical aspects of patient care under the supervision of staff proton physicists. These activities include quality assurance (daily, monthly, annual and patient-specific), patient treatment simulation, treatment planning, review of patient positioning and immobilization.

Didactic Activities:

a. Attend proton specific chart rounds/peer review
b. Attend proton physics meetings for plan pre-check
c. Review functionality of clinical software programs: RayStation, Mosaiq

Clinical Activities:

The resident will work with staff proton physicists and dosimetrists on the activities listed below:

1. Shadow the physicist of the day
    a. Observe simulation
    b. Observe chart check
2. Complete 1-2 treatment plans
    a. Under the supervision of a dosimetrist and physicist,
3. Complete proton specific QA
    a. Complete monthly QA
    b. Complete patient specific QA

Reading list:

1. AAPM TG 224 Report: Comprehensive proton therapy machine quality assurance
2. Chapter 10: IAEA TRS-398 Absorbed Dose Determination in External Beam Radiotherapy: An International Code of Practice for Dosimetry based on Standards of Absorbed Dose to Water
3. ICRU 78 Prescribing, Recording, and Reporting Proton-Beam Therapy

Evaluation

The resident's performance will be evaluated based on his/her understanding and confidence of handling clinical situations, behavior and relationship with other clinical staff and patient.

The resident will have observed the simulations and plans listed below (depending on the clinical load at the PTC during that time). The will have observed the QA outlined below.

An oral examination will be taken by the mentor and/or other staff physicist worked with the resident in this rotation.

Simulations:	Plans:	QA:
☐ Prostate	☐ Prostate	☐ Observe Daily QA
☐ Breast	☐ Breast	☐ Observe CT QA
☐ Brain	☐ Brain	☐ Observe Monthly QA
☐ CSI	☐ CSI	☐ Physics plan check
☐ Head and neck	☐ Head and neck*	☐ Physics chart check
		☐ QACTs