University of Michigan Health System
University of Michigan
Department of Radiation Oncology
Division of Radiation Physics

Treatment Planning Rotation

Resident: ___________________________________

Rotation staff mentor/ advisor: _Martha Matuszak, Chuck Mayo, Kelly Younge, Jean Moran (supplemental)__

Rotation Duration: 5 months
Rotation Dates: ______________________________

A medical physics resident in radiation oncology at the University of Michigan will be expected to demonstrate the following competencies associated with treatment planning. These are considered the minimum standards. Resident should complete the list of assignment during his/her rotations.

Rotation milestones and suggested approximate timeline

First two weeks:
- Begin reading of required references
- Discuss introduction to treatment planning with Chuck
- Observe cases in the simulator (begin filling out Practical Factors)
- Observe cases at the treatment unit (begin filling out Practical Factors)
- Practice contouring and beginner treatment planning using anonymized patient training sets
- Begin notes on site specific considerations

First month:
- Continue reading of required references
- Begin discussion of 3D treatment planning knowledge factors with faculty mentors
- Begin observing treatment planning in the dosimetry office, with research dosimetrists at Argus, and / or at Brighton
- Continue practice planning with anonymized patient training sets
- Complete required observations of simulations and treatments
- Complete notes on site specific considerations

Second month:
- Complete reading of required references related to 3D treatment planning
- Continue discussion of 3D treatment planning knowledge factors with faculty mentors
- Continue observation of treatment planning and practice planning
- Receive training on IMRT and VMAT treatment planning in Eclipse from faculty mentors

Third month:
- Complete mid-rotation evaluation with faculty mentors
- Begin discussions of IMRT-related knowledge factors with faculty mentors
- Continue observation of treatment planning and practice planning

Fourth month:
- Complete reading of all required references
- Begin discussions of advanced treatment planning topics with faculty mentors
- Continue observation of treatment planning and practice planning

Fifth month:
- Complete any remaining knowledge factor discussions
- Complete any remaining practical factors

Knowledge Factors – List of references

Reference books

- Washington and Leaver, Principles and Practice of Radiation Therapy, 3rd Edition, Mosby, 2009
- E. D. Halperin, C. A. Perez, L. W. Brady, Principles and Practice of Radiation Oncology, 5th Edition, Lippincott Williams & Wilkins, 2007
- G.C. Bentel, Radiation Therapy Planning, 2nd Edition, McGraw Hill, 1996.
- F.M. Khan, The Physics of Radiation Therapy, 3rd Edition, Lippincott Williams & Wilkins, 2003.
- The Modern Technology of Radiation Oncology, Editor J. Van Dyk, Medical Physics Publishing, 2005.
- Varian Eclipse Reference Guide
- The Modern Technology of Radiation Oncology, Volume 2, Editor J. Van Dyk, Medical Physics Publishing, Copyright 2005.
- Chapter 4, Q. Wu et al., "Inverse treatment planning."
- Chapter 5, V. Moiseenko et al., "Radiobiological modeling for treatment planning."
- Image-Guided IMRT, Editors T. Bortfeld, R. Schmidt-Ullrich, W. de Neve, and D. Wazner, Springer-Verlag, Heidelberg, German, 2006.
- Intensity-Modulated Radiation Therapy: The State of the Art, Editors J. Palta and T. Mackie, Medical Physics Publishing Corporation, 2003.
- A Practical Guide to Intensity-Modulated Radiation Therapy, Memorial Sloan-Kettering Cancer Center, Medical Physics Publishing Corporation, 2003.

Reading assignments

3D and electron-related manuscripts:

- ICRU Report 50, *"Prescribing, Recording, and Reporting Photon Beam Therapy."*
- ICRU Report 62**, "***Prescribing, Recording and Reporting Photon Beam Therapy (Supplement to ICRU Report 50)".*
- Emami B. et al., Int. J. Radiat Oncol Biol Phys, 21: 109 – 122, 1991. Quantitative Analyses of Normal Tissue Effects in the Clinic (QUANTEC), IJROBP 76(3), 2010
- AAPM MPPG 5.a. "Commissioning and QA of Treatment Planning Dose Calculations – Megavoltage Photon and Electron Beams" (2016)
- AAPM TG 63, "Dosimetric consideration for patients with HIP prostheses undergoing pelvic irradiation.", (2002)
- AAPM TG 65, Report No. 85, "Tissue inhomogeneity corrections for megavoltage photon beams", (2004)
- AAPM TG70, "Recommendations for clinical electron beam dosimetry: Supplement to the recommendations of Task Group 25", (2009)
- AAPM TG 71, "Monitor unit calculations for external photon and electron beams", (2014)
- AAPM TG 114, "Verification of MU calculations for non-IMRT" (2011)
- SAMs Presentations >> 2012 >> 2012 Annual Meeting >> Electron Radiotherapy: Past, Present, and Future
- **AAPM TG 158: "Measurement and calculations of doses outside the treated volume from external-beam radiation therapy" (2017)**
- **AAPM TG 176: "Dosimetric effects caused by couch tops and immobilization devices" (2014)**
- **Astro Safety White Paper: Standardizing Dose Prescriptions (2016).**

IMRT and VMAT-related manuscripts

- **Teoh M. et al, Volumetric modulated arc therapy: a review of current literature and clinical use in practice, Br. J. Radiol. 84 (1007): 967-996 (2011).**
- IMRT Safety White Paper – full text online at www.practicalradonc.org
- TG-119 – full text available online at www.aapm.org.
- Yu, C. X. et al., Planning and delivery of intensity-modulated radiation therapy, Med Phys. 35 (12) 5233-5241 (2008).
- Galvin, J. M. et al., Implementing IMRT in clinical practice: a joint document of the ASTRO and the AAPM, Int J Radiat Oncol Biol Phys. 58 (5), 1616-1634 (2004).
- Ezzell, G.A. 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).
- IMRT collaborative working group, IMRT: Current status and issues of interest, Int. J. Rad. Oncol. Biol. Phys. 51 (4), 880 – 914 (2001).
- **Otto K. Volumetric modulated arc therapy: IMRT in a single gantry arc. Med Phys. 35:310–17 (2008).**

University of Michigan Publications (optional, for your reference)

- Vineberg KA, Eisbruch A, Coselmon MM, McShan DL, Kessler ML, Fraass BA: Is uniform target dose possible in IMRT plans in the head and neck. Int. J. Rad. Onc. Biol. Phys. 52: 1159-1172. 2002.
- Kessler ML, McShan DL, Vineberg KA, Eisbruch A, Lawrence TS, Epelman, M, Fraass BA: Costlets: a generalized approach to cost functions for automated optimization. Optimization and Engineering 6: 421-448, 2005.
- MM Coselmon, JM Moran, J Radawski, BA Fraass: Improving IMRT delivery efficiency using intensity limits during inverse planning. Med Phys 32: 1234-1245, 2005.

- DL McShan, ML Kessler, K Vineberg, BA Fraass. Inverse Plan Optimization Accounting For Geometric Uncertainties With A Multiple Instance Geometry Approximation (MIGA). Med Phys 33:1510-21, 2006.
- Matuszak MM, Larsen EW, Fraass BA: Reduction of IMRT beam complexity through the use of beam modulation penalties in the objective function. Med Phys 34: 507-520, 2007.
- Jee K, McShan DL, Fraass BA: Preemptive Lexicographic Ordering: More Intuitive IMRT Optimization. Phys Med Bio 52: 1845-1861, 2007.
- Matuszak MM, Larsen EW, Jee K-W, McShan DL, Fraass BA: Adaptive diffusion smoothing: A diffusion-based method to reduce IMRT field complexity. Med Phys 35: 1532-1546, 2008.
- B. A. Fraass, J. M. Steers, M. M. Matuszak, and D. L. McShan: Inverse-optimized 3D conformal planning: Minimizing complexity while achieving equivalence with beamlet IMRT in multiple clinical sites. Med. Phys. 39: 3361, 2012.
- K. C. Younge, M. M. Matuszak, J. M Moran, D. L. McShan, B. A. Fraass, and D. A. Roberts: Penalization of aperture complexity in inversely planned volumetric modulated arc therapy. Med Phys 39: 7160-70, 2012.

Knowledge Factors – Beam properties

Demonstrate an understanding of photon PDDs. Resident should be able to draw PDDs of 6MV and 16MV.

Signature / Date	

Demonstrate an understanding of electron PDDs for different energies. Resident should be able to draw PDDs of different electron beam energies.

Signature / Date	

Demonstrate an understanding of electron ranges (Rp, R80, R90, dmax for different energies).

Signature / Date	

Demonstrate an understanding of electron hot/ cold spots for non-flat surfaces.

Signature / Date	

Demonstrate an understanding of flatness and symmetry of the photon and electron beams (e.g., TG-40, TG-45).

Signature / Date	

Demonstrate an understanding of TAR, TPR, TMR, OAR (off-axis-ratio).

Signature / Date	

Demonstrate an understanding of SAD and SSD setup for treatment.

Signature / Date	

Demonstrate an understanding of proton ranges.

Signature / Date	

Knowledge Factors – Beam Modifiers

Demonstrate an understanding of the design and purpose of MLC. Discuss different types of MLC designs per manufacturers.

Signature / Date	

Demonstrate an understanding of the wedges (i.e., wedge angle, wedge direction, hinge angle).

Signature / Date	

Demonstrate an understanding of the Cerrobend blocks for photon and electron beams (material composition, thickness, etc.).

Signature / Date	

Demonstrate an understanding of custom bolus. (Different types, application, thickness calculation)

Signature / Date	

Knowledge Factors – TPS QA

Demonstrate an understanding of treatment planning system QA (TG-53, AAPM MPPG 5.a).

Signature / Date	

Knowledge Factors – MU Hand Calculations

Demonstrate an understanding of the importance of a second check for MU

Signature / Date	

Demonstrate an understanding of MU hand calculation formula for photon external treatment (SAD setup, SSD setup)

Signature / Date	

Demonstrate an understanding of MU hand calculation formula for electron. Electron cone output factors.

Signature / Date	

Perform electron output measurement for cut-outs. (Use cone output measurement form in S: drive)

Signature / Date	

Develop your own code/ spreadsheet to perform photon MU hand calculation using physics data book data

Signature / Date	

Perform MU hand calculation for at least 10 cases of photon fields. Keep the list of cases.

Signature / Date	

Perform MU hand calculation for at least 10 cases of electron fields. Keep the list of cases.

Signature / Date	

Knowledge Factors – Motion Assessment

Demonstrate an understanding of the impact of breathing motion on treatment delivery

Signature / Date	

Demonstrate an understanding of 4DCT acquisition / artifacts / motion assessment / ITV creation for free-breathing Tx

Signature / Date	

Demonstrate an understanding of general SDX operation and application / acceptable reproducibility

Signature / Date	

Knowledge Factors – Site-specific considerations

For each anatomical site, generate notes on the following information: Disease locations and staging information, typical treatment field arrangement, radiosensitive structures, tolerance doses of radiosensitive structures, and prescription dose.

Brain

Signature / Date	

Head and neck

Signature / Date	

Thorax (include breast, lung, esophagus)

Signature / Date	

Abdomen

Signature / Date	

Pelvis (include prostate, rectum, GYN)

Signature / Date	

Extremity (include soft-tissue sarcoma)

Signature / Date	

Cranio-spinal

Signature / Date	

Knowledge Factors – Plan evaluation and dose metrics

Observe various faculty members performing electron, 3D, IMRT, and VMAT chart checks.

	Date	Faculty Member	Tx type, site and notes
1			
2			
3			
4			
5			
6			
7			
8			

Demonstrate an understanding of following treatment plan evaluation metrics:

Dose Volume Histogram (Vxx, Dxx, mean dose, cumulative and differential)

Signature / Date	

Conformity index/ homogeneity index

Signature / Date	

Biological dose metrics (EQD2, BED, and alpha/beta ratio)

Signature / Date		

Knowledge Factors – Intensity Modulated Radiotherapy

Demonstrate an understanding of the difference between conventional, 3D conformal, and IMRT/VMAT treatment planning (e.g., normalization, delivery parameters, dose distribution, and delivery technique and time). The resident should understand the fundamental differences and be able to discuss the pros and cons of each method.

Signature / Date	

Discuss the use of objective functions for inverse optimization.

Signature / Date	

Discuss the different types of IMRT planning techniques; including forward planned segments, inverse beamlet based optimization, inverse segment optimization, tomotherapy,VMAT, etc. Discuss the pros and cons of each method.

Signature / Date	

Discuss the role of contouring in IMRT planning and how the requirements may different from 3D CRT.

Signature / Date	

Discuss the different types of optimization algorithms and demonstrate understanding of when to apply them (Ch. 3, A Practical Guide to IMRT).

Signature / Date	

Read and demonstrate an understanding of reading assignments and literature.

Signature / Date	

Knowledge Factors – Advanced Topics

Review the department's Special Medical Physics Consultation documentation and discuss potential cases where a consult would be necessary

Signature / Date	

Discuss bio-evaluation techniques for Special Medical Physics Consultations

Signature / Date	

Discuss the potential workflows for retreatment Special Medical Physics Consultations

Signature / Date	

Discuss knowledge-based planning applications in radiotherapy

Signature / Date	

Discuss advanced IMRT optimization techniques including multi-criteria optimization and lexicographic ordering. See a demo of prioritized optimization/lexicographic ordering in UMPlan or the Eclipse LO prototype.

Signature / Date	

Practical Factors – Simulation and Treatment Observation

For each of the following treatment sites, the resident should participate in and observe the simulation and treatment (including fabrication/set-up of any immobilization device, daily patient localization) and actual treatment. Keep a copy of the sim directive and discuss with staff physicist. For case participation, acquire signature/date from the therapist you shadow.

Brain (2 sim's, 2 tx's)

Signature / Date	
Signature / Date	
Signature / Date	
Signature / Date	

Head and neck (2 sim's, 2 tx's)

Signature / Date	
Signature / Date	
Signature / Date	
Signature / Date	

Thorax (2 sim's, 2 tx's)

Signature / Date	
Signature / Date	
Signature / Date	
Signature / Date	

Breast (2 sim's, 2 tx's)

Signature / Date	
Signature / Date	
Signature / Date	
Signature / Date	

Breast electron boost (2 tx's)

Signature / Date	
Signature / Date	

Abdomen (2 sim's, 2 tx's)

Signature / Date	
Signature / Date	
Signature / Date	
Signature / Date	

Spine (1 sim's, 1 tx's)

Signature / Date	
Signature / Date	

Skin (electron) (2 tx's)

Signature / Date	
Signature / Date	

Extremity (1 sim's, 1 tx's)

Signature / Date	
Signature / Date	

Cranio-Spinal (1 sim's, 2 tx's)

Signature / Date	
Signature / Date	
Signature / Date	

Other body sites (optional)

Signature / Date	
Signature / Date	
Signature / Date	

Practical Factors – Motion Assessment

Perform motion assessments for the following body sites.

Breast (SDX)

Signature / Date	
Signature / Date	
Signature / Date	

Lung (SDX / 4DCT)

Signature / Date	
Signature / Date	
Signature / Date	

Abdomen – Liver, Pancreas, etc(SDX / 4DCT)

Signature / Date	
Signature / Date	
Signature / Date	

Practical Factors – Site-specific Contouring and Treatment Planning Practice

The faculty mentor(s) will train the resident on the process of 3D treatment planning in Eclipse. This includes a step-by-step demonstration of the planning process from contouring to evaluation.

Signature / Date	

Demonstrate an understanding of contouring tools in Eclipse by contouring on provided anonymized training structure sets.

Signature / Date	

`

Demonstrate operation (under staff supervision but satisfactorily complete without staff intervention) of Varian Eclipse treatment planning system to generate CT-based treatment plans for each of the following. Make notes about special considerations for each case.

Brain (whole brain, partial brain)

Signature / Date	
Signature / Date	

Thorax (other than breast – esophagus, lung)

Signature / Date	
Signature / Date	

Breast tangents (with wedges and with segmented fields)

Signature / Date	
Signature / Date	
Signature / Date	

Breast tangents with SCLAV field

Signature / Date	
Signature / Date	

Breast tangent with electron IMC

Signature / Date	

Breast electron boost

Signature / Date	
Signature / Date	

Abdomen

Signature / Date	

Pelvis (bladder, rectum)

Signature / Date	
Signature / Date	

Spine (AP/PA, PA only)

Signature / Date	
Signature / Date	

Skin (electron)

Signature / Date	

Extremity

Signature / Date	

Cranio-spinal

Signature / Date	

TLI – Mantle field

Signature / Date	

Other body sites

Signature / Date	
Signature / Date	
Signature / Date	

Practical Factors – Training and observation for IMRT

The faculty mentor(s) will train the resident on the process of IMRT & VMAT treatment planning in Eclipse. This includes a step-by-step demonstration of the planning process from contouring to evaluation.

Signature / Date	

The resident will observe a dosimetrist planning clinical IMRT/VMAT treatments for prostate, head/neck, and 2 other sites (depending on caseload). ***As needed, the faculty mentor and/or a dosimetrist will be available for additional training and discussion.***

	Date	Site	Dosimetrist signature
1		Prostate	
2		H&N	
3			
4			

Practical Factors – IMRT Exercises

The resident will download the TG119 package from AAPM and upload and plan all datasets in the projects database in Eclipse according to the specifications in TG-119. Summarize and present result to the faculty mentor.

	Date	Site	Signature
1		Multi-target	
2		Prostate	
3		HN	
4		CShape-Easy	
5		CShape-Hard	

Anonymize clinical cases and their directives and load to the projects database in Eclipse. Then, set up a starting cost function in Eclipse that you think will achieve the clinical goals. Save this cost function but also tweak it as needed to meet the planning directive goals. Review the results with the faculty mentor.

	Date	Site	Signature
1		Prostate	
2		H&N	

3		Brain	
4			

Plan a head/neck IMRT treatment with 5, 7, and 9 equally-spaced IMRT beams and with single and dual arcs in Eclipse. The resident will present their results and provide a summary of the effect of the number of beams on the overall plan quality to the faculty mentor.

# of beams	Date	Signature
5		
7		
9		
1 arc		
2 arc		

Plan a brain or sinus IMRT or VMAT treatment with coplanar only and non-coplanar beams/arcs in ECLIPSE. Discuss the advantages and disadvantages of non-coplanar beams in IMRT.

	Date	Signature
Co-planar		
Non-coplanar		

With clearance from the faculty mentor(s), the resident will plan IMRT/VMAT case(s) for the clinic for a variety of clinical sites. The number and type of cases will depend on the caseload and resident's training level. The faculty mentor or a dosimetrist will sign off on each resident-planned case.

	Date	Supervisor	Site and notes
1			
2			
3			
4			
5			

Practical Factors - Physics Chart Checks

Demonstrate an understanding of the physics plan check and weekly check process for all types of treatment plans. Perform plan and weekly chart check under the supervision of the faculty physicists.

3D / Electron Physics plan checks

	Date	Supervisor	Site and notes
1			
2			
3			
4			
5			

Pre-measurement QA IMRT/VMAT plan checks (at least 3 unique Faculty). The resident must do 6 cases, HN VMAT and prostate IMRT cases are required. At least 1 additional VMAT and 1 additional IMRT case must be done. The final 2 can be any combination of site and modality.

	Date	Supervisor	Site and notes
1			HN-VMAT
2			Prostate-IMRT
3			VMAT
4			IMRT
5			
6			

Physics weekly chart checks

	Date	Supervisor	Site and notes
1			
2			
3			
4			
5			

Practical Factors – Special Medical Physics Consultations

Observe a faculty physicist performing Special Medical Physics Consultations and second check the involved calculations.

	Date	Faculty member	Notes
1			
2			