Clinical Rotation Summaries – 2 pages each

Rotation Title: **General Physics and Quality Assurance**
Preceptor/Mentor: **Kwok Lam and Donald Roberts**
Duration: **Two months**

Recommended References:

1. F.M. Khan, The Physics of Radiation Therapy, 3rd Edition, Lippincott Williams & Wilkins, Copyright 2003.
2. The Modern Technology of Radiation Oncology, Editor J. Van Dyk, Medical Physics Publishing, Copyright 1999.
3. C.J. Karzmark *et al.*, Medical Electron Accelerators, McGraw-Hill Companies, Copyright 1993.
4. P.Metcalfe, T. Kron, and P. Hoban, The Physics of Radiotherapy x-rays from Linear Accelerators, Medical Physics Publishing, Copyright 1997.
5. AAPM Task Group #40, "Comprehensive QA for Radiation Oncology."
6. AAPM Task Group #21, "A protocol for the determination of absorbed dose from high-energy photon and electron beams."
7. AAPM Task Group #51, "Protocol for Clinical Dosimetry of High-Energy Photon and Electron Beams."
8. AAPM Task Group #53, "Quality assurance for clinical radiotherapy treatment planning."
9. AAPM Task Group #66, "Quality assurance for computed-tomography simulators and the computed-tomography-simulation process."
10. "Ion chamber dosimetry instrumentation, beam scanning systems and calibration phantoms for radiation dosimetry", L. Humphries and J.A. Purdy.
11. H.E. Johns and J.R. Cunningham, The Physics of Radiology, 4th Edition, Charles C. Thomas, Copyright 1983.
12. F.H. Attix, Introduction to Radiological Physics and Radiation Dosimetry, Wiley-VCH, Copyright 2004.

Evaluation Scheme:
To evaluate the successful completion of this rotation, the resident will meet with, a minimum of two faculty members, one of whom is their primary rotation mentor, for an oral examination.

List of Competencies:

Initial Rotation:
Goal: The purpose of this rotation is to familiarize residents with the department of radiation oncology, and to introduce them to the operation and quality assurance of medical linear accelerators and CT simulators.

Aims:
1. Understand the general theory of operation of a medical linear accelerator. Learn how to operate a linear accelerator.
2. Learn how to operate a CT simulator.
3. Understand the interactions of ionizing radiation in matter. Learn about the basic principles of operation of different dosimeters (i.e. ion chambers, diodes, film, TLD's).
4. Learn how and why QA is defined. Learn how to perform daily and monthly QA on linear accelerators and CT simulators.
5. Learn how to manage machine malfunctions and perform QA checks to release the machine for clinical use.

Advanced Rotation:

Goal: An annual inspection of a linear accelerator is an essential part of QA for that machine. An annual inspection is performed to ensure the continued compliance of the unit with the standards of operation and assures the beam(s) parameters are consistent with the beam models used in the treatment planning system(s).

Aims:

1. Understand which tests are necessary to assure proper mechanical operation of the linac and learn how to properly perform these tests.
2. Understand which tests are necessary to assure the correct dosimetric output of the linac and learn how to correctly perform these tests for all modalities and energies.
3. Learn how to perform and access the necessary QA tests to check units that are utilized for special procedures (i.e. TBI, TSET).
4. Learn how to properly analyze acquired data, and understand the action levels and when correction procedures are necessary.

Rotation Title: **Treatment Planning**
Preceptor/Mentor: **Hazim Jaradat, Benedick Fraass, Jean Moran, Joann Prisciandaro, and Peter Roberson**
Duration: **Three months**

Recommended References:

1. G.C. Bentel, Radiation Therapy Planning, 2nd Edition, McGraw Hill, Copyright 1996.
2. F.M. Khan, The Physics of Radiation Therapy, 3rd Edition, Lippincott Williams & Wilkins, Copyright 2003.
3. The Modern Technology of Radiation Oncology, Chapter 8, Editor J. Van Dyk, Medical Physics Publishing, Copyright 1999.
4. UMplan documentation, S:\Physics\Documentation\UMPlan
5. van de Geijn J, Fraass BA: Net fractional depth dose: A basis for a unified analytical description of FDD, TAR, TMR and TPR. Med Phys, 11:784-793, 1984.
6. McShan DL, Fraass BA, Lichter AS: Full integration of the Beam's Eye View concept into clinical treatment planning. Int J Rad Oncol Biol Phys, 18:1485-1494, 1990.
7. Stern RL, Fraass BA, Gerhardsson A, McShan DL, Lam KL: Generation and use of measurement-based 3-D dose distributions for 3-D dose calculation verification. Med Phys, 19:165-173, 1992.
8. McShan DL, Fraass BA: Use of an octree-like geometry for 3-D dose calculations. Med Phys, 20(4):1219-1228, 1993.
9. McShan DL, Fraass BA, Ten Haken RK: Dosimetric verification of a 3-D electron pencil beam dose calculation algorithm. Med Phys 21:13-23, 1994.
10. Kessler ML, Ten Haken RK, Fraass BA, McShan DL: Expanding the use and effectiveness of dose-volume histograms for 3-D treatment planning I: Integration of 3-D dose-display. Int J Rad Oncol Bio Phys, 29: 1125-1131, 1994.
11. Fraass BA, McShan DL: "Three-Dimensional Photon Beam Treatment Planning" in Medical Radiology Diagnostic Imaging and Radiation Oncology, Volume; "Radiation Therapy Physics" (ed) AR Smith, (Springer-Verlag, Berlin, Heidelberg, New York 1995).
12. BA Fraass, A Eisbruch: Conformal Therapy, Treatment Planning, Treatment Delivery, and Clinical Results. In Textbook, 2nd Edition, Ed. JE Tepper, 2006.
13. AAPM Report #85, "Tissue inhomogeneity corrections for megavoltage photon beams".
14. ICRU Report 50, *"Prescribing, Recording, and Report Photon Beam Therapy."*
15. ICRU Report 62**, "***Prescribing, Recording and Reporting Photon Beam Therapy (Supplement to ICRU Report 50)".*
16. M. Van Herk, P. Remeijer, C. Rasch, and J.V. Lebesque, "The probability of correct target dosage. Dose-population histograms for deriving treatment margins in radiotherapy," Int. J. Radiat. Oncol., Biol., Phys. 47, 1121 – 1135 (2000).
17. M. Van Herk, P. Remeijer, and J.V. Lebesque, "Inclusion of geometric uncertainties in treatment plan evaluation," Int. J. Radiat. Oncol., Biol., Phys. 52, 1407 – 1422 (2002).

Evaluation Scheme:
To evaluate the successful completion of this rotation, the resident will meet with two faculty members, one of whom is their primary rotation mentor, for an oral examination.

List of Competencies:

Initial Rotation:
Goal: Learn how to create 3D conformal treatment plans.

Aims:
1. Basics of treatment planning, patient model
    a. Use of imaging
    b. Contours – normal and critical structures
    c. GTV, CTV, ITV and PTV
2. Planning directive

    a. History of diseases
    b. Staging
    c. Normal tissue tolerances
    d. NTCP and TCP
3. Treatment planning considerations:
    a. Choose beam angles and weights.
    b. Effect of beam modifiers (i.e. wedges, bolus)
    c. Beam and plan normalization.
    d. Grid size
    e. Hetereogeneity corrections
4. Treatment plan evaluation tools
    a. DVH's
    b. Dose distributions
5. Monitor unit calculations

Advanced Rotation:
Goal: Learn how to commission an algorithm for use in treatment planning. As part of their rotation, residents will be required to perform a subset of algorithm tests. To evaluate the successful completion of this rotation, the resident will meet with two faculty members, one of whom is their primary rotation mentor, for an oral examination. In addition, at the end of their rotation, the resident will write a summary and deliver a presentation on the commissioning project to the clinical physics group.
Aims:
1. Understand the importance of commissioning algorithms prior to use for patient care.
2. Study the basic modeling, physics, and parameterization contained in an individual algorithm.
3. Define the characteristics which need to be tested for a specific algorithm.
4. Create a test methodology and define the dataset required to perform the test procedure for the calculation algorithm commissioning.
5. Perform the test calculations according to the procedure which was designed, and analyze the results.
6. Define a dataset and experimental conditions for the required measurements.
7. Select appropriate dosimeters for measurements.
8. Perform measurements and compare to calculations.
9. Identify the cause of discrepancies and determine the range of acceptable use in the clinic for the algorithm.
10. Document the commissioning process and results.

Rotation Title: **IMRT**
Preceptor/Mentor: **Hazim Jaradat, Dale Litzenberg, Jean Moran, and Don Roberts**
Duration: **Two months**

Recommended References:

1. The Modern Technology of Radiation Oncology, Volume 2, Editor J. Van Dyk, Medical Physics Publishing, Copyright 2005.
   a. Chapter 6, P. Xia and L.J. Verhey, "Intensity-Modulate Radiation Therapy."
2. P.C. Williams, "IMRT: delivery techniques and quality assurance," *The British Journal of Radiology*, 76, 766-776 (2003).
3. E.E. Klein *et al.*, "Clinical implementation of a commercial multileaf collimator: dosimetry, networking, simulation, and quality assurance," *Int. J. Radiation Oncology Biol. Phys.*, 33, 1195-1208 (1995).
4. J. Chang *et al.*, "Relative profile and dose verification of intensity-modulated radiation therapy," *Int. J. Radiation Oncology Biol. Phys.*, 47, 231-240 (2000).
5. T. LoSasso *et al.*, "Comprehensive quality assurance for the delivery of intensity modulated radiotherapy with a multileaf collimator used in the dynamic mode," *Medical Physics*, 28, 2209 – 2219 (2001).
6. M. Graves *et al.*, "Calibration and quality assurance for rounded leaf-end MLC systems," *Medical Physics*, 28, 2227 – 2233 (2001).
7. 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.
8. 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.
9. MM Coselmon, JM Moran, J Radawski, BA Fraass: Improving IMRT delivery efficiency using intensity limits during inverse planning. Med Phys 32: 1234-1245, 2005.
10. 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.
11. 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.
12. Jee K, McShan DL, Fraass BA: Preemptive Lexicographic Ordering: More Intuitive IMRT Optimization. Phys Med Bio 52: 1845-1861, 2007.
13. 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.
14. Moran JM, Radawski J, Fraass BA: A dose gradient analysis tool for IMRT QA. J Appl Clin Med Phys 6: 62-73, 2005.
15. A Practical Guide To Intensity-Modulated Radiation Therapy, Medical Physics Publishing, Copyright 2003, Memorial Sloan-Kettering Cancer Center, Department of Medical Physics
16. Intensity-Modulated Therapy, The State of the Art, Monograph No. 29, Medical Physics Publishing, Copyright 2003.
   a. Page 415, J. Moran, "Dosimetry metrology for IMRT."
   b. Page 561, T. LoSasso, "IMRT delivery system QA."
   c. Page 593, J. Palta *et al.,* "Tolerance limits and action levels for planning and delivery of IMRT."
   d. Page 613, G. Ezzell, "Quality Assurance: When and what is enough for IMRT?"
17. Image-guided IMRT, T. Bortfeld, R. Schmidt-Ullrich, W. de Neve, Wazer, D.E. eds., Springer-Verlag (Heidelberg, Germany), Copyright 2006.
   a. Page 129, J.M. Moran and P. Xia, "QA-QC of IMRT: American Perspective."

Evaluation Scheme:

To evaluate the successful completion of this rotation, the resident will meet with two faculty members, one of whom is their primary rotation mentor, for an oral examination.

List of Competencies:

Initial Rotation:
Goal: Learn how to create an IMRT plan from contouring through plan evaluation.

Aims:

1. Understand why IMRT is utilized for treatment planning.
2. Understand the importance of contours for optimization.
3. Learn how to create and evaluate cost functions for IMRT.
4. Understand the impact of beam geometry and the number of treatment fields.
5. Learn how to evaluate an IMRT treatment plan.

Advanced Rotation:
Goal: To learn about IMRT delivery techniques and QA.

Aims:

1. Learn about why IMRT QA is performed.
2. Learn about the appropriate dosimeters and techniques for IMRT QA.
3. Learn about various IMRT delivery techniques (i.e. MLC-based IMRT, tomotherapy and physical compensation).
4. Understand the distinction between accelerator/MLC QA and pre-treatment QA.
5. Learn about various evaluation criteria for IMRT QA.
6. Learn about common problems and causes for failure.

Rotation Title: **Special procedures**
Preceptor/Mentor: **James Balter,Scott Hadley, and Kwok Lam**
Duration: **Two months**

Recommended References:

1. AAPM Task Group #29, “The physical aspects of total and half body photon irradiation.”
2. AAPM Task Group #30, “Total skin electron therapy: Technique and dosimetry.”
3. AAPM Task Group #42, “Stereotactic radiosurgery.”
4. The Modern Technology of Radiation Oncology, Editor J. Van Dyk, Medical Physics Publishing, Copyright 1999.
5. B.E. Pollack, “Stereotactic radiosurgery for Arteriovenous Malformations”, Neurosurgery Clinics of North America, Vol. 10 (2) 281-290 (1999).
6. L. Ma *et al.*, “Comparative analyses of linac and Gamma Knife radiosurgery for trigenminal neuralgia treatments, Phys. Med. Biol. 50, 5217-5227 (2005).
7. M. Fuss *et al.*, “Stereotactic body radiation therapy: An ablative treatment option for primary and secondary liver tumors”, Annals of Surgical Oncology, 11 (2) 130-138 (2004).
8. K.K. Herfarth *et al.*, “Stereotactic single-dose radiation therapy of liver tumors: Results of a phase I/II trial”, Journal of Clinical Oncology, 19 (1) 164-170 (2001).
9. Ten Haken RK, Diaz RF, McShan DL, Fraass BA, Taren JA, Hood TW: From manual to computerized planning for 125-I stereotactic brain implants. Int J Rad Onc Biol Phys, 15:467-480, 1988.

Evaluation Scheme:
To evaluate the successful completion of this rotation, the resident will meet with two faculty members for an oral examination.

List of Competencies:

Goal: Learn about treatment techniques and planning for special radiation therapy procedures (SRS, SBRT, TBI, and TSET).

Aims:

1. Stereotactic radiosurgery and stereotactic body radiation therapy
   a. Review basic SRS literature.
   b. Review in-house procedures and documentation.
   c. The resident will shadow patients from simulation through treatment delivery.
   d. Residents will observe and actively discuss the treatment planning process with dosimetry and their faculty mentor. The resident will learn about dose tolerances for single fraction or hyperfractionated treatments.
   e. Residents will perform daily QA and be involved in any physics measurements necessary during their rotation.
   f. At the end of the rotation, residents should be able to discuss the implementation of a new SRS/SBRT program.
2. Total body irradiation
   a. Review basic TBI literature.
   b. Review in-house TBI simulation, calculation and delivery procedures. By the end of this rotation, residents should demonstrate a proficiency in performing these procedures independently.
   c. Learn about CT simulations for the generation of lung and kidney blocks.
3. Total skin electron therapy
   a. Review basic TSET literature.
   b. Review in-house TSET commissioning and procedures.

c. Perform TSET output check.

Rotation Title: **Brachytherapy and Radiation Safety**
Preceptor/Mentor: **Joann Prisciandaro, Scott Hadley, Paul Heckman, and Vrinda Narayana**
Duration: **Three months**

Recommended References:

1. AAPM Task Group #32, "Specification of brachytherapy source strength."
2. AAPM Task Group #43, "Dosimetry of Interstitial brachytherapy sources."
3. AAPM Task Group #56, "Code of practice for brachytherapy physics."
4. AAPM Task Group #59, "HDR brachytherapy treatment delivery."
5. AAPM Task Group #64, "Permanent prostate seed implant brachytherapy."
6. The Modern Technology of Radiation Oncology, Editor J. Van Dyk, Medical Physics Publishing, Copyright 1999.
7. F.M. Khan, The Physics of Radiation Therapy, 3rd Edition, Lippincott Williams & Wilkins, Copyright 2003.
8. ICRU Report 38, "*Dose and volume specification for reporting intracavitary therapy in gynecology"*
9. S. Nag and N. Gupta, "A simple method of obtaining equivalent doses for use in HDR brachytherapy," Int. J. Radiation Oncology Biol. Phys., 46, 507 – 513 (2000).
10. ABS recommendations – papers available on S:/Physics/Clinical Physics/Brachy/Ir-192_HDR/HDR Related Papers.
11. The Suggested State Regulations – Michigan Department of Community Health.
12. AAPM Brachytherapy Physics Summer School, conference proceedings.
13. Title 10 of the federal code of regulations (parts 19, 20, & 35).

Evaluation Scheme:
To evaluate the successful completion of this rotation, the resident will meet with two faculty members for an oral examination.

List of Competencies:

Goal: Learn about treatment techniques, radiation safety, treatment planning, and delivery for a brachytherapy program.

Aims:

1. High dose rate brachytherapy
    a. Radiation safety
    b. Acceptance and commissioning of hardware and software
    c. HDR quality assurance
        i. Daily, monthly and quarterly QA
        ii. Source exchange
    d. Simulation and planning for:
        i. Endometrial
        ii. Cervical
        iii. Esophageal
        iv. Interstitial
        v. Endobronchial
    e. Patient specific QA and treatment delivery
2. Low dose rate brachytherapy
    a. Eye plaques (I-125), Prostate implants (I-125 or Pd-103), Gyn implants (Cs-137), Interstitial implants (Ir-192), TheraSpheres (Y-90)
        1. Treatment planning
        2. Seed orders and assay

    3. Source loading
    4. Radiation safety
3. Radiation Safety
    a. Radiation measurements – detector selection, and calibrations
    b. Receiving/shipping radioactive packages – ordering, surveys/wipe tests, source disposal
    c. Source room activities – inventory and survey/wipe tests
    d. Room shielding calculations
    e. Federal regulations.
    f. State regulations
    g. UM radiation safety