Chapter 16

Radiation Oncology Medical Physics Resources for Working, Teaching, and Learning

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16.1 Introduction

Medical physics is the application of physics to medicine. Radiation oncology medical physics is a sub-discipline within medical physics that has a special application of medical physics in the context of radiation oncology. However, there are three other major sub-disciplines associated with radiation oncology medical physics as shown in the figure below. To practice their professional discipline, radiation oncology medical physicists need to have a clear understanding of relevant medical physics, in addition to components of clinical radiation oncology, radiobiology, and imaging. Furthermore, the other associated professionals—i.e., radiation oncologists, radiation therapists, and dosimetrists—need to have an appropriate knowledge of radiation oncology medical physics. While the Venn diagram below demonstrates overlapping sub-topics, the magnitude of these sub-topics is not to scale and, moreover, these are dynamic with time.

Twenty years ago, imaging was only a small component of a radiation oncology medical physicist’s needed knowledge base, but there has been a tremendous growth in the use of computerized tomography (CT) both for treatment planning and image guidance, in addition to the more recent applications of imaging modalities such as magnetic resonance imaging (MRI), positron emission tomography (PET), single photon emission tomography (SPECT), and ultrasound (US). Additionally, with a greater use of dose-volume constraints for treatment planning, combined with the possibility of optimizing individual treatment plans based on radiobiological endpoints, a much greater knowledge of radiobiology is also required.

In terms of the working environment, the radiation oncology medical physicist is involved in all the technical and physics aspects associated with radiation treatment:

1. Physicists participate in the general design of radiation therapy facilities.

2. Physicists are major partners in the purchase and acquisition of radiation treatment and related equipment.
3. Physicists have a major responsibility for the accuracy and quality of the computerized treatment planning process.

4. Physicists develop and execute the quality assurance program, including the quality control of individual technologies associated with radiation treatment, as well as patient-specific treatment and dose verification.

5. Physicists are involved in all aspects of radiation safety, including the design of treatment and imaging rooms, licensing applications for nuclear regulatory agencies, staff monitoring of radiation exposures to personnel, development of an incident (error) reporting system, and addressing any radiation-related concerns for patients, the hospital staff, students, and the general public.

6. Physicists keep abreast of the developments in new technologies which are evolving at an enormously rapid rate and provide a leadership role in the implementation of new techniques and technologies as they become available to the clinic.

7. Physicists provide in-service education sessions for staff on topics related to treatment techniques, quality assurance programs, and radiation safety procedures.

8. For institutions having academic responsibilities associated with nearby universities, medical physicists may be involved in teaching radiation oncology medical residents, radiation therapists, medical physics residents, or medical physics students at the undergraduate and graduate levels. Furthermore, all medical physicists are involved in some sort of teaching, whether this be formal course lectures to students, in-service education, introductions to new techniques and technologies, or the necessary annual radiation safety lectures to professional staff.
9. Furthermore, academically oriented medical physicists may have significant research responsibilities.

The education and training required for radiation oncology medical physicists and the career structure of radiation oncology medical physicists in Canada has been described in detail by Van Dyk and Battista [2].

16.2 General Textbook References

The following references are categorized by the sub-title of the section and then listed in reverse chronological order, i.e., the most recent being first.

16.2.1 Basic radiation therapy physics


16.2.2 Clinically applied radiation oncology physics


Sample on-line Chapter 6, “Treatment Planning Considerations Using IMRT” at:
Sample on-line Chapter 10, “IMRT for Head and Neck Cancer,” available at:


Sample on-line Chapter 10, “Introduction and Overview: Intravascular Brachytherapy— Fluoroscopically Guided Interventions” at:


16.2.3 Radiobiology


16.2.4 Clinical radiation oncology


16.2.5 Radiation treatment accelerator technology


16.2.6 Radiation protection and shielding design


16.2.7 Radiation dose measurements


16.2.8 Diagnostic imaging


16.2.9 Miscellaneous


16.3 Resources from National and International Organizations

16.3.1 American Association of Physicists in Medicine (AAPM) task group reports

The AAPM’s task group reports can be found at http://www.aapm.org/pubs/reports/. The individual reports, primarily related to radiation oncology medical physics, are listed below by descending report number, which is largely reverse chronological order from most recent to earliest. Some reports may require AAPM membership for direct access.


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Report No. 197: Academic Program Recommendations for Graduate Degrees in Medical Physics. (This is a revision of Reports #44 and #79.) http://www.aapm.org/pubs/reports/RPT_197.pdf.


Radiation Oncology Medical Physics Resources for Working, Teaching, and Learning


Radiation Oncology Medical Physics Resources for Working, Teaching, and Learning

Report No. 84S: Supplement to the 2004 update of the AAPM Task Group No. 43 Report


Report No. 80: The Solo Practice of Medical Physics in Radiation Oncology.


Report No. 72: Basic Applications of Multileaf Collimators.

Report No. 71: A Primer for Radioimmunotherapy and Radionuclide Therapy.


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16.3.2 American Association of Physicists in Medicine (AAPM) practice guidelines


16.3.3 American Association of Physicians in Medicine (AAPM) summer school proceedings

The AAPM Summer School proceedings are summarized below to as far back as 1990.


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16.3.4 American College of Radiology–American Society for Radiation Oncology (ACR–ASTRO) practice guidelines


ACR–ASTRO–SIR Practice Guideline for Radioembolization with Microsphere Brachytherapy Device (RMBD) for Treatment of Liver Malignancies. American College of Radiology (ACR), the American Society for Radiation Oncology (ASTRO), and the Society of Interventional Radiology (SIR), 2008.

16.3.5 Canadian Partnership for Quality Radiotherapy (CPQR) technical quality control guidelines

*These guidelines can be found at: http://www.cpqr.ca/programs/technical-quality-control. Standards on the CPQR website include:*

Patient-Specific Dosimetric Measurements for IMRT. (Feb. 2015)
Reference Dosimetry. (Feb. 2015)
Volumetric Modulated Arc Therapy. (Feb. 2015)
Accelerator Integrated Cone Beam Systems for Verification Imaging. (April 2013)
Medical Linear Accelerators and Multileaf Collimators. (Feb. 2015)
Treatment Planning Systems. (Feb. 2015)
Brachytherapy Remote Afterloaders. (Feb. 2015)
Major Dosimetry Equipment. (Feb. 2015)
Conventional Radiotherapy Simulators. (Feb. 2015)
Kilovoltage X-Ray Radiotherapy Machines. (Feb. 2015)

*Other documents are listed but are undergoing external review.*

16.3.6 European Atomic Energy Community (EURATOM)


16.3.7 European Society for Radiotherapy and Oncology (ESTRO) publications

16.3.7.1 ESTRO physics booklets


16.3.7.2 ESTRO handbooks

16.3.8 Institute of Physics and Engineering in Medicine (IPEM) reports


16.3.9 International Atomic Energy Agency (IAEA) reports and documents


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Radiation Oncology Medical Physics Resources for Working, Teaching, and Learning


16.3.10 International Atomic Energy Agency (IAEA) training materials


16.3.11 International Commission of Radiation Units and Measurements (ICRU) reports

The ICRU reports are now available on-line through the AAPM website (for AAPM members) at http://www.aapm.org/pubs/ICRU/?d=d.


16.3.12 International Commission on Radiological Protection reports


16.3.13 Italian Association of Medical Physicists/Associazione Italiana di Fisica Medica (AIFM)


16.3.14 National Committee on Radiation Protection (NCRP) reports

The following is a listing of relevant reports from the U.S. National Committee of Radiation Protection (NCRP) since 1980. All NCRP reports since 1971 are now available on-line through the AAPM website (for AAPM members) at http://www.aapm.org/pubs/NCRP/.


16.3.15 Netherlands Commission on Radiation Dosimetry/Nederlandse Commissie voor Stralingsdosimetrie (NCS) reports

Some of the NCS reports are in English and some are in Dutch with an English summary. The reports are located at: www.stralingsdosimetrie.nl/ncs-report.php.


16.4 Educators’ Resource Guides and General Training Materials


IAEA e-Learning modules on Quality Assurance for SPECT systems:


Medical Physics Clinical Skills Workbook for Therapy Physics, 2012.
http://www.rosalindfranklin.edu/Portals/3/Documents/Clinical_Skills_Workbook_ONLINE_VER-
SION_10-23-12A%5B1%5D.pdf.

Training, Education and Assessment Program for Radiation Oncology Medical Physics. Australasian Col-
lege of Physical Scientists and Engineers in Medicine, 2012-04-26.

Teaching Medical Physics. Institute of Physics

Radiation Treatment Program (RTP) Learning Centre course on Ethics and Errors. Tom Baker Cancer
Centre, Calgary, Alberta, Canada. Freely available. Need registration to get access.
http://www.rtp-learning-centre.ca/moodle/.

Modified teaching approach for an enhanced Medical Physics graduate education experience. I. B. Rutel.

Radiation Treatment Planning Tutorial using the Prism treatment planning system.
http://www2.phys.canterbury.ac.nz/~physmed/prismtutorial/Mainpage.html. (See Meyer J, Hartmann B,


Methods and Resources for Physics Education in Radiology Residency Programs: Survey Results. L. Bre-
http://radiology.rsna.org/content/249/2/640.long.

Teaching Medical Physics, National Stem Centre (STEM = science, technology, engineering and mathe-


2004.

Compilation of Radiobiology Practice Examinations: For Residents in Diagnostic Radiology and Radia-
tion Oncology. J. D. Chapman, S. Shahabi, and B.A. Chapman. Madison, WI: Advanced Medical Publish-
ing, 2000.


16.5 Journals

American Journal of Roentgenology (AJR)
Applied Radiation and Isotopes (Appl Radiat Isot)
Biomedical Imaging and Intervention Journal (Biomed Imaging Interv J)
Brachytherapy
British Journal of Radiology (Br J Radiol)
Cancer
Cancer Journal (Cancer J.)
Cancer/Radiothérapie (Cancer Radiother.)
Clinical Oncology (Clin. Oncol.)
European Journal of Cancer (Eur. J. Cancer)
European Journal of Radiology (Eur. J. Radiol.)
Frontiers in Oncology (Front. Oncol.) Freely available open access journal available at: http://www.frontiersin.org/oncology.
Frontiers in Radiation Therapy and Oncology (Front. Radiat. Ther. Oncol.)
Health Physics (Health Phys.)
Journal of Clinical Oncology (J. Clin. Oncol.)
Journal of the ICRU (J. ICRU)
Journal of Medical Imaging and Radiation Oncology (J. Med. Imaging Radiat. Oncol.)
Journal of Medical Physics (J. Med. Phys.)
Journal of Radiotherapy in Practice (J. Radiother. Pract.)
Journal of the American College of Radiology (J. Am. Coll. Radiol.)
Lancet
Medical Dosimetry (Med. Dosim.)
Medical Engineering and Physics (Med. Eng. Phys.)
Medical Physics (Med. Phys.). Medical Physics open access papers: http://scitation.aip.org/content/aapm/journal/medphys/info/open-access.
Nuclear Instruments and Methods (Nucl. Instrum. Methods)
Practical Radiation Oncology (Pract. Radiat. Oncol.)
Radiation Measurement (Radiat. Meas.)
Radiation Protection Dosimetry (Radiat. Prot. Dosim.)
Radiation Research (Radiat. Res.)
Radiology
Radiotherapy and Oncology (Radioth. Oncol.)
Seminars in Radiation Oncology (Semin. Radiat. Oncol.)
Strahlentherapie und Onkologie (Strahlenther. Onkol.) German Journal but contains many articles in English.
Tumori

16.6 Reports and Websites on Safety Considerations and Errors in Radiation Therapy


16.7 Miscellaneous Resources

16.7.1 Patient protection


US Department of Veteran Affairs, National Center for Patient Safety. Safety in Radiation Therapy: A Call to Action.


16.7.2 Policy statements/special procedures


16.7.3 Conference proceedings


16.7.4 Radiological emergency response


16.7.5 Miscellaneous


16.8 On-line Resources


Chart Rounds: Chartrounds brings together academic disease site specialists from leading cancer treatment institutions and connects them with the Chartrounds network of over 1300 physicians and medical physicists. On a scheduled basis, discuss patient management and treatment plans with trusted colleagues in real time. https://www.chartrounds.com/default.aspx.


eContour, a contouring resource from University of California, San Diego. http://eContour.org/


Histogram Analysis in Radiation Therapy (HART). http://hart.research.uic.edu/.


IROC Houston Quality Assurance Center (formerly known as the Radiological Physics Center). http://rpc.mdanderson.org/rpc/.


ResearchGate. (Social networking site for scientists – includes medical physics, radiation therapy, and imaging professionals and topics.) http://www.researchgate.net/.


16.9 Mailing Lists/Discussion Forums

American Medical Physics mailing list. http://lists.wayne.edu/cgi-bin/wa?A0=MEDPHYSUSA.
Global Medical Physics mailing list. http://lists.wayne.edu/cgi-bin/wa?A0=MEDPHYS.

16.10 Guide to Medical Physics Practice


16.11 On-line Medical Physics-related Staffing Information


16.12 Medical Physics Graduate Schools


Canadian universities offering graduate programs in Medical Physics. https://www.comp-opcm.ca/english/membership-services/for-students/graduate-programs.html.


16.13 Medical Physics Jobs


16.14 Medical Physics-related Organizations

Association of Medical Physicists of India (AMPI). http://ampi.org.in/.
Belgian Hospital Physicists Association (BHPA). http://www.bhpa.eu/.
Brazilian Association of Medical Physics/Associação Brasileira de Física Médica (ABFM). http://www.abfm.org.br/.
Canadian College of Physicists in Medicine (CCPM). http://www.ccpm.ca/.
Chinese Society of Medical Physics, Taipei (CSMPT).
Cyprus Association of Medical Physics and BioMedical Engineering (CAMPBE). http://www.campbe.org/.
European Society for Radiotherapy and Oncology (ESTRO). http://estro.org/.
Institute of Physics and Engineering in Medicine (IPEM). http://www.ipem.ac.uk/.
International Centre for Theoretical Physics (ICTP). http://www.ictp.it/.
Jordanian Association for Physicists in Medicine (JAPM). http://www.japm.org/.
Latin American Association of Medical Physicists/Asociación Latinoamericana de Fisica Médica (ALFIM). http://www.alfim.net/.
Malaysian Association of Medical Physics (MAMP).
Middle East Federation of Organizations of Medical Physics (MEFOMP). http://mefomp.org/.
Nepalese Association of Medical Physicists (NAMP).
North American Chinese Medical Physicist Association (NACMPA).
Physicien Médical Sans Frontières (PMSF, French Medical Physicists Without Borders).
http://www.pmsf.asso.fr/.
Romanian College of Medical Physicists (CFMR): www.medicalphysics.ro.
South African Association of Physicists in Medicine and Biology (SAAPMB).
http://www.saapmb.net/.
South-East Asian Federation of Organizations for Medical Physics (SEAFOMP). https://sites.google.com/a/sci.ui.ac.id/seafomp/.
Sri Lanka Medical Physics Association (SLMPA).
Swiss Society of Radiobiology and Medical Physics (SSRMP). http://www.sgsmp.ch/.
Union for International Control of Cancer (Union Internationale Contre le Cancer, UICC).
http://www.uicc.org/.
Vietnam Association of Medical Physics (VAMP).

16.15 Medical Physics and Radiation Oncology-related Aid and Non-government Organizations

AMPATH. http://www.ampathkenya.org/.
Association Cancérologues sans Frontières (French for “Oncologists Without Borders.”)


Union for International Control of Cancer (Union Internationale Contre le Cancer, UICC). http://www.uicc.org/.


16.16 Regulatory Information


16.17 Publications Search Websites


Medical Physics. Open access papers. http://scitation.aip.org/content/aapm/journal/medphys/info/open-access.


OJOSE (Online JOurnal Search Engine). Makes “search-queries in different databases by using only 1 search field.” http://www.ojose.com/.


16.18 Smart Phone Applications


Anatomy Lite: Reference for people who want to know more about human anatomy.

BED calculator: Calculates biologically effective dose (BED) based on the linear-quadratic model (LQ) model.

Brain MRI Atlas: Navigates through hundreds of labeled brain structures.


CT-Gently: A tool that can be used to estimate radiation doses to the organs from CT and CBCT scans based on a person’s anatomic information and scan mode. In addition, it can be used to compare optimized mAs and kVp settings with reference settings for personalized low-dose CT and CBCT scans.


DoseCalc: Rapid calculation of parameters associated with use of radioisotopes.

Equivalent dose, EQD2, calculator: http://www.buhl-development.dk/apps/eqd2/.


Geiger Calc: Performs calculations after entering measured data.


Nano, micro, milli convert: Converts some prefixes (nano, micro, milli, and none) to other prefixes. Also converts per second, per minute, per hour, and per year.

Radiation Calculator: Developed to learn about many types of imaging studies and also to track your radiation exposure.

Radiation Oncologist Tool: Calculates Isoeffective dose in 2 Gy fractions and Isoeffective dose of schedule with multiple fractions per day.

Radiation Therapy Flash Card.

Radiotherapy and Oncology.


Wolfram Radiation Protection Reference App calculates shielding requirements, CSDA ranges of different particles, equivalent doses, decay of radioisotopes, and unit conversions.

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References
