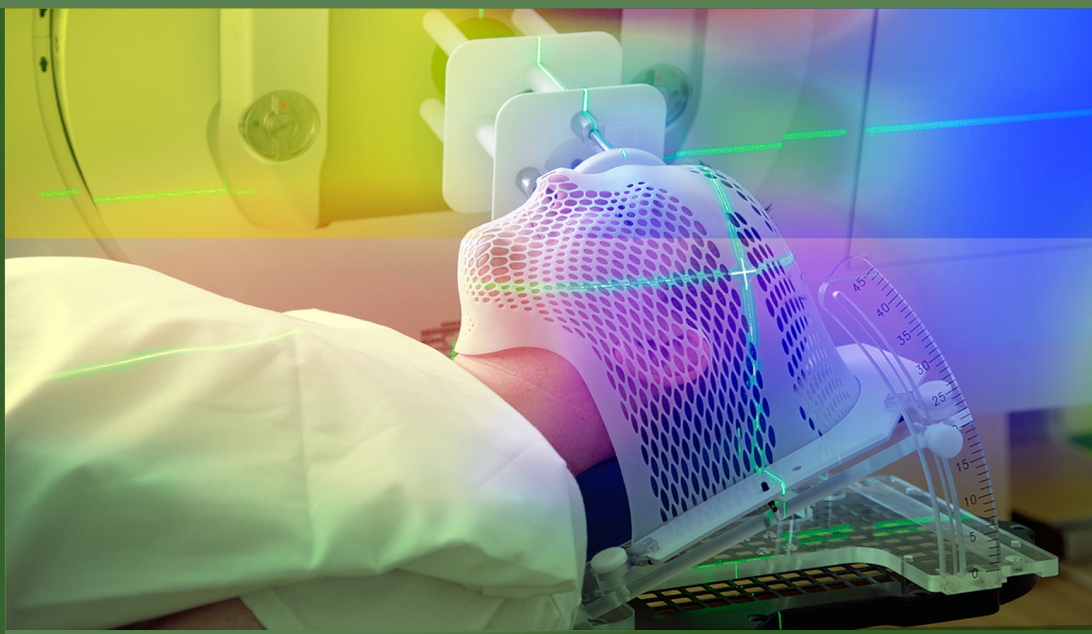
Specialty Portfolio in Radiation Oncology

A global certification roadmap for trainers and trainees

Handbook – Logbook



Endorsed by The Arab Medical Association Against Cancer (AMAAC)

Layth Mula-Hussain
Shada Wadi-Ramahi
Benjamin Li
Soha Ahmed
Fabio Ynoe de Moraes

دار نشر جامعة قطر
Qatar University Press

Specialty Portfolio in Radiation Oncology

A global certification roadmap for trainers and trainees

(Handbook – Logbook)

Prepared by

Layth Mula-Hussain
Shada Wadi-Ramahi
Benjamin Li
Soha Ahmed
Fabio Ynoe de Moraes

Endorsed by
The Arab Medical Association Against Cancer (AMAAC)

2021 AD/ 1442 AH

دار نشر جامعة قطر
Qatar University Press

Qatar National Library Cataloging-in-Publication (CIP)

Mula-Hussain, Layth, author.

Specialty portfolio in radiation oncology: a global certification roadmap for trainers and trainees (Handbook – Logbook) / prepared by Layth Mula-Hussain, Shada Wadi-Ramahi, Benjamin LI, Soha Ahmed, Fabio Yone de Moraes ; endorsed by The Arab Medical Association Against Cancer. – [Doha] : Qatar University Press, 2021.

153 pages; 21.5 cm

ISBN 978-992-713-933-8 (print)

ISBN 978-992-713-932-1 (electronic)

1. Cancer -- Radiotherapy. 2. Oncology. I. Wadi-Ramahi, Shada, author. II. Li, Benjamin, author. III. Ahmed, Soha, author. IV. De Moraes, Fabio Yone, author. V. Arab Medical Association Against Cancer. VI. Title.

RC271.R3 M85 2021 202128084640

615.842 – dc 23

دار نشر جامعة قطر
Qatar University Press

ص.ب.: 2713، الدوحة - قطر

بريد إلكتروني: qupress@qu.edu.qa

دار نشر جامعة قطر: نحن دار نشر جامعية غير ربحية، تأسست عام 2018، تعمل على تعزيز ونشر الكتب والبحوث المحكَّمة في العديد من مجالات المعرفة. تسعى الدار إلى أن تصبح رائدة في نشر الكتب والمجلات العلمية. كما تهدف الدار إلى دعم رؤية جامعة قطر نحو التميّز في البحث والتعليم في دولة قطر وخارجها.

Qatar University Press (QU Press): We are a nonprofit university publishing house established in 2018, dedicated to promoting the dissemination of peer-reviewed and research-based publications in various fields. QU Press aims to be a leading publisher of scholarly books and journals. QU Press endeavors to support QU's vision towards excellence in research and education in Qatar and beyond.

هذا الكتاب لا يعبر بالضرورة عن رأي دار نشر جامعة قطر.

This book does not necessarily reflect the opinion of QU Press.

ISBN 978-9927-139-32-1

CONTENTS

ENDORSEMENT

I am incredibly pleased and honored to be writing this letter of support for the [Specialty Portfolio in Radiation Oncology: A global certification roadmap for trainers and trainees (Handbook – Logbook)] authored by Dr. Layth Mula-Hussain and his colleagues. This great piece of work gives a delightful guide, which is full of important information in radiation oncology certification pathway from a global perspective. The portfolio provides a training roadmap that can be applied in many communities, particularly the low-middle and low-income nations, to produce qualified, competent and safe radiation oncology practitioners.

While passing through the book, I felt how it is friendly-to-implement, to help establish successful certification programs in radiation oncology worldwide, particularly in limited-resources nations. The portfolio may be taken as a general guide in tailoring and refining the programs at every accredited authority, or as a representative model and content, or through its sample tools to facilitate documentation, beside its references to key resources which will be useful to trainers and trainees to achieve the required milestones of radiation oncology training, to further advance the level of education and practice in these countries.

Globally, it is clear that there is gap in radiotherapy services and the qualified practitioners in this medical specialty. While the economy and machines are part of the problem, the work force and level of training are the other components that this portfolio is helping to address. For instance, about half of the member states in The League of Arab States are having training programs in this specialty, and definitely, this portfolio can help the other half in establishing such training programs. This example can be extrapolated to many developing countries in Asia, Africa and South America.

The Arab Medical Association Against Cancer (AMMAC) aims at strengthening relationships between oncologists in the twenty-two Arab states to raise the level of cooperation in the field of oncology in both scientific and practical aspects. We feel a deep responsibility to support the efforts put in this work, which is providing easy comprehensive

guide, collected from many well-established international programs in this field. We hope that this addition in the scientific literature will be a useful resource to trainers and trainees in radiation oncology, in a trial to help improving access to radiotherapy worldwide.

AMAAC is proud to endorse the [Specialty Portfolio in Radiation Oncology: A global certification roadmap for trainers and trainees (Handbook – Logbook)] and thought this is truly well done.

Sami Khatib, MD, PhD
Senior Consultant, Clinical Oncology
Secretary General, The Arab Medical Association
Against Cancer (AMMAC)
www.amaac.org

FOREWORD I

In the last decade, there has been a growing focus on global oncology. This is urgently needed as it is estimated that 70% of all new cases of cancer in 2020 will occur in low- and middle-income countries (LMIC) whereas only about 5% of the World's radiotherapy resources are available for these countries.

The urgent need for radiotherapy resources in terms of bunkers and megavoltage machines is important, but equally important is the tremendous lack of properly educated healthcare professionals. This includes not just medical doctors, but also medical physicists, radiation therapists (RTTs) and nurses, as well as other supporting healthcare personnel.

Postgraduate training of radiation oncologists needs to be developed in standard setting frames for securing the minimum level of training. Competency-based education as defined by the CanMEDS system has set the trend as the globally accepted model for education and training of medical professionals.

Competency-based education should also form the basis of the curricula in LMICs in order to secure an international standard and hence free movement of the workforce. However, developing curricula can be quite cumbersome and even if internationally developed curricula is used, these need to be adapted and content transferred into logbooks and supporting documents. Very often, pre-existing documents are developed in countries rich in resources and do not take into account the challenges of LMIC's.

The present portfolio in radiation oncology contains a solution for trainers and trainees – specifying not just the curriculum but also how to fulfill each competence by providing suggestions for logbook and relevant documents. The authors have practical knowledge of the challenging training conditions from many places in the world and thus this publication is suitable as it is or with small adaptions, a comprehensive training document for established training centers

as well as training institutions in the developmental phase in most LMIC's.

Good training is the key to beat cancer!

Jesper Grau Eriksen
Professor, Radiation Oncology
Director, ESTRO School – European SocieTy for Radiotherapy & Oncology
www.estro.org

FOREWORD II

Oncology Education: Time for Action

The field of oncology tends to be a chance encounter for medical students in the west. There is little in the curriculum to guide them to seek specialization in this field. At best, they are given a few lectures. Most of them are introduced to it during their clerkship year while on the medicine rotation. During this time, they see patients in the wards. These patients are most likely diagnosed with advanced diseases and considered palliative cases. Students take the message that cancer is essentially "an end stage disease". This is contrary to the fact that cancer is a chronic disease. A PubMed search with search terms, "oncology education and medical students", while returning 1628 hits (accessed 10/18/2020), has only nine exact matches! A couple of references are cited herewith by way of example[1,2]. A situation like this means that oncology is not sought after by medical students for further study, thus impacting personnel resources available to deal with the burgeoning burden of cancer worldwide. If this is the situation in the west, can one imagine what the challenges are like in developing countries?

Consider the following scenario: A 24-year-old young girl meeting an 80-year-old man. The first is a final year medical student at Kirkuk Medical College (KMC), on an urology rotation at the Azadi Hospital, the university's teaching hospital in Kirkuk, Iraq. The encounter takes place in May 2017. The student, is an Arabic speaker, with very little knowledge of Kurdish. The 80-year-old man, a Kurd, who turned out to have metastatic prostate cancer. He showed up at the hospital, accompanied by his son. Neither the patient, nor the son had any idea of the nature of the patient's illness. The language of instruction at KMC is English. The student has not had prior education in cancer. It was her job to work-up the patient and present the case to her professor. She managed, with her broken Kurdish, to take the patient's medical history, examine him and establish a correct diagnosis despite the aforementioned challenges! I know this firsthand. The student is my niece, who has since graduated and is now a practicing physician. I came across this scenario having been invited to participate as faculty in the

Best-of-ASTRO conference organized by the author of this work, Dr. Layth Mula-Husain in Sulaymaniyya, Iraq (18-20 May 2017). I found time for a personal visit and savor this encounter. This demonstrates the dearth of educational resources in oncology as a whole and associated difficulties in developing countries (DC's) in particular.

Now I cast my memory back two decades earlier: In 1997, I was attending the international conference on radiation oncology (ICRO-97) in Beijing, China. I had just completed setting up a modern cancer center in Canada, fully equipped with the latest technologies and modalities of the time. I was presenting a talk on the role of the medical physicist in this effort. In the front row, was seated the late Dr. Philip Rubin, founding editor of the international journal of radiation oncology, biology and physics (IJROBP), commonly referred to as the "Red Journal", the premier radiation oncology journal in the United States of America (USA). He was nodding approvingly while I was speaking. The real message was not that I have given a good talk. It was the most humbling experience of listening to the speaker who came immediately after me. He was from the IAEA speaking about cancer resources in Africa, especially pertaining to radiation oncology (RO). He stated that in one country, there was one single orthovoltage unit for the entire population and nobody knew where it was located. The country had one practicing radiation oncologist. This was a real revelation and a stimulus for me to be even more involved in volunteer activities sharing experiences with my international colleagues in DC's.

Oncology education is critical to capacity building in DC's. Shortage of healthcare facilities, personnel included, and oncology resources in particular, constitutes an economic drain on these countries. It often deprives families of their primary breadwinner. Furthermore, lack of local healthcare facilities means that they have to travel significant distances to seek care, exasperating the economic burden on the family and the country as a whole[3,4] radiotherapy is essential for effective treatment. In high-income countries, radiotherapy is used in more than half of all cases of cancer to cure localised disease, palliate symptoms, and control disease in incurable cancers. Yet, in planning and building

treatment capacity for cancer, radiotherapy is frequently the last resource to be considered. Consequently, worldwide access to radiotherapy is unacceptably low. We present a new body of evidence that quantifies the worldwide coverage of radiotherapy services by country. We show the shortfall in access to radiotherapy by country and globally for 2015–35 based on current and projected need, and show substantial health and economic benefits to investing in radiotherapy. The cost of scaling up radiotherapy in the nominal model in 2015–35 is US$26·6 billion in low-income countries, $62·6 billion in lower-middle-income countries, and $94·8 billion in upper-middle-income countries, which amounts to $184·0 billion across all low-income and middle-income countries. In the efficiency model the costs were lower: $14·1 billion in low-income, $33·3 billion in lower-middle-income, and $49·4 billion in upper-middle-income countries—a total of $96·8 billion. Scale-up of radiotherapy capacity in 2015–35 from current levels could lead to saving of 26·9 million life-years in low-income and middle-income countries over the lifetime of the patients who received treatment. The economic benefits of investment in radiotherapy are very substantial. Using the nominal cost model could produce a net benefit of $278·1 billion in 2015–35 ($265·2 million in low-income countries, $38·5 billion in lower-middle-income countries, and $239·3 billion in upper-middle-income countries.

It has been my good fortune to have met Dr. Mula-Hussain while participating as faculty in the American Association of Physicists in Medicine (AAPM) International Scientific Exchange Program (ISEP) conference and workshop on therapeutic and diagnostic medical physics organized by one of the authors of this work, Dr. Shada Wadi-Ramahi, in Amman, Jordan (October 7-10 2010). Since then, I have been privileged to collaborate with Drs. Mula-Hussain and Wadi-Ramahi on several educational activities in the Middle East, a part of the world where oncology education is desperately needed.

Dr. Mula-Hussain has championed countless educational initiatives in his native Iraq under the most challenging conditions. He provided the first account on cancer in Iraq in his seminal work, “Cancer in Iraq

– A descriptive study"[5]. His educational activities are numerous and varied. Particularly significant is his, single-handedly, setting up the first organized radiation oncology residency program at the Zhinawa Cancer Center (ZCC), in Sulaimaniyya, Iraq[6]. ZCC, being a modern and successfully functioning oncology center is fully staffed by Dr. Mula-Hussain's trainees. It cares for the population of eastern Iraqi Kurdistan of over three million. The current offering on global oncology education is a welcome addition to this collection of much needed resources in this field.

Muthana Al-Ghazi; PhD, FCCPM, FAAMP, FIOMP
Medical Physics – Department of Radiation Oncology,
University of California, Irvine, USA
www.uci.edu

ABBREVIATIONS

ABR	American Board of Radiology
ACGME	Accreditation Council for Graduate Medical Education
ACR	American College of Radiology
AMAAC	Arab Medical Association Against Cancer
ASTRO	American SocieTy for Radiation Oncology
CARO	Canadian Association of Radiation Oncology
CanMEDS	Canadian Medical Education Directives for Specialists
EBRT	External Beam Radio-Therapy
EPA	Entrustable Professional Activities
ESTRO	European SocieTy for Radiotherapy and Oncology
GRaCE	Global Radiation Oncology Collaboration in Education
IAEA	International Atomic Energy Agency
IGRT	Image-Guided Radio-Therapy
IMRT	Intensity-Modulated Radio-Therapy
LPD	Local Program Director
MDT	Multi-Disciplinary Team
MMM	Morbidity & Mortality Meeting
MOC	Maintenance of Certification
NPC	New Patients' Clinic
NPD	National Program Director
OTC	On Treatment Clinic

PTC	Post-Treatment Clinic
QA	Quality Assurance
QC	Quality Control
RANZCR	Royal Australian and New Zealand College of Radiologists
RO	Radiation Oncology
ROP	Radiation Oncology Practitioner
ROT	Radiation Oncology Trainee
ROS	Radiation Oncology Supervisor
RT	Radio-Therapy
SBRT	Stereotactic Body Radio-Therapy
SFRT	Stereotactic Fractionated Radio-Therapy
SRS	Stereotactic Radio-Surgery
TOT	Training Of Trainees
VMAT	Volumetric Modulated Radio-Therapy

PREFACE

Radiation Oncology (RO) is the discipline of clinical medicine that uses ionizing radiation for the treatment of patients with many malignant and some non-malignant diseases. RO includes the responsibility for the diagnosis, the treatment, the follow-up and the supportive care of the cancer patient[7]. Radiotherapy (RT) is an essential component in the management of cancer patients, either alone or in combination with surgery or chemotherapy, both for the cure and palliation. Of those cancer patients who are cured, it is estimated that 49% are cured by surgery, about 40% by RT alone or combined with other modalities, and 11% by chemotherapy alone or combined[8].

There is a global gap in the Radiation Oncology Practitioners (ROPs) in many countries, where the deficit is focused in the low-middle and low-income countries[9]. This significant deficit in ROP (estimated to be 664 in lower-middle and low-income countries in 2018) will likely persist and widen in 2030 (needs to grow to 13,322) unless suitable strategies are pursued[10]. To fill this gap, the Global Task Force on Radiotherapy for Cancer Control (GTFRCC) was established by the Union International for Cancer Control (UICC) in 2013[3], with the Global Radiation Oncology Collaboration in Education (GRaCE) group in 2015 creating a roadmap for training and education[11].

One of the crucial factors towards creating and maintaining a successful RO training program in the resource constraint setting is the resources required for sustaining the infrastructure and teaching capacity. While the local institutional commitment is the mainstay, a global partnership is an important addition to support and enable. There is an example from a war-torn country, Iraq, where the first RO board-certified training program was launched in 2013. Visiting consultants and scholars and the enrolment of the Iraqi RO Trainees (ROTs) with their peers from USA in the American College of Radiology (ACR) in-training examinations in RO were among the essential steps that enriched the growing program[6].

This RO specialty portfolio aims to provide a training roadmap in RO certification, which can be applied in many communities, particularly

low-middle and low-income nations, to produce qualified, competent and safe ROP. This suggested global portfolio consists of full-time four-year training in RO (after the general postgraduate clinical training that comes post-completion of the medical school), during which, the ROT will acquire knowledge in cancer science and gain experience in clinical RO. We agree with the well-established CanMEDS framework that every specialist, including ROP, should be not only a medical expert but also a professional, scholar, leader, collaborator, communicator and health advocate[12].

This portfolio is a practical roadmap in RO certification. It is an extract from many well-structured resources in RO training, such as the International Atomic Energy Agency (IAEA) syllabus that is endorsed by the American SocieTy for Radiation Oncology (ASTRO) and the European SocieTy for Radiotherapy and Oncology (ESTRO)[7], the CanMEDS Framework of the Royal College of Physicians and Surgeons of Canada (RCPSC)[13–18], the ESTRO Core Curriculum for Radiation Oncology/Radiotherapy[12], the Royal Australian and New Zealand College of Radiologists (RANZCR)[19], the American Board of Radiology (ABR)[20], the Accreditation Council for Graduate Medical Education (AGMCE) in USA[21] and the Royal College of Radiology (RCR) in UK[22]. In addition to other programs like that from Moffitt Cancer Center & Research Institute at the University of South Florida[23], Tata Memorial Center in India[24], the Kurdistan Board of Medical Specialties in Iraq[25] and the Saudi Commission for Health Specialties[26].

While we acknowledge all the efforts put in the resources mentioned above, we hope that this modest addition, "The Specialty Portfolio in Radiation Oncology: Global Roadmap for trainers and trainees (Handbook & Logbook)" will be a useful resource to trainers and trainees in developing communities, in a trial to help fill some of the gaps in global RO and improve access to RT worldwide.

Authors

CHAPTER ONE

INFRASTRUCTURE

HOW TO USE THIS PORTFOLIO

The Specialty Portfolio in Radiation Oncology: Global Roadmap for trainers and trainees (Handbook & Logbook) is aiming to help establish successful certification programs in radiation oncology (RO) worldwide, and the limited-resources nations are a particular target in this regard. This portfolio may be taken as a general guide in tailoring and refining the programs at every accredited authority, as a representative content, sample tools to facilitate documentation, references to essential resources. It is not aiming to replace these authorities and their roles in defining what is more suitable to achieve their visions and missions in this regard.

This version of the portfolio is extracted from many well-structured curricula and syllabi. It comes with many tables and annexes that might be useful to trainers and trainees to achieve the milestones of RO training and practice. The final objective is to improve and expand the level of RO education, training and practice and to increase the number of qualified, safe, competent ROPs worldwide in general, and in limited-resources communities in particular.

THE METHODOLOGY OF THE PORTFOLIO

The methodology here is a combination between exploring the currently available, well-structured, curricula and syllabi in RO, with the practical insights from the collective experiences of the authors of this portfolio. They came from different backgrounds and collaborated to make this possible. Many of the statements and suggestions here are extracted from the mentioned references in the preface of this portfolio, and without these former efforts, this work would be non-existent.

DEFINITIONS

RO is the discipline of clinical medicine that uses ionizing radiation either alone or in combination with other modalities for the treatment of patients with many malignant and some non-malignant diseases. The specialty can be practiced as an independent oncology specialty or may

be integrated into the broader medical practice of clinical oncology with the use of chemotherapy agents and targeted therapy to enhance the effectiveness of radiotherapy in a multi-modality setting for providing comprehensive treatment to cancer patients.

RO includes the responsibility for the diagnosis, the treatment, the follow-up and the supportive care of the cancer patient[7]. It has been estimated that radiotherapy (RT) is a well-established tool of therapy that can be utilized in over half of the cancer patients, whether for curative or palliative intents[8]. This specialty had changed dramatically in terms of objectives, periods, and outcomes over time in the last 100 years. It was used to be practiced by radiologists and surgeons during the early decades, and around mid of the previous century, specialty-training programs started to refine this field. In recent years, more emphasis was put to further refine the required competencies in this field[12] trainees, recently appointed specialists, members of the European Union Medical Specialists Radiotherapy section, an RTT, a radiobiologist, a physicist and lay members from ESTRO staff developed and commented on iterations of the curriculum. Results: The 4th edition is based on the CanMEDS 2015 framework and identifies 14 Entrustable Professional Activities (EPAs.

RT can be in different forms, like teletherapy (treatment from-far, or External Beam Radiotherapy, EBRT), or brachytherapy (treatment from-near). ROP need high competencies in four fundamental corners: cancer medicine, radiation physics, radiation biology and radiological anatomy. ROP carry the responsibility of the diagnosis, the treatment, the follow-up and the supportive care of the cancer patient[7]. ROP are increasingly moving from general ROP to site-specific and technique-specific ROP.

In this portfolio, RO is the specialty name, RT is the service name, ROP is the person who practises RO at specialist or consultant level (also known as a radiation oncologist), ROT is the trainee who is enrolling in an accredited training program (also known as a resident or house officer or postgraduate student), and ROS (RO supervisor) is the ROP who is doing education and training to ROT.

AUTHORITY

The IAEA advises each country to have a national authority, which should be the ultimate responsible body for the organization and monitoring of the training program in the country, including the implementation of an audit system for the periodical evaluation of recognized training institutions and programs. This authority should also be responsible for the eligibility of the ROTs and their certification. Each certification authority should create a suitable mechanism for continuous re-certification, to keep them updated with recent developments in RO, by a system of life-long learning to maintain competence within this evolving practice environment[7].

MISSION

To serve patients, the public, and the medical profession by certifying that the diplomates have acquired, demonstrated, and maintained a requisite standard of knowledge, skill, understanding, and performance essential to the safe and competent practice of RO[27].

VISION

Advanced safety and quality in healthcare by setting the definitive professional standards for RO.

CERTIFICATE

Board Certification in RO or Fellow of the National Board (or Council or College) in RO.

CanMEDS ROLES AND ENTRUSTABLE PROFESSIONAL ACTIVITIES

ROT is expected to follow the seven CanMEDS roles and to attain high-level in fourteen Entrustable Professional Activities (EPT), as detailed in tables 1 and 2.

Table 1: The 14 Entrustable Professional Activities developed for the 7 CanMEDS roles[12]

Role	Entrustable Professional Activities
Medical Expert	1. Develop a management plan for a patient with cancer diagnosis 2. Implement a treatment strategy 3. Develop and implement a management plan for survivorship
Communicator	4. Communicate appropriately and effectively with patients and their relatives
Collaborator	5. Work effectively with other healthcare professionals to provide safe care and to optimize the quality of treatment
Leader	6. Discuss the context in which they work and apply the principles of change management including quality improvement methodology in this context 7. Use resources appropriately 8. Demonstrate the ability to work in, build and lead teams
Advocate	9. Advocates for cancer patients
Scholar	10. Plan personal learning experiences and use them to enhance patient care 11. Educate others to improve patient care 12. Contribute to the knowledge base that underpins patient care
Professional	13. Demonstrate that the care of their patients is their first concern 14. Manage their work-life balance to maintain their wellbeing

Table 2: Levels of Entrustable Professional Activities[12]

Level	Trust ROT
Level 1	Observation only
Level 2	Direct proactive supervision, i.e., with a supervisor present in the same room
Level 3	Indirect reactive supervision, i.e., the supervisor is readily available if necessary
Level 4	Without immediate supervision but with post hoc report or remote supervision
Level 5	ROT supervises more junior trainees

RADIATION ONCOLOGY CANMEDS COMPETENCIES[15]

I. Medical Expert

ROPs integrate all of the CanMEDS roles, applying medical knowledge, clinical skills, and professional values in their provision of high-quality and safe patient-centered care. Medical Expert is the central physician role in the CanMEDS Framework and defines the physician's clinical scope of practice. ROPs can:

- Practise medicine within their defined scope of practice and expertise.
- Perform a patient-centered clinical assessment and establish a management plan.
- Plan and perform procedures and therapies for assessment and management.
- Establish plans for ongoing care and, when appropriate, timely consultation.
- Actively contribute, as an individual and as a member of a team providing care, to the continuous improvement of healthcare quality and patient safety.

II. Communicator

ROPs form relationships with patients and their families that facilitate the gathering and sharing of essential information for effective healthcare. ROPs can:

- Establish professional therapeutic relationships with patients and their families.
- Elicit and synthesize accurate and relevant information, incorporating the perspectives of patients and their families.
- Share healthcare information and plans with patients and their families.
- Engage patients and their families in developing plans that reflect the patient's healthcare needs and goals.
- Document and share written and electronic information about the medical encounter to optimize clinical decision-making, patient safety, confidentiality, and privacy.

III. Collaborator

ROPs work effectively with other healthcare professionals to provide safe, high-quality, patient-centered care. ROPs can:

- Work effectively with physicians and other colleagues in the healthcare professions.
- Work with physicians and other colleagues in the healthcare professions to promote understanding, manage differences, and resolve conflicts.
- Hand over the care of a patient to another healthcare professional to facilitate continuity of safe patient care.

IV. Leader

ROPs engage with others to contribute to the vision of a high-quality healthcare system and take responsibility for the delivery of excellent patient care through their activities as clinicians, administrators, scholars, or teachers. ROPs can:

- Contribute to the improvement of healthcare delivery in teams, organizations, and systems.
- Engage in the stewardship of health care resources.
- Demonstrate leadership in healthcare systems.
- Manage career planning, finances, and human health resources in personal practice(s).

V. Health Advocate

ROPs contribute their expertise and influence as they work with communities or patient populations to improve health. They work with those they serve to determine and understand needs, speak on behalf of others when required, and support the mobilization of resources to effect change. ROPs can:

- Respond to an individual patient's health needs by advocating with the patient within and beyond the clinical environment.
- Respond to the needs of the communities or populations they serve by supporting with them for system-level change in a socially accountable manner.

VI. Scholar

ROPs demonstrate a lifelong commitment to excellence in practice through continuous learning, and by teaching others, evaluating evidence, and contributing to scholarship. ROPs can:

- Engage in the continued enhancement of their professional activities through ongoing learning.
- Teach students, residents, the public, and other healthcare professionals.
- Integrate best available evidence into practice.
- Contribute to the creation and dissemination of knowledge and practices applicable to health.

VII. Professional

ROPs are committed to the health and well-being of individual patients and society through ethical practise, high personal standards of behaviour, accountability to the profession and community, physician-led regulation, and maintenance of personal health. ROPs can:

- Demonstrate a commitment to patients by applying best practices and adhering to high ethical standards.
- Demonstrate a commitment to society by recognizing and responding to societal expectations in healthcare.

- Demonstrate a commitment to the profession by adhering to standards and participating in physician-led regulation.
- Demonstrate a commitment to physician health and well-being to foster optimal patient care.

GENERAL CORE COMPETENCIES (Non-Clinical Skills)[23]

RO training will be competency-based and will focus on educational outcomes. ROT will be required to demonstrate the general core competencies in each of their respective rotations throughout the entirety of their training experience. ROT will be formally evaluated on their success in achieving the core competencies during each of their rotations, which are:

I. Patient Care and Safety:

ROTs are expected to:

1. Demonstrate the ability to provide patient care that is compassionate, appropriate, and effective for the patients undergoing treatment.
2. Communicate effectively and demonstrate caring and respectful behaviors when interacting with patients and their families.
3. Compile essential and accurate information about their patients.
4. Make informed decisions about diagnostic and therapeutic interventions based on patient information and preferences, up-to-date scientific evidence, and clinical judgment.
5. Develop and carry out patient management plans appropriate for the individual patient scenario.
6. Counsel and educate patients and their families in an appropriate manner.
7. Utilize information technology to support patient care decisions and patient education.

8. Perform all medical procedures considered essential for the area of practice competent per their level of training.
9. Provide healthcare services aimed at preventing health problems and maintaining health.
10. Work directly with healthcare providers from various disciplines to provide comprehensive patient care.

II. Quality Assurance and Improvement:

ROTs are expected to:

1. Investigate and evaluate patient care practices.
2. Appraise and assimilate scientific evidence.
3. Improve patient care practices.
4. Analyze practice experience and perform practice-based improvement activities using a systematic methodology.
5. Locate, appraise, and assimilate evidence from scientific studies related to their patients' health problems.
6. Obtain and use information about his or her population of patients and the larger population from which their patients are drawn.
7. Apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on diagnostic and therapeutic effectiveness.
8. Use information technology to manage information; access on-line medical information; and support his or her education.
9. Develop proficiency in the quality assurance process in treatments, including dosimetry, dose plan assessment and optimization, and portal film assessment.
10. Ability to discuss and evaluate the medical literature in the conference series, including didactic conferences, case conferences, morbidity and mortality conferences, and journal clubs.

11. Develop proficiency in the multidisciplinary care of cancer patients in cooperation with colleagues in medical oncology, surgery, pathology, diagnostic radiology, and in multidisciplinary conferences.
12. Facilitate the learning of students and other healthcare professionals.
13. Review personal practice outcomes.

III. Medical Knowledge, Research and Academia:

ROTs are expected to:

1. Demonstrate knowledge about established and evolving biomedical, clinical, and cognate sciences (e.g. epidemiological and social-behavioral) and the application of this knowledge to patient care.
2. Critically evaluate and demonstrate knowledge in an investigatory and analytic thought approach to clinical situations.
3. Know and apply the basic and clinically supportive sciences, which are appropriate to Radiation Oncology.
4. Develop the ability to apply the knowledge base acquired from medical literature in management of cancer patients.
5. Ability to critically review the medical literature and apply new research findings to clinical practice.
6. Demonstrate recognition of the importance of lifelong learning.

IV. Interpersonal and Communications Skills:

ROTs are expected to:

1. Demonstrate interpersonal and communication skills that result in effective information exchange and teaming with patients, their families, and professional associates.
2. Create and sustain a therapeutic and ethically sound relationship with patients.

3. Use effective listening skills, elicit, and provide information using effective nonverbal, explanatory, questioning, and writing skills.
4. Work and communicate effectively with others as a member or leader of a healthcare team or other professional groups.
5. Counsel and educate patients and their families in a caring, compassionate manner, taking the appropriate amount of time with each family.
6. Effectively document practice activities, counseling sessions, etc.
7. Clearly explain the rationale, procedures, potential side effects and follow-up care after the radiation therapy to patients and families, colleagues, peers, and ancillary personnel (nurses, therapists, dosimetrists, physicists).

V. Professionalism and Medical Ethics:

ROTs are expected to:

1. Demonstrate a commitment to carrying out professional responsibilities.
2. Adhere to ethical principles and sensitivity to a diverse patient population.
3. Demonstrate respect, compassion, and integrity.
4. Demonstrate responsiveness to the needs of patients and society that supersedes self-interest.
5. Maintain accountability to patients, society, and the profession.
6. Maintain a commitment to excellence and on-going professional development.
7. Demonstrate a commitment to ethical principles on provision or withholding of clinical care, the confidentiality of patient information, informed consent, and business practices.
8. Demonstrate sensitivity and responsiveness to patients' culture, age, gender, and disabilities.

9. Maintain a high level of ethical behavior.
10. Demonstrate a commitment to continuity of patient care.
11. Maintain a professional appearance that is neat, clean and appropriate in the dress.
12. Demonstrate sensitivity to ethnic, social and psychological concerns of the patient population.
13. Demonstrate ethical principles in personal behavior and interactions with patients and colleagues.
14. Fulfill commitments to patients needs promptly.
15. Complete documentation in a thorough and timely manner.
16. Attend to clinical responsibilities punctually and efficiently.
17. Demonstrate a respectful demeanor towards patients and families, peers, colleagues and staff.

VI. Systems-Based Practice:

ROTs are expected to:

1. Demonstrate an awareness of and responsiveness to the broader context and system of healthcare and the ability to effectively call on system resources to provide care that is of optimal value.
2. Demonstrate knowledge of risk-benefit analysis.
3. Understand how patient care and other professional practices affect other healthcare professionals, the healthcare organization, and the larger society and how these elements of the system affect their practice.
4. Understand how types of medical practice and delivery systems differ from one another, including methods of controlling healthcare costs and allocating resources.
5. Practice cost-effective healthcare and resource allocation that does not compromise the quality of care.
6. Be an advocate for quality patient care and assist patients in dealing with system complexities.

7. Understand how to collaborate with healthcare managers and healthcare providers to assess, coordinate, and improve healthcare.
8. Understand the activities that can affect system performance.
9. Coordinate appointments with other physicians, or schedule appropriate tests as indicated with an understanding of the patient's insurance issues and geographical preferences.
10. Assess psychosocial needs and refer the patient to appropriate services for social, psychological or financial assistance.
11. Coordinate the patient's comprehensive cancer care and other medical needs during their RT.
12. Display proficiency with hospital-based computer data systems and medical records databases.
13. Understanding of billing and coding associated with brachytherapy and external beam radiotherapy.

LEVELS OF TRAINING

RO level of training can be categorized into three levels depending on the infrastructure of the training center[7]:

I. Basic level:

a) Basic RT planning by orthogonal X-rays or a conventional fluoroscopic simulator using bony landmarks, skin marks, intraluminal or intracavitary contrast media and/lead wire or radio-opaque marks identifying target volumes and critical structures.

b) Manually calculated dose distributions using isodose charts or a simple 2D calculation programme on a contour reconstruction.

c) Treatment by a cobalt unit using simple field arrangements. The use of orthovoltage units for the treatment of skin cancer or superficial tumours is included in this level.

d) Brachytherapy using manual/remote afterloading with standard dosimetry.

e) Simple mould room techniques.

II. Standard Level:

a) Intermediate level of planning using a simulator with patient contouring or a CT simulator, anatomical reconstruction using diagnostic CT information acquired in treatment-position, identifying target volumes and critical structures. Based on this information, an individual treatment two-dimensional (2D) or three-dimensional (3D) plan is created using a treatment planning system.

b) Treatment is given using a linear accelerator. Patient position is checked during treatment and corrected if necessary. Mould room and immobilization devices are used.

c) Brachytherapy using intracavitary, interstitial and intraluminal afterloading techniques is practiced with individual dose planning.

III. Advanced level:

a) Complex treatment planning is performed by the use of a dedicated CT-simulator.

b) MRI, PET and/or PET/CT information can be incorporated by image fusion technology. Target volumes and organs at risk are identified. Beam's-Eye Views and Dose Volume Histograms (DVH) are used. An individual 3D plan is made, which is highly conformal using multiple fields and/or segments based on forward or inverse treatment planning.

c) Treatment is given with a linear accelerator using a multi-leaf collimator (MLC). Portal imaging verification protocols and in-vivo dosimetry are used.

d) This level includes techniques such as virtual simulation; intensity modulated radiation therapy (IMRT), image-guided radiotherapy (IGRT), intra-operative radiation therapy (IORT), stereotactic radiosurgery (SRS), adaptive radiotherapy (ART), respiratory gating and three-dimensional (3-D) image-based brachytherapy planning.

e) The training in Level 3 should include the study and understanding of axial radiological anatomy, the identification of tumours and organ structures, the delineation and contouring volumes of tumours and organs at risk and the implementation of treatment plans based on volumes.

TRAINING MILESTONES[28]

RO milestones are the actionable steps of knowledge, skills, and attitudes, which are organized in a developmental framework from less to more advanced, to achieve the ROP goals. They are descriptors and targets for the performance as a ROT moves from entry into the program through graduation. The five levels in these milestones are:

Level 1: The ROT demonstrates milestones expected of an incomer.

Level 2: The ROT is advancing and demonstrates additional milestones but is not yet performing at a mid-residency level.

Level 3: The ROT continues to advance and demonstrate additional milestones, consistently including the majority of milestones targeted for residency.

Level 4: The ROT has advanced so that he or she now substantially demonstrates the milestones targeted for residency. This level is designed as the graduation target.

Level 5: The ROT has advanced beyond performance targets set for residency and is demonstrating "aspirational" goals, which might describe the performance of someone who has been in practice for several years. It is expected that only a few exceptional ROTs will reach this level.

LENGTH OF TRAINING

The suggested program here consists of a full-time, 100 academic-credits over four-years of study and training in RO (after finishing the postgraduate general clinical training, which could be of 1-2 years after the completion of the medical school).

TRAINING CENTER/S

Under the umbrella of the national authority, the qualified RT centers can be recognized as training centers for the accredited specialty training in RO. There are different requirements related to infrastructure (like 2 MVMs), patients (like a minimum of 500 new patients), staff, etc. The Accreditation Council for Graduate Medical Education (ACGME) requires at least four full-time ROPs at the training program, dedicated to teaching activities, with at least a 0.67 educator-to-resident ratio[21], the ratio that can be decreased sometimes to 0.5 as a minimum (2 ROT for every single supervisor). Detailed check-list can be accessed at Annex 1 of the IAEA syllabus[7].

ADMISSION

1. To be a medical doctor, graduated from one of the recognized medical schools.
2. To be licensed to practice medicine by the regulatory authority in the region.
3. Must have completed the postgraduate general clinical training of 1-2 years.
4. To be proficient in the language of instruction and patient communication.
5. To be proficient in computer use.
6. Must pass the entrance examination.
7. Must pass the personal interview.

REGULATION

1. The minimum training period is full-time four years, at an accredited specialty-training center in RO.
2. ROT must attend all the required scientific activities as advised by the trainer.
3. ROT must keep training logbook (electronic or hard copy) of specific required RT procedures. This to be approved by the trainer and scientific supervisor of the program at the end of each rotation.

4. ROT will be encouraged and supported to publish research project/s in peer-reviewed medical journals during the period of the program.
5. In addition to the didactic lectures that will be arranged for the ROT, independent learning is strongly advocated.
6. ROT will follow the training program curriculum and be assessed by the trainer. He/she has to successfully pass the required regular tests and annual evaluations inside the training center, the first and then the final board examinations.

TRAINING STRUCTURE

1st – 3rd year (every 11 weeks), there will be major rotation in the following suggested four teams (Table 3):

Repeated every 11 weeks during the 1st three years of training

- Head & Neck, Central Nervous System (CNS), Skin tumors and benign conditions.
- Gastro-intestinal (GI), Genito-urinary (GU) and Gynecological (GYN) tumors.
- Breast, Pediatric tumors and cancers of unknown primary (CUP).
- Lymphoma, Leukemia, Thoracic & Musculo-Skeletal tumors.

Table 3: ROT's annual 11-week suggested teams and major rotations

Teams	Cancer sites and systems
Yellow team	GI, GU & GYN
Pink team	Breast, Pediatric, and CUP
Green team	H&N, CNS, Skin & benign conditions
Blue team	Lymphoma, Leukemia, Thoracic & Musculo-Skeletal

- Minor rotations:
  - 1st year:
    - Four weeks in onco-imaging and nuclear oncology.

- Four weeks in onco-pathology and laboratory.

- 2nd year:
  - Four weeks in medical oncology (adult and pediatric, including solid and hemato-oncology).
  - Four weeks in palliative oncology and emergency oncology.
- 3rd year:
  - Eight weeks in surgical oncology (including neuro-onco-surgery, gyne-onco-surgery, GU-onco-surgery, GI-onco-surgery, breast-onco-surgery, head and neck onco-surgery, thoracic onco-surgery, musculo-skeletal onco-surgery and pediatric onco-surgery).
  - During each RT rotation, ROT will pass through: New Patients' Clinic (NPC), On Treatment Clinic (OTC), Post-Treatment "follow up" Clinic (PTC), Simulation techniques, Contouring and Plan assessment sessions (Planning), in addition to the active participation of the weekly Multi-Disciplinary Team rounds (MDT) of the specific cancer sites and rotations (Table 4).
  - At the 4th year, ROT can either continue at the same center or rotate at another recognized RT training program, inside or outside the country. The clinical rotations' periods in this year are better to be customized on the interests or needs of each ROT.

Table 4: ROT's weekly 5-day suggested schedule (These groups, schedules and colors are kinds of suggestions that are not obliged to be followed)

Days	NPC	Simulation	Contouring	OTC & PTC
Monday	Blue	Pink	Yellow	Green
Tuesday	Green	Blue	Pink	Yellow
Wednesday	Yellow	Green	Blue	Pink
Thursday	Pink	Yellow	Green	Blue
Friday	Academic day (rounds, lecture series, etc.)			

Note: Palliative patients can be seen on any day of the week, either at a special palliative RT clinic or with other site-specific clinics; NPC: New Patients Clinic; OTC: On-Treatment Clinic; PTC: Post-Treatment Clinic.

ANNUAL TRAINING GOALS

First Year ROT[23]

During the first two weeks of their rotation in RO program, ROT will benefit from a focused orientation, which will include: basic radiation safety, multidisciplinary team (MDT) patient care, treatment planning: clinic structure, physics, radiobiology, simulation, port/electronic films and equipment at the primary institution. Besides the local sources during this orientation period, the Introductory Radiation Oncology Curriculum (IROC)[29–31], which consists of seven didactic downloadable recorded sessions, can be a useful addition. Following this orientation period, the rest of the year will be dedicated to clinical rotations and lecture series in basic RO sciences, which will be weighted toward services that provide a broad spectrum of RO problems. During the clinical rotations, ROT will perform an initial history and physical examinations, review radiographic images and pathology, and formulate treatment plans at NPC. ROT will participate in the simulation, treatment planning and dosimetry and OTC, and later on in PTC. During each clinical rotation, ROT will be supervised and instructed on a one-to-one basis by the ROS. ROT will be required to complete two 4-week minor rotations in diagnostic radiology and nuclear medicine and in tumor pathology. Attendance at the basic teaching courses is encouraged for each ROT (for example, the ESTRO school's courses).

Objectives for Satisfactory Completion of the 1st Year

Basic:

1. Knowledge about RO procedures and policies.
2. Attendance of lecture series in basic RO sciences.
3. Satisfactory performance review by ROS and the local program director (LPD).

Clinical:

Satisfactory completion and evaluations on clinical rotations geared towards more general and basic principles of RO, including imaging, staging, patient work-up and multi-modality treatment approaches:

1. Ability to present summaries of service patients during chart rounds or other conferences.
2. Ability to properly determine the clinical stage and the performance status of the patients.
3. Ability to identify necessary relevant clinical data required to evaluate and manage general oncology patients.
4. Completion of logbook files demonstrating care of approximately 150 cases/year (new patients and/or patients on planning).
5. Beginning of basic understanding of quality assurance processes as they apply to RO.

Academic:

1. Satisfactory development of presentation skills focused on general topics (facile in the use of PowerPoint or equivalent presentation media; ability to present introductory lectures).
2. Facile with use of medical informatics tools including departmental and hospital comprehensive information systems.
3. Understanding of patient rights and privacy issues as they relate to the specialty.
4. Begin self-learning with textbook reading supplemented with classic literature and critical clinical trials.
5. Demonstrate beginning ability to critically evaluate and review medical literature relevant to patient care and conference discussions.
6. Attendance of other ROT seminars.
7. Acquire part of the required first two-year basic RO knowledge (in cancer biology and radiobiology, medical physics, medical statistics and research methods, cancer epidemiology, onco-pharmacology, radiological anatomy & tumor imaging, tumor pathology and laboratory).

Second Year ROT[23]

The clinical rotations during the second year are intended to foster more in-depth learning by focusing on site-specific services, which interact with

the referral base, and other oncology and surgical specialties practice. During the second year, each ROT will complete the required basic RO knowledge, regular RO clinical rotations, and will complete two 4-week minor rotations: in medical oncology and in palliative oncology / emergency oncology. It is expected that ROT will take an increasingly active role in diagnosis, recommending treatment, performing simulations and monitoring treatments. ROT will begin focused training in brachytherapy. During the clinical rotation, ROT will be supervised and instructed on a one-to-one basis by the ROS. Attendance at the basic and/or clinical teaching courses is encouraged for each ROT (for example, the ESTRO school's courses).

Objectives for Satisfactory Completion of the 2nd Year

Basic:

1. Ability to deliver general presentations on essential clinical RO topics.
2. Understanding the basics of molecular biology and interactions of RT and systemic therapies.
3. Satisfactory performance review by ROS and the local program director (LPD).

Clinical:

1. Ability to handle on-call emergencies under ROS.
2. Mastery of basic clinical RO with a knowledge base commensurate with the level of training.
3. Completion of logbook files demonstrating care of approximately another 150 cases, focused on general and moderately complex oncologic entities.
4. Essential experience in brachytherapy, with at least 5 to 10 observed or performed cases.
5. Successfully complete rotations on more complex services than the 1st year ROT.
6. Assume more responsibility on more general RT services.
7. Demonstrate an increased understanding of the technical aspects of RT by participating fully in the treatment planning processes.

8. Basic understanding of quality assurance processes as they apply to RO.
9. Basic understanding of brachytherapy procedures.

Academic:

1. Demonstrate the ability to self-learn by identifying and citing pertinent primary literature in common oncological diseases.
2. Demonstrate the ability to evaluate and review medical literature critically.
3. Presentation of seminars with satisfactory evaluations from other ROTs and ROSs.
4. Determine areas of interest for research project(s).

Third Year ROT[23]

The clinical rotations will be designed to increase the level of focus and intensity of the learning experience for the ROT, who will be expected to build on the knowledge and experience of the preceding years, to the point that they will have the ability to propose and carry out treatment of the various disease sites. During the clinical rotation, ROT will be supervised and instructed on a one-to-one basis by the ROS. ROT will be required to complete 8-week minor rotation in surgical oncology. ROTs are encouraged to perform research and produce abstracts and manuscripts for submission to peer-reviewed journals or presentations at regional and national scientific meetings. The extra-mural rotation at another center will be arranged to accomplish one-year rotation there in the coming forth final year of the program, if possible. ROTs will be required to engage in an investigative project with ROSs. Senior ROTs are expected to take on a substantial teaching and mentoring role within the training program, helping to organize and lead discussions in the various conferences.

Objectives for Satisfactory Completion of the 3rd Year

Basic:

1. Attend lecture series, with a further increased teaching role.

2. Give thorough presentations on general or focused oncologic topics.
3. Increase understanding of complex treatment planning, such as 3D conformal and intensity/volumetric modulated radiotherapy (IMRT / VMAT), steriotaxy principles and techniques, and gain experience in clinical brachytherapy and treatment planning.
4. Satisfactory performance review by ROS and the local program director (LPD).

Clinical:

1. Ability to handle on-call and/or emergent situations with ROSs in a more independent manner.
2. Ability to manage general clinical situations on an independent basis.
3. Participate in rotations with a variety of complexities, with an emphasis on problem-solving and decision-making (ROT at this level should be able to assess a patient situation, determine the appropriate course of treatment and develop and implement the treatment plan, with ROS).
4. Completion of logbook files demonstrating care of approximately 150 cases per-year focused on moderate to highly complex oncologic entities.
5. Continue experience in brachytherapy, with at least 5 to 10 observed or performed.
6. Continue to improve with more complicated treatments, including stereotactic radiotherapy, 3D treatment planning, IMRT/VMAT, and treatment planning for brachytherapy.
7. Beginning ability to formulate a valid critique of treatment and treatment plans for quality assurance purposes.

Academic:

1. Self-learning should focus on developing an in-depth understanding of pertinent clinical, biological and technical literature.
2. Be conversant in critical clinical studies and understand their application to treatment decision-making.

3. Presentation of seminars with satisfactory evaluations from ROTs and ROSs.
4. Complete research project(s), write and submit abstract(s) and/or full manuscript(s) for publication and presentation at a national meeting with ROSs.

Fourth Year ROT[23]

ROT is encouraged, if possible, to spend about 6-12 months at another recognized RO training program, whether inside or outside the country, otherwise he/she can repeat the four major rotations as in the previous years with a high level of learning. During this year, ROTs will also be supervised and instructed on a one-to-one basis by ROS.

Objectives for Satisfactory Completion of the 4th Year

Basic:

1. Attend lecture series.
2. Satisfactory performance review by ROS and the local program director (LPD).

Clinical:

1. Ability to handle on-call situations under ROS.
2. Ability to manage highly complex clinical situations on an independent basis.
3. Successful completion of required clinical rotations (areas of interest or subspecialty training) while continuing to develop independent skills in clinical decision-making and treatment planning.
4. Completion of logbook files demonstrating care of approximately 150 cases per year focused on more complex oncologic entities.
5. Sufficient experience in the complex treatments and delivery of brachytherapy, to assure the ROT can independently plan and perform such procedures.
6. Ability to formulate a valid critique of treatment and treatment plans for quality assurance purposes.

7. Demonstrate competency to act as ROP.

Academic:

1. Self-learning should focus on areas of interest, areas where experience may be lacking with more in-depth reading on all aspects of academic oncology.
2. Demonstrable ability to design, either in abstract or real form, clinical studies pertinent to the field.
3. Satisfactory completion of research projects.

TRAINING OPPORTUNITIES

1. New patients (seen as inpatients or outpatients): ROT may, with ROS, assess new patients; discuss treatment recommendations with the patient and family; review tests and referrals; submit a specific dose and fractionation schedule; obtain feedback on the presentation of patients at MDT; reflect on new patients seen and treatment planned; dictate letters and reports.
2. Follow up patients: ROT may, with ROS, assess patients under active follow up; conduct an audit of the documentary record of findings; conduct an audit of recommended treatments for symptom control and toxicity; counsel a patient and family; conduct an audit of referrals to other specialists and health professionals.
3. Treatment review: ROT may, with ROS, assess patients during the course of RT and manage toxicities; conduct an audit of documentation of diagnosis and management of acute toxicities; prepare treatment summaries; obtain feedback on referrals to other health professionals; receive appraisal of performance by radiation therapists, physicists, medical oncologists and nurses.
4. Inpatient Care: ROT may, with ROS, assess patients and make decisions regarding management; discuss treatment recommendations with patient and family; review tests results; reflect on patients seen and treatment planned; review, and seek feedback on, documentation of patient care; present patients on ward rounds, and receive feedback; conduct an audit of patient care or discharge planning.

5. Radiation Therapy Planning and Treatment: ROT may, with ROS, submit a provisional RT prescription; contour structures, and receive feedback; critically appraise treatment plans; reflect on RT plans; participate in simulator sessions, including using planning software; participate in physics tutorials regarding treatment techniques and quality assurance; review treatment verification; complete a planning module; outline response to set-up errors; observe and discuss specific methods in brachytherapy, e.g. gynecological.
6. Other learning opportunities: ROT may engage in self-directed study e.g. reading; discuss oncology issues with a radiation oncologist; participate in departmental tutorials; participate in hospital grand rounds; engage in online and other computer-based learning activities e.g. attend a literature searching course, learn to use reference manager software, undertake a Cochrane Library users course; participate in journal clubs; participate in MDT meetings; participate in planning review meetings; participate in Morbidity and Mortality meetings; participate in special meetings e.g. examination preparation courses, scientific meetings; supervise and teach attached junior medical staff, medical students, nurses and radiation therapists; conduct a literature review or internet search, relating to patients seen or for research; spend time on treatment machines; spend time in planning with radiation therapists and physicists; observe surgical and interventional procedures; complete the required minor rotations; engage in basic research projects, etc.

RECOMMENDED REFERENCES

Including and not limiting to:

- **Websites:**
  - Professional: ESTRO, GEC-ESTRO, ABS, ASTRO, ASCO, ABR, ACR, ESMO, IAEA, ESO, ESCO, AAHPC, IAHPC, RCR, PROS, CARO, FARO, UICC, WHO, RCC, IARC, RTOG, TROG, ARRO, AACR, EORTC, ACS, NCI, ACRO, AAPM, etc.
  - PubMed, Cochrane Library, The IAEA Applied Sciences of Oncology (ASO) distance-learning course, NCCN guidelines,

ROECSG, UptoDate, e-Anatomy, eContour, Wikibooks in RO, LearnOncology, i.treatsafely, OncoLink, CTEP, RadOncReview, ACR in-training exam, Clinical Trials, NRG Oncology, Radiation Nation, I*CARE, EduCase, etc.

- **Books:** Khan's The Physics of Radiation Therapy; Khan's Treatment Planning in Radiation Oncology; Radiobiology for the Radiologist; Human Cross-Sectional Anatomy; Introduction to Research in the Health Sciences; Imaging in Radiotherapy; Essentials of Clinical Radiation Oncology; Perez & Brady's Principles and Practice of Radiation Oncology; Handbook of Evidence-Based Radiation Oncology; Fundamentals of Radiation Oncology: Physical, Biological, and Clinical Aspects; Bethesda Handbook for Clinical Oncology; Talking to Cancer Patients & their Relatives; Medical Ethics for Physicians in Training; AJCC and UICC latest editions in TNM Cancer Staging.
- **Journals:** The New England Journal of Medicine; Seminars in Radiation Oncology; The Lancet; The Lancet Oncology; Journal of Clinical Oncology & Journal of Global Oncology (both by ASCO); Annals of Oncology (by ESMO); International Journal of Radiation Oncology, Biology, Physics (Red Journal) & Practical Radiation Oncology (both by ASTRO); Radiotherapy and Oncology (Green Journal) & Clinical and Translational Radiation Oncology (both by ESTRO); JAMA Oncology, others.

ACADEMIC CREDITS

A suggested Hundred-Credit academic program can be summarized in Table 5.

Table 5: A suggested Hundred-Credit academic RO specialty program

Modules		**Didactic hours**	**Practical hours**	**Credits* (Didactic/ Practice)**
Basic Modules				
1.	Medical Physics	30 (1st–2nd Y)	135** (1st–4th Y)	5 (2 + 3)
2.	Onco-Radio-Biology	30 (1st–2nd Y)	0	2 (2 + 0)
3.	Critical Appraisal	30 (1st–2nd Y)	0	2 (2 + 0)
4.	Onco-Pharmacology	30 (1st–2nd Y)	0	2 (2 + 0)
5.	Onco-Pathology & Laboratory	30 (1st–2nd Y)	45*** (1st Y)	3 (2 + 1)
6.	Onco-Imaging and Radio-Anatomy	30 (1st–2nd Y)	45*** (1st Y)	3 (2 + 1)
Clinical Modules				
1.	Radiation Oncology	120 (1st–4th Y)	2835** (1st–4th Y)	71 (8 + 63)
2.	Nuclear Oncology	15 (1st Y)	45*** (1st Y)	2 (1 + 1)
3.	Medical Oncology	30 (2nd Y)	90*** (2nd Y)	4 (2 + 2)
4.	Palliative Oncology	7.5 (2nd Y)	45*** (2nd Y)	1.5 (0.5 + 1)
5.	Emergency Oncology	7.5 (2nd Y)	45*** (2nd Y)	1.5 (0.5 + 1)
6.	Surgical Oncology	15 (3rd Y)	90*** (3rd Y)	3 (1 + 2)
Total Modules		**405 hours**	**3, 285 hours**	**100 (26D+74 P)**

Note: The training is supposed to be of full-time over four years, five days a week, with about 240 working days per year, 9 hours a day, of 100 credits (74% practical and 26% didactic; 83% clinical modules and 17% non-clinical); *1 Credit equals 15 theoretical hours (like one weekly hour times 15 weeks) or 45 practical hours (like three weekly hours times 15 weeks); **A total of 2970 hours (135 plus 2835) distributed as 600, 600, 810, and 960 annual hours (average of 2.5, 2.5, 3.5, and 4 daily practical teaching hours under supervision) during the 1st, 2nd, 3rd and the 4th year, respectively; ***During the 8-week annual minor rotations.

EVALUATION, PROMOTION & EXAMINATION

- Regular evaluation (quiz and oral assessment) will be arranged at the end of each clinical rotation, and each theoretical course.
- Assessments and questions can be arranged based on the modified 6-level bloom taxonomy in learning outcomes, and to have lower order (first three levels) and high order (second three levels) questions, but more from the latter type of questions. These levels may be defined as[32]:
  - Knowledge - The ability to recall or remember facts, e.g. Define, Describe, Determine, Identify, Know, Outline, State.
  - Comprehension - The ability to understand and interpret learned information, e.g. Discuss, Explain, Understand.
  - Application - The ability to use the acquired knowledge in new situations to solve problems, e.g. Advise, Apply, Build, Communicate, Compare, Contribute, Demonstrate, Exhibit, Elicit, Enable, Engage, Facilitate, Implement, Inform, Manage, Modify, Negotiate, Participate, Perform, Provide, Respond, Run, Structure, Support, Undertake.
  - Analysis - The ability to breakdown the information into its components; to look for the relationships between the components, e.g. Analyse, Assess, Compare, Contrast, Determine, Recognise, Review, Stage.
  - Synthesis - The ability to put the parts together to build a pattern from them, e.g. Construct, Develop, Diagnose, Document, Plan, Prevent.
  - Evaluation - The ability to judge the value of material for a given purpose, e.g. Appraise, Evaluate, Estimate, Justify, Review, Revise.
- Annual evaluation (written and oral examination, in addition to the expected roles from the ROT at that level) will be arranged at the end of each year of training, on-campus (at the training center) and an annual report will be sent to the head-quarter (HQ) of the national training authority about the promotion of the ROT to the next level.

- Part one board examination (of MCQs and short assays, along two days), will be conducted at the HQ after successful completion of the 2nd ROT year.
- Final board examination will be conducted after successful completion of the 4th ROT year.
  - Candidates for this examination shall be assessed for their ability to function independently and responsibly to several multidisciplinary teams. Candidates are expected to have the competency in managing patients with malignant diseases, all aspects of the investigation and required treatments and follow up. The main emphasis is on RO, but a good knowledge of medical/surgical oncology is expected (and relevant questions on pathology and radiology may be asked at any stage in the examination). In the practical part, candidates will be examined by pairs of examiners (more than half of them better to be invited as external examiners).
  - The final board examination shall itself consist of:
    (a) Written part, composed of 1. MCQs and; 2. Assay, along two days (each of 3 hours).
    (b) Practical part (after passing the written part), in a hospital-based setting, also along two days.
- The suggested lowest passing degree of success is around 70%, but it may be different, as the idea is to probe critical areas of competency. Unsuccessful candidates will be required to re-sit the whole set of examination. The exam faculty reserves the right to refer for twelve months any candidate who performs poorly in the final examination as a whole or who fails in one or more components of the examination. Any candidate who does not attempt all parts of the final examination will be deemed to have failed the examination overall.
- The subjects covered in this examination will include but are not limited to Head and Neck Cancer, Lung Cancer, Gastrointestinal, Breast, Central Nervous System, Genitourinary, Gynecology, Miscellaneous (Pediatric, Musculoskeletal, Endocrine and Hematology RO), Basic

Sciences: Molecular / Radio-Biology, Pathology, Population Health, Epidemiology, Methodology, Physics, and Clinical Oncology[18], and as in Table 6.

Table 6: A suggested written examination content[18]

Primary Classification	**Secondary Classification**	**% Marks***
1. Head and Neck Cancer and Lung Cancer	1. Small Cell Lung Cancer; 2. Non-small Cell Lung Cancer; 3. Nasopharyngeal Cancer; 4. Oropharyngeal Cancer; 5. Laryngeal Cancer; 6. Other Head and Neck cancers	10 – 20
2. Gastrointestinal	1. Oesophageal Cancer; 2. Gastric Cancer; 3. Pancreatic Cancer; 4. Colorectal Cancer; 5. Anal Canal Cancer; 6. Other GI malignancies	0 – 20
3. Breast	1. Early-Stage Breast Cancer; 2. Locally Advanced Breast Cancer; 3. Metastatic Breast Cancer	5 – 10
4. Central Nervous System	1. Brain Metastasis; 2. High-Grade Glioma; 3. Low-Grade Glioma; 4. Other Benign Tumors; 5. Other Malignant Tumors	5 – 10
5. Genitourinary	1. Prostate Cancer; 2. Bladder Cancer; 3. Seminoma; 4. Other Genitourinary Malignancies	0 – 15
6. Gynecology	1. Cervix Cancer; 2. Endometrial Cancer; 3. Vulvar Cancer; 4. Vaginal Cancer; 5. Other Gynecologic Cancer	0 – 5
7. Miscellaneous	1. Pediatric Cancer; 2. Hematology; 3. Sarcoma; 4. Endocrine; 5. Skin Cancer; 6. Other Cancers	5 – 25

8. Basic Sciences: Molecular / Radio-Biology, Pathology	1. Anticancer Drug Mechanism/ Toxicity; 2. Tumour Markers; 3. Radiation Pathology/Late Effects/ Tolerance; 4. Cancer Pathology; 5. Anatomy; 6. Molecular Oncology/ Radiobiology; 7. Cancer Genetics; 8. Classical Radiobiology	15 – 20
9. Population Health, Epidemiology, Methodology	1. Cancer Prevention; 2. Ethics; 3. Epidemiology; 4. Clinical Trials Methodology/Statistics	0 – 5
10. Physics and technology	1. Quality Assurance; 2. Dosimetry and Clinical Physics; 3. Brachytherapy; 4. Radiation Devices; 5. Radiation Safety	5 – 15
11. Clinical Oncology	1. Surgical Oncology; 2. Oncologic Imaging; 3. Oncologic Emergencies and Supportive Care; 4. Combined Modality Therapy; 5. Quality of Life; 6. Paraneoplastic Syndromes; 7. Benign Disorders; 8. Biophysical Models; 9. Other	10 – 15
12. CanMEDS other than Medical Expert	1. Communicator; 2. Collaborator; 3. Leader; 4. Health Advocate; 5. Scholar; 6. Professional	0 – 5

*The ranges are approximate and may vary slightly.

NATIONAL BOARD AND LOCAL CENTER MEMBERS

National Program Director (NPD) at the HQ

Senior Leader and Educator in Radiation Oncology.

National Scientific Board (Council) at the HQ

Selected members and educators in Radiation Oncology and other related disciplines.

Local Program Director (LPD) at the Training Center

Leader and Educator in Radiation Oncology.

LOCAL FACULTY TRAINING MEMBERS

Educator/s in:

- Medical Physics.
- Onco-and Radio-Biology.
- Critical Appraisal.
- Onco-Pharmacology.
- Onco-Pathology and Laboratory.
- Onco-Imaging and Radio-Anatomy.
- Radiation Oncology (ROS).
- Medical Oncology.
- Surgical Oncology.
- Palliative Oncology.
- Emergency Oncology.
- Nuclear Oncology.

FACULTY AND PROGRAM EVALUATION

The program must evaluate faculty members' performance as it relates to the educational program. These evaluations should include a review of the ROS clinical teaching abilities, commitment to the educational

program, clinical knowledge, professionalism, scholar activities and multi-source feedbacks, including the ROTs in a personal approach. The purpose is to facilitate continuous faculty development.

The NPD must appoint the program evaluation committee (PEC), which must be composed of at least two program faculty members and should include at least one senior ROT; must have a written description of its responsibilities and should participate actively in:

1. Planning, developing, implementing, and evaluating the educational activities of the program.
2. Reviewing and making recommendations for the revision of competency-based curriculum goals and objectives.
3. Addressing areas of non-compliance with the board's standards
4. Reviewing the program annually using evaluations of faculty, ROTs, graduates, etc.

MAINTENANCE OF CERTIFICATION

Maintenance of certification (MOC) in radiation oncology is critical to practice the specialty in a safe, modern and competent fashion. This can be different from country to country and can be achieved through different pathways, including and not limited to, continuous medical education credits and courses, annual evaluation by the employer, national assessment with formal examination every five to ten years for example, assessment of the scientific productivity, medical practice and education by a peer-review committee.

In this regard, as an example, the ABR implemented MOC process, known as Continuous Certification, for all participating MOC diplomates. The Continuous Certification method uses an annual review to evaluate these four MOC parts, which are[33]:

Part 1: Professionalism and Professional Standing.

Part 2: Lifelong Learning and Self-Assessment.

Part 3: Assessment of Knowledge, Judgment, and Skills.

Part 4: Improvement in Medical Practice.

CHAPTER TWO

SYLLABUS

PART ONE: BASIC SCIENCES

I. MEDICAL PHYSICS[34]

The emphasis is on acquiring a broad knowledge of physics relevant to the clinical practice of RT. It is essential that during instruction, there should be demonstrations of therapeutic and related equipment and procedures to illustrate the importance of the subject to radiotherapeutic practice. The syllabus is meant to be given over the first two years. The first year concentrates on general medical physics including radiation physics, instrumentation, nuclear medicine physics, imaging physics, basics of dose theory and computer knowledge. The second year focuses exclusively on the physics of RT (See Eric Ford Interactive videos).

1. Basic concepts in physics:

Atomic structure, atomic and mass numbers; electron shells and energy levels; Electromagnetic Radiation; Electromagnetic Spectrum; Energy Quantization; relationship between wavelength, frequency and energy; description of an x-or gamma-ray beam (quality, energy, intensity, size); basics of production of x-or gamma-rays; continuous and discrete spectra; attenuation, absorption, scattering of x-rays; Aattenuation Coefficients, half-value layer.

2. Electromagnetic Radiation and its interaction with matter:

For each of the following, understand the nature of the effect and its dependence on the properties of the irradiated material (e.g. density, atomic number), its variation with energy and the relative importance in therapy and imaging: Elastic Scattering; Compton Effect; Photoelectric Effect; Pair Production; Photonuclear Interactions; Auger Effect; Scattered Radiation; Secondary Electrons; range versus energy; and the linear energy transfer.

3. Interaction of sub-atomic particles with matter:

Ionization and excitation due to charged particles; electrons; Collision Loss; Radiative Loss; stopping power due to each and total stopping power; Particle Range; Bragg Peak; Bremsstrahlung;

Neutrons: elastic and inelastic collisions; protons, Ionization Profile; elementary knowledge of pions and heavy ions.

4. Radioactive Sources:

Basics of radioactivity (including types of radiation and radioactive decay; isotopes; concepts, definitions and units of activity and half-life; characteristics of radiation; parent and daughter decay series; Radioactive equilibrium; sealed and unsealed sources); types of sources and their construction (wires, hairpins, seeds, tubes, needles, ovoids, etc.); requirement for clinical sealed sources; specific forms of sources (^{198}Au, ^{192}Ir, ^{137}Cs, ^{125}I, ^{90}Sr); Inverse-Square Law; specifications of source strength, air KERMA rate; calculation of absorbed dose from a source; dose distributions around standard sources; hazards with sealed sources; control and testing of sealed sources; measurement of activity; storage and movement control; Source Handling; Leak Testing, inspection; safety devices.

5. Radiotherapy Treatment Planning:

Data required for treatment planning; Immobilization (techniques and accuracy); effects and minimization of patient and organ movement; tumor localization: direct visual, simulator, CT, MRI, ultrasound; separation and contour information (uniplanar, multiplanar); transposition of patient data: magnification, target volumes, sensitive structures, dose modifying structures; structure and use of a simulator; use of a CT scanner in radiotherapy planning; CT simulator; fixed FSD versus isocentric planning; Coplanar planning in a uniform medium; Isodose distributions in each of the following situations, their uses and critical assessment (single field; isodose summation; multifield planning; weighting); Principles of Conformal Therapy; Principles of Arc and Rotational Therapy; Principles of Non-coplanar Planning; Principles of Stereotactic Localization; Tissue Compensators; Surface Obliquity; Inhomogeneous Media; volume definition, including GTV, CTV, ITV, PTV and PRV (various methods including ICRU 50, 62); dose prescription (different methods including ICRU 50, 62); basics of dose calculations in the presence of extensive shielding (e.g. sector

or Clarkson integration); field matching; total body irradiation (TBI); Principles of CT Treatment Planning [acquisition of data and data transfer; image manipulation and image fusion; defining the volume, growing tools; beam placement using beam's eye view; plan verification and evaluation using isodose display, dose volume histograms (DVH cumulative and frequency) and digitally reconstructed radiographs (DRR); elements of inverse planning; elements of IMRT / VMAT]. Dose calculation engines: PB, AAA, CCC AcurosXB and Monte Carlo; Optimization Concept.

6. Beam Therapy Equipment:

Principles of Superficial and Orthovoltage x-ray Production; Principles of the Linear Accelerator (LINAC); basics of the following (microwave production; waveguide construction; electron beam production; x-ray production, beam control and stability); basics of the LINAC head construction; basic structure of a cobalt machine; Output; concept and definition of the isocenter (source size; defining the beam geometry: collimators, applicators, multileaf collimators, cast blocks, penumbra, factors influencing penumbra; defining the beam quality; wedges and applicators: types, construction, action, use and effect on depth dose; shielding: techniques, materials, transmission, scatter, doses under shields); Irradiating the target (the treatment couch; positioning the patient; lasers; pointers; light fields; monitoring radiation output; control of the accelerator); Multi-leaf collimators (MLC): edge definition, leaf leakage, influence of leaf size; Stereotactic equipment. New and specialized linacs: Tomotherapy, Halcyon, Cyberknife, MR-linac.

7. Radiation Dosimetry:

Concept of absorbed dose; definitions and units; variation of absorbed dose in different tissues and materials; concept of exposure and the kinetic energy released per unit mass (KERMA); simple introduction to the relationship between exposure, KERMA and absorbed dose; charged particle equilibrium (CPE) and transient CPE; Ionization in gases; the physical principles underlying radiation dose measurement; concepts and practice of dose

measurement; relationship between measurement of ionization and derived measurement of dose; measurement of exposure; free air ionization chamber; methods of measurement; elemental knowledge of the construction, advantages and disadvantages of the following: (ionization methods, "ionization chamber, Geiger Counter, diodes"; chemical methods, primarily films; thermoluminescence (TLD); scintillation counters; calorimetry); calibration methods (intercomparisons; standards "local and national"; corrections (temperature, pressure, beam direction etc); constancy checks; practical dose measurements (introduction to the derivation of isodose curves; central axis depth dose profiles).

8. **Physics of Teletherapy Beams (X-rays):**

   Machines generating clinical beams; x-rays beams used in clinical practice; energy ranges; effect of KERMA on build up region and skin-sparing; percentage depth dose (PDD), tissue maximum ratio (TMR) and related quantities; effect of scatter (field size) on PDD, TMR and related quantities; Penumbra and quantities affecting it. Isodose curves for x-rays; fixed focus skin distance (FSD) and isocentric approaches; principles of wedges; Wedge Angle; Trays; Output Factors; Beam Geometry; field size definition; Multi-leaf colliamtors (MLCs), their design and leakage contribution to beam qualities; Monitor Unit calculation.

9. **Physics of Electron Beams:**

   Components of machines generating clinical electron beams; energy ranges; percentage depth dose; factors affecting depth dose; build up and skin-sparing for electrons; isodose curves for electrons; effects of surface obliquity and inhomogeneities on dose distributions; internal shielding; Monitor Unit calculation.

10. **Quality Assurance (QA) and Quality Control (QC) in Radiotherapy:**

    Definition of QA and QC; writing and implementing the RT prescription; the role of computer verification; manual checking; monitoring accuracy of treated volume: verification films and

mega-voltage imaging; monitoring accuracy of positioning (laser, light-fields, mechanical pointers, tolerances); monitoring accuracy of radiation output: symmetry and field flatness (tolerances); legal requirements; quality assurance for CT-simulators and motion management devices. Special considerations: QA for small beams (SRS/SBRT).

11. Brachytherapy:

Principles of Clinical Use; various sealed isotopes used in Brachytherapy and their characteristics; distribution rules and dose calculation basis for Paris System; Gynaecological Intracavitary Brachytherapy Systems, source and dose distributions; dose specification; Principles of Afterloading; types of afterloading (manual, remote, low, intermediate and high dose rate); other clinical uses like prostate and ocular. CT and MRI-based treatment planning; geometrical distoration and other consideration for MR-based planning; special focus on gynecological implants introducing the EQD2 concept and the GEC-ESTRO recommendations.

12. Radiation Protection and Safety:

Radiation risks; stochastic and non-stochastic processes; quality factors and dose equivalent; statutory framework; background radiation; low-level exposure effects; radiation limits; classification of staff, designated areas; guidance notes; local rules; dose limits; controlled areas and screening; protection mechanisms: time, distance, shielding; Design of treatment rooms; primary/secondary barriers; transmission through barriers, elementary calculations; mazes, doors and interlocks; leakage and scattered radiation; design of sealed sources; monitoring of personnel: construction and operating of film badge, TLD badge, direct reading dosimeter; dose reporting mechanisms and dose levels.

13. Information Technology (IT) concepts in Hospital Settings:

Hospital information system (HIS), Oncology Management system (OMS), digital imaging and communication in medicine (DICOM), picture archiving and communication system (PACS).

14. Nuclear Medicine Physics:

Concepts of the gamma camera and PET, isotopes used, detectors, formation of image, statistics and quantum noise, image quality, patient management (before, during and after administration of radioisotope), shielding and radiation incidents. Isotopes; stability, half-life; physical versus biological half-life; Radiopharmaceuticals; use in imaging and therapy; clinical applications and dose calculations.

15. Imaging Physics:

a) Ionizing Radiation: regular x-ray and flouroscopy. Tube composition, image formation, quantities affecting image quality, image characteristics. Patient management.

b) Computed Tomography: machine components, image formation and back projections, hounsefled units, image sizes and computer power.

c) Non-ionizing Radiation: MRI and Ultrasound; machine composition, basic concepts, image formation, image characteristics.

16. Emerging Technologies:

3D printing, use of nano particles, FALSH Therapy, Artificial Intelligence and Informatics.

II. ONCO-RADIO-BIOLOGY

An understanding of carcinogenesis, cellular and molecular features of malignancy, including biochemical control, signalling and cell death; tumor development, growth kinetics, micro-environmental changes, metastasis and immune response, besides the common laboratory techniques to demonstrate these features. Knowledge of the cellular and molecular basis for the response of cells, tissues and tumors to ionizing radiation and chemotherapy. An understanding of current models of radiation response and the biological principles underlying the application of RT to the

treatment of disease, including normal tissue responses (See Cancer Biology for radiation oncologists lecture, High Yield Radiobiology Board Review, ASTRO Radiation Biology and Physics Webinar Series and Radiobiology Review Course by William McBride). The sections can be categorized as follows:

1. **General Principles of Tumor Biology:**

   Definitions of and distinctions between different types of growth disorder, dysplasia and carcinoma in-situ; the cell cycle, fundamental cell kinetics, including parameters associated with cell cycle times; mechanisms of spread, local invasion/ migration, metastasis; effects of tumors: local (e.g. pressure), distant (metastatic and non-metastatic); tumor vasculature and angiogenesis; local and systemic immune response and immune cell infiltration (NK, DCs, CD4+/CD8+ etc.).

2. **General Principles of Radiobiology:**

   Cellular systems (hierarchical, flexible) and their response to radiation; parallel and linear systems; Radiation Biology Models (monolayer, spheroids, animal (normal and transgenic), regrowth curves, clonogenic assay, MTT colorimetric assay; linear energy transfer (LET) and its relevance to cellular damage; radiation damage at the cellular level (membrane, cytoplasmic, nuclear).

3. **Normal and Aberrant Mechanisms of Cell Growth Control:**

   Control of normal cell growth and behavior; autocrine, paracrine and endocrine growth factors; altered expression, function and control of these mechanisms in cancer; signal transduction (MAP kinases); the role of cyclin kinases; gene promoters and their activity in normal and malignant cells.

4. **Normal Tissue Radiobiology:**

   Normal tissue damage (early and late) and tolerance; Factors influencing tolerance; Effects of radiation on different tissues and organs; Tolerance levels for different tissues and organs; Organ tolerance to retreatment with radiation; Schemes for reporting normal tissue damage.

5. Population Radiobiology:

Cell death forms (apoptosis vs necrosis); production of the cell survival curve; descriptive models, e.g. linear quadratic (LQ) model; the concept of damage (lethal, sublethal, potentially lethal); concept of repair (early and late); effect of cell cycle on radiation sensitivity; repopulation; the cell survival curve as a basis for fractionation; terms describing cellular sensitivity (SF2, a, b, mean inactivation dose); a/b ratio and its relevance to acute and late responding tissues; isoeffect curves (various forms) and formulae, including biological effective dose (BED); fractionation and 5Rs and the influence on outcome with varying a/b ratio; hyperfractionation, accelerated fractionation and hypofractionation; influence of gaps in RT and their management; influence of time on radiation response, including dose rate effects; relative biological effect (RBE) and relation to LET; influence of oxygen on radiosensitivity, including oxygen enhancement ratio (OER); reoxygenation; relationship between OER and LET; methods of identifying hypoxia experimentally; hypoxic cell sensitizers and cytotoxins; use of high LET radiation; radiation protectors.

6. The Genetics of Normal and Malignant cells:

Normal chromosomal structure and function, normal gene transcription and its control; normal DNA repair mechanisms; polymorphisms, mini and microsatellites; chromatin structure and function; methylation, hypomethylation and methylation reversal; chromosomal and genetic changes in malignancy, point mutations, translocations, deletions, gene amplification and over-expression; oncogenes, proto-oncogenes, tumor suppressor genes (a knowledge of well-established examples in each class is expected); protein-protein interactions.

7. Techniques in Molecular Biology:

Principles of the common techniques in molecular biology, like: Nucleic acid analyses including electrophoresis, hybridization, blotting, polymerase chain reaction (PCR), sequencing, transfection; microarray techniques; transgenic models.

8. Molecular Biology of Radiation Damage and repair:

The basics of experimental molecular radiobiology; molecular processes involved in Radiation Damage and repair; time course of repair; molecular biology of chemotherapy drug resistance.

9. Causation of Human Cancers:

Environmental factors and influences; Carcinogenesis in vitro and in vivo; Viral Carcinogenesis; viruses firmly associated with cancer (HPV, EBV etc.); Radiation Carcinogenesis; ionizing and non-ionizing radiation associated with Carcinogenesis; DNA damage and repair (differing effects with various radiation types); Nucleotide Excision repair; genes and products related to repair.

10. Cancer Genetics:

Inherited syndromes associated with cancer: ataxia telangiectasia, xeroderma pigmentosa, Nijmegen Break Syndrome, Li-Fraumeni, Lynch, multiple endocrine neoplasia (MEN), Cockayne's, familial polyposis coli, inherited breast cancer syndromes; genes conferring susceptibility to cancer and mechanisms; linkage analysis; Principles of Genetic Counseling.

11. The Physiology of Haemopoiesis:

Marrow structure and organization; the haemopoietic microenvironment; cell lineages and hierarchies; control mechanisms in normal haemopoiesis.

12. The Immune System:

Cellular involvement in the immune system; antigen recognition and processing; dendritic cells; clonal expansion of lymphoid cells in response to stimulation; immunological surveillance; tumor immunology.

13. Late Effects and Radiation Protection:

a) Radiation Carcinogenesis (dose response for radiation-induced cancers, importance of age at exposure, time since exposure, sex, and tissue, second tumors in radiation therapy patients, risk estimates in humans).

b) Heritable effects of radiation (relative vs absolute mutation risk, doubling dose, heritable effects in humans, risk estimates for hereditable effects).

c) Radiation effects in the developing embryo (dependence of abnormalities and death on dose and gestational stage, microcephaly, intellectual disabilities).

d) Radiation Protection (Stochastic effects and tissue reactions, tissue and radiation weighting factors, equivalent dose, effective dose, committed dose, dose limits for occupational and public exposure).

14. Combined Modality Therapy:

a) Chemotherapeutic agents and radiation therapy: classes of chemotherapy agents, mechanisms of action, oxygen effect on Radiation Therapy and chemotherapy, main drug resistance mechanisms (e.g., MDR genes), interactions/synergism of chemotherapy with radiation therapy, targeted therapeutic agents.

b) Radiosensitizers, bioreductive drugs, and radioprotectors: definition of therapeutic window, tumor radiosensitizers "e.g., oxygen" and mimics "e.g., nitromidazole", normal tissue radioprotectors (e.g., amifostine), biological response modifiers "e.g., IL-2 and IFN", DNA repair inhibitors "e.g., PARPi, ATMi, ATRi, Chk1/2i."

c) Immune therapeutics

- Types of immunotherapy treatments in oncology: monoclonal antibodies (MABs), checkpoint inhibitors, Cytokines, Vaccines, Adoptive Cell transfer types (chimeric antigen receptors [CARs], tumor infiltrating lymphocytes [TILs], and T Cell receptors [TCRs]).
- Combination of immune therapies and radiation: recently published trials (e.g., PACIFIC, KEYNOTE): known predictors of response/biomarkers.

d) Hyperthermia.

15. **Special Radiation Therapy techniques:**

    Like Brachytherapy including low dose rate, high dose rate and pulsed treatments, ablative stereotactic radiosurgery, and charged particle therapy.

III. CRITICAL APPRAISAL

ROT will be required to have sufficient knowledge of the principles of population health, cancer epidemiology, searching for evidence, design of clinical trials, critical appraisal of treatment studies, survival analysis, patient-based endpoints in clinical trials, systematic reviews and meta-analysis, clinical decision analysis, and prognostic indices. Among the required concepts, are:

1. **Types of Data**:

   Presenting and summarizing individual variables; categorical data (nominal, ordinal); numerical data (discrete and continuous, the normal distribution, transformation to normality); bar charts and histograms; measures of central tendency and spread.

2. **Sampling:**

   Concept of a source population; random sampling; estimation of population statistics; standard error of a sample mean and of a proportion and their differences; confidence intervals; reference ranges.

3. **Principles of Statistical Inference:**

   Hypothesis testing and estimation; Type I and II errors; interpretation of p-values and confidence intervals; statistical and clinical significance.

4. **Comparing two or more groups**:

   T-tests; Chi-square with corrections.

5. **Measures and Tests of association between Variables:**

   Correlation and regression; scatter plots; screening tests; sensitivity; specificity; positive and negative predictive value.

6. **Survival Analysis**:

   Types of time-to-event data (survival data, recurrence data); presentation of survival data; Kaplan-Meier and actuarial survival curves; summarising survival data; comparing groups; log-rank test for two or more groups, including ordered groups; use of Cox's proportional hazards regression model; hazard ratios and their interpretation.

7. **Clinical Trials**:

   Phases I-IV of clinical trials; randomisation; the need for randomization; problems with non-randomized studies and historical controls; methods of randomization (simple, block, stratified minimization); blinding/masking; designs: parallel-group, cross-over, factorial; contents of a trial protocol; ethics and informed consent; measures of response; tumor regression; quality of life; morbidity; local and regional recurrence; distant metastases; death; Principles of Sample Size Calculation; interim analyses; intent-to-treat analysis; role and basic principles of meta-analysis.

8. **Concepts in Cancer Epidemiology:**

   Candidates will be required to have sufficient knowledge of the principles of Cancer Epidemiology to enable them to study cancer-related epidemiological data. These head points have to be accomplished:

   a) Design and interpretation of retrospective (case-control) and prospective (cohort) studies,
   b) Odds ratios and relative risks,
   c) Trends in cancer incidence and mortality (crude and standardized rates),
   d) Survival and local control rates,
   e) Cancer registration and follow-up.

IV. ONCO-PHARMACOLOGY

The emphasis is on the bases and use of cytotoxic drugs, hormones and biological therapies in clinical practice, their mode of action and side-effects, in brief. The syllabus also includes the basic principles of pharmacokinetics and pharmacodynamics, clinical trials and the basic pharmacology of drugs used in the supportive care of patients with cancer.

1. **Mode of action of Cytotoxic Drugs**:

   Mechanisms of action; Phase specific and cycle-specific drugs; mechanisms of cell death; mechanisms of drug resistance; drug resistance modifiers.

2. **Drug Design and Development**:

   Novel therapeutic targets; new drug discovery and development; preclinical assessment of candidate compounds; clinical studies (Phase I, II, III, IV).

3. **Pharmacokinetics and Pharmacodynamics:**

   General principles of Pharmacokinetics; route and timing of administration; plasma concentration and its relationship to drug actions; Area Under the Curve (AUC); drug activation, metabolism and clearance; protein and tissue binding; drug concentration at the target site.

4. **Principles of Clinical Use**:

   Dose-response curves; dose intensity; single-agent and combination therapy; adjuvant and neoadjuvant therapy; high-dose chemotherapy; regional therapy; targeting of drugs; modification of drug resistance; the clinical pharmacology and technology of continuous infusion; the clinical pharmacology of intrathecal treatment.

5. **Toxicity of Chemotherapy:**

   Dose-limiting and common toxicities; common toxicities; dose-related and idiosyncratic toxicity; early, intermediate and late toxicity; mechanisms of toxicity; chemical and other modifying-factors' drug-toxicity; safe handling of cytotoxic drugs.

6. **The Clinical Pharmacology of Analgesics:**

   Morphine and derivatives; drug combinations; different formulations, e.g. slow release and patch formulations.

7. **The Clinical Pharmacology of Steroids and Anti-emetics:**

   Mechanisms of actions and principles of use; categories and types; interactions.

8. **Drug Interactions in Cancer Treatment**:

   Common or important interactions between drugs used in cancer therapy and other commonly used agents, e.g. increased toxicity in patients receiving methotrexate who are taking NSAIDs.

9. **Endocrine Therapy**:

   Mechanisms of action; mechanism of resistance; common side-effects; combination with other therapies.

10. **Biological and Novel therapies:**

    Biological therapies, their mechanism of action, their combination with standard therapy; the mode of action of interferons, interleukins, growth factors, antibody therapy, gene therapy and immunotherapy; novel targets for anti-cancer drugs, including vasculature, cell signal control and oncogene products; bioreductive drugs; cancer vaccines.

11. **The basic Principles of High-dose Therapy:**

    The clinical pharmacology and rationale of high-dose therapy; methods for protection/rescue of stem cells; unusual toxicities, e.g. veno-occlusive disease, etc.

V. ONCO-PATHOLOGY AND LABORATORY

It is assumed that ROT has good knowledge and understanding of general pathology (at least to university undergraduate level) before attempting this subject. Areas of general pathology, which are pertinent to the practice of RO may be examined. The study of tumor pathology is to enable ROT to, (a) obtain a detailed

knowledge of the pathology of human tumors and their natural history, on which to base their practice of Radiation Oncology, (b) assess the value of a pathology report and to communicate effectively with the pathologist, regarding pathological features which may influence the diagnosis, modes of treatment and/or responses to treatment, (c) understand the disease processes associated with malignancy and radiation effects.

ROTs are advised to prepare themselves by day to day study of the biopsy and autopsy material which becomes available in the Anatomical Pathology Department of their institution, especially that originating from the cases with which they have been professionally associated. They should also avail themselves of the opportunity of attending any regular demonstrations held in their center. A certain amount of microscopic study is advised, as far as it assists in the broad understanding of disease processes. Sufficient knowledge of Histopathology is required to enable the ROT to conduct effective communication and dialogue with an attending Pathologist.

Outlines of onco-pathology include:

1. General: Nature of neoplasia - distinction between hyperplasia, hypertrophy, regeneration, malformation and neoplasia; malignant transformation - initiation and promotion stages of Carcinogenesis; mode of origin - monoclonal, multifocal; retention of function - differentiation and dedifferentiation; structural and functional changes in the cellular components; criteria for tumor diagnosis - macroscopic, histological and cytological; classification of tumors - histogenic, histological, behavioral and immunological; nomenclature - solid tumors, lymphomas, leukaemias; structure and organization of tumors - vascular supply, stroma, etc; systems of grading; normal tissue reactions to tumors; modes of spread of tumors; mechanisms of metastases - cell dose and "tumor take", "seed and soil"; precancerous states; endocrine aspects of malignancy - production of hormones by tumors, effect of hormones on tumors; paraneoplastic syndromes (Hypertrophic Pulmonary Arthropathy, CNS syndromes, Thrombophlebitis, Dermatological Syndrome); pathology of complications of treatment of malignant disease.

2. Etiology: Genetic predispositions (Congenital Syndromes, e.g. Polyposis Coli), testicular maldescent, chromosomal abnormalities, hereditary tumors, Oncogenes, Virogenes, multifactorial causation, nutrition and cancer, environmental causes of cancer (biological - protozoal, bacterial, viral, chemical - classes of Carcinogenic chemicals, smoking, physical - trauma, irradiation "UV and x-rays"), common occupational cancers, experimental tumors in animals - relationship to humans, Mutagenicity.
3. Tumor Immunology: Organization and development of the immune system and the role of immune responses in disease; cellular basis of immunity and measurement of immune function. Graft versus host reaction; Tumor Immunity, tolerance, enhancement; immune surveillance hypothesis; immunological markers in diagnosis and monitoring; experimental and clinical immunotherapy; The HLA systems, viruses and neoplasia.
4. Pathology of Radiation Injury: Pathology of whole-body irradiation; macroscopic and microscopic changes associated with radiation injury in all tissues of the body and factors influencing these including age, cytotoxic drugs and genetic influences.
5. Neoplasms of Specific Sites: Candidates should study in detail the primary and secondary tumors of each site or organ of the body. Thorough knowledge of the pathological features, including epidemiology and etiology, of all common tumors of the body, is expected. In addition, a reasonable understanding of the pathology of conditions that are the common differential diagnosis of tumors at various sites is expected.

VI. ONCO-IMAGING AND RADIO-ANATOMY:

These learning outcomes should be used as a guide to studying anatomy from an oncological perspective. Comprehensive knowledge of anatomy with cancer medicine allows an oncologist to interpret a given clinical situation or individual presentation to formulate a diagnosis and to devise a management plan. Also, a good knowledge of anatomy is crucial to the accurate delivery of

a course of radiation therapy and to the process of defining organs and regions as part of the treatment planning process. Knowledge of the anatomy of all sites will be required for the completion of part one exam of RO training. Competencies (knowledge and skills) needed within this subject in the first two years will be assessed through the clinical assignments and part one examination. Due to the importance of anatomy, all components learnt in these two years will be assessable during the final examination. Anatomy and its clinical applications will be assessed through completion of case reports and within parts of the final examinations.

Anatomy study and assessment will aim to ascertain that the ROT is developing an oncological approach to this subject and has competence when applying anatomical principles to the management of cancer patients. To guide learning, the organs and structures relevant to the management of commonly encountered tumor sites are listed in Table 7. For each anatomical site or organ listed, ROT is able to discuss and demonstrate the: location of the structure or organ, including definition of boundaries and normal variations between individuals; natural variations occurring in a person in relation to normal body functions e.g. respiration; in vivo (macroscopic) appearance of structure or organ; normal histology (microscopic appearance) of the organ; appearance of structure or organ on relevant imaging modalities; routes of potential cancer spread [including: local planes/direct spread; lymphatic spread; Hematogenous; Transcelomic; Neurological; Iatrogenic]; "Critical" and clinically-relevant tissues and anatomical regions related to the structure, organ or tumor under study e.g. supraclavicular fossa for breast cancer, rectum for prostate cancer; landmarks (surface body, radiological, other imaging techniques); neurological pathways and main arterial supply and venous drainage to organs and structures, especially those which impact on radiation planning and treatment decisions; lymphatic drainage of organs and structures including major nodal stations; important deviations from "normal" anatomy, either developmental or arising from iatrogenic causes.

As a clinical specialist devoted to the management of cancer patients, ROP uses all aspects of imaging and, especially tumour imaging. Besides, he will use specialized techniques of tumour imaging in the precise planning of radiation treatment. The general objectives of the rotation in onco-imaging are to give to ROT the necessary knowledge of diagnostic radiology that will allow him to fulfil his role adequately.

1. **CT-Scanning:**

   a) The trainee will be able to briefly describe the physical principles of CT scanning. He will be able to explain the rationale behind the use of contrast agents and to discuss the main indications for their use in tumor imaging.

   b) ROT will be able to recognize on CT Scans, the normal gross anatomy of the brain, the chest and mediastinum, the abdomen and the pelvis. He will be able to identify and describe the modification of normal anatomy related to tumors in these different sites.

2. **Magnetic Resonance Imaging (MRI):**

   a) The trainee will be able to briefly describe the physical principles of MR imaging and the different parameters that can vary in the production of MR scans as well as the general effect of these variations. He will be able to name the principal contrast agents used and to recognize and describe the changes caused by these contrast materials.

   b) The trainee will be able to recognize on MRI scans the normal anatomy of the brain, the head and neck region, the cord, the thorax, abdomen and pelvis and will be able to recognize and describe the main MRI changes caused in these organs by tumours.

   c) The trainee will be able to compare the relative advantages of MRI over other imaging modalities, and especially CT Scanning, for the main tumours.

Table 7: Organs and structures relevant to the management of commonly encountered tumor sites[19]

Neuro-Anatomy	Functional and anatomical compartments of the cerebrum and cerebellum; brainstem; ventricular system; cranial nerves including their origin and distribution (intra and extracranial); spinal cord and cauda equine; meninges; brachial plexus; sacral plexus; innervation of the upper and lower limbs; autonomic nervous system.
Head and Neck Anatomy	Nasopharynx; oropharynx; oral cavity; tongue; paranasal sinuses; major salivary glands; larynx; hypopharynx; thyroid gland; parathyroid glands; pituitary gland; orbits; paranasal/facial sinuses; course and relations of the internal and external carotid arteries and their major branches bilaterally; course and relations of internal and external jugular veins and their major tributaries bilaterally; anterior and posterior triangles of the neck; supraclavicular fossa; pterygopalatine fossa; temporal and infratemporal fossae; base of the skull including pituitary fossa, cavernous sinus, Meckel's cave, Rathke's pouch, clivus. All vascular and neural foramina for major vessels, cranial nerves and their branches traversing the base of the skull.
Thoracic Anatomy	Mediastinum; trachea and main bronchi; lung; pleura and pleural cavities; heart and great vessels; azygos vein; oesophagus; thoracic course of the thoracic duct; breast; chest wall anatomy; pericardium.
Abdominal Anatomy	Stomach; duodenum; liver; spleen; gall bladder and biliary tract; pancreas; kidneys; adrenal glands; ureters; cysterna chyli and abdominal course of the thoracic duct; abdominal wall anatomy.
Pelvic Anatomy	Rectum; anal canal; bladder; male and female urethra; prostate; testes, epididymis, vas deferens, seminal vesicles; penis; ovaries; fallopian tubes; uterus; cervix; vagina; vulva.
Upper and Lower Limbs	Axilla; inguinal and femoral canals; dermatomes and myotomes of the upper and lower limbs; muscular compartments and major muscles of the limbs.

PART TWO: CLINICAL SCIENCES
I. RADIATION ONCOLOGY

A. HEAD AND NECK TUMORS[26]

ROT will possess a body of knowledge and technical skills relevant to head and neck oncology. This will enable the trainee to collect and to interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be familiar with:

1. Epidemiology

a) Risk factors for head and neck cancer such as smoking, alcohol, viral (EBV and HPV) and immune deficiency.

b) The relative incidence of the common types of benign and malignant head and neck tumors.

2. Anatomy

a) Surface anatomy, draining lymphatics, blood supply and nerve supply of all head and neck anatomical sites.

b) The radiological anatomy of the head and neck and base of the skull using plain x-ray, ultrasound, CT scan, MRI and PET scan.

3. Pathology

a) Benign and neoplastic lesions of the head and neck.

b) The normal histology found in the different head and neck organs.

c) The process of Carcinogenesis.

d) The classification of neoplastic disease arising from various anatomical sites in the head and neck, including epithelial and mesenchymal malignancies.

e) The importance of pathological prognostic factors, including histological differentiation, resection margins, the presence of perineural and lymphovascular invasion and extracapsular extension on the pathological report.

f) The methods used for tissue diagnoses such as FNA, core biopsy, excision biopsy, and lymph node biopsy.

g) The principle of molecular pathology, including important growth factors receptors and different tumor markers, especially in thyroid malignancy.

4. Diagnostic Imaging

The radiological anatomy of the head and neck using different radiological modalities, particularly CT scan, MRI and PET scan.

5. Clinical Presentation

a) The natural history of each disease site.

b) The clinical presentation of local, regional and metastatic disease.

c) The risk of nodal disease in relation to the anatomical site and stage of the disease.

6. Clinical Skills

a) A complete history and physical examination including flexible endoscopy and CNS examination.

b) Identification and management of treatment-related side effects of therapy, including mucositis, skin reactions, xerostomia, loss of taste, weight loss, febrile neutropenia, thrombocytopenia, electrolytes and water balance, as well as the different paraneoplastic syndromes associated with head and neck cancer.

7. Staging

a) TNM categories and stage sub-grouping for head and neck cancer using the UICC system.

b) The principle of clinical, radiological and pathological staging, as well as the restaging of recurrent disease.

8. Radiobiology

a) The concept of fractionation and its impact on both tumor

control, as well as the normal tissue induced toxicity; such fractionation schedules include hyperfractionation, accelerated fractionation, concomitant boost, and hypofractionation.

b) The principle of radiation-induced malignancies.

9. Radiation Pathology

a) Radiation-induced clinical and pathological changes in normal tissue, both at the histopathological and physiological levels.

b) The impact of other factors such as co-morbidities and systemic chemotherapy on the incidence and severity of the radiation-induced pathological changes in the irradiated organs.

10. Radiation Physics

a) Physical properties of other modalities such as the protons, neutrons, and heavy ions as appropriate for the treatment of head and neck and base of skull tumors.

b) The principles of stereotactic radiosurgery, TomoTherapy and Cyberknife techniques appropriate to each anatomical site and stage of the disease.

11. Clinical Trials

a) Relevant literature on head and neck oncology, especially with randomized clinical trials (RTOG, DAHANCA, EORTC, NCIC, etc).

b) Relevant local clinical trials, if available.

12. Medical Oncology

a) Systemic chemotherapy and targeted therapy in the context of head and neck oncology.

b) The principles of concomitant, induction, and adjuvant chemotherapy sequences with radiotherapy.

13. Surgical Oncology

a) The principles of surgical management in head and neck cancer.

b) Surgical procedures include total laryngectomy, thyroidectomy, lymph node neck dissection, laser excision and reconstructive procedures including myocutaneous and vascularized graft.

14. Radiotherapy Principles and Planning

a) Knowledge of standard-dose/fractionation schedules.

b) Early and late side effects.

c) Immobilization methods and the importance of patient comfort and set-up reproducibility.

d) Identification of surgical scars, drain sites and swellings.

e) Determination of GTV, CTV, and PTV.

f) Dose-volume constraints for neoplastic and normal tissues relevant to the fractionation schedule proposed for the plan.

g) Tissue inhomogeneity corrections.

h) Compensation for anatomical variations in the irradiated volume.

i) Dosimetric planning including use of bolus, choice of photon and/or electron energies, beam weighting and use of wedges.

j) The ICRU recommendations for dose prescriptions for external beam therapy and Brachytherapy.

k) Verification of treatment delivery, including patient set-up and imaging.

B. CENTRAL NERVOUS SYSTEM TUMORS[26]

ROT will possess a body of knowledge and technical skills relevant to neuro-oncology. This will enable the trainee to collect and to

interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be familiar with:

1. **Epidemiology**

   a) Influence of sex, age, occupation, known etiologic agents and association between genetic syndromes and primary brain tumours (e.g. neurofibromatosis, Von Hippel-Lindau.

   b) The relative incidence of the common types of benign and malignant brain tumours (both intra-axial and extra-axial lesions).

   c) The primary histologies commonly associated with brain metastases and spinal cord compression due to metastatic epidural disease.

2. **Anatomy**

   The anatomy (both structural and functional anatomy) of the brain, skull base and spinal cord.

3. **Pathology**

   a) The WHO grading for gliomas and meningiomas.

   b) The clinical biomarkers for specific tumor types such as MGMT methylation status, IDH mutation for malignant glioma and cytogenic abnormalities (e.g. 1p/19q codeletion) for oligodendroglial tumors.

   c) CSF evaluation in selected CNS tumors.

4. **Diagnostic Imaging**

   a) The normal radiological anatomy of the brain, skull base and spine.

   b) The typical radiological appearance of the common types of benign and malignant brain tumours (both intra-axial and extra-axial lesions) on CT, MRI and PET scan.

   c) The use of different MRI sequences such as T1, T2 and Flair, as well as gadolinium enhancement in the interpretation of CNS lesions.

5. Clinical Presentation

a) The natural history of the common types of brain and spinal cord tumours.

b) The clinical presentation according to the site of local involvement, and the probability of craniospinal axis and distant metastatic disease.

6. Clinical Skills

a) A complete history and physical examination including thorough neurological examination, recognizing and describing abnormal findings.

b) Identification and management of common tumour or treatment-related side effects such as seizures, increased intracranial pressure, DVT and steroid-induced side effects.

c) Distinguish focal brain injury (necrosis) and more diffuse brain injury (neurocognitive side effects and their histopathologic correlates).

d) Identification of the signs and symptoms of intracranial metastatic disease and spinal cord compression.

e) Management of seizures and increased intracranial pressure.

7. Staging

a) Neuropathological as well as neuroimaging staging.

b) The importance of other prognostic variables, such as age and Karnofsky Performance Status.

8. Radiobiology

a) The rationale of altered fractionation schemes such as hyperfractionation, accelerated fractionation, hypofractionation, stereotactic radiosurgery, and their potential impact on both tumour control and normal nervous tissue toxicity.

b) The principle of radiation-induced secondary malignancies in the central nervous system.

9. Radiation Pathology

a) Radiation therapy-induced clinical and pathological changes in the normal neurologic tissue, both at the histopathological and physiological level.

b) The impact of other factors, such as co-morbidities and/or systemic chemotherapy, on the incidence and severity of the radiation-induced pathological changes in the central nervous system.

10. Radiation Physics

a) Principles of IMRT, including QA.

b) Principles of SRS.

11. Medical Oncology

a) Chemotherapeutic and targeted therapies in neuro-oncology, as well as the side effect profile of the various agents and the risks or benefits of concurrent radiotherapy treatment.

b) The indications for the use of these agents in the concomitant, neo-adjuvant and adjuvant setting.

12. Surgical Oncology

a) The methods of obtaining histological diagnosis such as stereotactic biopsy.

b) The principles of neurosurgical management of brain and spinal cord tumours such as craniotomy, transsphenoidal pituitary adenectomy, skull base resection and a decompressive laminectomy.

c) Role of surgery: impact of extent of resection, the role of surgery in solitary brain metastasis, indications of surgical intervention in spinal cord compression.

13. Radiotherapy Principles and Planning

a) Knowledge of standard-dose/fractionation schedules.

b) The appropriate indications for using stereotactic radiosurgery and stereotactic radiotherapy techniques.

c) Immobilization methods and the importance of patient comfort and set-up reproducibility.

d) Identification of surgical scars, drain sites and swellings.

e) The clinical mark-up for palliative whole-brain treatment, identify the position of the lens, orbit, cribriform plate and optic nerve on lateral skull x-ray.

f) Stereotactic localization systems.

g) Determination of GTV, CTV, and PTV, use of image-fusion to minimize contouring uncertainties.

h) Dose-volume constraints for neoplastic and normal tissues relevant to the fractionation schedule proposed for the plan.

i) Tissue inhomogeneity corrections.

j) Compensation for anatomical variations in the irradiated volume.

k) Dosimetric planning including choice of photon energies, beam arrangement and weighting, use of wedges or other beam modifiers; use of non-coplanar beams in SRS.

l) The ICRU recommendations for dose prescriptions for external beam therapy using photons or protons.

m) Verification of treatment delivery, including patient set-up and imaging.

C. CUTANEOUS AND MUSCULOSKELETAL TUMORS (SKIN, BONE AND SOFT TISSUE TUMORS)[26]

ROT will possess a body of knowledge and technical skills relevant to mesenchymal tumors, with particular emphasis on soft tissue sarcoma and retroperitoneal sarcomas. This will enable the trainee to collect and to interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be familiar with:

1. Epidemiology

a) Risk factors for soft tissue sarcoma such as radiation exposure and hereditary conditions.

b) The incidence of soft tissue sarcomas.

2. Anatomy

a) Surface anatomy, draining lymphatics, blood supply and nerve supply of extremities.

b) The radiological anatomy of the extremities using plain x-ray, CT scan, MRI and PET scan.

3. Pathology

a) The WHO classification of neoplastic disease of mesenchymal malignancies.

b) The importance of pathological prognostic factors, including histological differentiation, resection margins, the presence of perineural and lymphovascular invasion, and nodal involvement on the pathological report.

a) The principle of molecular pathology, including important growth factors, receptors and different tumor markers.

4. Diagnostic Imaging

The use of different radiological modalities, particularly, CT scan, and MRI needed for accurate staging of a patient with extremity sarcomas.

5. Clinical Presentation

a) The natural history.

b) The clinical presentation of local, regional and metastatic disease.

a) The risk of nodal disease in relation to the histology, anatomical site and stage of the disease.

6. Clinical Skills

a) A complete history and physical examination pertinent to a patient with sarcoma.

b) Identification and management of treatment-related side effects of therapy, including skin reactions, sexual, functional impairment.

c) Recognize and manage disease complications, such as neurovascular involvement.

7. Staging

a) TNM categories and stage grouping for sarcomas.

b) The principle of clinical, radiological and pathological staging, as well as the restaging of recurrent disease.

8. Radiobiology

a) The effect of x-rays on the normal and neoplastic tissues in the irradiated volumes.

b) The principle of acute, early-delayed and delayed radiation reactions.

9. Radiation Pathology

a) Radiation therapy-induced clinical and pathological changes in normal tissue, both at the histopathological and physiological levels.

b) The impact of other factors such as co-morbidities and/or systemic chemotherapy on the incidence and severity of the radiation-induced pathological changes in the irradiated organs.

10. Radiation Physics

a) Properties of photons and electrons.

b) Principles of radiation safety relevant to linear accelerators and Brachytherapy.

11. Clinical Trials

a) The literature on soft tissue sarcomas, especially with randomized clinical trials (RTOG, NCI) that have impacted our current management in soft tissue sarcomas.

b) Relevant clinical trials in their center.

12. Medical Oncology

a) Systemic chemotherapy and targeted therapy in the context of soft tissue sarcomas.

b) The array of chemotherapeutic and molecular agents used in the treatment of sarcomas, as well as the side effect profile of the various agents and the risks or benefits of concurrent radiotherapy treatment.

c) The indications for the use of these agents in the adjuvant and metastatic setting.

13. Surgical Oncology

a) The methods of obtaining a histological diagnosis, including core biopsy, incisional biopsy.

b) Surgical procedures including amputation vs limb-sparing, wide local excision, radical excision.

14. Radiotherapy Principles and Planning

a) Knowledge of standard-dose/fractionation schedules.

b) Early and late side effects.

c) Immobilization methods and the importance of patient comfort and set-up reproducibility.

d) Identification of surgical scars, drain sites and swellings.

e) Determination of GTV, CTV, and PTV.

f) Dose-volume constraints for neoplastic and normal tissues relevant to the fractionation schedule proposed for the plan.

g) Tissue inhomogeneity corrections.

h) Compensation for anatomical variations in the irradiated volume.

i) Dosimetric planning including use of bolus, choice of photon and/or electron energies, beam weighting and use of wedges.

j) The ICRU recommendations for dose prescriptions for external beam therapy and Brachytherapy.

k) Verification of treatment delivery, including patient set-up and imaging.

D. THORACIC TUMORS[26]

ROT will possess a body of knowledge and technical skills relevant to lung oncology. This will enable the trainee to collect and to interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be familiar with:

1. Epidemiology

a) Risk factors for lung cancer, such as smoking and occupational and environmental exposures.

b) The incidence of the various lung cancer sub-types.

2. Anatomy

a) Surface anatomy, draining lymphatics, blood supply and nerve supply of the lungs.

b) Functional anatomy of the lung as described by pulmonary function tests.

3. Pathology

a) Benign and neoplastic lesions of the lungs.

b) Normal histology of the lungs.

c) The process of Carcinogenesis.

d) The classification of neoplastic disease arising from different anatomical sites in the lungs and pleura, including epithelial and mesenchymal malignancies.

e) The importance of pathological prognostic factors, including histological differentiation, resection margins, the presence of perineural and lymphovascular invasion and nodal involvement on the pathological report.

f) The principle of molecular pathology, including important growth factors receptors and different tumor markers.

4. Diagnostic Imaging

The use of different radiological modalities, particularly endoscopic US, CT scan, MRI and PET scan, needed for the accurate staging of a patient with lung cancer.

5. **Clinical Presentation**
    a) The natural history of each disease site.
    b) The clinical presentation of local, regional and metastatic disease.
    c) The risk of nodal disease in relation to the anatomical site and stage of the disease.
6. **Clinical Skills**
    a) A complete history and physical examination pertinent to a patient with lung cancer.
    b) The indications for the use of a Pleurex catheter for symptom management.
    c) Identification and management of treatment-related side effects of therapy, including skin reactions, weight loss, dysphagia, dyspnea and cough, febrile neutropenia, thrombocytopenia, electrolytes and water balance, as well as the different paraneoplastic syndromes associated with lung cancer.
7. **Staging**
    a) TNM categories and stage sub-grouping for lung cancer using the UICC system.
    b) The principle of clinical, radiological and pathological staging, as well as the restaging of recurrent disease.
8. **Radiobiology**
    a) The concept of fractionation and its impact on both tumor control, as well as the normal tissue induced toxicity; such fractionation schedules include hyperfractionation, accelerated fractionation, concomitant boost, and hypofractionation.
    b) The principle of radiation-induced malignancies.
9. **Radiation Pathology**
    a) Radiation-induced, clinical and pathological changes

in normal tissue, both at the histopathological and physiological levels.

b) The impact of other factors such as co-morbidities and systemic chemotherapy on the incidence and severity of the radiation-induced pathological changes in the irradiated organs.

10. Radiation Physics

a) Principles of 3D, IMRT and 4D and the role of PET/CT.

b) The principles of extracranial stereotactic radiosurgery and TomoTherapy.

11. Clinical Trials

a) The literature on lung oncology, especially with randomized clinical trials (RTOG, EORTC, NCIC) that have impacted our current management in lung oncology.

b) Relevant clinical trials in their center.

12. Medical Oncology

a) Systemic chemotherapy and targeted therapy in the context of lung oncology.

b) The principles of concomitant, induction, and adjuvant chemotherapy sequences with radiotherapy.

13. Surgical Oncology

a) The methods used for tissue diagnoses such as sputum cytology, FNA, core biopsy, excisional biopsy, and lymph node biopsy.

b) The methods of obtaining histological diagnosis including thoracentesis, bronchoscopy and mediastinoscopy.

c) The principles of surgical procedures including lobectomy, intraoperative lymph node biopsy, and pneumonectomy.

14. Radiotherapy Principles and Planning

a) Knowledge of standard-dose/fractionation schedules.

b) Early and late side effects.

c) Immobilization methods and the importance of patient comfort and set-up reproducibility.

d) Use of 4D-CT and respiratory gating.

e) Identification of surgical scars, drain sites and swellings.

f) Determination of GTV, CTV, and PTV.

g) Dose-volume constraints for neoplastic and normal tissues relevant to the fractionation schedule proposed for the plan.

h) Tissue inhomogeneity corrections.

i) Compensation for anatomical variations in the irradiated volume.

j) Dosimetric planning including use of bolus, choice of photon and/or electron energies, beam weighting and use of wedges.

k) The ICRU recommendations for dose prescriptions for external beam therapy and Brachytherapy.

l) Verification of treatment delivery, including patient set-up and imaging.

E. GASTROINTESTINAL TUMORS[26]

ROT will possess a body of knowledge and technical skills relevant to GI oncology, with particular emphasis on oesophageal, gastric, rectal and anal cancers. This will enable the trainee to collect and interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be familiar with:

1. Epidemiology

a) Risk factors for GI cancers, such as smoking, diet, family history, viral (HPV) and immune deficiency, hereditary syndromes that predispose to colon cancer.

b) The incidence of GI tumors, by sub-site.

2. Anatomy

a) Anatomy, draining lymphatics, blood supply and nerve supply of the GI sub-sites.

b) The radiological anatomy of the chest, abdomen and pelvis using plain x-ray, CT scan, MRI and PET scan.

3. Pathology

a) Benign and neoplastic lesions of the GI sub-sites.

b) The normal histology found in the gastrointestinal organs.

c) The process of Carcinogenesis, molecular pathways leading to colorectal tumorigenesis (e.g. chromosomal instability, mismatch repair pathway, hypermethylation phenotype).

d) The classification of neoplastic disease arising from different anatomical GI sub-sites including epithelial and mesenchymal malignancies.

e) The importance of pathological prognostic factors, including histological differentiation, resection margins, the presence of perineural and lymphovascular invasion and nodal involvement on the pathological report.

f) The principle of molecular pathology, including important growth factors receptors and different tumor markers.

4. Prevention

a) Indications of screening and identification of risk groups.

b) Screening methods: fecal occult blood, sigmoidoscopy, colonoscopy in colorectal cancer.

c) Risks and benefits of screening and impact on mortality.

5. Diagnostic Imaging

a) The use of different radiological modalities, particularly endorectal and the esophageal US, CT scan, MRI and PET scan, needed for accurate staging of a patient with GI cancer.

6. Clinical Presentation

a) The natural history of each disease site.

b) The clinical presentation of local, regional and metastatic disease; patterns of spread (local, lymphatic, haematogenous, peritoneal).

c) The risk of nodal disease in relation to the anatomical site and stage of the disease.

7. Clinical Skills

a) A complete history and physical examination pertinent to a patient with GI cancer, particularly DRE in the assessment of rectal and anal canal cancer and evaluation of nutritional status in a patient with esophageal cancer.

b) Identification and management of treatment-related side effects of therapy, including skin reactions, weight loss, nausea and vomiting, diarrhea and metabolic abnormalities.

c) Recognize and manage disease complications such as fistulas, bowel incontinence, rectal bleeding, and obstruction of GI tract.

8. Staging

a) TNM categories and stage sub-grouping for GI cancer using the UICC system.

b) The principle of clinical and pathological staging, as well as the restaging of recurrent disease.

9. Radiobiology

a) The normal and malignant tissue effects related to RT.

b) The principle of radiation-induced malignancies.

10. Radiation Pathology

a) Radiation therapy-induced clinical and pathological changes in normal tissue, both at the histopathological and physiological levels.

b) The impact of other factors such as co-morbidities and/

or systemic chemotherapy on the incidence and severity of the radiation-induced pathological changes in the irradiated organs.

11. Radiation Physics

a) Principles of radiation safety relevant to linear accelerators.

b) Principles of IMRT and liver SBRT.

12. Clinical Trials

a) The literature on GI oncology, especially with randomized clinical trials (RTOG, EORTC, NCIC) that have impacted our current management in GI oncology.

b) Relevant clinical trials in the center.

13. Medical Oncology

c) Systemic chemotherapy and targeted therapy in the context of GI oncology, especially 5FU, cisplatin, mitomycin C.

d) The array of chemotherapeutic and molecular agents used in the treatment of GI cancers, as well as the side effect profile of the various agents and the risks or benefits of concurrent radiotherapy treatment.

e) The indications for the use of these agents in the neoadjuvant, adjuvant and metastatic setting.

14. Surgical Oncology

a) The methods of obtaining histological diagnosis including core biopsy, excisional biopsy, lymph node biopsy.

b) Surgical procedures including endoscopy, colonoscopy, esophagectomy including differences in surgical approach and its impact on radiotherapy, gastrectomy (subtotal/total) including options for anastomosis and reconstruction, ERCP, Meso-rectal excision (MRE), defunctioning colostomy/ileostomy, abdominoperineal resection (APR), low anterior resection (LAR), and inguinal lymph node resection.

15. Radiotherapy Principles and Planning

a) Knowledge of standard-dose/fractionation schedules.

b) Early and late side effects.

c) Immobilization methods and the importance of patient comfort and set-up reproducibility.

d) Use of contrast agents for radiation planning.

e) Identification of surgical scars, drain sites and swellings, specifically identifying the location of colostomy and anastomosis radiologically.

f) Determination of GTV, CTV, and PTV.

g) Dose-volume constraints for neoplastic and normal tissues relevant to the fractionation schedule proposed for the plan.

h) Tissue inhomogeneity corrections.

i) Compensation for anatomical variations in the irradiated volume.

j) Dosimetric planning including use of bolus, choice of photon and/or electron energies, beam weighting and use of wedges.

k) The ICRU recommendations for dose prescriptions for external beam therapy and Brachytherapy.

l) Verification of treatment delivery, including patient set-up and imaging.

F. GENITOURINARY TUMORS[26]

ROT will possess a body of knowledge and technical skills relevant to GU oncology, with particular emphasis on the prostate, bladder, testicular and penile cancer. This will enable the trainee to collect and to interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be familiar with:

1. **Epidemiology**
   a) Risk factors for GU cancer such as smoking, ethnic background, family history, age, and cryptorchidism.
   b) The incidence of GU tumors, by sub-site.
2. **Anatomy**
   a) Surface anatomy, draining lymphatics, blood supply and nerve supply of the GU sub-sites.
   b) The radiological anatomy of the pelvis using plain x-ray, CT scan, MRI and PET scan.
3. **Pathology**
   a) Benign and neoplastic lesions of the GU sub-sites.
   b) The normal histology found in the genitourinary organs.
   c) The process of Carcinogenesis.
   d) The classification of neoplastic disease arising from different anatomical GU sub-sites including epithelial and mesenchymal malignancies.
   e) The importance of pathological prognostic factors, including histological differentiation, resection margins, the presence of perineural and lymphovascular invasion, the extent of disease burden in prostate cancer and nodal involvement on the pathological report.
   f) The principle of molecular pathology, including important growth factors receptors and different tumor markers.
4. **Prevention**
   a) Indications of screening and identification of risk groups.
   b) Screening methods: PSA or PSA derivatives, DRE in prostate cancer.
   c) Risks and benefits of screening and impact on mortality.
5. **Diagnostic Imaging**

   The use of different radiological modalities, particularly prostate

US, CT scan, MRI and PET scan with its different more specific radioisotopes, needed for accurate staging of a patient with GU cancer.

6. Clinical Presentation

a) The natural history of each disease site.

b) The clinical presentation of local, regional and metastatic disease.

c) The risk of nodal disease in relation to the anatomical site and stage of the disease.

7. Clinical Skills

a) A complete history and physical examination pertinent to a patient with GU cancer, particularly DRE in the assessment of prostate cancer, characterization and quantification of urinary symptoms in prostate cancer.

b) Identification and management of treatment-related side effects of therapy, including skin reactions, weight loss, GI toxicities, rectal bleeding, sexual dysfunction and hormonal toxicities.

c) Recognize and manage disease complications such as hematuria, obstructive uropathy, hypercalcemia, and marrow failure; as well as paraneoplastic conditions associated with renal and prostate cancer.

8. Staging

a) TNM categories and stage sub-grouping for GU cancer using the UICC system.

b) Risk stratification in prostate cancer.

c) The principle of clinical, radiological and pathological staging, as well as the restaging of recurrent disease.

9. Radiobiology

a) The normal and malignant tissue effects related to dose rate in Brachytherapy.

b) The principle of radiation-induced malignancies.

10. Radiation Pathology

a) Radiation therapy-induced clinical and pathological changes in normal tissue, both at the histopathological and physiological levels.

b) The impact of other factors such as co-morbidities and/or systemic chemotherapy on the incidence and severity of the radiation-induced pathological changes in the irradiated organs.

11. Radiation Physics

a) Principles of radiation safety relevant to 3D, IMRT and SBRT.

b) The physical properties of isotopes used in prostate Brachytherapy, including radiation protection advantages and disadvantages of each.

12. Clinical Trials

a) The literature on GU oncology, especially with randomized clinical trials (RTOG, EORTC, NCIC) that have impacted our current management in GU oncology.

b) Relevant clinical trials in their center.

c) Investigational procedures, such as cryotherapy and HIFU.

13. Medical Oncology

a) Systemic chemotherapy and targeted therapy in the context of GU oncology.

b) The array of chemotherapeutic, hormonal and molecular agents used in the treatment of GU cancers, as well as the side effect profile of the various agents and the risks or benefits of concurrent radiotherapy treatment.

c) The indications for the use of these agents in the neoadjuvant, adjuvant and metastatic setting.

14. Surgical Oncology

a) The methods of obtaining histological diagnosis including

cytology, core biopsy, excisional biopsy, lymph node biopsy, particularly principles of systematic biopsy of the prostate.

b) Surgical procedures including cystoscopy, TURP, radical prostatectomy, cystectomy with ileal conduit, nephrectomy, and orchiectomy.

15. Radiotherapy Principles and Planning

a) Knowledge of standard-dose/fractionation schedules.

b) Early and late side effects.

c) Immobilization methods and the importance of patient comfort and set-up reproducibility.

d) Identification of surgical scars, drain sites and swellings.

e) Determination of GTV, CTV, and PTV.

f) Dose-volume constraints for neoplastic and normal tissues relevant to the fractionation schedule proposed for the plan.

g) Tissue inhomogeneity corrections.

h) Compensation for anatomical variations in the irradiated volume.

i) Dosimetric planning including use of bolus, choice of photon and/or electron energies, beam weighting and use of wedges.

j) The ICRU recommendations for dose prescriptions for external beam therapy and Brachytherapy.

k) Verification of treatment delivery, including patient set-up and imaging.

G. GYNECOLOGIC TUMORS[26]

ROT will possess a body of knowledge and technical skills relevant to gynecologic oncology. This will enable the trainee to collect and to interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be familiar with:

1. **Epidemiology**
    a) Risk factors for gynecologic cancers such as HPV, obesity, diabetes, lifetime estrogen exposure and genetic factors (BRCA1, BRCA2).
    b) The incidence of gynecologic tumors, by sub-site.
2. **Anatomy**
    a) Surface anatomy, draining lymphatics, blood supply and nerve supply of all gynaecologic sub-sites.
    b) Age and pregnancy-related physiologic changes in the gynecologic tract.
    c) Radiological anatomy of the gynaecologic sites using plain x-ray, CT scan, MRI and PET scan.
3. **Pathology**
    a) Benign and neoplastic lesions of the gynecologic sub-sites.
    b) Normal histology found in the gynecologic organs.
    c) The process of Carcinogenesis in all sub-sites, the molecular pathway to Carcinogenesis in cervical cancer as a prototype for viral-induced cancers.
    d) The classification of neoplastic disease arising from different anatomical sites in the gynecologic tract including epithelial and mesenchymal malignancies.
    e) The importance of pathological prognostic factors, including histological differentiation, resection margins, depth of invasion, the presence of lymphovascular invasion and nodal involvement on the pathological report.
    f) The principle of molecular pathology including important growth factors receptors and different tumor markers.
4. **Prevention**
    a) Indications and frequency of cervical cytology.
    b) Identification of risk groups.

c) Screening methods: PSA or PSA derivatives, DRE in prostate cancer.

d) Risks and benefits of screening and impact on mortality.

e) Other preventative methods: HPV vaccination.

5. Diagnostic Imaging

The use of different radiological modalities, particularly CT scan, MRI and PET scan, needed for accurate staging of a patient with gynecologic cancer.

6. Clinical Presentation

a) The natural history of each disease site and the clinical presentation of local, regional and metastatic disease.

b) The risk of nodal disease in relation to the anatomical location and stage of the disease.

7. Clinical Skills

a) A complete history and physical examination, including EUA, pertinent to a patient with gynecologic cancer, recognizing and describing abnormal findings.

b) Identification and management of treatment-related side effects of therapy, including skin reactions, weight loss, GI toxicities, and menopausal symptoms.

c) Management of disease complications such as hemorrhage, ureteric obstruction and ascites.

d) Insertion of Brachytherapy applicator for cervical cancer and endometrial cancer.

8. Staging

a) Particularly FIGO but also TNM categories and stage sub-grouping for gynecologic cancers using the UICC system.

b) The principle of clinical, radiological and pathological staging, as well as the restaging of recurrent disease.

9. Radiobiology

a) The concept of fractionation and its impact on both

tumor control and normal tissue induced toxicity; such fractionation schedules include hyperfractionation, accelerated fractionation, concomitant boost, and hypofractionation.

b) The normal and malignant tissue effects related to dose rate in Brachytherapy.

10. Radiation Pathology

a) Radiation therapy-induced clinical and pathological changes in normal tissue, both at the histopathological and physiological levels.

b) The impact of other factors such as co-morbidities and/or systemic chemotherapy on the incidence and severity of the radiation-induced pathological changes in the irradiated organs.

11. Radiation Physics

a) Principles of radiation safety relevant to 3D and IMRT.

b) The physical properties of isotopes used in Gynecologic Brachytherapy, including radiation protection advantages and disadvantages of each.

12. Clinical Trials

a) The literature on gynecologic oncology especially with randomized clinical trials (GOG, EORTC, NCIC) that have impacted our current management in gynecology oncology.

b) Relevant clinical trials in their center.

13. Medical Oncology

a) Systemic chemotherapy and targeted therapy in the context of gynecologic oncology.

b) The principles of concomitant, induction, and adjuvant chemotherapy sequences with radiotherapy.

14. Surgical Oncology

a) The methods of obtaining histological diagnoses such as

Pap Smear, punch biopsy, cone biopsy, Pipelle Sampling, and fractional D&C.

b) The principles of surgical management in gynecologic cancer including radical hysterectomy, TAH & BSO, radical vulvectomy, pelvic lymph node and also inguinal node dissection, ovarian surgery including debulking.

15. Radiotherapy Principles and Planning

a) Knowledge of standard-dose/fractionation schedules.

b) Early and late side effects.

c) Immobilization methods and the importance of patient comfort and set-up reproducibility.

d) Identification of surgical scars, drain sites and swellings.

e) Determination of GTV, CTV, and PTV.

f) Dose-volume constraints for neoplastic and normal tissues relevant to the fractionation schedule proposed for the plan.

g) Tissue inhomogeneity corrections.

h) Compensation for anatomical variations in the irradiated volume.

i) Dosimetric planning including use of bolus, choice of photon and/or electron energies, beam weighting and use of wedges.

j) The ICRU recommendations for dose prescriptions for external beam therapy and Brachytherapy.

k) Verification of treatment delivery, including patient set-up and imaging.

H. BREAST TUMORS[26]

ROT will possess a body of knowledge and technical skills relevant to breast oncology. This will enable the trainee to collect and to interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be familiar with:

1. **Epidemiology**
   a) Risk factors for breast cancer such as family history, genetic abnormalities (BRCA1 and BRCA2), benign breast disease, parity, age of menarche and menopause, use of hormone replacement therapy, and prior radiation exposure.
   b) The incidence of the common types of benign and malignant breast tumors.
2. **Anatomy**
   a) Surface anatomy, draining lymphatics, blood supply and nerve supply of the breast and regional lymph nodes.
   b) Age and pregnancy-related physiologic changes in the breast.
   c) Radiological anatomy of the breast and regional nodes using mammography, ultrasound, CT scan and MRI.
3. **Pathology**
   a) Benign and neoplastic lesions of the breast.
   b) Normal histology of the breast.
   c) The process of Carcinogenesis.
   d) The classification of neoplastic disease arising in the breast, including epithelial and mesenchymal malignancies using the WHO classification system.
   e) The importance of pathological prognostic factors, including histological differentiation, resection margins, the presence of lymphovascular invasion and extent of lymph node involvement on the pathological report.
   f) The process of special stains and studies as well as prognostic implications of hormone receptors and molecular pathology.
   g) The use of genomic assays (e.g. OncotypeDx, Mammaprint) prognostic and predictive tools in breast cancer.
4. **Prevention**
   a) aIndications of screening and identification of risk groups.

b) Screening methods: mammogram, breast MRI.

c) Risks and benefits of screening and impact on mortality and other health parameters.

d) Other risk reduction methods such as bilateral mastectomy +/- oophorectomy in BRCA-1/2, hormonal therapy.

5. Diagnostic Imaging

a) Indications for mammography, breast ultrasound, and MRI of the breast in screening (both in a normal population and in a high-risk population) and follow-up.

b) Sensitivity and specificity of these imaging modalities.

c) Interventional radiology techniques such as stereotactic biopsy and wire localization for diagnosis of non-palpable lesions.

6. Clinical Presentation

a) The natural history of breast cancer and the clinical presentation of local, regional and metastatic disease.

b) The risk of nodal disease in relation to the size and grade of the primary tumor.

c) The risk of residual axillary disease in the setting of micrometastasis in a sentinel node.

7. Clinical Skills

a) A complete history and physical examination of the breast and regional nodal areas, recognizing and describing abnormal findings.

b) Identification and management of treatment-related side effects of radiation as well as hormonal therapy, including skin reactions and menopausal symptoms.

8. Staging

a) TNM categories for breast cancer using the UICC system.

b) The principle of clinical and pathological staging following neoadjuvant systemic therapy.

c) The principle of clinical and pathological staging, as well as the restaging of recurrent disease.

9. Radiobiology

a) The effect of x-rays on the normal and neoplastic tissues in the irradiated volumes.

b) The concept of fractionation and its impact on both tumour control and normal tissue induced toxicity; such fractionation schedules include concomitant boost and hypofractionation.

10. Radiation Pathology

a) Radiation therapy-induced clinical and pathological changes in normal tissue, both at the histopathological and physiological levels.

b) The impact of other factors such as co-morbidities and/or systemic chemotherapy on the incidence and severity of the radiation-induced pathological changes in the irradiated organs.

11. Radiation Physics

a) Properties of photons and electrons.

b) Principles of radiation safety relevant to linear accelerators and Brachytherapy.

12. Clinical Trials

a) The literature on breast oncology, especially with meta-analyses (Oxford overviews) and randomized clinical trials (NSABP, OCOG, EORTC, NCIC) that have impacted our current management in breast oncology.

b) Relevant clinical trials in the center.

13. Medical Oncology

a) Chemotherapeutic, hormonal and molecular agents used in the treatment of breast cancer, as well as the side effect profile of the various agents and the risks or benefits of concurrent radiotherapy treatment.

b) The indications for the use of these agents in the neoadjuvant, adjuvant and metastatic setting.

c) The indications for the use of hormonal therapies in breast cancer prevention.

14. Surgical Oncology

a) The methods of obtaining histological diagnoses such as FNA, core biopsy, excisional biopsy, and sentinel lymph node biopsy.

b) The principles of surgical management in breast cancer, including breast-conserving surgery, modified radical mastectomy, sentinel node biopsy, axillary node dissection, and also with reconstructive techniques such as TRAM flap and implants.

15. Radiotherapy Principles and Planning

a) Knowledge of standard-dose/fractionation schedules.

b) Early and late side effects.

c) Immobilization methods and the importance of patient comfort and set-up reproducibility.

d) Identification of surgical scars, drain sites and swellings.

e) Determination of GTV, CTV, and PTV.

f) Dose-volume constraints for neoplastic and normal tissues relevant to the fractionation schedule proposed for the plan.

g) Techniques used to reduce heart-dose such as prone position and deep inspiration breath-hold (DIBH).

h) Tissue inhomogeneity corrections.

i) Compensation for anatomical variations in the irradiated volume.

j) Dosimetric planning including use of bolus, choice of photon and/or electron energies, beam weighting and use of wedges.

k) Planning using more advance techniques such as tomotherapy and IMRT.

l) The ICRU recommendations for dose prescriptions for external beam therapy and Brachytherapy.

m) Verification of treatment delivery, including patient set-up and imaging.

I. LYMPHOMA AND LEUKEMIA[26]

ROT will possess knowledge and technical skills relevant to hematology oncology. This will enable the trainee to collect and to interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be familiar with:

1. Epidemiology

a) Risk factors for hematologic cancer such as family history, genetic abnormalities, infectious agents (HIV, EBV, Helicobacter pylori) and prior radiation exposure.

b) The principle of malignant transformation in hematologic malignancy.

c) The incidence of the common hematologic malignancies.

2. Anatomy

a) Of the lymphoreticular system, including bone marrow and spleen.

b) b) The microarchitecture as well as the functional anatomy of the lymphoreticular system.

3. Pathology

a) Benign and neoplastic diseases of the lymphoreticular system.

b) Normal hematopoiesis.

c) The process of Carcinogenesis.

d) The classification of neoplastic disease arising in the lymphoreticular system using the WHO classification system.

e) The importance of pathological prognostic factors, in particular, molecular and genetic factors.

f) The unique methods of a lymphoma protocol used for tissue diagnosis including immunohistochemical stains, flow cytometry and PCR.

g) Evaluation of bone marrow biopsy and aspirate.

4. Diagnostic Imaging

a) Indications for and interpretation of CT and PET in staging, re-staging and follow-up.

b) The sensitivity and specificity of these imaging modalities.

5. Clinical Presentation

a) The natural history of hematologic malignancies, in particular, lymphoma and plasma cell disorders.

b) The presentation of nodal (both Hodgkin and non-Hodgkin) lymphoma as well as extra-nodal lymphomas such as CNS, GI tract, testis and skin.

6. Clinical Skills

a) A complete history and physical examination relevant to the lymphoreticular system, including assessment of all nodal areas as well as spleen and skin, recognizing and describing abnormal findings.

b) Recognize and manage treatment-related toxicities, in particular, febrile neutropenia.

7. Staging

a) Ann Arbor staging with Cotswold Modifications.

b) Risk stratification systems: IPI and FLIPI.

c) The principle of clinical, radiologic and pathological staging, as well as the restaging of recurrent disease.

8. Radiobiology

a) The effect of x-rays on the normal and neoplastic tissues in the irradiated volumes.

b) The principle of acute, early-delayed and delayed radiation reactions.

9. Radiation Pathology

a) Radiation therapy-induced clinical and pathological changes in normal lymphoreticular tissue, both at the histopathological and physiological levels.

b) The impact of other factors such as co-morbidities and/or systemic chemotherapy on the incidence and severity of radiation-induced pathological changes in the irradiated tissues.

10. Radiation Physics

a) Principles of total body irradiation and total skin irradiation.

b) Principles of Brachytherapy using unsealed sources as well as related radiation safety issues.

11. Clinical Trials

a) The literature on hematologic oncology especially randomized clinical trials (NCI, CALGB, GELA, German Hodgkin Study Group) that have impacted our current management in hematologic oncology.

b) Relevant clinical trials in their center.

12. Medical Oncology

a) The array of chemotherapeutic and molecular agents used in the treatment of hematologic cancer, as well as the side effect profile of the various agents and the risks or benefits of concurrent radiotherapy treatment.

b) The indications for the use of these agents in the neoadjuvant, adjuvant and metastatic setting.

c) The indications for bone marrow or stem cell transplant and understand when allo-vs auto-transplant is indicated.

13. Radiotherapy Principles and Planning

a) Knowledge of standard-dose/fractionation schedules.

b) Early and late side effects.

c) Immobilization methods and the importance of patient comfort and set-up reproducibility.

d) Identification of surgical scars, drain sites and swellings.

e) Determination of GTV, CTV, and PTV.

f) Dose-volume constraints for neoplastic and normal tissues relevant to the fractionation schedule proposed for the plan.

g) Tissue inhomogeneity corrections.

h) Compensation for anatomical variations in the irradiated volume.

i) Dosimetric planning including use of bolus, choice of photon and/or electron energies, beam weighting and use of wedges.

j) The ICRU recommendations for dose prescriptions for external beam therapy and Brachytherapy of unsealed sources.

k) Verification of treatment delivery, including patient set-up and imaging.

J. PEDIATRIC TUMORS[23]

a) Learn to care for children with cancer and their families in a compassionate, caring manner.

b) Understand the clinical presentation, natural history, staging, and treatment options for patients with Wilm's Tumor, neuroblastoma, rhabdomyosarcomas, Ewing's Sarcoma, Hodgkin's Disease, retinoblastoma and childhood brain tumors.

c) Understand the indications for stem cell/bone marrow transplantation for acute lymphoblastic leukemia (ALL), acute myelogenous leukemia (AML), and neuroblastoma.

d) Master RT principles for the treatment of Wilm's Tumor, neuroblastoma, rhabdomyosarcomas, Ewing's Sarcoma, Hodgkin's Disease, retinoblastoma and childhood brain tumors (medulloblastomas, gliomas, ependymomas). This

will include (a) the use of CT simulation, outlining normal tissues, GTV, & CTV, (b) knowledge of relevant normal tissue tolerances, (c) appropriate treatment fields and doses, (d) use of MRI/CT fusions for tumors of the CNS and head and neck region and (d) the appropriate role of IMRT in the treatment of brain tumors.

e) Understand the indications for emergency RT in pediatric malignancies (i.e. respiratory compromise due to mediastinal mass from lymphoma/leukemia or abdominal mass from neuroblastoma, spinal cord compression from neuroblastoma impinging through neural foramina).

f) Understand the late complications that are particularly important in children, specifically; impairment of bone and soft tissue growth, decreased neurocognitive function and risk of second malignancies.

g) ROT will be expected to read and interpret the appropriate reference materials on the diseases and treatment modalities listed above. Assessment of the trainee's knowledge base will be done through periodic teaching sessions with the specialists on the service.

h) Learn to effectively communicate with children who are old enough and their parents, as well as other health professionals.

i) Develop awareness of the role that radiotherapy plays in the larger treatment plan for children with cancer.

II. MEDICAL ONCOLOGY

ROT will possess knowledge and management skills relevant to pediatric and adult medical oncology. This will enable ROT to collect and to interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise. ROT will be able to:

a) Elicit a focused and accurate history and physical exam relevant to a particular tumor site (breast, lung, GU, GI,

hematologic, CNS, H&N, skin and musculoskeletal), recognizing and describing abnormal findings.

b) Order appropriate staging investigations for a new or relapsed malignancy and be able to interpret the results.

c) Know the classification of chemotherapeutic agents, targeted/ molecular agents, hormonal agents, and bisphosphonates, which drugs are commonly used for specific cancers, usual frequency of administration, typical doses and adverse effects, the principles of titration, the routes of administration, the effects of renal and liver dysfunction on chemotherapeutic drugs.

d) Recognize and manage common complications of cancers and their treatment in the curative and palliative settings, such as venous thrombosis, pneumonia, nausea and vomiting, pan-mucositis, febrile neutropenia, pericardial tamponade, SVC obstruction, cord compression, hypercalcemia, and hyponatremia.

e) Recognize and manage common complications of treatment with chemotherapy, particularly febrile neutropenia, GI toxicities and allergic drug reactions.

f) Understand the principles of medical oncology treatment decision-making, including consideration of benefits and risks of different drugs for cancer management and evaluation of response.

g) Understand the process of director's privileges and special access for non-formulary agents.

h) Learn to perform the following procedures:

1. Paracentesis.
2. Lumbar puncture.
3. Thoracentesis.

III. SURGICAL ONCOLOGY

ROT will possess a body of knowledge and management skills relevant to surgical oncology. This will enable ROT to collect and interpret data, to carry out diagnostic and therapeutic procedures

within the limits of their expertise. ROT will be able to appreciate R-0/1/2 resections, as follows:

- R0: All macroscopic and microscopic disease removed. The "gold-standard" desired goal of any cancer operation.
- R1: All macroscopic disease removed, but microscopic disease present on pathologic margins.
- R2: macroscopic disease knowingly left behind (therefore, unquestionably microscopically positive margins as well).

Under direct surgical oncologists' supervision, ROT will assess cancer patients (in different surgical oncology subspecialties, like neuro-onco-surgery, gyne-onco-surgery, GU-onco-surgery, GI-onco-surgery, breast-onco-surgery, head and neck-onco-surgery, thoracic-onco-surgery, musculo-skeletal onco-surgery and pediatric-onco-surgery) and observe the suitable approaches, procedure and operation in the 8-week minor rotation in the 3rd year. Outlines of the objectives and roles in this knowledge and rotation are already addressed in different site-specific cancer sites.

IV. PALLIATIVE ONCOLOGY

ROT will possess knowledge and management skills relevant to palliative care. This will enable ROT to collect and to interpret data and to carry out diagnostic and therapeutic procedures within the limits of their expertise.

The objectives for the palliative medicine rotation are based on principles common to palliative care and oncology. The palliative medicine rotation will enable the ROT to obtain the knowledge and skills necessary to diagnose and manage patients with advanced cancer in a multidisciplinary team environment. At the completion of training, ROT will have demonstrated the necessary knowledge and skills to provide palliative care as part of the RO consultant practice, integrating all the required competencies in order to provide optimal, ethical and patient-centered medical care[26].

Basic and Clinical Knowledge

1. Physical Aspects

a) Disease process: ROT should know the meaning of "terminal illness" and of "palliative medicine"; understand the concept of clinical re-evaluation as the disease progresses; be able to anticipate potential problems, caused either by the disease or by treatments; have skills in diagnosis and management of common concurrent conditions; know the natural history, markers of progression and range of treatments available at each stage of malignant diseases.

b) Symptom control: ROT should know that symptoms may be caused by the disease itself, caused by treatment, related to disease or associated disability, or caused by a pre-existing or concurrent disorder. ROT should be able to direct the management of each symptom appropriately. This includes candidiasis, anorexia, nausea and vomiting, constipation, diarrhea, intestinal obstruction, dysphagia, pruritis, jaundice, dyspnea, cough, hiccups, anxiety and fear and their role in intensifying symptoms, depression (situational vs clinical), delirium, fatigue, sexual dysfunction, incontinence, bladder and rectal spasms, and lymphedema.

c) Pain: ROT should be able to take a pain history, including the use of assessment tools such as Edmonton Symptom Assessment Score (ESAS), Brief Pain Inventory and EORTC QLQ C30. Be able to differentiate between nociceptive and neuropathic pain. Elicit factors influencing pain (physical, psychological, social, and spiritual). Assess opioid responsiveness and appropriate use of co-analgesics. Recognize when appropriate referral to radiation oncology or anesthesia is indicated. Be aware of non-drug treatments and complementary/alternative therapies.

d) Management of emergencies: ROT should be able to identify and direct the management of common emergencies such as hypercalcemia, spinal cord compression, superior vena cava obstruction, hemorrhage, and seizures.

e) Management of sub-acute issues: ROT should be able to direct the management of fungating lesions and wound care, pressure area care, raised intracranial pressure, fistulae, and malignant effusions.

2. Pharmacology

ROT should know the classification of analgesics (as defined by the World Health Organization) and their use; which drugs are commonly used for the control of symptoms, usual frequency of administration, typical doses and adverse effects, and the Principles of Titration; the pharmacological management of difficult pain syndromes such as incident pain, and neuropathic pain; the various routes available for drug administration and when each is appropriate; the effects of renal and liver failure on drugs commonly used in palliative medicine; how to weigh up benefits and risks of different drugs for symptom control, being aware that these may change as a patient condition deteriorates; the rationale for, and clinical practice of opioid switching.

3. Psychosocial Aspects

ROT should be able to assess the differing perceptions and expectations of disease and treatment among the various family members; understand the importance of meetings with the family; be aware of the psychodynamics of interpersonal relationships and the changes which can occur in illness; assess the need for bereavement support and know how to refer to other disciplines for assistance in supporting a bereaved person.

4. Organizational Aspects

ROT should know about statutory regulation such as certification of death and controlled drugs regulations.

5. Palliative Radiotherapy

ROT should:

a) Develop an understanding of the natural history of incurable cancer.

b) Develop competence in management decisions for incurable cancer, and whether there will be a place for the palliative RT.

c) Develop proficiency in the palliative RT techniques, schedules and approaches.

d) Proficiency in the treatment of metastases to bone, CNS, bladder and gynecological malignant bleeding, superior vena cava obstruction, including the ability to design and set-up treatment fields, prescribe dose, evaluate dose plans, assess set-up and weekly quality assurance portals.

e) Ability to manage acute toxicities of palliative RT fields, such as steroid implementation and tapers for CNS disease, and to manage pain and fatigue.

V. EMERGENCY ONCOLOGY

ROT should be familiar with oncological emergencies, from RT perspective and non-RT perspective. This will be achieved during the rotation in medical oncology, surgical oncology and site-specific cancer sites' rotations. ROT should differentiate between cancer and its-treatment related emergencies and the non-related emergencies like stroke, myocardial infarction, burns, psychosis, etc.

ROT should display effective clinical skills in the following:

a) Perform a focused history and examination pertinent to the patient's presenting emergency

b) Learn how to present a case in a clear, concise, integrated, and problem-based manner, and record it in accurate, problem-oriented notes.

c) Order pertinent laboratory and other investigations, justify their use, interpret and integrate the information appropriately.

d) Demonstrate a systematic approach to clinical problem solving and implement a management plan with clear, comprehensive and correct orders.

e) Display effective technical skills in the following: care of

fractures/dislocations, wound care (local anaesthesia, suturing, dressings) and airway control (intubation), needle thoracentesis, paracentesis, lumbar puncture, eye patching, nasal packing, NG tube insertion, blood gases, and bladder catheter insertion, etc).

VI. NUCLEAR ONCOLOGY

ROT will possess general knowledge relevant to nuclear medicine. This will enable ROT to collect and to interpret diagnostic and therapeutic procedures in relation to nuclear medicine. This includes and not limited to, bone scan, renal scan, lung scan, cardiac scan, thyroid scan, PET/CT scan, MIBG scan, systemic radioisotope therapy, etc.

Nuclear Oncology Objectives:

a) ROT will become familiar with scientific principles, technology, and clinical applications of Nuclear Medicine studies as they pertain to the practice of oncology.

b) ROT will obtain an understanding of the physical and biological properties of radiopharmaceuticals used in the diagnosis and treatment of cancer.

c) ROT will develop knowledge of radiation safety procedures.

d) ROT will become familiar with the clinical indications and usefulness of the different nuclear medicine examinations.

e) ROT will develop knowledge of the advantages & disadvantages of the various examinations in relationship to other radiologic imaging modalities.

f) ROT will become familiar with the following techniques:
   - Bone scanning, three-phase studies, spot views, whole-body imaging, quantitative assessment and SPECT.
   - PET (Positron Emission Tomography in Oncology).
   - Thyroid uptake determination and imaging with 99mTc, I^{123}, and/or I^{131}.
   - I^{131} body scanning.

PART THREE: ADVANCED TRAINING CONCEPTS

Note: These advanced training concepts are not part of the academic credits.

I. Business Administration of Radiotherapy Services[35]:

ROT is expected to provide a general understanding of the ROP managerial roles and responsibilities, highlight the main management challenges of today's complex healthcare and radiotherapy environment, understand the day-to-day process of management, understand how incentives can help to manage processes and relate to motivation and performance, question classical approaches to management and their applicability to healthcare in general and cancer radiotherapy in particular. ROT is also expected to show the basic understanding of economic action, taking into account public health and economic conditions, besides learning how to analyze business issues and to develop solutions for economic problems. This also can include, and not limited to, the technical specifications of the machines, appropriateness of the machines to the clinical care, features of the bunkers to host the machines, the technical complexity of the machines and its maintenance, the backup availability of resources, etc.

II. Radiotherapy Team:

RT process is a teamwork effort. ROPs are unable to deliver the treatment courses without the availability of qualified medical physicists who are responsible for plan preparation and commissioning from a medical physics point of view, the radiotherapy technologists and therapists who are responsible for proper patient fixation, simulation and treatment delivery, and the nurses and clinical assistants who help in arranging the clinics and patients and their follow-ups[36]. ROT has to learn how to keep the harmony in attitudes and actions among the team members and that this is quite important to fasten the process of treatment, which might have an impact on the treatment outcomes.

III. Regulatory Bodies:

ROT is expected to know the spectrum of work of the regulatory bodies in licensure. This can include the licensure for medical care and the licensure to practice radiation safely. Every country has certain regulatory authorities that regulate the practice of healthcare in general and the usage of medical radioisotopes. Licensing bodies also license locations (for use as a bunker for machines), license machines (for use as radiation medical machines) and license personnel as radiation workers. Lastly, regulatory bodies impose specific minimum quality control standards that should be applied.

A radiation therapy clinic is more complicated in setting-up and management than a radiology clinic and involves various professional groups. The IAEA published many technical reports, and usually, there are national liaisons in each member state that can transfer these reports and guidelines to the national atomic authorities[36].

IV. Cancer Patients' Managment[35]:

ROT is expected to understand the specific needs and demands of cancer patients in healthcare and be able to identify strategies to cover cancer patients' needs in a face-to-face situation. Also, to know about common instruments to assess cancer patients' needs and satisfaction and to understand the institutional and system-driven barriers to patients' orientation in healthcare. ROT needs to create knowledge as well as a more in-depth understanding for the importance of shared decision-making between health professionals and patients and to be able to identify the positive effects of more patient orientation on the single patient and the cost development in healthcare.

ROT is expected to be able to see models of good practice, i.e. guidelines or institution as suggestions for students' professional work and to understand the challenges in informing patients due

to their different health literacy levels. There is an importance to realizing the value of patients' judgement about the quality in healthcare institutions, and to explore the role of patient groups for individual members and decision on a health system level.

V. Leadership in Radiation Oncology[35]:

ROT is expected to develop an understanding of principal leadership styles and the importance of situational leadership; to assess their leadership style and understand its strengths and weaknesses; to develop a leadership self-development plan. ROT needs to understand issues of motivation in organizations, especially performance evaluation and feedback, improve the ability to motivate colleagues and provide feedback effectively, and develop an understanding of the role of effective communication and feedback in performance management. Other essential skills include negotiation skills and to build knowledge of the personal approach to conflict resolution.

VI. National and Global Cancer Control Plans and Programs:

ROT is expected to know about aims of cancer registration (population and clinical cancer registration) and to get an overview about international and national cancer registries, to learn about outputs of cancer registries including incidence, prevalence, trends and survival and the standard methods in the analysis of data including standardization and incidence ratios and the usage of cancer registries information and its application to decrease cancer burden. At the same time, ROT needs to be familiar with the cancer control plans and programs at the national and global levels and how he/she can have an input in these efforts, whether through the governmental authorities or the non-governmental bodies and groups.

CHAPTER THREE

ANNEXES

Annex 1:
ROT Personal Details

Passport size photo

Reg. No. .....

Training Center Name: .....

ROT Name: .....

Candidate Signature: .....

Date of joining the training program: ..... / ..... / .....

Date of completion of the training program: ..... / ..... / .....

Date of final written examinations: ..... / ..... / .....

Date of final practical examinations: ..... / ..... / .....

Date of final result declaration: ..... / ..... / .....

Address: .....

E-Mail: .....

Phone: .....

Local Program Director (LPD)

Name: ..... E-Mail: .....

Work: ..... Phone: .....

Address: ..... Signature: .....

National Program Director (NPD)

Name: ..... E-Mail: .....

Work: ..... Phone: .....

Address: ..... Signature: .....

Annex 2:
ROT Resume

Personal Data:

Name: .....

Date of Birth: ..... Gender: .....

Marital Status: ..... Nationality: .....

Address: .....

Telephone: .....

E-mail: .....

Passport No: ..... Place of Issuance: .....

Date of Issue: ..... Expire Date: .....

Professional Data:

Present occupation:

.....

.....

Degrees (Qualifications):

.....

.....

.....

Previous Jobs:

.....

.....

.....

Professional Organizations & NGOs:

Experience & Training:

Honors & Distinction:

Publications:

Referees:

Annex 3:
Clinical Rotations

SN	From dd/mm/yyyy	To dd/mm/yyyy	Period weeks	Clinical rotation	ROS
1.	../../....	../../....			
2.	../../....	../../....			
3.	../../....	../../....			
4.	../../....	../../....			
5.	../../....	../../....			
6.	../../....	../../....			
7.	../../....	../../....			
8.	../../....	../../....			
9.	../../....	../../....			
10.	../../....	../../....			
11.	../../....	../../....			
12.	../../....	../../....			
13.	../../....	../../....			
14.	../../....	../../....			
15.	../../....	../../....			

Signature: ..... Signature: .....

Name: ..... Name: .....

(Supervisor / LPD) (Council Chair / NPD)

Date: ..... Date: .....

Annex 4:

Didactical Lectures and Teaching Sessions Attended by the ROT

[**N.B.** This page is an example and needs to be repeated based on the number of the didactic lectures]

SN	Date dd/mm/yyyy	Topic	Lecturer
1.	____/____/____		
2.	____/____/____		
3.	____/____/____		
4.	____/____/____		
5.	____/____/____		
6.	____/____/____		
7.	____/____/____		
8.	____/____/____		
9.	____/____/____		
10.	____/____/____		
11.	____/____/____		
12.	____/____/____		
13.	____/____/____		
14.	____/____/____		
15.	____/____/____		
16.	____/____/____		
17.	____/____/____		
18.	____/____/____		
19.	____/____/____		
20.	____/____/____		

Annex 5:
Scientific Presentations Delivered by the ROT

[**N.B.** This page is an example and needs to be repeated based on the number of the scientific activities that are delivered by the ROT]

SN	Date dd/mm/yyyy	Type	Topic
1.	____/____/____		
2.	____/____/____		
3.	____/____/____		
4.	____/____/____		
5.	____/____/____		
6.	____/____/____		
7.	____/____/____		
8.	____/____/____		
9.	____/____/____		
10.	____/____/____		
11.	____/____/____		
12.	____/____/____		
13.	____/____/____		
14.	____/____/____		
15.	____/____/____		
16.	____/____/____		
17.	____/____/____		
18.	____/____/____		
19.	____/____/____		
20.	____/____/____		

Annex 6:
ROT Presentation Evaluation by ROS

[**N.B.** This page is an example and needs to be repeated based on the number of the scientific activities that are delivered by the ROT]

ROT name: ..... **Level:** ..... **ROS name:** .....

Date of Presentation: ..... **Topic:** .....

Please use the following scale to evaluate the presentation:

Medical Expert	**>90**	**80-90**	**70-80**	**60-70**	**<60**
Demonstrated thorough knowledge of the topic.					
Presented at an appropriate level and with adequate details.					
Comments (Optional):					
Communicator	**>90**	**80-90**	**70-80**	**60-70**	**<60**
Provided objectives and an outline.					
The presentation was clear and organized.					
Used clear, concise and legible materials.					
Used an effective method / style of presentation.					
Established good rapport with the audience.					
Collaborator	**>90**	**80-90**	**70-80**	**60-70**	**<60**
Invited comments from learners and led the discussion.					
Worked effectively with the ROS in preparing the session.					
Comments (Optional):					

Health Advocate	**>90**	**80-90**	**70-80**	**60-70**	**<60**
Managed time effectively.					
Addressed preventive aspects of care if relevant.					
Comments (Optional):					
Scholar	**>90**	**80-90**	**70-80**	**60-70**	**<60**
Posted appropriate learning questions.					
Accessed and interpreted the relevant literature.					
Comments (Optional):					
Professional	**>90**	**80-90**	**70-80**	**60-70**	**<60**
Maintained patient's confidentiality if clinical material is used.					
Identified and managed relevant conflict of interest.					
Comments (Optional):					

Annex 7:
Scientific Projects, Abstracts and Publications

[**N.B.** This page is an example and needs to be repeated based on the number of research projects of the ROT]

SN	Date dd/mm/yyyy	Topic / Outlines	ROS
1.	...../...../.....		
2.	...../...../.....		
3.	...../...../.....		
4.	...../...../.....		

Annex 8:
Logbook of the Clinical Cases for the 1ST–4TH Year of Training (150/year x 4, a total of 600)

[**N.B.** This page is an example and needs to be repeated for 120 times]

SN	Date dd/mm/yyyy	MRN	Clinical Case	Work	Level of Supervision	ROS
1.	___/___/___ ___/___/___ ___/___/___ ___/___/___ ___/___/___ ___/___/___		Type: ..... Stage: ..... Pathology/Grade: ..... RT role: ..... Other treatments: ..... RT plan:	H/P: O/E: Simulation: Planning: OTC: FUC:	F M N/A F M N/A F M N/A F M N/A F M N/A F M N/A	
2.	___/___/___ ___/___/___ ___/___/___ ___/___/___ ___/___/___ ___/___/___		Type: ..... Stage: ..... Pathology/Grade: ..... RT role: ..... Other treatments: ..... RT plan:	H/P: O/E: Simulation: Planning: OTC: FUC:	F M N/A F M N/A F M N/A F M N/A F M N/A F M N/A	
3.	___/___/___ ___/___/___ ___/___/___ ___/___/___ ___/___/___ ___/___/___		Type: ..... Stage: ..... Pathology/Grade: ..... RT role: ..... Other treatments: ..... RT plan:	H/P: O/E: Simulation: Planning: OTC: FUC:	F M N/A F M N/A F M N/A F M N/A F M N/A F M N/A	
4.	___/___/___ ___/___/___ ___/___/___ ___/___/___ ___/___/___ ___/___/___		Type: ..... Stage: ..... Pathology/Grade: ..... RT role: ..... Other treatments: ..... RT plan:	H/P: O/E: Simulation: Planning: OTC: FUC:	F M N/A F M N/A F M N/A F M N/A F M N/A F M N/A	

RT role: Curative (neoadjuvant, definitive, adjuvant) / palliative; other treatments: CTX, Surgery; RT plan: 2D, 3D, IMRT / VMAT; H/P: History of present illness; O/E: On Examination; OTC: On Treatment Clinic; FUC: Follow Up Clinic; F: Full Supervision; M: Minimal Supervision; N/A: Not Available.

Annex 9:
Brachytherapy Procedures

[**N.B.** This page is an example and needs to be repeated based on the number of the Brachytherapy procedures done by the ROT]

SN	Date dd/mm/yyyy	MRN	Procedure	ROS	Supervision Full/Minimal	Notes
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						
12.						
13.						
14.						
15.						
16.						
17.						
18.						

Annex 10:
Vacations and Leaves

#	Type of Vacation	Days of Vacation	Total Days	Notes
1.	Study leave			
2.	Annual leave			
3.	Sick / Maternity leave			
4.	Other			

Signature: ..... Signature: .....

Name: ..... Name: .....

(Supervisor / LPD) (Council Chair / NPD)

Date: ..... Date: .....

Details of Study Leaves

#	From	To	Days #	Reasons
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				

Signature: ..... Signature: .....

Name: ..... Name: .....

(Supervisor / LPD) (Council Chair / NPD)

Date: ..... Date: .....

Details of Annual Leaves

#	From	To	Days #	Reasons
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				

Signature: ..... Signature: .....

Name: ..... Name: .....

(Supervisor / LPD) (Council Chair / NPD)

Date: ..... Date: .....

Details of Sick and Maternity Leaves

#	From	To	Days #	Reasons
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				

Signature: ..... Signature: .....

Name: ..... Name: .....

(Supervisor / LPD) (Council Chair / NPD)

Date: ..... Date: .....

Details of Other Leaves

#	From	To	Days #	Reasons
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				

Signature: ..... Signature: .....

Name: ..... Name: .....

(Supervisor / LPD) (Council Chair / NPD)

Date: ..... Date: .....

Annex 11:

Annual Evaluation Form

[**N.B.** This page is an example and needs to be repeated four times at the end of each year of training]

- Training Center Name: .....
- Level of Training: 1 2 3 4 From ..... to ..... (mm/yyyy)
- Did ROT complete educational training program? Yes No

Role	Entrustable Professional Activities	>90	80-90	70-80	<70
Medical Expert	1. Develop a management plan for a patient with a cancer diagnosis. 2. Implement a treatment strategy. 3. Develop and implement a management plan for survivorship.				
Communicator	4. Communicate appropriately and effectively with patients and their relatives.				
Collaborator	5. Work effectively with other healthcare professionals to provide safe care and to optimize the quality of treatment.				
Leader	6. Discuss the context in which they work and apply the principles of change management including quality improvement methodology in this context. 7. Use resources appropriately. 8. Demonstrate the ability to work in, build and lead teams.				

Advocate	9. Advocates for cancer patients.				
Scholar	10. Plan personal learning experiences and use them to enhance patient care. 11. Educate others to improve patient care. 12. Contribute to the knowledge base that underpins patient care.				
Professional	13. Demonstrate that taking care of patients is their first concern. 14. Manage their work-life balance to maintain their wellbeing.				
Examinations	Quizzes and written examinations in basic and clinical sciences.				

Notes: _____

_____

_____

Signature: ..... Signature: .....

Name: ..... Name: .....

(Supervisor / LPD) (Council Chair / NPD)

Date: ..... Date: .....

Annex 12:

Other ROT`S Assessment Notes (for Regular, Annual and Final Evaluations)

I. General CanMEDS roles[26]:

A. Medical Expert

Basic and Clinical Knowledge

1. Understanding of the basic and clinical science and pathophysiology of common medical illnesses.
2. Understand the clinical presentation, natural history and prognosis of common medical illnesses.
3. Demonstrate expertise in all aspects of the diagnosis and management of common medical illnesses.
4. Practice contemporary, evidence-based and cost-effective medicine.
5. Avoid unnecessary or harmful investigations or management.
6. Provide care to diverse communities.
7. Demonstrate the appropriate knowledge, skills, and attitudes relating to gender, culture, and ethnicity.
8. A complete and accurate history and physical examination.
9. Formulate appropriate differential diagnosis.
10. Develop an appropriate plan of investigation and interpret the results.
11. Develop a therapeutic plan.
12. Develop a plan for secondary prevention.
13. Demonstrate appropriate clinical judgment.
14. Demonstrate knowledge of the used medications; mechanisms of action, clinically relevant pharmacokinetics, indications, contraindications, and adverse effects.

Procedural Skills

15. Understand the indications, contraindications and complications of the specific procedure.
16. Demonstrate mastery of specific procedure techniques.

B. Communicator

17. Write appropriate progress notes; transfer and discharge summaries.
18. Communicate appropriately with junior medical, nursing and allied health staff.
19. Communicate appropriately with patients.
20. Appropriate communication with patient families.
21. Establishes therapeutic relationships with patients/families.
22. Delivers understandable information to patients/families.
23. Provides effective counseling to patients/ families.
24. Maintains professional relationships with other healthcare providers.
25. Provides clear and complete records, reports, informed and written consent.

C. Collaborator

26. Works effectively in a team environment.
27. Able to work with allied healthcare staff.
28. Able to work with the nursing staff.
29. Able to work with attending and junior medical staff.
30. Consults effectively with other physicians and other healthcare providers.

D. Leader

31. Participate in activities that contribute to the effectiveness of their healthcare organizations and systems.

32. Manage their practice and career effectively.
33. Allocate finite healthcare resources appropriately.
34. Serve in administration and leadership roles, as appropriate.
35. Utilize information technology to optimize patient care, life-long learning, and other activities.

E. Health Advocate

36. Attentive to preventive measures.
37. Demonstrate adequate patient education on compliance and the role of medications.
38. Attentive to issues of public policy for health.
39. Recognizes essential social, environmental and biological determinants of health.
40. Demonstrates concern that patients have access to appropriate supports, information and services.
41. Offers advocacy on behalf of patients at the practice and general population levels.

F. Scholar

42. Attends and contributes to rounds, seminars and other learning events.
43. Appropriately discuss present selected topics as requested.
44. Demonstrate adequate ability to search the literature.
45. Demonstrate efforts to increase the knowledge base.
46. Accepts and acts on constructive feedback.
47. Reads around patient cases and takes an evidence-based approach to management problems.
48. Contributes to the education of patients, house staff, students, and other health professionals.
49. Contributes to the development of new knowledge.

G. Professional

50. Recognizes limitations and seeks advice and consultation when needed.
51. Understands the professional, legal and ethical obligations of physicians.
52. Delivers evidence-based care with integrity, honesty and compassion.
53. Demonstrates appropriate insight into their strengths and weaknesses.
54. Exercises initiative within limits of knowledge and training.
55. Discharges duties and assignments responsibly and in a timely and ethical manner.
56. Reports facts accurately, including own errors.
57. Maintains appropriate boundaries in work and learning situations.
58. Respects diversity of race, age, gender, disability, intelligence and socio-economic status.

II. Mini-clinical Evaluation Exercice (Mini-CEX)

Brief summary of the case:

Type:	New:	Follow up:	Ambulatory:	Inpatient:
Complexity:	Low:	Moderate:	High:	
Focus:	Date gathering:	Diagnosis:	Therapy:	Counselling:

SCORE FOR STAGE OF TRAINING			
Questions	**Unsatisfactory**	**Satisfactory**	**Superior**
History taking Facilitates patients to tell their story; effectively uses appropriate questions to obtain accurate, adequate information; responds appropriately to verbal and non-verbal cues.			

Physical examination skills Follows efficient, logical sequence; examination appropriate to a clinical problem; explains to a patient, sensitive to patient's comfort and modesty.			
Communication skills Explores the patient's perspective, jargon-free, open and honest, empathic, agrees management plan/therapy with the patient.			
Critical Judgment Makes appropriate diagnosis and formulates a suitable management plan; selectively orders/performs relevant diagnostic studies; considers risks and benefits.			
Humanistic quality/ Professionalism Shows respect, compassion, empathy, establishes trust, attends to patient's needs of comfort; respects confidentiality; behaves ethically; awareness of legal frameworks; aware of own limitations.			
Organization and efficiency Prioritizes; is timely and concise; summarizes.			
Overall clinical care A global judgment based on the above question areas.			

III. RT Contouring and Planning[26] [Standardized Assessment of a Clinical Encounter Report (STACER)/ RT Planning Competency Evaluation]

Score	Description
1	Vague, unsure, lacking precision, failed to incorporate relevant clinical and/or imaging information; lacks understanding of dose constraints and/ or dose/ fractionation; unable to identify the need for plan revision; assessor needed to make major revisions to contours and/ or plan.
2	Correct application of clinical and/or imaging information; applies dose constraints and fractionation according to guidelines; able to identify the need for plan revision; contours and or plan mostly acceptable but at least one major revision needed.
3	Confident and thorough understanding of clinical and/or imaging information; thorough knowledge of dose constraints and fractionation according to guidelines; able to recommend and describe the purpose of plan revision; assessor needed to make no or minor corrections to contours or plan.

Other domains in contouring:

- Contouring – explains the rationale for the GTV.
- Contouring – explains the rationale for the CTV.
- Contouring – explains the rationale for the PTV.
- Radiation prescription – states planning aims for the target (dose and fractionation).
- Radiation prescription – states planning aims for organs at risk (dose constraints).
- Radiation prescription – specifies planning technique / energy.
- Plan evaluation – evaluates target coverage.
- Plan evaluation – evaluates normal tissue constraints/ dose to organs at risk.
- Plan evaluation – respects guidelines for dose specification (e.g. ICRU report).
- Plan evaluation – suggests plan modifications or approves plan.

IV. Procedures[26]

- Vaginal Vault Applicator Insertion.
- Uterine Tandem and Ring Insertion.
- Flexible Endoscopy of Ear, Nose and Throat.
- Core Biopsy.
- Punch Biopsy.
- Paracentesis.

Annex 13:

The Final Summary of the Scientific, Educational Activities

	Meeting	Activity	
		Presentation	Attendance
1.	Didactic Lectures		
2.	Clinical Meeting		
3.	Grand Round		
4.	MMM		
5.	Seminar		
6.	Journal Club		
7.	Imaging Meeting		
8.	Pathology Meeting		
9.	Oncology Meeting		
10.	Audiovisual Meeting		
11.	TOT		
12.	Lectures		
13.	E-learning		
14.	External Meetings		
15.			
16.			
17.			

MMM: Morbidity & Mortality Meeting; TOT: Training of Trainees

Signature: ..... Signature: .....

Name: ..... Name: .....

(Supervisor / LPD) (Council Chair / NPD)

Date: ..... Date: .....

Annex 14:
Final Evaluation

Reference No: .....

Name and Identification No: .....

In view of the Residency Program Committee, this ROT has acquired the competencies of the radiation oncology specialty as prescribed in the *Radiation Oncology CanMEDS Competencies* and is competent to practise as a specialist in Radiation Oncology.

[ ] YES [ ] NO

The following sources of information were used for this evaluation:

- Regular and annual clinical observations from the training supervisors.
- Logbook of the cases during the training.
- Completion of a scholarly project.
- Written final examinations.
- Oral final examinations.
- Structured Assessment of Treatment/ Planning Evaluation Report (STAPLER).
- Objective Structured Clinical Examination (OSCE)

Signature:	Signature: .....
Name:	Name: .....
(Council Chair / NPD)	Dean/President
Date:	Date: .....

Annex 15:
Other Notes

BIBLIOGRAPHY

1. Hirsch, A. E., Singh, D., Ozonoff, A. & Slanetz, P. J. Educating Medical Students About Radiation Oncology: Initial Results of the Oncology Education Initiative. *J. Am. Coll. Radiol.* **4**, (2007).

2. Pavlidis, N. *et al.* Oncology for medical students: a European School of Oncology contribution to undergraduate cancer education. *Cancer Treat. Rev.* **33**, 419–426 (2007).

3. Atun, R. *et al.* Expanding global access to radiotherapy. *Lancet Oncol.* **16**, 1153–1186 (2015).

4. Datta, N. R., Samiei, M. & Bodis, S. Are State-Sponsored New Radiation Therapy Facilities Economically Viable in Low- and Middle-Income Countries? *Int. J. Radiat. Oncol.* **93**, (2015).

5. Mula-Hussain, L. *Cancer Care in Iraq: A Descriptive Study*. (LAP LAMBERT Academic Publishing, 2012).

6. Mula-Hussain, L. *et al.* Board-certified specialty training program in radiation oncology in a war-torn country: Challenges, solutions and outcomes. *Clin. Transl. Radiat. Oncol.* **19**, 46–51 (2019).

7. International Atomic Energy Agency. *IAEA Syllabus for the Education and Training of Radiation Oncologists*. https://www-pub.iaea.org/MTCD/Publications/PDF/TCS-36_web.pdf (2009).

8. International Atomic Energy Agency. *Radiotherapy in Cancer Care: Facing the Global Challenge | IAEA*. (International Atomic Energy Agency, 2017).

9. Elmore, S., Prajogi, G., Rubio, J. & Zubizarreta, E. The global radiation oncology workforce in 2030: Estimating physician training needs and proposing solutions to scale up capacity. *Appl. Radiat. Oncol.* **8**, 10–16 (2019).

10. Abdel-Wahab, M., Zubizarreta, E., Polo, A. & Meghzifene, A. Improving Quality and Access to Radiation Therapy—An IAEA Perspective. *Seminars in Radiation Oncology* vol. 27 109–117 (2017).

11. Turner, S. *et al.* Establishing a Global Radiation Oncology Collaboration in Education (GRaCE): Objectives and priorities. *Radiother. Oncol.* **117**, 188–192 (2015).

12. Benstead, K. *et al.* Recommended ESTRO Core Curriculum for Radiation Oncology/Radiotherapy 4th edition. *Radiother. Oncol.* (2019) doi:10.1016/j.radonc.2019.08.013.

13. Frank, J. R., Snell, L. & Sherbino, J. *CanMEDS 2015 Physician Competency Framework*. (The Royal College of Physicians and Surgeons of Canada, 2015).

14. The Royal College of Physicians and Surgeons of Canada. *Pathway to Competence: Radiation Oncology*. http://www.royalcollege.ca/rcsite/home-e (2018).

15. The Royal College of Physicians and Surgeons of Canada. *Radiation Oncology Competencies*. http://www.royalcollege.ca/rcsite/documents/ibd/radiation-oncology-competencies-e.pdf (2018).

16. The Royal College of Physicians and Surgeons of Canada. *Radiation Oncology Training Experiences*. https://www.royalcollege.ca/rcsite/documents/ibd/radiation-oncology-rte-training-experiences-e.pdf (2018).

17. The Royal College of Physicians and Surgeons of Canada. *Objectives of Training in the Specialty of Radiation Oncology* |. http://www.royalcollege.ca/rcsite/documents/ibd/radiation-oncology-otr-e (2018).

18. The Royal College of Physicians and Surgeons of Canada. Format of the Comprehensive Objective Examination in Radiation Oncology. http://www.royalcollege.ca/rcsite/documents/ibd/radiation_oncology_examformat_e (2020).

19. The Royal Australian and New Zealand College of Radiologists. *Radiation Oncology Training Program Curriculum*. https://www.ranzcr.com/trainees/rad-onc/forms-resources/radiation-oncology-training-program-curriculum (2012).

20. The American Board of Radiology. Study Guide for Clinical (General and Radiation Oncology). https://www.theabr.org/radiation-oncology/initial-certification/the-qualifying-exam/studying-for-the-exam/clinical-radiation-oncology (2020).

21. The Accreditation Council for Graduate Medical Education. *ACGME Program Requirements for Graduate Medical Education in Radiation Oncology*. https://www.acgme.org/Portals/0/PFAssets/ProgramRequirements/430_RadiationOncology_2019.pdf?ver=2019-06-19-092340-397 (2020).

22. The Royal College of Radiologists. *Specialty Training Curriculum for Clinical Oncology*. www.rcr.ac.uk/sites/default/files/2016_curriculum_-_clinical_oncology_15_november_2016.pdf (2016).

23. Moffitt Cancer Center. *Radiation Oncology Residency: Curriculum Goals and Objectives*. (2010).

24. Tata Memorial Center. Radiation Oncology at Tata Memorial Center. https://tmc.gov.in/tmh/index.php/en/radiation-oncology (2016).

25. Mula-Hussain, L. *Training Handbook of The Kurdistan Board for Radiation Oncology*. www.kbms.org (2016).

26. Saudi Commission for Health Specialties. *Radiation Oncology Curriculum*. www.scfhs.org.sa (2018).

27. American Board of Radiology. What We Do. https://www.theabr.org/about (2020).

28. ACGME and ARB. *The Radiation Oncology Milestone Project*. https://www.acgme.org (2015).

29. Radiation Oncology Education Collaborative Study Group. Introductory Radiation Oncology Curriculum (IROC). https://voices.uchicago.edu/roecsg/iroc/ (2020).

30. Gunther, J. R. *et al.* Introductory Radiation Oncology Curriculum: Report of a National Needs Assessment and Multi-institutional Pilot Implementation. *Int. J. Radiat. Oncol. Biol. Phys.* **101**, (2018).

31. Jimenez, R. B. *et al.* The Impact of an Introductory Radiation Oncology Curriculum (IROC) for Radiation Oncology Trainees Across the United States and Canada. *Int. J. Radiat. Oncol. Biol. Phys.* **107**, 408–416 (2020).

32. The European Society for Radiotherapy and Oncology. *Recommended ESTRO Core Curriculum for Radiation Oncologists/Radiotherapists 4th Edition (April 2019)*. https://www.estro.org/ESTRO/media/ESTRO/Education/ESTRO-CC-clin-4th-edition-April-2019.pdf (2019).

33. American Board of Radiology. Maintenance of Certification. *Maintenance of Certification for Radiation Oncology* https://www.theabr.org/radiation-oncology/maintenance-of-certification (2019).

34. Xiao, Y. *et al.* The American Society for Radiation Oncology's 2010 Core Physics Curriculum for Radiation Oncology Residents. *Int. J. Radiat. Oncol.* **81**, (2011).

35. Ulm University - Faculty of Medicine. Master Online Advanced Oncology: Management Module. *Ulm University - Faculty of Medicine* https://icas.soon-community.de/course/view.php?id=16 (2010).

36. International Atomic Energy Agency. *Setting up a radiotherapy programme: clinical, medical physics, radiation protection and safety aspects*. (International Atomic Energy Agency - IAEA, 2008).

AUTHORS

Layth Mula-Hussain, MB ChB, MSc, EF

Radiation Oncology – University of Ottawa, Ottawa ON, Canada

Shada Wadi-Ramahi, PhD, DABR

Medical Physics – University of Pittsburgh Medical Center - Hillman Cancer Center, Pittsburgh PA, USA

Benjamin Li, MD, MBA

Radiation Oncology – University of California, San Francisco CA, USA

Soha Ahmed, MD, MBA

Radiation Oncology – Aswan University, Aswan, Egypt

Fabio Ynoe de Moraes, MD

Radiation Oncology – Queen's University, Kingston ON, Canada

For correspondence:

Layth Mula-Hussain, MB ChB, MSc, EF.

Radiation Oncology – The Ottawa Hospital Cancer Centre / Faculty of Medicine - University of Ottawa, 501 Smyth Road, Ottawa, Ontario K1H 8L6, Canada.

Email: lmulahussain@aol.com

حقيبة التخصص في علاج الأورام بالإشعاع

خارطة طريق عالمية في التخصص للمدربين والمتدربين (كتيب - سُجُل)

يقدّم الكتاب إرشادات لنيل شهادة التخصص في علاج الأورام بالإشعاع من منظور عالمي. وتكمن الفكرة في المساعدة في إنشاء برامج اعتماد قائمة على الكفاءة في علاج الأورام بالإشعاع في جميع أنحاء العالم. توفر هذه الحقيبة خارطة طريق تدريبية يمكن تطبيقها في العديد من المجتمعات، لا سيما تلك المتصفة بالموارد المحدودة، تهدف إلى إنتاج ممارسين مؤهلين ومتمكنين وآمنين في علاج الأورام بالإشعاع، وقد انبثقت هذه الحقيبة من مصادر تخصصية عديدة في هذا المجال.

يمكن استخدام هذه الحقيبة كدليل عام في تصميم وتنقيح البرامج التدريبية المعتمدة لنيل التخصص في معالجة الأورام بالإشعاع، أو كنموذج ومحتوى تمثيلي، كما يمكن من خلال أدواتها وملحقاتها تسهيل عملية التوثيق، بالإضافة إلى إنها تشير إلى العديد من المصادر العلمية المفيدة للمدربين والمتدربين؛ لتحقيق الأهداف المطلوبة في نيل شهادة التخصص في علاج الأورام بالإشعاع، بما يسهم في الارتقاء بمستوى التعليم وممارسة علاج الأورام بالإشعاع على مستوى العالم.

Specialty Portfolio in Radiation Oncology:
A global certification roadmap for trainers and trainees

A book gives guidance with information in radiation oncology certification from a global perspective. The idea is to help establish competency-based certification programs in radiation oncology worldwide. The portfolio provides a training roadmap that can be applied in many communities, particularly those with limited resources, to produce qualified, competent and safe radiation oncology practitioners. It is extracted from different well-established resources in this field and can be used as a general guide in tailoring and refining the programs at every accredited authority, or as a representative model and content, or through its sample tools to facilitate documentation. It refers to many resources that can be useful to trainers and trainees to achieve the required milestones in radiation oncology certification, which will further advance the level of education and practice of radiation oncology globally.

Cover design: Neda Ahrari

ISBN 978-9927-139-33-8
9 789927 139338