



Successful Development of a Competency-Based Residency Training Program in Radiation Oncology: Our 15-Year Experience from Within a Developing Country

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Abstract

One of the main challenges of delivering high quality of care to cancer patients in developing countries is the lack of well-trained radiation oncologists. This is a direct cause for the lack of residency programs coupled with lack of resources. This article describes and details establishments of a successful and sustainable radiation-oncology residency program in our country. The program has been in operation for 14 years and has trained and graduated radiation oncologists who are now working in various countries. The curriculum of the 4-year residency program, fashioned according to American College of Radiologists (ACR) recommendations, includes site-specific clinical rotations and didactic lectures in clinical oncology, radiobiology, medical physics, statistics, and epidemiology. It also includes a component of advanced clinical experience in the form of 3-month externship at one of collaborating centers outside the country. Evaluation of the residents is conducted annually via written exams and 360° feedback. Residents also sit for the formal certification exam in radiation oncology from the national Medical Council. The exam consists of 2 written exams and one oral. As a form of benchmarking residents' knowledge, they are required to sit for the ACR examinations held annually and conducted in Amman in tandem. The program has successfully trained and graduated 28 residents, who now work as consultant radiation oncologists locally and abroad. Each resident has gone through a structured training that includes exposure to a Western-style patient-management culture, enhancing the breadth and width of their clinical experience. The residency program, initiated in a developing country, underwent many challenges, yet it overcome all obstacles and resulted in a successful training of competent radiation oncologists serving the region.

Keywords Radiation oncology · Postgraduate education · Residency · Jordan · Developing countries

Introduction

The ever-changing oncology guidelines and the rising new technologies have necessitated higher quality clinical training of radiation oncologists. In developed countries, competency-based radiation oncology training programs have become the

pathway for qualified radiation oncologists [1–3]. Creating similar competency-based radiation oncology programs in developing countries is a struggle and limited by the lack of equipment, shortage of radiation oncologists, supporting staff, and limited resources.

Obstacles to Establishing Radiation Oncology Residency Programs in Developing Countries

Radiation therapy is one of the main pathways of care for cancer patients. However, in developing countries, radiation oncology facilities are scarce. Only 23 African countries are known to have radiation therapy [4]. In addition, the mortality to incidence ratio is higher in the middle-/low-income countries than in high-income countries [5]. Therefore, the few radiation oncologists in developing countries are burdened with the rising incidence of cancer and the high morbidity rates. This is further complicated by the absence of training programs. Adopting programs (as is) from developed countries is unpractical due

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to differences in population needs, social norms, and available resources. As such, the need for a home-grown residency program has become evident recently [6].

This article reports on the 15-year experience in running a successful competency-based radiation oncology residency program in the Middle East and details all the inputs and challenges faced during the inception and continued improvement.

Overview of Our Institution

The institution is a comprehensive cancer care center located in Amman, Jordan, providing cancer care for both adult and pediatric populations. It was founded in 1997 and has since grown to become one of the leading oncology centers in the Middle East. In 2007, it became the first center outside the USA to receive the Joint Commission International Accreditation, Disease-Specific (Oncology) Certification (JCI-DSC) [7]. Recently, it also received recognition as a leading medical center in the Arab World [8]. In 2017, the new building expansion was inaugurated, doubling the center's capacity. The center receives 4500 patients every year representing Jordanians, expatriates, and citizens of nearby countries. The Radiation Oncology Department treats around 2500 new cancer patients per year.

Establishing of a Competency-Based Medical Education Training Program

Competency education refers to a complete set of academic and personal skills including knowledge, practical skills, exposure to different schools of thought, personal attributes, and attitude. This set of skills allows the physician to be part of the community and impart the maximum benefit to the patients [9–12]. The Canadian Medical Education Directive defines seven attributes that the trainee should attain competency-based medical education: (1) professional, (2) communicator, (3) scholar, (4) collaborator, (5) health care advocate, (6) leader, and (7) medical expert [13].

Our program was established in 2004 as a structured 4-year competency-based program, recognized and accredited by the national Medical Council. Figure 1 illustrates the various inputs to the training, which includes a 3-month external (outside of Jordan) training at an affiliate center.

Program Scope and Structure

The scope of the program includes both basic clinical oncology and radiation oncology competencies. The training includes modern treatment techniques in external beam delivery as well as training in brachytherapy. The training spans 44 months distributed as 38 months in radiation oncology, 2 months in medical oncology, 2 weeks in pathology, 2 weeks in diagnostic radiology and nuclear medicine, and 3 months of external training at one of our affiliated cancer centers in either the USA or the UK.

Program Personnel

The training program started with only three radiation oncology consultants, one PhD/ABR-certified medical physicist, five BSc-level medical physicists, and no dosimetrists. Personnel now includes 17 radiation oncology consultants, nine medical physicists (one with the International Medical Physics Certification Board (IMPCB) certification and many with MSc-degree), and 5 dosimetrists one of whom is certified by the Medical Dosimetry Certification Board (CMD).

Program Objectives and Core Competencies

- To provide a robust educational experience for clinical training in radiation oncology, with a comprehensive understanding of oncologic principles, treatment techniques, dosimetry, physics, and radiobiology.
- To provide a clinical learning environment that promotes expertise in oncology, with exposure to treatment of the full spectrum of disease sites, the pathology of each disease site, radiographic findings, and the surgical and medical options.
- To foster a multidisciplinary approach to cancer care through participation in disease site-oriented conferences that combine specialized medical oncologists, surgical oncologists, pathologists, nuclear medicine physicians, and radiologists.
- To introduce and promote clinical research through retrospective and prospective evaluations of patient outcomes

The core competencies for our radiation oncology residency program are:

- 1 Basic knowledge; medical physics, radiobiology, statistics, pathology, and clinical oncology.
- 2 Clinical competencies in radiation oncology
- 3 Communication skills
- 4 Leadership skills
- 5 Research

Program Resources

Table 1 provides a list of equipment and techniques available at the radiation oncology department.

Residents Selection

Each perspective resident has to meet the Institutional Guidelines for Postgraduate Training before they can be scheduled for an interview:

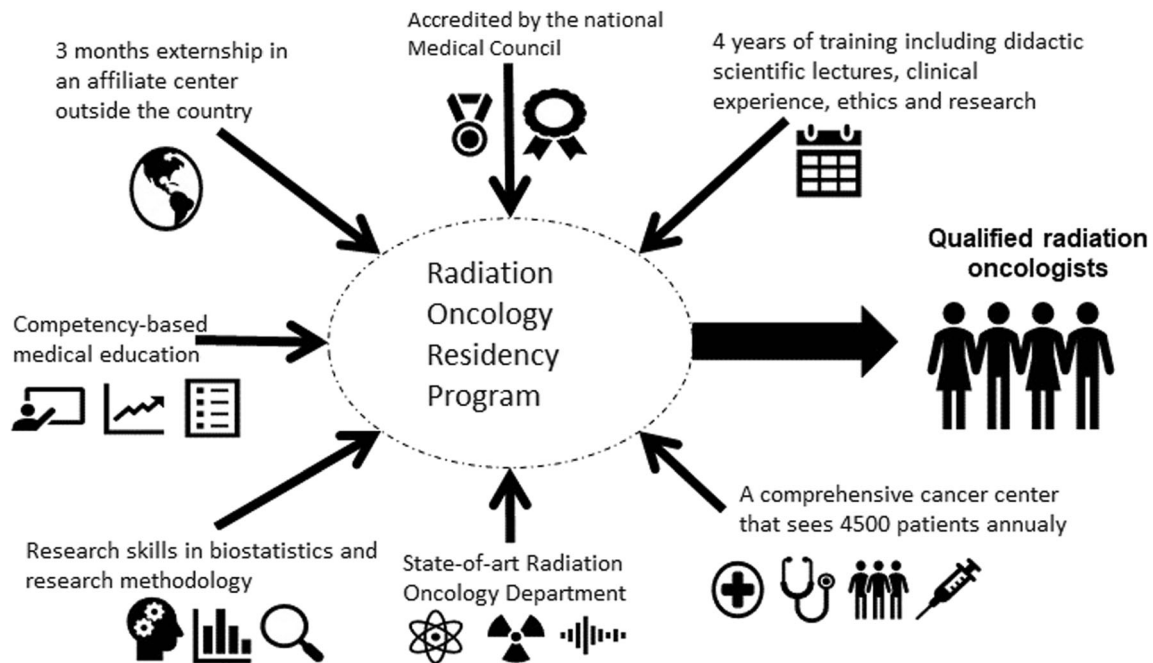


Fig. 1 The key features of the radiation-oncology residency program

- 1- Medical degree license, the applicant must have obtained the Bachelor of Medicine or the Bachelor of Surgery (MBBS/MBBCh) Certificate
- 2- Completion of 12 months of clinical internship rotations in medicine, general surgery, pediatrics, and obstetrics and gynecology.
- 3- Passing of the entrance written exam

Successful applicants are invited for an interview on site. The interviews are ranked based on interactions with faculty, interpersonal skills, professional attitude, English language efficiency, self-confidence, and any research or academic

achievements. The average number of accepted residents is two per year. The evaluation form of the residency program applicants is shown in Appendix 3.

Educational Curriculum

As illustrated in Table 2, year 1 and 2 residents (PGY-1/PGY-2) are expected to gain basic training in the principles of clinical oncology and attend special physics and radiobiology courses. Senior PGY-3 and PGY-4 residents are expected to shoulder more responsibilities in the management of patients and their individualized treatment plans, while consolidating the clinical

Table 1 A list of the main equipment and techniques in the radiation oncology department

Equipment	Techniques
<ul style="list-style-type: none"> • Two Elekta Synergy linacs (one with an Apex head, micro MLC) • Two Elekta Infinity linacs • Two Elekta Versa HD linacs (Elekta - Versa HD) • One Elekta Nucletron High Dose Rate Afterloader • One Active Breathing Control (ABC) system • One ExacTrac system • One Hexapod table • Treatment planning systems (TPS): Pinnacle, Monaco, Brainlab (iplan and element), and Oncentra Masterplan. • Oncology Information System (OIS): Mosaiq • One CT-Sim (Philips Big Bore) • Various quality assurance (QA) devices • Film dosimetry • Diode-based in vivo dosimetry 	<ul style="list-style-type: none"> • Volumetric modulated arc therapy (VMAT) • Image-guided radiotherapy (IGRT) • Intensity-modulated radiation therapy (IMRT): Forward and inverse • 3D Conformal radiotherapy • Conventional radiotherapy • Stereotactic X-Knife Radiosurgery and fractionated radiotherapy (SRS, FSRT) • Stereotactic body radiosurgery (SBRT) • Total body irradiation (TBI) • Total skin irradiation (TSI) • HDR and LDR brachytherapy • Electron treatment

Table 2 The learning outcomes, resources of training, evidence of training, and evaluation methods in our residency program

Year	Learning outcomes	Resources of training	Evidence of training	Evaluation method
PGY-1	Understanding of medical physics, radiobiology, radiation safety, and statistics Understanding the basics of cancer and its diagnosis	Attend basic physics, radiobiology, and radiation protection courses over a 3-month period, presented by senior physicists, senior radiation therapist, and senior consultants Read and discuss reference books; for example, Khan's Physics of Radiation Therapy, physics for clinical oncology (radiotherapy practice)/Oxford and Hall's Radiobiology for radiologists Statistics courses and epidemiology, by local staff Departmental lectures by residents: Journal club, and Quality assurance periodic meetings, which discusses the new cases and their treatment planning. The entire staff of the department attends these meetings Inter-departmental lectures and meetings by senior consultants and international experts Case discussions Contouring, doses to QAR, DVH evaluation, side effects AJCC TNM staging Attend multidisciplinary clinic Teleconferences with international institutions; Sick Children Hospital, MD Anderson Cancer Center All procedures must be done under the direct approval and supervision of the attending In-depth knowledge of the physics of radiation therapy and radiobiology Patient case presentation Attend multidisciplinary clinic	Attendance log-book Oral discussions with seniors	Periodic quizzes Clinical evaluation using TNM staging assessment (after 6 months) Periodic quizzes—clinical evaluation of side effects grades and management (after 9 months) Annual exam ACR exam
PGY-2	Understanding of medical physics, radiobiology, radiation safety Understand the decision-making process for cancer management Ability to establish personalized patient treatment Research and case reporting	Case presentation Planning and contouring, doses to QAR, DVH evaluation Participating in active research projects in the department Participating in international conferences Play supervisory role to PG-1 and two residents Starting research activities Attending masterclasses of European School of Oncology held in Jordan, Arab World, or Europe Case presentation Attendance of workshops conducted at the center in collaboration with UICC, WHO Participating in international conferences Participating in the teaching process in the department Play a supervisory role with increased teaching, consultative, and research activities Inter-professional communication Efficient patient time management, coordination with support staff, ordering diagnostic studies, and therapeutic interventions, as confirmed or discussed with attending.	Attendance log-book Oral discussions with seniors	Annual exam ACR exam Jordanian board of radiation oncology basic knowledge Periodic quizzes—contouring-session assessment Annual exam ACR exam
PGY-3	Consolidate knowledge Leadership skills		Attendance log-book Oral discussions with seniors	Periodic quizzes—contouring-session assessment Annual exam ACR exam Jordanian board of radiation-oncology advanced clinical knowledge

skills with the knowledge base acquired in the previous years. A list of the learning outcomes, resources of training, evidence of training, and evaluation methods is provided in Table 2.

Evaluation of Residents

Table 2 shows the evaluation of residents and the frequency at which it is performed. Evaluation by mentor is done after completion of 3 months of each clinical rotation. Appendix 1 shows an example of an evaluation form. In addition to periodic oral quizzes, residents take annual department-based exams, as well as the American College of Radiology (ACR) exam. Our program is the first outside the USA that was granted the opportunity to hold the ACR exam at the same time as it is held in the USA. The aim of participating in ACR is to have an unbiased and independent evaluation to benchmark each resident’s competencies.

The residents sit for the national Medical Council Board written exam (part I) at the end of the second year, whereas part II written exam and the oral are taken at the end of the fourth year.

Evaluation of Mentors: 360° Evaluation

The 360° evaluation approach offers feedback to mentors on the educational level received during clinical services. Feedback includes mentors’ availability, adherence to timeline and learning objectives, style of teaching, and stimulation of residents’ thought process in case management. Thus, the 360° evaluation is an essential component of the program’s continuous improvement. Appendix 2 shows an example of this evaluation.

Regional and International Collaboration

Partnerships with radiation oncology centers worldwide were established to offer a well-rounded training for residents. Each resident spends a 3-month externship at one of the affiliate centers: Leeds cancer Center (UK), Lombardi Comprehensive Cancer Center, MD Anderson Cancer Center, Sidney Kimmel Cancer Center, and Moffitt Cancer Center (USA).

This exposes them to different schools of clinical practice and cancer management. Fourteen of the graduating residents have also completed 1–2 years of advanced fellowships at one of the following centers: Princess Margret Hospital (Canada), St-Jude Children’s Research Hospital and Dana Farber Hospital (USA), and Leeds Cancer Center (UK).

In addition to providing positions for fellowships, we also accredit these centers to helping our patient population by aiding us in implementation of advanced treatment techniques [14, 15, 18].

Opportunities for Research

The cancer center has a unit that manages and supports all clinical trials, including a biostatistics unit that provides

comprehensive statistical support to the needs of researchers. As part of their training, each resident is encouraged to make use of the facilities and participate in various research groups, including retrospective analysis and clinical trials. This exposes them to the needed bureaucracy that governs clinical research and ethics in research. To this day, our residents have contributed to more than 20 presentations in national and international conferences. Peer-reviewed articles include case reports, case series, and systematic reviews [14, 16–23].

Residents Outcomes

As shown in Table 3, 28 residents completed the program from 2004 to 2018. Of these, 20 (71.4%) were male and eight (28.6%) were female, 23 (82.2%) residents were Jordanians while 5 (17.8%) were from other Arabic countries. The median age of the program residents at recruitment was 27 years.

Challenges Faced

As an innovative, pioneering radiation oncology program in a developing country, we have faced several challenges in the early stages of implementation. Here, we report the most important challenges and how we overcame them. (1) Lack of equipment: In 2004, the department started the residency program with two Philips linacs, one conventional simulator and one Plato TPS station capable of performing the 2D calculation. A very active fundraising program was initiated, and within the next couple of years, we added two Elekta precise linacs, Philips Pinnacle3 TPS, and 1 CT-sim. The department continued to expand to its current state (Table 1). (2) Lack of senior radiation oncologists: Solved by hiring new graduates from the residency program who have shown exceptional qualities. The faculty size increased from three senior radiation oncologists in 2004 to 17 in 2018. (3) Lack of experience in specialized treatments such as TBI, SRS, IMRT, SBRT, and brachytherapy: Solved by technical collaboration with renowned centers as mentioned earlier.

Program Outcome

The graduating residents successfully passed the Jordanian Board of Radiation Oncology (part I and part II) and they

Table 3 The characteristics of residents in our program since 2004

Character	Descriptive
Age (mean, SD) years	27 (ranging from 25 to 31 years)
Gender	Male 20 (71.4%) Female 8 (28.6%)
Nationality	Jordan 23 (82.2%) Arab countries 5 (17.8%)

practice as certified radiation oncologists around the world: two in the USA (one fully licensed and one as a fellow), two in the UK (one fully licensed and one as a fellow), two in Canada (as fellows), one in the Gaza Strip (fully licensed), two in Bahrain (fully licensed), two in Saudi Arabia (fully licensed), two in Iraq (fully licensed), and the rest are in Jordan employed at various government, military, and private cancer centers. Currently, there are 11 residents in the program, seven from Jordan, three from Palestine, and one from Bahrain.

Conclusion

Since its establishment in 2004, the residency program has evolved continuously in teaching styles, curricula, and research projects. Board-certified radiation oncologists have graduated from the program and are practicing in various other countries. We believe our model is an excellent example of a radiation oncology-training program in a developing country. We recommend this model to be replicated to overcome the current limitations of well-trained radiation oncologists.

Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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