MEDICAL PHYSICS DEVELOPMENT IN SYRIA

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***Abstract*— Medical physics began in the seventies of the last century at the Nuclear Medicine Center in Damascus, which is dedicated as radiation oncology center, At the beginning of the twenty-first century, the teaching of a diploma in radiation protection began, which was the fruit of scientific cooperation between the Atomic Energy Commission of Syrian (AECS), the University of Damascus and the International Atomic Energy Agency (IAEA). In 2013/2014, a two years master's degree in qualification and specialization in medical physics was created in order to fill the gap in this important field for the development of work in the medical field; where 14 students enrolled yearly. Its curriculum based on the recommendations mentioned in the IAEA publications on medical physics. The medical physics role within national healthcare facilities and hospitals has become more effective and the cooperation with the regional and international organizations will accelerate the development of clinical training and establishing the professional accreditation services. The development of competences usually acquired through IAEA fellowships under TC projects.**

***Keywords*—** Medical Physics, Education, Training, Accreditation

I. Introduction

Syria has a population of 19.8 million, with a total area of 185,180 km^2 [1]. Syrian has an average life expectancy at birth of 72.7 years [2]. According to the Ministry of Health statistics, 2053 health units are available around the country where 30875 medical doctors provide different health services to the public [3]. The medial use of radiation in the country is an important source for diagnostic and therapy, which contribute to improve the patient treatment plans. In 2019, the number of radiological images was 2998133 for 2424359 patients [3].

The medical physicist works in health care and apply his knowledge in the field of physics to the better use of medical radiation devices, and technologies. The medical physicists have an important role in the safe and effectiveness use of radiation in medicine for diagnosis and treatment of diseases. Cancer rates are rising worldwide, therefore, proper number of well-qualified medical physicists requiring is required. Moreover, in recent years, the increasing complexity of equipment producing radiation and used both for diagnosis and treatment, coupled with the raising of the expectations of good health care, as well as the implementation of more stringent radiation safety standards and accreditation requirements have exacerbated the already critical shortage of fully competent medical physicists.

Close cooperation between the AECS and University of Damascus is exist to provide education and training related to Nuclear Science and Technology including radiation protection and medical physics. Postgraduate education Diploma and MSc in the field of radiation protection and medical physics were established since 2000. In addition, AECS established the Nuclear Science and Technology Training Centre (NSTTC) in February 2010. The strategy of the NSTTC is to meet training plans and needs of the AECS, the national government and private sectors, in addition to the Arab and international organizations. It aims to establish a dynamic structure capable of considering and assessing the national training needs in medical and industrial fields and setting plans to build training programmes to meet these needs.

Medical physicists in Syria are mostly employed in radiotherapy hospitals and provide a wide range of services to radiation oncology, diagnostic radiology, nuclear medicine and a variety of other areas. However, challenges remain with professional recognition and accreditation. The present paper discusses these challenges and their relation to education and accreditation.

II. Infrastructure

The radiation therapy was established in Syria at the Nuclear Medicine Centre (the oldest radiotherapy center in Syria) in 1970s. Co-60 teletherapy and deep x-ray machines were used to treat cancer patients. Recently, more than 4000 patients are diagnosed with cancer in Syria, and are treated with external radiation beams (high-energy photons or electrons beams) and some of them are treated using radioactive sources placed inside the patient (brachytherapy, nuclear medicine).

The radiation doses delivered to patients are monitored with accurate radiation dosimeters in order to safe patients from radiation injuries. These dosimeters are calibrated at the National Radiation Metrology Laboratory (NRML), which is a member of IAEA/WHO's SSDL network . In addition, a dedicated Quality Audit program (QA) of the radiation doses delivered to patients in the radiotherapy centers around the country is established.

In nuclear medicine, the unsealed radiation sources are used in Syrian hospitals for diagnostic and treatment of patients. Approximately, 10,000 patients receive radionuclides for diagnostic purposes per year. Radiation protection local rules are established in order to obtain the safe and successful use of radionuclides for medical diagnosis, which depends mainly on the accurate measurement of the activity administered to the patient.

In diagnostic x-ray modalities, the patient radiation dose is minimized according to ALARA principle by applying IAEA recommendations. AECS in cooperation with the Ministry of Health established a Quality control (QC) program 20 years ago, in order to monitor the quality of the diagnostic equipment and measure the radiation doses received by patients during radiology procedures in order to achieve the acceptable image quality levels. The number of radiological equipment in the country is given in Table 1 while the statistical values related to different imaging modalities in 2019 are shown in Table 2.

Table 1 Number of radiological facilities/equipment in Syria (as set of Dec. 2020)

Facilities/Equipment	Number
Radiotherapy:	
Co-60 Units	5
EBRT (including LINAC, IMRT, IGRT)	4
Brachytherapy System	1
Nuclear Medicine:	
Gamma Camera (including SPECT System)	7
PET/CT Scanner	4
Medical Cyclotron	1
Diagnostic Radiology	
CT Scanner	340
Fluoroscopy and angiography system	908
Mammography	206
General X-ray system	1119
Dental X-ray Equipment	3870

Abbreviations:
EBRT: External beam radiotherapy.
LINAC: Linear accelerator
IMRT: Intensity-guided radiotherapy.
IGRT: Image- guided radiotherapy.
SPECT: Single photon emission computed tomography.

Table 2 The number of patients and produced diagnostic images for several imaging modalities in Syria (2019)

Imaging Modalities	Patients	Images
Conventional X-ray	1516658	1789403
Computed Tomography	196275	211178
MRI	30773	34263
Mammography	22659	43626
Dental Panorama	20556	24488

III. Graduate Training

The increasing number of new radiotherapy centers in Syria, and the growth in Linear Accelerators (LINAC) and digital imaging technology need to improve the quality assurance and quality audit services according to international standards, thus contributing to improving the quality of medical service and thus patient safety. In Syria, Decree No. 64 of 2005 and its executive regulations and instructions related to the ionizing radiation safety and security emphasized the need for a medical physicist to be present in hospitals where ionizing radiation is used in both diagnosis and treatment.

Moreover, the IAEA assigns high priority to education and training in nuclear and radiation safety, considering them key mechanisms in strengthening radiation protection around the world. AECS applied the standard syllabus of IAEA (in Arabic) [4] for the Postgraduate Educational Course in Radiation Protection and the Safety of Radiation Sources (PGEC) since 2000. PGEC is a 'long-duration' course that provides the initial basic professional training (in medical and non-medical fields) for young professionals who are expected to become, over the course of time, regulators, decision makers, qualified experts in radiation protection or trainers in radiation protection and safety of radiation sources. More than 500 students were graduated from different Arab countries.

In addition, the M.Sc. of Medical Physics has established at Damascus University on 2013, in collaboration with Atomic Energy Commission of Syria, in order to graduate qualified medical physicist to work in hospitals. The master consists of two academic years, and the curriculum was developed based on the recommendations mentioned in the IAEA publications on medical physics to cover its theoretical and practical aspects [5-8]. This curriculum is taught in Arabic language by a group of specialized researchers in this field from Atomic Energy Commission and Damascus University. The first academic year consists of several fundamentals of: radiation physics and radiation detection; Electronics and medical image processing; Physiology and human biology; Diagnostic radiology physics; Nuclear medicine physics; in addition to the General principles of radiation protection. The second academic year is dedicated to the internal and external radiotherapy physics and practical sessions in hospitals and radiotherapy centers. The most of practical and clinical training is hold at AlBairouni University Hospital (the old name was Nuclear Medicine Center), which have the all medical physics facility which needs for clinical training in field of diagnostic radiology; nuclear medicine and radiotherapy. The average number of students enrolled in this master is about 14 students per year and from the both sex.

IV. Clinical Training

Training and continuous professional development are vital to ensure safe and effective use of radiation in medicine, and human health (specifically radiation medicine) is one of those areas of activity. For the last 30 years, The AECS has organized numerous courses and seminars in medical physics

and radiation protection for physicists and radiographer, radiation oncologists and radiotherapy technologists who are working in hospital in order to strengthen and maintain a high level of medical physics on site.

The most of the medical physicists, who are working in hospital; were trained on-the-job after obtaining their postgraduate degrees. On the other hand, some of them were trained under the IAEA's Technical cooperation program, via TC project related to a Post-Graduate Educational Course in Medical Physics at MSc which has been established at the University of Jordan as well as with others IAEA's projects (Strengthening Medical Physics in Radiation Medicine). In addition, a clinical training program document for ARASIA Member States has been established under a TC project, and adopted by the ARASIA Member States. The elaborated document will be used as a training tool of medical physicists in the hospital setting. Also, during 2014-2016 a national IAEA TC project entitled "Strengthening Quality Control and Quality Assurance Services in the field of Diagnostic Radiology in Syria" had established in order to strength and train the medical physicists in field of Diagnostic Radiology. Another IAEA national TC project entitled "Strengthening Radiation Protection in Medical Exposure" was running from 2018-2020. The project plan includes several external fellowships and scientific visits for a number of medical physicists who trained abroad on diagnostic radiology, nuclear medicine and radiotherapy. These IAEA's TC programs have been very useful to enhance the capacity of medical physicists and to develop their practical skills and apply it in their field of work. Table 3 shows the distribution of medical physicist according to sub-disciplines in Syria as set of December 2020.

Table 3 Distribution of Medical physicist according to sub-disciplines in Syria (as set of Dec. 2020)

Facilities/Equipment	Number
Radiotherapy	18
Nuclear Medicine	4
Diagnostic Radiology	5
Other Sub-Discipline (researcher, QC team and Calibration)	10

V. Future Opportunities and Challenges

Medical Physics is a small profession however; the number of students in this discipline starts to increase in Syria to cover not only radiotherapy centers but also to reply to the real demands in diagnostic radiology and nuclear medicine. The medical physics role within national healthcare facilities and hospitals has become more effective and clear as an important branch of healthcare professionalism especially during the COVID-19 pandemic, where the medical physicists stands with the frontlines to preserve the quality of healthcare services.

The on-site clinical training and professional accreditation services are the most important challenges towards developing the medical physics in our hospitals as the number of the qualified medical physicists and experts are still limited. However, a close cooperation with regional and international medical physics organizations will accelerate the steps to overcome this problem and establish a national accreditation and training standard to correlate with the clinical practices change. In fact, Medical physicists from Syria participated in many regional events related to medical physics (such as the MEFOMP Workshop on Medical Physics in Diagnostic Radiology from 28 – 29 September 2019 in Muscat, Oman).

VI. Conclusions

Medical physics training and practice has seen steady progress over the past 10 years. A two years post graduated M.Sc. of medical physics has been started in 2013 where 14 students enroll yearly. The proposed curriculum based on the recommendations mentioned in the IAEA publications on medical physics. The development of competences usually acquired through IAEA fellowships under TC projects. The medical physics role within national healthcare facilities and hospitals has become more effective and the cooperation with the regional and international organizations will accelerate the development of clinical training providing and establishing the professional accreditation services.

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