MEDICAL PHYSICS STATUS AND CHALLENGES IN LEBANON

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Abstract — **A steady and notable increase in cancer incidence was observed in Lebanon since 1998 that exceeded in 2020 all rates shown in the neighboring Arab countries. Radiotherapy is important for managing most cancers especially breast, lung, prostate and bladder cancer which account for more than two-fifths of cases worldwide. Trained Professionals like qualified medical physicists are at the front line in the fight against cancer. Medical physicists in Lebanon are mostly employed in hospitals and provide a wide range of services to radiation oncology, radiation safety and a variety of other areas including academia. Two universities offer a master's program in medical physics and related field. However, challenges remain with professional recognition, especially the importance of their presence in diagnostic radiology and nuclear medicine departments.**

The present paper is based on an online study that was conducted on all medical physicists practicing in Lebanon (23 medical physicists: 13 Qualified Medical Physicists and 10 Assistant Medical Physicists). An online questionnaire was used to collect data. The data collected was analyzed to identify infrastructure, therapy machines and challenges faced by medical physicists. Challenges are listed, their relation to education is detailed and based on a description of academic education and clinical training as it was developed over the last year. Finally, a list of recommendations is addressed to Lebanese authorities (government, ministry of public health and the Lebanese Atomic Energy Commission) in order to support financially, train and employ more medical physicists to handle all radiation safety issues in nuclear medicine and radiology departments.

Keywords — **Qualified Medical Physicist, Radiotherapy, Education, Lebanon.**

I. Introduction

Cancer is the second leading cause of death with 13% of worldwide mortalities[1]. Increasing access to radiotherapy worldwide through greater investment could save millions of lives, according to The Lancet Oncology Commission's report presented at the 2015 European Cancer Congress in Vienna, Austria[2]. Radiotherapy is important for managing most cancers, such as breast, lung, prostate, head and neck, and cervical cancers, which account for more than two-fifths of cases worldwide.

Lebanon is a small country in the Middle East with one of the highest levels of Human Development Index. The population of this country reached 6.8 Million in 2020 while the number of cancer cases reached 11,589 cases[3]. A steady and notable increase in breast, prostate and bladder cancer incidence was observed in Lebanon since 1998, this number exceeds all rates shown in the neighboring Arab countries[4]. Lung cancer incidence rates are among the highest in the region as well for both males and females; these are consistent with the smoking habits in the Lebanese population compared to neighboring countries.

Trained professionals including radiation oncologists and medical physicists are in demand to deal with the increase of cancer incidence in this country.

According to the definition of the International Basic Safety Standards (BSS)[5], a medical physicist is: "a health professional, with specialist education and training in the concepts and techniques of applying physics in medicine, and competent to practice independently in one or more of the specialties of medical physics."

The present paper is based on an online study that was conducted on all medical physicists working in Lebanon. An online questionnaire was used to collect data. The data collected are presented and analyzed in order to identify infrastructure, therapy machines, therapy techniques and challenges faced by clinical medical physicists.

II. Regulation of medical physics

The employment of a qualified medical physicist in radiotherapy departments is a national legal requirement in Lebanon. His/her main role is to establish and maintain a quality assurance program. Every year, the Lebanese Atomic Energy Commission (LAEC) send their external auditors to check the presence of a qualified medical physicist in each radiotherapy department and the implementation of quality assurance program as well as a radiation safety program for all staff engaged in the use of radiation. Treatment license permit cannot be given to any radiotherapy department without a certified or qualified medical physicist supervising radiation treatment planning and delivery.

Unlike in radiotherapy, the presence of a medical physicist in radiology and nuclear medicine departments is not yet a national legal requirement while the presence of a radiation safety officer is mandatory.

III. Education and clinical training

In order to address the shortage of certified medical physicists and taking into account the limited number of medical centers dedicated for training of certified medical physicist, two universities (Table 1) introduced different MSc Degree in Medical Physics and alternative programs in Radiation safety to fulfill the academic requirements for training "assistant medical physicists". The curriculum for the programs was developed with support of the LAEC and under the supervision of qualified medical physicists. In addition to teaching and training, Medical Physicists are often involved in research and technical development in most academic settings.

The initial enrolment in the program was 12 students at the Lebanese University in September 2015. The program is composed of two years with the second year dedicated to a research project or clinical placements. "Basic physics and radiobiology, physics of non-ionising radiations, radiotherapy physics, nuclear medicine physics, dosimetry and instrumentation, medical imaging physics and safety and quality management" are the main elements of the curriculum.

After completion of the MSc degree program, graduates are allowed to work as Assistant Medical Physicist under the supervision of a Clinically Qualified Medical Physicist. Until this date, ten graduated students of these MSc degrees were hired in different radiotherapy centers in order to support qualified medical physicists in their daily work.

In order to continue and pursue a PhD degree in the Medical Physics field, three universities (Lebanese University, Saint Joseph University and Beirut Arab University) conduct research in collaboration with French universities and European institutions. While the type of research conducted in most universities and institutions varies, research in radiation dosimetry is the most common one in the three main subspecialties of the Medical Physics: therapy, radiology, and nuclear medicine. Though research is required from all the PhD students, students in MSc programs are also encouraged to have optional research projects.

Specialty	University	Opening	Number of students
M1&2- Medical Physics (Professional)	Beirut Arab University	2017	5
M2- Medical Physics and Imaging Technologies (Professional)	Lebanese University	2015	12
M2- Medical Physics and Life Imaging (Research)	Lebanese University	2015	12
M1&2 - Lasers and Ionizing Radiations : Safety and Protection (Professional)	Lebanese University	2017	9

Table 1: *Different MSc Degrees in Medical Physics and alternative programs in Radiation safety to fulfill the academic requirements for training "assistant medical physicists".*

IV. Methods

A study was carried out to identify the challenges faced by medical physicists in Lebanon and the objectives of the study were to identify the number of qualified medical physicists and their work experience/conditions in hospitals and to identify the challenges faced by medical physicists in the country. The study was conducted on 23 medical physicists (13 Qualified Medical Physicists and 10 Assistant Medical Physicists). An online questionnaire was used to collect data. The data collected was analyzed to identify challenges faced by medical physicists.

V. Results

For all the reasons listed above, the practice of medical physicist in Lebanon is limited till now to radiation therapy. Thirteen certified medical physicists are employed in 12 radiation therapy departments. The number of certified medical physicist per million of population decreased to 1.9 in 2021 against 2.6 in 2017[6], which remains among the lowest in the region. The economic crisis hitting the country since the end of 2019 and the depreciation of the local currency pushed 20% of the medical physicists to migrate towards developed countries searching for better work opportunities.

Although an evolution of technology was observed between 2016 and 2020, where a significant number of fully equipped linear accelerators was installed in the country, the number of operational therapy units per million of population decreased to 2.5 against 2.8 in 2017[6].

It should also be noted that this actual number of operational therapy units per million remains the highest in the Arab region.

Table 2: Distribution of radiotherapy centers, number of linear accelerators per institution, the presence of IGRT and gating respiratory systems as well as the techniques of treatments and number of patients treated per day.

Hospital	Number of accelerators	Machine	Imaging systems	Gating respiratory	MLC	Techniques of treatments	Number of patients / day
A	1	Elekta	EPID	No	80	3DCRT	20
B	1	Truebeam	IGRT	yes	120	3DCRT, IMRT	45
C	2	Truebeam	IGRT	yes	120	3DCRT, IMRT	30
		Truebeam	IGRT	yes	120	3DCRT, IMRT, SRT, SRS, SBRT	30
D	3	Truebeam	IGRT	yes	120	3DCRT, IMRT, SRT, SRS, SBRT	50
		Clinac 2300	IGRT	No	120	3DCRT, IMRT	50
		Halcyon	IGRT	No	120	IMRT	50
E	1	Elekta Synergy	EPID	No	120	3DCRT, IMRT	25
F	1	ARTISTE, Siemens	IGRT	No	160	3DCRT, IMRT	50
G	1	Versa HD	IGRT	Yes	160	3DCRT, IMRT, VMAT	15
H	1	Versa HD	IGRT	Yes	160	3DCRT, IMRT, VMAT	20
I	2	ARTISTE, Siemens	IGRT	No	160	3DCRT, IMRT	35
		Mevatron	Portal Film	No	No	3DCRT	10
J	1	Truebeam	IGRT	No	120	3DCRT, IMRT	35
K	1	Oncor Impression	EPID	No	120	3DCRT, IMRT	22
L	2	ARTISTE, Siemens	IGRT	Yes	160	3DCRT, IMRT, SRT, SRS, SBRT, TBI	30
		ARTISTE, Siemens	IGRT	yes	160	3DCRT, IMRT, SRT, SRS, SBRT, TBI	30

Table 3: Distribution of brachytherapy units, number of HDR afterloaders per institution as well as the techniques of treatments and number of patients treated per year.

Hospital	Afterloader	Treatment techniques	Number of patients / year	Localization
A	Varian, Gammamed	3D	80	Cervix, Vaginal vault
B	Varian, Gammamed	3D	50	Cervix, Vaginal vault, Prostate, Breast, keloids, Cholangiomas
C	Varian, Gammamed	3D	70	Cervix, Vaginal vault

Table 2 shows the distribution of radiotherapy centers, number of linear accelerators per institution, the presence of image guided radiotherapy 'IGRT' and gating respiratory systems as well as the techniques of treatments and number of patients treated per day. The average number of patients treated per day for all departments is 32 patients on 17 operational linear accelerators. All the centers have computerized treatment planning systems and a comprehensive information management system. Complex treatments such as intensity modulated radiotherapy, Stereotactic radiotherapy treatments, stereotactic radiosurgery and stereotactic body radiotherapy (IMRT, SRT, SRS and SBRT) are done on 15 of 17 radiotherapy linacs.

Table 3 shows the distribution of brachytherapy units, number of high dose rate afterloaders per institution as well as the techniques used for treatments and number of patients treated per year. 3D planning based on CT scans and MRI images is used for all kind of treatments in brachytherapy. Brachytherapy is not only used for gynecological treatments (cervix, vaginal vault) but also used for prostate, breast, keloids and cholangiomas as well.

Results indicate that most medical physicists are working in Radiotherapy and practicing mainly in this area. The level of involvement of medical physicists in Radiology and Nuclear Medicine is minimal.

The law governing the use of ionizing radiation in Nuclear Medicine and Radiology is still not implemented in the country, and there is a need to employ qualified medical physicists in these fields. Nonetheless, there is no full recognition of the role of medical physicists from the hospital managers and health ministry.

All Assistant Medical physicists complained of the lack of national board examination or certification program.

Twenty per cent of the participants working in governmental hospitals suffered from the lack of equipment that has limited the performance of their duties especially in areas of dosimetry and dose assessment. This has minimized their participation in research, publication and implementing complex treatments such as Intensity Modulated Radiotherapy or Stereotactic treatments.

Seventy five per cent of radiotherapy centers have no budget for continuous education to fund conferences or congress attendance.

Finally, all medical physicists admit their salaries are very low taking into account their daily duties and responsibilities.

VI. Conclusion

The number of Medical Physicists per million of the population is projected to triple by 2035 Worldwide. As a result, this may cause significant problems to healthcare providers in the Middle East - especially in the fields of Radiotherapy, Medical Imaging and Nuclear Medicine. The challenges identified in this study can be resolved by the Lebanese authorities; effective communication between Lebanese medical physicists and the government authorities can help improve work conditions and provide better future prospects.

The Lebanese government, ministry of public health and the LAEC should support financially continuous education, training, further employment of medical physicists to handle all radiation dose safety issues pertaining to all departments using ionizing radiation in medicine especially in nuclear medicine and radiology departments.

The presence of medical physicists in Medical Imaging and Nuclear Medicine departments should be mandatory in order to guarantee quality imaging procedures with less dose to the patients.

There is a need for a national board examination to certify medical physicists and to ascertain their role in the clinical settings. National universities should work in collaboration with private hospitals to implement an accredited Medical Physics program and establish the needed laboratories and validate training centers.

Increasing the number of qualified medical physicists should be accompanied by opening new job opportunities in diagnostic departments. Eventually, this will lead to the foundation of a medical physicist's syndicate which will look after the welfare of its members.

Finally, more effective communication among the members of the Lebanese medical physicists' community is needed to face the challenges facing and that lie ahead of us.

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References

1. American Cancer Society: The global economic cost of cancer. http://www.cancer.org/acs/groups/content/@internationalaffairs/documents/ Data on Cancer document/ acspc-026203.pdf Accessed on January 30, 2014.
2. Atun R, et al. Expanding global access to radiotherapy. Lancet Oncol. 2015, Sep;16(10):1153-86. http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(15)00222-3/fulltext
3. The Global Cancer Observatory - March, 2021. 422-lebanon-fact-sheets.pdf (iarc.fr)
4. Dr Ali Shamseddine, Cancer Trends in Lebanon & Projections to 2020, Human and health N°32 - Summer 2015
5. International Atomic Energy Agency. Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, General Safety Requirements Part 3. Vienna: IAEA; 2014.
6. Azam Niroomand-Rad et al, Status of medical physics in education and training in middle east, medical physics international journal, vol5, No2, 2017

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