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GUEST EDITORIAL

The current status of medical physicist certification program in Iran, compared to Turkey, China, Japan, UK, and USA

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Introduction

In developed countries medical physicists (MPs) are certified. For example, in the USA and UK they are certified by the American Board of Radiology (ABR) [1] and Health & Care Professions Council (HCPC) [2, 3] respectively. In the USA, certification of physicists was started by the Radiological Society of North America (RSNA) dating back to the 1930s [3]. Subsequently, the ABR took over the certification of health physicists [4]. However, certification of clinical physicists titled "medical physicists" was initiated in 2002, the last revision of which occurred in 2011 [4]. ABR is a member organization of the American Board of Medical Specialties (ABMS), which is supported by several sponsors including the American Association of Physicists in Medicine (AAPM) and American Society for Radiation Oncology (ASTRO). The ABR also declares the standards of the qualifications of independent physicians [5].

In the UK, the history of the MP diploma dates back to 1963 and was held by Hospital Physicists' Association (HPA) [6]. In 2002 the HCPC replaced the Council for Professions Supplementary to Medicine (CPSM) and it regulates 16 health and care professions including MPs [7]. The MP profession is a subset of 'clinical scientist' and thus it is a protected title [7, 8]. The Association of Clinical Scientists (ACS) consists of 12 scientific societies including the Institute of Physics and Engineering in Medicine (IPEM). The ACS issues the ACS Certificate of Attainment that verifies the applicant has successfully completed the 3 year Scientist Training Programme (STP) since 2011 [6, 9, 10].

In China, medical physics began in the 1930s. The Chinese Society of Medical Physics (CSMP) was founded in 1981 by MPs in Guangzhou city [11]. The number of radiotherapy departments, linear accelerators (LINACs) and MPs has continually increased, and in 2015 there was 1579 radiotherapy departments and about 2400 MPs, with an annual growth rate of about 12% and 10%, respectively [12]. In China, the certification examination consists of a simplified theoretical test with some questions on fundamental issues. In China, the Association of Medical Physics is not the responsible authority for holding the examination; the *Chinese Medical Association* is the executive authority.

The Japan Society of Medical Physics (JSMP) originates from the Japan Radiological Society (JRS) Physics Task Force, which was established in March 1961. Later, the group was renamed the JRS Physics Group, Japanese Association of Radiological Physicist. In March 2000, the group left the umbrella of JRS and became the current system [13]. In Japan, as of 2017 there are 846 radiation treatment facilities, including 375 IMRT facilities and number of external radiotherapy machines are 1052. There are 182 intra-cavity/intra-tissue treatment facilities and the number of RALS are 160 [14].

In Turkey, about 163,500 new cases of cancer are diagnosed annually [15]. Of the current 596 Radiation Oncology specialists, 276 are working in hospitals affiliated to the Ministry of Health, 226 in university hospitals and 94 in private centers. The number of LINACs and the number of radiation oncologists is increasing steadily, for example,

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there were 30 radiation oncologists in 1985, but today that number exceeds 596 [15–17]. In accordance with the recommendations of the Board of Directors of Turkish Radiation Oncology Association (TROA), various working groups have been established in different fields of Radiation Oncology (TROA Radiotherapy Physics Working Group, TROA Uro-Oncology Working Group, etc.) [18]. The Working Groups are the scientific and technological organizations that bring together the members who are interested in the specific areas of Radiation Oncology, develop communication between these members, collect, interpret and publish scientific information about their fields. The TROA is also providing scholarships for ESTRO courses every year.

In Iran, the first exam for physicists was held in 2017, thus the purpose of this article is to examine the similarities and differences of the new certification program in Iran to that of other countries.

Brief history of radiotherapy physics in Iran

The first radiotherapy department was located in Emam Khomeini Hospital (Cancer Institute) in 1968, wherein the first Cobalt-60 machine was installed and began treatment. Initially, it was administered by Indian physicians, who were then substituted by Professor Maleki and Professor Afshari as the specialized radiologists during those years. A few years later, the radiotherapy specialty was founded in Iran, thereby training physicians in this specialty was initiated.

At first, apparatus such as Cobalt-60 and superficial radiation therapy equipment were used, with the first LINACs imported to Iran in the 1980s, being the Saturn 20 (CGR, France) and Nepton 10PC (ZDAJ, Poland). Later, in 2002, LINACs capable of producing electron beams were imported. The first 3D treatment planning system was installed at Emam Hosein Hospital in 2005; however, it was initially used only for calculating the dose distribution, not monitor unit (MU) for several years.

In the early years, due to the lack of specialists in medical physics or radiation physics in the country, individuals with bachelor's degrees in physics were employed for this purpose. Dr. Arbabi, Dr. Bahreini, etc. were the first graduates in this field, who returned to Iran in the 1970s. According to the IAEA's guidelines, a radiotherapy physicist must have a university degree in either physics or engineering; at least one year of postgraduate study in medical physics or equivalent; and two years of training [19, 20]. However, in Iran, holders of Bachelors degrees in radiological science, radiotherapy technologist, or general practitioners (GPs), etc. are permitted to become a MP if they have a postgraduate degree in medical physics or medical radiation. Moreover, in many countries, the field of medical physics is considered as a subfield of physics, while in Iran, there is a Medical Physics department at the Medical Sciences universities (ministry of health, treatment, and medical education) under Medical and paramedical faculties.

Since the early 1990s, medical radiation as a part of nuclear engineering was available for university (Ministry of Science, Research, and Technology) study in Iran. According to the Atomic Energy Organization of Iran Rules and Regulations, a radiotherapy physicist must have a Master's degree in either medical physics or medical radiation [21]. However, degrees in physics, medical engineering, etc. are not acceptable. Subsequently, a person who held Bachelor and Master degrees in physics and having research experience in radiotherapy physics, cannot become a radiotherapy physicist, because his/her degree title is different to "medical physics" or "medical radiation", despite the fact that the syllabus of these two disciplines are very close together. A notable point about the postgraduates of medical physics is that they have Bachelor's degrees mostly in radiological science or physics, but, the medical radiation postgraduates hold physics, electronics, and engineering [22, 23].

Table 1 shows the official statistics and indicate that, currently, there are 81 LINACs in Iran [24]. Until 2017, only conformal radiotherapy was available, but recently other techniques such as IMRT and VMAT have been initiated in a limited capacity in some hospitals.

The European Society for Radiotherapy & Oncology (ESTRO) suggests one LINAC per 450 patients [25]. A radiotherapy application factor of 50% for new cancer cases must be considered in this value. This is equal to one LINAC per 225 new cancer cases. As a result, according to this guideline and Table 1, only the USA, Japan, and Turkey have

Table 1 The Number of LINACs and new cancer cases for different countries [24]

	Iran	Turkey	China	Japan	USA	UK
Number of LINACs (Until 2017) [24]	113	245	1086	1052	3712	344
Population (Millions)	81	80	1386	127	327	66
LINACs Per Million Population	1.39	3.06	0.78	8.28	11.35	5.21
Number of new cancer cases (2019)	110,000 [36]	210,000 [37]	4,285,000 [38]	883,000 [39]	2,129,000 [40]	446,000 [41]
LINACs Per 225 patients (by considering a radiotherapy application factor of 50%)	0.92	1.04	0.23	1.04	1.56	0.69

the standard number of LINACs in the countries examined here. In addition, the number of LINACs in Iran is within 8% of achieving the ESTRO recommendation.

Physicist certification conditions in Iran

Late in the previous course of the board-of-directors of the *Iranian Association of Medical Physics (IAMP)* (in 2017), the association announced its decision to hold a physicist qualification examination, with the text books by Khan [26] and Podgorsak [27] used as the sources of this examination [28]. The essential requirement for participation in this examination was the certificate of attendance of training course for at least 6 months, which was later increased to a year, in a radiotherapy center [28]. However, there is no official information about the probable international certificate of members of the board-of-directors of the *IAMP* [28], who take the exam from the candidates. In addition, those with experience of more than 10 years are exempted from taking the written test, but still must pass the oral exam [29]. The examination was held under the supervision of the Atomic Energy Organization of Iran as the principal authority for any radiation-related affairs. It was later decided to hold this examination twice a year, so a total of five examinations have been held to date [28]. As mentioned earlier, the graduates of medical physics and medical radiation can participate in the physicist qualification examination in order to obtain the approval of the association and the Atomic Energy Agency. Furthermore, the IAMP has designated a reference physicist for each province as its representative so that this reference physicist is authorized to approve and certify the applicants' attendance in the one-year training course. In addition, the reference MP is to have an interview with the applicant who is interested in applying for IAMP exam and the reference MP should sign the referrer letter to verify the potential examinee is eligible to sit for exam. It should be noted that some densely populated provinces, such as Tehran, have multiple reference physicists. Also, in some provinces, there is a non-resident reference physicist, meaning that the reference physicist lives in another province, and even in a unique case for one of the provinces, the physicist lives in a foreign country. Some of these reference physicists have a part-time job background of fewer than 10 years, yet the *Association of Medical Physics* has the full power and authority to select the representatives and has not yet introduced any criteria or measures for its selections.

Figure 1 shows the most and least participants and passing rate in the certificate exam belonging to the latest and first sessions, respectively [30].

Physicist certification conditions in selected other countries

Table 2 shows that the physicist's certificate is new in Iran and the UK, in comparison with the USA, Japan, and China.

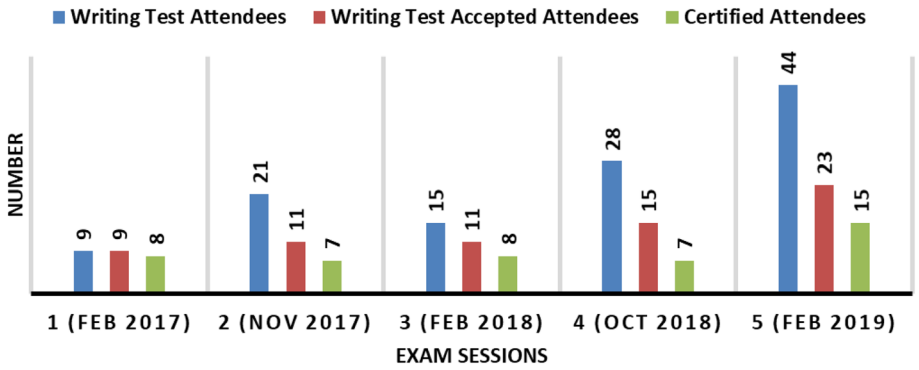

Fig. 1 The sessions of medical physicist certificate in Iran

Table 2 The establishment date and the responsible organization for medical physicist certificate exam

	Iran	Turkey	China	Japan	USA	UK
The first session of the exam date	2017	There is no certificate yet	1996	1987	1930s (revised since 2002)	1963 (revised since 2011)
Responsible organization	Iranian association of medical physics	NA	Chinese Medical Association	Japanese Board of Medical Physicist	American Board of Radiology	HCPC

There is a qualification evaluation program in China operated by the Ministry of Public Health since 1996 and conducted annually by Chinese Medical Association associated academic societies. This assessment system is planned specifically for those people who are interested in utilizing LINAC, CT/MRI, etc., including MPs and radiation oncologists [31, 32].

In the Xiangshan meeting held in 2004 in Beijing, the CSMP intended to set up a profession system for MPs working in hospitals and clinical oriented research institutes as a four-level system in China: assistant MP, MP, Associate Professor of Medical Physics and Professor of Medical Physics.

In Japan, just as in the USA, there is an accredited residency program focused on specialized training of the MPs. To become a medical physicist in Japan, a person must receive accreditation from the Japanese Board of Medical Physicist Qualification (JBMP). In order to do so, it is necessary to pass the MP qualification test, meet the performance criteria, apply for certification, and undergo an examination. To be certified, they need to pass the Medical Physicist Certification examination, fill performance standards and apply for certification. The certified MPs in Japan is 1,178 (as of June 7, 2019). The pass rate for the MP exam is about 30% [33]. Certification of MPs in Japan started in March 1987 with the medical physics certification system by JRS. Since then, with the development of radiation therapy, the need to develop excellent MPs has increased. JSMP, JRS and Japanese Society for Radiation Oncology are established the JBMP in 2009 [34]. The qualifications of MPs in Japan is not national qualifications but qualifications by the organization. The examination subjects include basic physics, radiation physics, statistics, health physics, radiation diagnostics physics, nuclear medicine physics, radiation therapy physics, radiation metrology, medical/image informatics, radiation related laws and recommendations/Medical ethics, Basic medicine, Radiology, Nuclear medicine, Radiation oncology, Radiobiology [35]. JBMP checks every five years whether the skills of each MP are maintained after certification. Moreover, the residency courses are the pre-requisite for receiving the physicist certificate in Japan and USA. Therefore, the graduates of physics or engineering, in the case of being clinically qualified, can enter the workforce as a physicist.

There is no board exams or certification in Turkey. If a person has a Bachelor degree in physics, physics engineering or nuclear engineering and then have a Master degree in radiotherapy physics then that person can become a MP.

Conclusion

It is promising progress that Iran has started a certification program. However, compared to other listed countries, Iran is the only country of those considered here, where the Association of Medical Physics is directly responsible for the medical physicists examination and certification (noting that in Australia and New Zealand, which are not considered here, physicists are certified by the Australasian College of Physical Scientists and Engineers in Medicine). This means that, in Iran, merely the Association of Medical Physics is responsible and authorized for this examination in contrast to the system implemented in some other indicated countries such as the USA, Britain, Japan, and China where the examination and qualification procedures are designated to a group composed of multiple scientific and guild institutions. In addition, since the residency course has not been defined yet in Iran, the trainees must pass a free-of-charge one-year internship course at the radiotherapy centers. However, IAEA recommends a two-year structured training course.

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