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Technical note

Evaluation of medical physics training in radiology residency in 67 countries

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A B S T R A C T

Purpose: The main aim of medical physics training in radiology residency is to have appropriate and safer imaging of patients and safety of personnel. The need to have adequate coverage of medical physics and radiation safety in curricula of radiology residency is well perceived, but it is not known how far it is implemented in practice.

Methods: We have analysed the data from 67 countries on medical physics teaching and assessment of residents in radiology programs, considering differences between countries in function of their human development index (HDI).

Results: The results indicate that teaching of medical physics by radiologists rather than by medical physicists is very common and there is relationship with the developmental status of a country. The majority of countries with very high HDI used a written test (69%) for medical physics topics, often in combination with other subjects (63%). Further, there is lack of direct involvement of medical physicists during the examination phase of residents. Geographically, it can be seen that Latin American countries in particular lack involvement of medical physicists during both the teaching and examination phase.

Conclusion: The lack of adequate involvement of medical physicists in training and in the formal examination of radiology residents in both developed and developing countries is a matter of concern with likely implications on patient and staff safety.

1. Introduction

The important goal of medical physics training in radiology residency is to have appropriate and safer imaging of patients and safety of personnel. The breadth and depth of scientific knowledge underlying the practice of diagnostic radiology helps a practicing radiologist in understanding the strengths and limitations of the tools in their practice. The resident should become familiar with the technical aspects of image formation in each imaging modality, factors that impact image quality, balancing of image quality and radiation dose and thus achieving patient and staff safety. The pivotal role of medical physics training in radiology residency has been recognized for decades [1,2] and the increasing complexity and enhanced utilization of imaging equipment involving radiation exposure have necessitated an enhanced role of medical physics training. Furthermore, it is necessary that the resident's knowledge, skills and competences in medical physics are properly assessed.

There are specific requirements of medical physics training to radiology residents in developed countries like US [1], UK [2,3] and in the European [4] region. The American Board of Radiology (ABR) and the Royal College of Radiologists (RCR) involve professional societies of medical physics [American Association of Physicists in Medicine (AAPM) and Institute of Physics & Engineering in Medicine (IPEM)] to determine the curriculum, to prepare the training material and seek participation of medical physicists (MPs) in the development of an evaluation system for board certification. A similar system prevails in Australia where the Royal Australian and New Zeeland College of Radiologists (RANZCR) and Australian College of Physical Scientists and Engineers in Medicine (ACPSEM) operate [5]. Unfortunately, a similar explicit role of MPs and corresponding national professional organizations is often lacking, also in the European Training Curriculum for Radiology.

The status of radiology education has recently been evaluated through a survey of 72 countries from four regions: Africa [6] Asia [7] Europe [8] and Latin America [9]. These papers did not analyze or cross-correlate specific information regarding the medical physics aspect such as inter-regional comparison as well as classification of countries by human development index [9], which is covered in this Technical Note.

2. Material & methods

This study is a part of a worldwide survey on radiology education that spans countries in Africa, Asia, Latin America, and Europe [6–9].

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The questions pertaining to medical physics included identifying if MPs or radiologists or both teach medical physics to radiology residents, if there is a separate question paper on this subject and if so, whether it is combined with another subject, and whether it is an oral and/or written test. Further questions inquired if radiologists or MPs review the answer sheets for medical physics portion and who conducts oral exam in medical physics and radiation safety. For intercomparing the countries, they were classified according to their Human Development Index (HDI), as defined by the 2016 Human Development Report of the United Nations Development Programme [10]. Also, categorization of the data was done per geographical region.

3. Results

The classification of countries included in this survey into HDI is:

- Very High HDI (n = 27): Argentina, Austria, Chile, Croatia, Denmark, Greece, Hong Kong SAR, Hungary, Israel, Italy, Japan, Lithuania, Malta, Norway, Poland, Portugal, Romania, Saudi Arabia, Serbia, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom
- High HDI (n = 23): Algeria, Armenia, Brazil, Bulgaria, China, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, Iran, Kenya, Lebanon, Malaysia, Mexico, Oman, Panama, Peru, Sri Lanka, Thailand, Turkey, Uruguay, Venezuela
- Medium HDI (n = 11): Bangladesh, Egypt, El Salvador, Ghana, Guatemala, Honduras, India, Nicaragua, Pakistan, Philippines, South Africa
- Low HDI (n = 6): Ethiopia, Nigeria, Senegal, Syria, Tanzania, Uganda

Table 1 shows that, in countries with a very high HDI, teaching of medical physics by radiologists was not so common (15%, n = 4/27), whereas in countries with low, medium or high HDI the teaching was solely performed by radiologists in 40% (n = 2/5), 50% (n = 5/10) and 41% (n = 9/22) of the surveyed countries, respectively. In a small minority of the countries, teaching was performed by both radiologists and MPs. There was not so much difference in the extent of involvement of MPs in teaching among low, medium and high HDI countries with respective figures of 40% (n = 2/5), 50% (n = 5/10) and 55% (n = 12/22), as compared to very high HDI countries where the figure was 74% (n = 20/27).

In the group with very high HDI, most countries included a formal examination of medical physics during the radiology residency, usually involving a written test (69%, n = 11/16) often in combination with other subjects (63%, n = 10/16). In the other HDI categories, an oral or combined oral/written test was more prevalent. In countries with medium, high or very high HDI, radiologists reviewed answers to medical physics questions in 27% (n = 3/11), 38% (n = 8/21) and 33% (n = 9/27) of the surveyed countries.

Some limitations of this analysis are apparent: the sample size of countries in HDI categories “low” (n = 6) and “medium” (n = 11) is small, which can skew percentage values. The sample size was further reduced due to blank answers provided to certain questions, as explained in Table 1.

When splitting up the surveyed countries by geographical location (Table 2), an interesting finding is the lower frequency of involvement of MPs during training in Latin American countries (40%, n = 6/15) compared with Africa (60%, n = 6/10), Asia (67%, n = 12/18) and Europe (71%, n = 15/21). Furthermore, examination of medical physics was more often done through a written test in Latin America (82%, n = 9/11) and Europe (58%, n = 7/12) than in Africa (22%, n = 2/9) or Asia (33%, n = 5/15).

4. Discussion

To appreciate these findings, it is appropriate to start with the prevailing system in countries like UK, US and Australia. In these countries, there is a professional body of radiology (e.g. RCR, ABR, RANZCR). This body provides certification to radiologists after satisfactory completion of requirements, which also includes a medical physics curriculum. For the medical physics part, the body depends upon the medical physics experts provided by the corresponding society of the country for forming a committee to design the curriculum, prepare a question paper or question bank, and evaluate answers. Regular formal assessment is invariably recommended, with no specific requirements regarding the type of assessment or the background of the assessor(s). The UK curriculum specifically mentions a multiple choice question based assessment [2]. The multisource feedback (MSF) tool assesses generic skills across the domain of Good Medical Practice [3]. It consists of collated views from a range of co-workers (previously described as 360-degree assessment). For MSF, the UK curriculum recommends a group of assessors with a mixed background, without specifically mentioning MPs. US training includes a Physics category

Table 1
Overview of medical physics training in countries categorized by Human Development Index.

	Human Development Index	Low		Medium		High		Very high	
	Number of countries	6		11		23		27	
		Freq.	Perc.	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
Medical physics taught by:	Radiologist	2	40%	5	50%	9	41%	4	15%
	MP	2	40%	5	50%	12	55%	20	74%
	Both	1	20%	0	0%	1	5%	2	7%
	Other	0	0%	0	0%	0	0%	1	4%
Formal examination:	No[a]	0	0%	0	0%	1	6%	0	0%
	Question paper with other subject[a]	0	0%	3	38%	4	25%	10	63%
	Separate question paper[a]	4	100%	6	75%	12	75%	8	50%
	Only oral test[b]	1	17%	1	10%	1	7%	3	19%
	Only written test[b]	0	0%	5	50%	7	47%	11	69%
	Both oral and written test[b]	5	83%	4	40%	7	47%	2	13%
	Radiologists review MP answers[c]	0	0%	3	27%	8	38%	9	33%
	Radiologists conduct oral exam in MP[c]	0	0%	0	0%	3	14%	2	7%

[a] The percentage was calculated according to the total number of countries that provided at least one answer out of the three possible options that show this footnote. Countries were allowed to select both options (i.e. both a combined and separate paper); therefore, the total percentage may be higher than 100%.

[b] The percentage was calculated according to the total number of countries that provided at least one answer out of the three possible options that show this footnote.

[c] The percentage was calculated according to the total number of countries that provided at least one answer for any option under the category ‘formal examination’.