Evaluating the Certification Examination for Medical Physicists in Japan Via Questionnaire Survey and Access Analyses

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Abstract
Background & Aims: With the development of radiology, the demand for medical physicists is increasing, and the training of new medical physicists is becoming a necessity. Although a few questionnaire surveys regarding medical physicists and medical physicist training courses have been conducted, no survey reports have yet been conducted on examinees. This study is the first survey of general examinees.

Methods: Gunma University has a webpage for test preparation, and we conducted a survey on examinees using this page, through a questionnaire and access analyses.

Results: Approximately 80% of the users qualified as technologists. Considering the percentage of users by region, the number of medical physicists and accredited facilities were strongly correlated. The proportion of females was extremely low. Exam papers on “science and technology” and “radiation physics” were accessed more than those on “medical and biology” field. Thus, physics may be a shortcoming of many examinees; science and engineering majors were less likely to take exams and have lower pass rates.

Conclusion: Recruitment and provision of learning environments for science and engineering graduates are required. To increase the number of students, while improving the quality of medical physicists, it is necessary to investigate current conditions of students in greater detail.

1. Introduction

There has been an increasing demand for diagnoses and treatments using radiology every year. Furthermore, with the rapid developments in radiology equipment over recent years, medical physicists have become increasingly more important. The certification of medical physicists in Japan commenced in 1987. However, the requirements for certification have changed over the years to meet the needs and circumstances of changing times; currently, the Japanese Board for Medical Physicist Qualification (JBMP) conducts the certification examinations. These examinations cover a wide range of fields, including physics, biology, and medicine, and require clinical knowledge. Unfortunately, only a few textbooks are available, and seminars covering the entire syllabus of the exam are only conducted in Tokyo.

There were approximately 1,200 medical physicists in Japan, as of December 2019. Approximately 90 people are certified each year. In addition, the number of retiring medical physicists is expected to gradually increase after 30 years. Owing to the increasing demand for radiology, the necessity of training additional medical physicists has also increased. Although surveys on medical physicists and questionnaires regarding medical physics training courses have been conducted in the past, surveys on the examinees have not been thus far. Therefore, the requirements to ensure appropriate education for medical physicists has not been sufficiently understood. To provide more effective education, it is also important to better understand the examinees.

To provide easy and ubiquitous learning opportuni-
ties, a webpage for studying medical physics, using the previous questions on the certification exam, “Preparing for the Medical Physics Certification Exam by Past Questions” (http://sakai-m.showa.gunma-u.ac.jp), was created and has been available since July 1, 2017.\textsuperscript{4} In this study, as basic data for future medical physicist training, we analyzed such information and examined the tendencies of examinees aiming to become certified medical physicists. This study is the first survey on the general examinees. The authors examined the characteristics of examinees through access analyses and a questionnaire survey; the existing problems in medical physics education were examined based on a comparison with previous survey reports on medical physicists.

2. Materials and methods

When registering to use the website, the names, organizations, and occupations of the users are enquired. An analysis of the website access was conducted using Google analytics.\textsuperscript{6} Data from the beginning of the analysis up to March 31, 2020, were tallied. Additionally, a questionnaire request was sent to 804 users via e-mail on February 18, 2020, with a deadline of March 3, 2020, i.e., two weeks later; this e-mail included the following items in the form of ID names:

- ID (required), wish to continue using the account (required), job type, acquired related qualifications
- Study environment, whether or not to take the examination, pass or fail, how the user found out about the site, and main access device
- Frequency of use, degree of satisfaction, points for improvement, requests, etc.

The questionnaire was answered by 192 persons. There was a slight difference in the number of items for each response, because only the registration ID and the desire to continue using the service mandated answers; some of the items remained unanswered.

3. Results

3.1. Number of registrations

The number of registrations is shown in Figure 1. After the webpage was opened to the public, it was announced on the website of Gunma University Heavy Ion Medical Center. Shortly after the announcement through the Medical Physics Society membership mailing list on July 24, 2017, subscriptions increased significantly. The number has since been increasing at an average rate of approximately 5 persons per week; there were 823 registered users as of March 31, 2019.

3.2. Job type

Based on the information entered at the time of registration, users’ occupations were classified into five categories: radiological technologists, academic/researcher, employees of private companies, students, and others. The proportion of radiological technologists was approximately 70% (Fig. 2). In the questionnaire, 75% replied that they were a radiological technologist. In addition, 85% answered that they were qualified as a radiological technologist, while 75% of the students held a radiological technologist qualification (Table 1).

3.3. Location

Figure 3 shows the number of organizations to which the users belonged at the time of registration and the number of sessions by prefecture. From the figure, it can be seen that a large number of accesses originated from urban areas.

3.4. Age and sex

The numbers of accesses by age and sex, obtained from the analysis, are shown in Figure 4. The percentages of data used for these analyses of age and sex were 33.2% and 33.7%, respectively.

![Fig. 1 Number of registrations of the webpage for preparation of qualification examination](image1)

![Fig. 2 Proportion of occupations obtained from the declaration of registration and the questionnaire](image2)

| Occupation                      | No.  |
|--------------------------------|------|
| Radiological technologist      | 163  |
| Professional radiotherapy technologist | 51   |
| Senior radiation protection supervisor | 97  |
| Junior radiation protection supervisor | 3   |
| Radiotherapy quality manager   | 8    |
| Medical physicist              | 13   |
| Other                          | 39   |

Table 1

![Fig. 3](image3)

![Fig. 4](image4)
3.5. Access device and time of day

The number of accesses by day of the week and time of day is shown in Figure 5. On weekdays (Monday-Friday), more accesses occurred from 7:00 to 8:00, from 12:00 to 13:00, and after 17:00. The most frequent accesses occurred between 21:00 and 22:00 on weekdays.

Figure 6 shows a cumulative graph of the number of accesses on weekdays based on the time of day and the device used. The period of increase in the number of accesses was mainly due to the increase in the number of accesses via mobile devices. According to the questionnaire survey, 48%, 27%, 24%, and 2% of the respondents answered that their primary access methods were a “PC,” “PC and smartphone at the same rate,” “smartphone,” and “tablet,” with a slight discrepancy. It is considered that responses to the questionnaire were based on
perceived use, including the time of use. The use of a smartphone tends to be shorter than the use of a PC, and there is a possibility that the sense of use is lower than the actual number of sessions.

4. Discussion

There are approximately 1,200 medical physicists in Japan. Considering the age of such medical physicists, approximately 150 are expected to retire within the next 10 years. The number of medical physicists reaching retirement age will increase further during the next 10-30 years. Recently, approximately 300 people have taken the certification exam, with an average of 90 people passing. If this trend continues, the rate of increase in medical physicists will gradually decline.

The age distribution of web users (Fig. 4) shows that the majority are approximately 30 years old. Certification as a medical physicist requires medical experience and a related academic degree. Therefore, the age at the time of examination is approximately 30 years. Assuming a retirement age of around 60-65 years, medical physicists have approximately a 30-year career. As mentioned above, if an estimated 90 medical physicists are qualified each year, there will be a maximum of approximately 3,000 medical physicists. For example, 1-1.5 medical physicists are required per multiple-energy LINAC in operation. It is expected that numerous medical physicists will be required in diagnostic departments. In addition, several medical physicists currently work as radiological technologists. Therefore, the training of additional medical physicists is required. However, the quality of a medical physicist cannot be ensured by simply increasing the number of successful examinees; thus, the education system needs to be improved.

The number of accredited medical physicist courses has increased over the years, and many educational programs have been provided to students. Kadoya et al. reported that the passing rate of the examination for graduates of such programs is higher than the overall passing rate: 69% for master’s courses and 92% for doctoral courses. The percentages of working adults in master’s and doctoral programs are 27% and 35%, respectively, suggesting the importance of a learning environment. In the questionnaire, many respondents indicated that the learning environment provided was inadequate. Specifically, 64 (47%) of the responses indicated that they had no mentor or a qualified person nearby. Therefore, the creation of an environment for learning through self-education is required.

More than 80% of the medical physicists in Japan have obtained a national certification as a radiological technologist. A similar, considerably high percentage was found in this study (Table 1). Currently, technologists are responsible for most of the duties of international medical physicists, and medical physicists are required to have immediate capabilities in Japan. In addition, they are often employed as technologists rather than medical physicists. Therefore, it is expected that this trend will not change in the near future. The results of the questionnaire and the increasing number of accesses on mobile devices during commutes and lunch breaks would also suggest that many of the examinees are technologists.

Radiological technologists have a wealth of knowledge and experience in medical care, and their medical education background has numerous advantages, including the ability to communicate smoothly with other professions. However, radiological technologists with medical physicist qualifications perform both duties, resulting in overwork. There is also a risk that the physical engineering perspective will be weakened. In the questionnaire, there were many requests for a detailed explanation of the calculation process of a physics question. This indicates that there is a problem regarding knowledge in the fields of science and engineering. In the access analyses, access to “science and technology” exam pages was 50% higher than that to “medical and biology” exam pages, with the highest access observed for the “radiation physics” exam page. In the free-description section of the questionnaire, there were several requests for more detailed explanations of calculation questions in the field of physics. Thus, many technologists would need an opportunity to learn physics effectively.

One of the advantages of hiring a medical physicist is that an evaluation and review from a third-party perspective can be applied; however, it is difficult to achieve this advantage when a person works as both a medical physicist and a technologist. Because a PhD is not a requirement for a medical physicist in Japan, one can become a medical physicist without accumulating considerable research experience. Further, the shortage of medical physicists in the area of research and development may become an issue and weaken the Japanese initiative in the field of medical physics in the future. In this survey, 30% of the respondents were not qualified as radiological technologists, while 20% were unqualified in the questionnaire for medical physicists. There is a possibility that the passing rate among science and engineering graduates is low. Thus, it is necessary to strengthen the recruitment of science and engineering graduates into the field of medical physics as well as consider the problems in medical physics education for science and engineering graduates. To solve these problems in the clinical field, it is necessary to create an educational environment unique to Japan that balances these factors.

This study also assessed the locality of the users. The numbers of registrations and accesses were higher in urban areas. In the access analysis, location was determined using the registered value of the IP addresses, which may differ from the actual access area, and access tended to increase in urban areas. The affiliation of the user also differs from the actual access area and may be higher in urban areas. Considering the distribution of medical physicists in the future, the location of the affiliations to which they belong may be closer.

There is a weak correlation between the number of users and the number of radiological technologists per prefecture (Fig. 7), although many of the users are...
radiological technologists. This is because the census likely counts the number based on the place of residence and not on the place of work. By contrast, an extremely good correlation is observed between the number of facilities authorized by the Japan Society for Radiation Oncology (JASTRO) and the present number of medical physicists by prefecture.\textsuperscript{18,19} A more detailed analysis indicates that the number of registered users in the Tohoku, Shikoku, and Kyushu regions was relatively high when compared to the number of certified facilities. This can be attributed to several factors. In these areas, the number of physicists is small because the number of accredited facilities is low, and the demand for medical physicists could increase. Alternatively, this may be influenced by limited learning opportunities in remote areas; for example, the minimum training courses available are only held in Tokyo.

There was a smaller proportion of female users (Fig. 4). The percentage of females, inferred from the names of their registration applications, was approximately 10%. This is also consistent with the proportion of female medical physicists (8%)\textsuperscript{19} and is extremely low in comparison with the ratio of female medical radiological technologists in other countries (20%—50%).\textsuperscript{20} It is also less than half of the 23% of female radiological technologists.\textsuperscript{17} It is necessary to continue graduate school to obtain a medical physicist degree. Because the percentage of females in graduate schools in the fields of medicine/dentistry and pharmacy/nursing is approximately 50%, it is difficult to consider higher education itself as a hurdle.\textsuperscript{21,22} Thus, there may be other social or professional difficulties that females must overcome to obtain a medical physics degree.

In Japan, an increasing number of universities are asking their departments to increase the ratios of female teachers and students.\textsuperscript{23,24} There is a concern that this will become an issue in the near future. The satisfaction level of medical physicists in Japan is relatively low.\textsuperscript{25} It may also be possible to increase the satisfaction of medical physicists by overcoming social or specialized difficulties of females in obtaining medical physicist qualifications. Comparing the results with actual examinees, the tendency of those who gave up while taking the examination could be observed. Thus, improvement policies for the examination environment could be determined.

This study has certain limitations. First, the study is
mainly based on a self-report and analyses using Google Analytics. There is no means for verifying the self-declaration of the registration application. This is difficult to verify because it involves privacy issues. It is also difficult to confirm which type of job is reported by people with multiple affiliations and occupations, such as working students. Therefore, the results contain certain errors. Furthermore, the questionnaire response rate was 24%, which may not be representative of the whole. However, in addition to the problem of the number of accesses described above, in the analysis conducted using Google Analytics, the sex and age are predicted by Google, and the ratio of data available for the analysis is low, approximately 35%. Therefore, there remains significant uncertainty regarding the results of this study. However, because no major discrepancies have been found in comparison with various other studies to date, it is considered to represent a partial truth. In addition, there was no difference in the percentage of jobs in the survey between the data from registration and the questionnaire. Thus the respondents’ bias would not be significant. Considering that the number of candidates each year is approximately 300 (with many of the 200 unsuccessful candidates retaking the test), 800 registrants or 192 respondents is a sufficiently large number to be considered.

For a more detailed verification, it is necessary to collect extensive information on the registrants and conduct individual access analyses. For this purpose, it is necessary to construct a system whereby personal information cannot be viewed, owing to the need for privacy considerations.

5. Conclusion

We conducted a survey on examinees using a questionnaire and an access analysis for users of the webpage described herein. As a result, more than 80% of the users qualified as radiological technologists. Considering the percentage of users by region, a strong correlation was observed between the number of medical physicists and the number of JASTRO-accredited facilities. Furthermore, the proportion of females was shown to be extremely low. To increase the number of students, while improving the quality of medical physicists, it is necessary to investigate the current conditions of students in greater detail.

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