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# Introduction of preclinical training for clinical participatory practice in radiologic technology education: Latest trends in Japan

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**ABSTRACT**

**Introduction:** In Japan, the objective structured clinical examination (OSCE) and computer-based testing (CBT) would be implemented from May 2023 to assess whether medical students possess the required knowledge and skills before starting clinical training. This paper reports the findings of a literature review on the current status of preclinical practice evaluation systems in radiologic technology education in Japan and the educational effects of the OSCE/CBT on-campus practice credit examination introduced in 2018.

**Materials and Methods:** The three fields of radiologic technology training, namely, “basic,” “specialized basic,” and “specialized,” were explained vis-à-vis the educational content of radiologic technologist training schools. The current status and their examples regarding OSCE/CBT in Japan were also described and introduced. The effectiveness of preclinical practice assessment was determined by use of the survey obtained from students in the department of radiological technology in the author’s school.

**Results:** The literature reviews showed that the students found pre-training useful, suggesting that the training had an effective educational effect on the students participating in the clinical training. The students’ survey also indicated that experiences with the preclinical education of OSCE and CBT were useful in clinical practice for the majority of the students (88.6%).

**Conclusion:** The OSCE is an effective way to evaluate students' clinical practice skills for the modalities of X-ray examinations and computed tomography in preclinical practice evaluations. To enhance clinical understanding, on-campus CBT training should teach students diagnostic imaging skills in modalities where clinical positioning experience is not expected.

**Implications to practice:** The educational effectiveness of future clinical training with medical participation will strongly depend on the students' positioning experience during clinical training.

## ABBREVIATIONS

Objective structured clinical examination (OSCE)
Computer-based testing (CBT)
Ministry of Education, Culture, Sports, Science and Technology (MEXT)
Ministry of Health, Labor and Welfare (MHLW)
Common Assessment and Testing Organization for medical colleges（CATO）
Supervisor (SV)
Simulated patient (SP)
Item response theory (IRT)

## INTRODUCTION

### *Educational courses for training radiologic technologists in Japan*

As of April 2023, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Ministry of Health, Labor and Welfare (MHLW) have jurisdiction over the training schools for radiologic technologists that meet the government's designation regulations. On the one hand, training schools under the jurisdiction of the MEXT are four-year universities, which generally have graduate schools and focus on research and development. On the other hand, training schools under the jurisdiction of the MHLW include three- and four-year vocational schools, which focus on the acquisition of practical skills. Both training schools offer educational programs to acquire the knowledge and skills necessary to become a radiologic technologist, and after graduation, students must pass a national examination in order to practice as a radiologic technologist.

### *Objective Structured Clinical Examination (OSCE) and Computer Based Testing (CBT) in Japan*

In Japan, a shared examination to assess whether medical students possess the required knowledge and skills before starting clinical training will be implemented from May 2023 under the guidance of a publicly established organization (the Common Assessment and Testing Organization for Medical Colleges: CATO), (Ordinance of the Ministry of Health, 2023). The shared examinations include the OSCE and the CBT. While the CBT is an examination to assess the level of knowledge of students, the OSCE evaluates the level of knowledge of students. Moreover, CBT examines students' knowledge levels, whereas OSCE is a practical examination that evaluates students' emotions, attitude, and skills, and a supervisor (SV) evaluates the candidate who performs the practical examination on a simulated patient (SP) using a standardized method. Presently, the OSCE and CBT in Japan are preceded by medical and dental education. Notably, OSCE/CBT is also being introduced in the education of other healthcare professions, and it is being attempted in the education of pharmacists (Tokunaga et al.,2011), physical therapists (Kamioka et al.,2011), nurses (Takashima & Arao, 2021), optometrists (Takasaki et al.,2008), and dietitians (Kawakami et al.,2008). In the field of radiologic technology education, some examples of OSCE/CBT practices have been reported and some results have been recognized (Sekine et al.,2007, Hatakeyama et al.,2009, Muto, 2012, Eto et al.,2021, Aoyama et al.,2022).

### *Aim of the study*

This paper presents the results of a literature survey on the current status of preclinical training evaluation systems for radiologic technology education in Japan, and the educational effects of the OSCE/CBT, introduced in 2018 as a preclinical training evaluation system to comprehensively evaluate students' skills, attitudes, and knowledge at the training institution, in the credit certification examination with regard to on-campus training.

### *Current status of preclinical training in Japan (on-campus training)*

*(1) General on-campus practice*

During the on-campus training program at a radiologic technologist training school, students acquire the following skills and knowledge:

1) Patient treatment skills: This includes the ability to communicate with patients, understand their conditions, and respect their privacy. Through practical training and role-playing using SPs and human phantoms, trainees learn how to interact with patients and provide appropriate explanations.
2) Ability to respond to examinations: This includes the ability to perform accurate and prompt examinations, understand positioning techniques necessary during imaging, and comprehend the setting of imaging conditions. Through practical training using the human phantom and SP, the trainees will acquire the techniques and skills necessary for examinations.
3) Clinical image reading skills: This includes the ability to judge whether images are normal or abnormal, how to evaluate image findings, and how to prepare reports. Clinical image evaluation skills are improved through training in reading images related to imaging anatomy and images of major diseases.

Fujii et al. of Fujita Health University studied the usefulness of role-plays in patient care for students prior to clinical practice and reported that role-play practice had an immediate effect on the acquisition of communication skills such as emotional transference (Fujii et al.,2003), while Kawamura et al. of Ibaraki Prefectural University of Health Sciences reported that the addition of evaluation of patient care by simulated patients to OSCE enabled multifaceted evaluation and was expected to improve educational effectiveness (Kawamura et al.,2011).

Thus, through on-campus training, students comprehensively acquire the skills, knowledge, and attitudes required for clinical practice and are able to provide safe, high-quality care to patients.

*(2) Examples of on-campus training in our school*

The on-campus training at the school is conducted in the form of cross-training, whereby students take turns taking on the roles of the patient and technician and learn photography skills such as hospitality and positioning.

Four faculty members with practical experience as radiologic technologists are in charge of the on-campus training. Notably, 40 students per class are divided into groups of 10, and practical skills instruction for each modality is provided in rotation. The educational content of the school consists of radiography, computer tomography (CT), magnetic resonance imaging (MRI), ultrasound equipment, X-ray TV, mammography, non-mydriatic fundus camera, bone densitometry, and procedures that extend the duties of radiological technologists (needle removal and hemostasis, insertion of catheters through the anus).

In the on-campus training, students are required to write a "Preparation Report" to be submitted before the training and a "Practice Report" to be submitted after the training as assigned studies. The preliminary report is to be submitted to the supervising instructor by the day before the practical training and is based on prior studies of the knowledge required for the practical training, such as imaging methods, modality characteristics, and image anatomy. At the introduction of the practical training, the instructor asks oral questions to the students to check their level of understanding. This makes the students understand what they will learn in the practical training and allows them to approach each training session with a sense of urgency.

## *Current status of OSCE in Japan*

*(1) General OSCE Practice*

Osaka Butsuryo University conducts a clinical skills education program using simple chest X-ray examination as an example. In this program, practical examinations are conducted for SPs, including explanations before examinations, safe positioning, setting of imaging conditions, wheelchair operation and assistance with movement on the bed, assuming imaging operations for postoperative patients. In addition, a written examination on normal image anatomy and clinical images of major diseases displayed on an imaging monitor is attempted (Yamaguchi et al.,2015).

At Ibaraki Prefectural University, third-year students prior to clinical practice are evaluated on patient care, radiographic and nuclear medicine examination techniques, radiotherapy site positioning, and dose calculation. Notably, SPs are students (senior fourth-year students) and faculty members who are instructed to ask appropriate questions once during the examination, and SVs use the comments from SPs as a reference for scoring. After the completion of clinical practice, an evaluation of clinical images of X-ray, CT, MRI, and SPECT is added in the form of an oral examination by the SV (Hatakeyama et al.,2007).

The level of knowledge of clinical imaging is included as part of the OSCE in both universities, and CBT has not yet been introduced for assessment.

*(2) Examples of OSCE implementation in our school*

In our OSCE, the faculty member in charge of practical skills instruction in on-campus training was the SV, and the SP was a student (a second-year student in the Department of Radiologic Technology, the same as the examinee). As the OSCE was conducted as a credit examination for on-campus training, the evaluation was not conducted by the SPs who were students, and any questions or complaints from the SPs were considered by the SVs and included in the evaluation.

As the venue for the practical examination, four radiography examination rooms (hereinafter referred to as "stations") were prepared for each modality, and one SV, one SP, and one PC for progress management were assigned to each station. Students participated in the OSCE in the roles of both examinee and SP and worked on the tasks performed at each station.

The OSCE timer (Dolphin ver. 1.50, Japan), a commercially available software, was used to manage the OSCE time. This enabled automatic and simultaneous OSCE time management by connecting multiple PCs for progress management via LAN and synchronizing the countdown display on the display with voice announcements.

To ensure that the OSCE assignments were consistent with the content taught in the on-campus training, assignments were prepared from radiography, CT, MRI, ultrasound, mammography, and X-ray TV modalities and made available to examinees two weeks before the OSCE. Examinees were allowed to cross-train on all the tasks prepared in the stations prior to the OSCE. However, in the actual OSCE, it was difficult for the candidates (80 students in 2 classes) to complete all the tasks in all the stations and for the SVs (4 SVs) to evaluate all the tasks due to the heavy workload and time constraints of the SVs. Therefore, just before the OSCE, one set of examinees (4 persons) drew lots to determine one station to be evaluated.

## *Current status of CBT in Japan*

*(1) General CBT practice*

In the common medical and dental examinations in which public CBTs have been introduced, the CBT consists of a huge pool of questions that differ from one examinee to another. For this reason, item response theory (IRT) is used to correct scores according to difficulty. In the education of radiologic technologists, no official CBT has been introduced, and each school employs its own method.

Sekine reported on the construction of a CBT system using e-learning software at Tokyo Metropolitan University. In this report (Sekine.,2011), a database of national examinations (about 1,400 questions) was compiled as a set of questions, and a system was constructed to extract and submit 100 questions focused on practical training subjects. The system was implemented before and after clinical practice, and the results of an analysis of changes in the score rate showed a significant increase in the category of "Radiographic Techniques."

*(2) Examples of CBT in our school*

The school's CBT utilized an infrared remote-controlled class response system, Clicker Nao (Fine Woods, Japan). This system is linked to PowerPoint (Microsoft, USA) via an add-in, enabling the display of examination question slides created in PowerPoint on a computer display and script control. The examinee uses the numeric keypad on the clicker terminal (Model-H) to wirelessly transmit answers to a controller connected to the computer.

The format of the CBT is a "five-choice" format, in which the examinee chooses one correct answer from among five options. The questions were presented consecutively on the computer display at regular intervals, and the examinee was not allowed to go back and answer the questions once the next question was displayed. The CBT took approximately 30 minutes for 50 questions, including practice questions to confirm the operation of the clicker terminal.

Because all examinees answered the same questions in our CBT, the questions were not weighted according to their difficulty level but were evaluated (50 points) using a point system in which one correct answer to a question was worth one point.

***Criteria for passing the preclinical evaluation (OSCE and CBT)***

*(1) General acceptance criteria*

In Japan, the standard of achievement for both the CBT and the OSCE will be defined as a passing score for the shared examination. This unified standard will be communicated to examinees and examiners, and IRT359 (a score of approximately 65%) is expected to be the minimum passing standard.

In the radiologic technology field, Osaka Butsuryo University uses a quantitative evaluation (2 levels) and a qualitative evaluation (5 levels) for the achievement level of skills and attitudes in the OSCE (Yamaguchi et al.,2015). The quantitative evaluation is based on the completion of all items, and the qualitative evaluation is based on the average value of all items being 3.0 or higher, with no "1" (inferior) being scored. The achievement level of knowledge is evaluated quantitatively for each question (2 levels), and the passing criterion is a correct answer rate of 60% or higher.

*(2) Criteria for acceptance in our school*

The school has introduced the OSCE/CBT as a preclinical training credit evaluation and conducts it twice a year as a regular examination in the first and second semesters. The grades for on-campus training are evaluated not only by the OSCE and CBT but also by a comprehensive evaluation that includes attendance and the evaluation of training reports. The evaluation ratio presented in the syllabus is OSCE (20%), CBT (20%), attendance (20%), and practice report (40%). Particular emphasis was placed on the evaluation of the practical training reports, which students spend a lot of time writing and teachers put a lot of effort into correcting and guiding them. At the end of the semester, the grade was calculated by multiplying the percentage of each evaluation and converting it to a perfect score of 100 points. Grades were A (100–80 points), B (79–70 points), C (69–60 points), and D (59 points or less), with C or above being passing and D being failing. Students who failed the OSCE and CBT were reexamined and reevaluated by submitting a report on their assignments.

## MATERIALS AND METHODS

***Determining the effectiveness of preclinical practice assessment in our school***

*(1) Survey subjects*

The subjects of the survey were third-year students in the Department of Radiologic Technology who graduated from the school in March 2022, passed the preclinical evaluation (twice/year) in the second-year on-campus training conducted by the school, and experienced 10 weeks of clinical training in the third year.

*(2) Ethical considerations*

The purpose of this study was fully explained to the subjects in writing and orally, and informed consent was obtained before the questionnaire survey was conducted. In addition, a check box was provided in the answer column to indicate whether or not the questionnaire results would be used for research purposes, and consent was obtained from all respondents. This study was conducted with the approval of the Ethical Review Committee.

*(3) Survey methodology*

The survey items were 1) students' positioning experience in clinical practice, 2) modalities and sites where positioning was experienced, and 3) experiences of preclinical training (on-campus training, OSCE, CBT) that were useful in clinical practice. A web questionnaire form (Google

Form, USA) was adopted. The responses to the open-ended questions were categorized and tabulated. The questionnaire was collected from March 15 to 31, 2022.

## RESULT

### *Effectiveness assessment of preclinical practice evaluation in Japan*

A post-clinical training questionnaire survey was conducted on students who received preclinical training at Osaka Butsuryo University[11]. Eighty-two students responded to this survey, yielding a valid response rate of 98.8%. To Question 1, "Was the clinical skills training provided before clinical practice useful?" 67 students (81.7%) responded "strongly agree" or "agree." To Question 2, "Which of the clinical skills education items were particularly useful?" 41 (50.0%), 50 (1.0%), 39 (47.6%), and 26 (31.7%) students responded that they found the training useful, suggesting that the training had an effective educational effect on the students participating in the clinical training.

### *Evaluation of the effectiveness of the preclinical training assessment in our school*

In a survey conducted after clinical practice at the university, 44 out of 59 students responded, for a response rate of 74.6%, with 28 male students (63.6%) and 16 female students (36.4%).

*(1) Students' positioning experiences in clinical practice*

During the clinical training period, students experienced an average of 26.7 positioning sessions per 10 weeks. The breakdown of the number of positioning experiences (number of students) was as follows: 0 (3 students) for observation only, 1–10 (13 students), 11–50 (22 students), and 51 or more (6 students). Some students indicated that they had more than 100 positioning experiences. As shown above, the implementation status of the medical participation training in terms of students' positioning experience varied significantly from one facility to another.

*(2) Modalities and sites where positioning was experienced*

The modality in which students experienced positioning in clinical practice (number of experiences: multiple responses) was radiography most frequently (41 students), followed by CT (13 students), MRI (3 students), and DEXA bone densitometry (2 students). In terms of the part of the body experienced (number of patients with multiple experiences), in radiography, the chest was the most common (37 patients), followed by the abdomen (14 patients), lumbar spine (10 patients), knee (9 patients), and hand, shoulder, cervical spine, foot, hip, and head all had 5 or fewer patients. In CT positioning experience, nearly half of the patients had positioning experience in the head (5 patients), followed by the chest (3 patients), abdomen (2 patients), and unknown (3 patients). In MRI positioning experience, patients had positioning experience in the abdomen (2 patients), followed by the neck (1 patients). None of the students had experience in positioning for mammography, X-ray TV, ultrasound equipment, nor non-mydriatic fundus cameras. Furthermore, none of the students had experience in positioning for nuclear medicine examinations nor radiation therapy.

*(3) Experience with preclinical education (on-campus training, OSCE, CBT) that was useful in clinical practice*

Figure 1 shows the modalities that students indicate are useful in their clinical practice (multiple responses). In order of the positioning experience in clinical practice, the most common responses were: radiography, CT, and MRI. In the case of MRI, 2.6 times more students answered that their on-campus training experience was useful than their OSCE experience.

Figure 2 shows the positioning areas experienced in clinical practice and the body part of radiography that are useful in on-campus training (multiple answers) in the radiography class. As a result, most students answered thorax, abdomen, lumbar spine, and knee in order of their positioning experience in clinical practice. However, many students answered that their positioning experience in clinical practice was useful in the hip, head, and breast, where they had little experience in positioning in clinical practice. All of the students who answered that breast positioning was helpful were female.

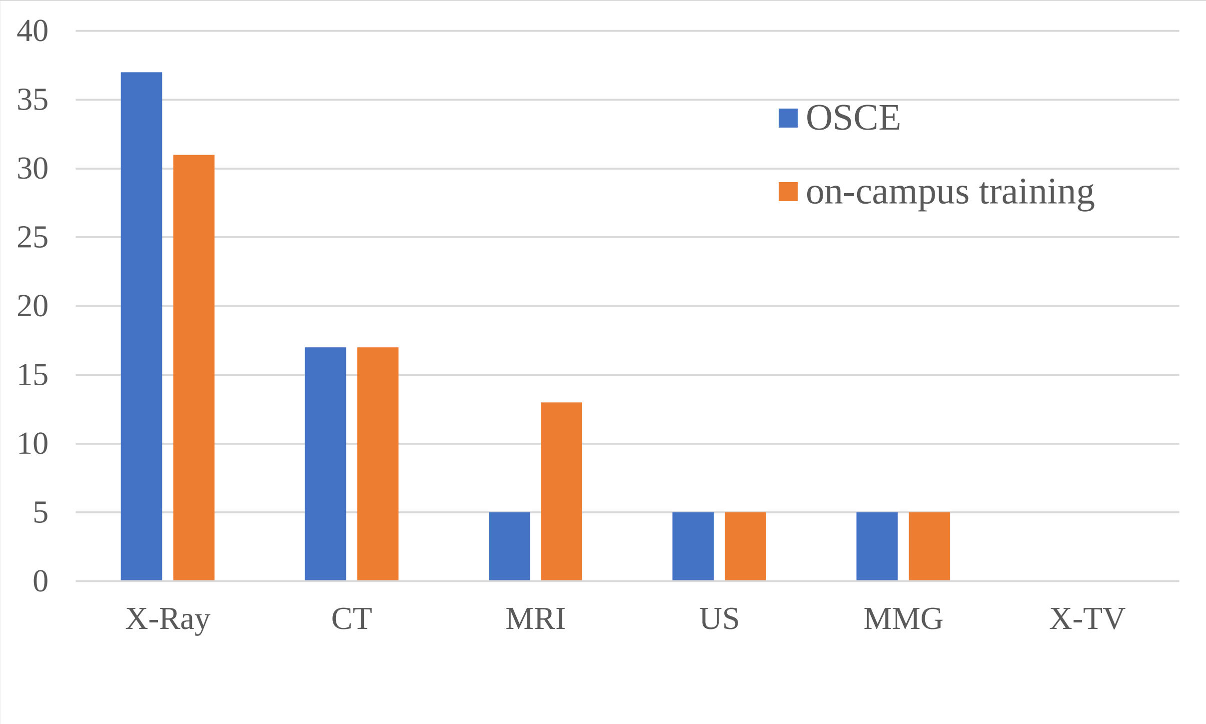


**Figure 1.** Useful modalities in clinical practice.

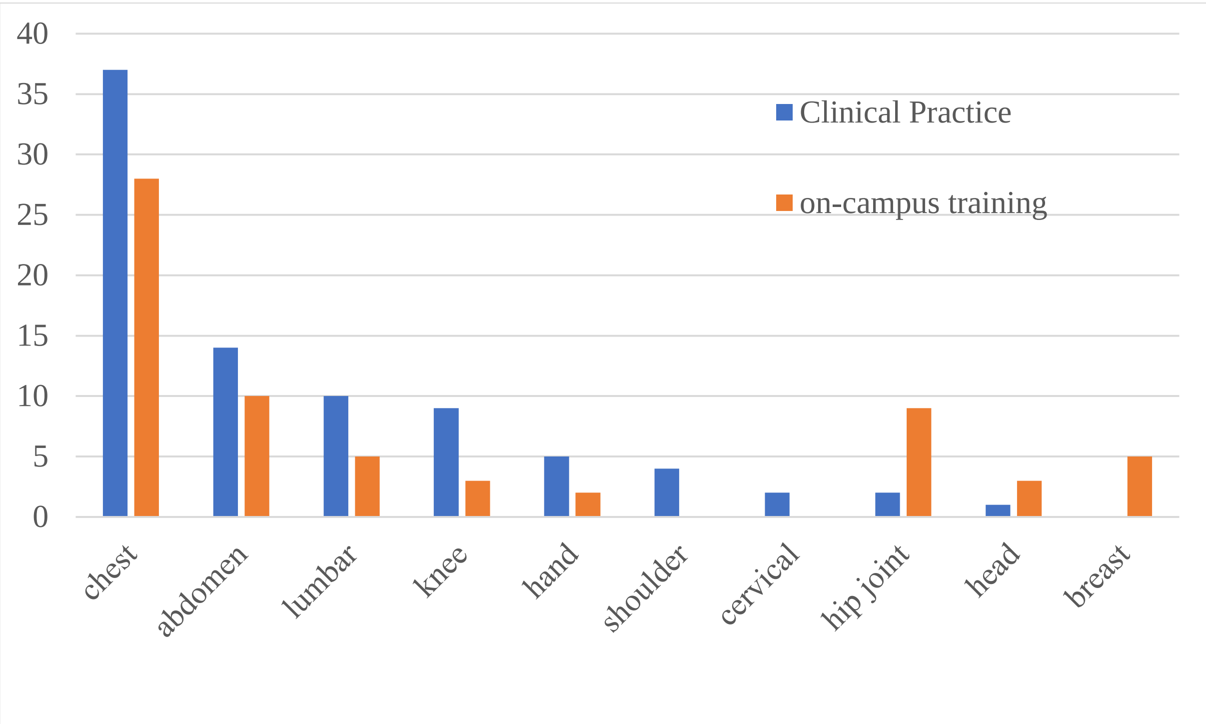


**Figure 2.** Positioning experienced in clinical practice and areas of imaging useful in on-campus training.

## DISCUSSION

***The student's positioning experience***

According to a previous survey, the current status of clinical training in the education of radiologic technologists is that the majority of clinical training is either observation-type clinical training or simulated clinical training conducted outside the framework of actual medical practice because students do not have a sufficient level of clinical practice ability to participate in medical practice, and the guidance system of clinical training facilities is insufficiently developed (Tokushige & Hoshino, 2021). However, our survey conducted in this study revealed that the majority of students (41 out of 44 students: 93%) had positioning experience in clinical practice.

Many students at four-year universities

experience clinical training at medical institutions affiliated with universities (university hospitals). University hospitals have educational, research, and clinical functions. While it is an attractive facility that provides adequate education, the radiology department is highly occupied during the daytime, and there is often insufficient time for teaching and supervising students in addition to normal duties. Therefore, it is expected that clinical training will be mainly in the form of observation, given the need for safe and efficient operations.

While most four-year universities have affiliated medical facilities, most of our clinical training facilities are private hospitals (100 to 200 beds), where many of our graduates work as radiologic technologists. These private hospitals have a relatively flexible work schedule, which allows for sufficient guidance and supervision of students, and thus, a clinical training guidance system that is enthusiastic about fostering junior students has been established.

***Effective preclinical training (educational effects of on-campus training, OSCE, and CBT)***

Based on the questionnaire survey, the modalities (body parts) in which students had the most opportunities to experience positioning under the guidance and supervision of instructors during clinical practice were X-ray (chest, abdomen, lumbar spine, and knee) and CT (head and chest). Therefore, we believe that the OSCE is an effective way to evaluate students' clinical practice skills for these modalities (sites) in preclinical practice evaluations.

Notably, MRI and X-rays (hip and head) were the modalities in which students had few opportunities to experience positioning in clinical practice. The reasons for the lack of positioning experience in hip joints in X-ray examinations may be due to the pain involved in the imaging position and consideration of the patient's sense of embarrassment. In head X-ray examinations, CT has become the mainstream. We believe that it is effective to improve students' understanding of clinical practice by giving them experience in imaging techniques for modalities and sites where positioning experience is not expected in clinical practice during on-campus training.

Other than MRI, mammography, ultrasonography, and X-ray TV were the most frequently observed modalities. The reason for this may be that examination results are easily influenced by the knowledge and skills of the examiner. Nuclear medicine examinations and radiotherapy examinations were also mainly observed because these examinations are relatively invasive to the patient and require the concentration of skilled technologists to perform the examinations and treatments. Therefore, providing students with experience through on-campus training and knowledge acquisition through CBT as much as possible is considered to be an effective preclinical training method, not only for MRI but also for other training items that are mainly performed on site.

***Limitations of the study***

This study was limited to Japan. Therefore, the results are limited, although they may be useful in other countries with different educational systems.

Notwithstanding the abovementioned research limitation, it is significant to note that this study reveals the characteristics of effective imaging techniques and knowledge for preclinical practice evaluation.

## CONCLUSIONS

A survey of students' positioning experiences in clinical practice revealed the current implementation of the practice of medical care participation. Consequently, it is effective to evaluate students in the OSCE for X-ray examinations of the chest, abdomen, lumbar spine, knees, and so on, as well as CT examinations of the head and chest, which have high frequency of positioning experiences in clinical practice. In addition, it is effective to provide students with experience in MRI, ultrasonography, and mammography, which are mainly performed on site, and to improve their knowledge level through CBT as part of preclinical training.

The results of this study suggest that the educational effectiveness of future clinical training with medical participation will strongly depend on the students' positioning experience during clinical training. Therefore, cooperation between training schools and medical institutions is considered to be extremely important to prevent differences in the level of practical skills instruction that students receive during clinical practice. The challenge is that both training schools and medical institutions need to share a common understanding of the level of practical training for radiologic technologists, and it is necessary to improve the content of preclinical training education while collaborating with external organizations.

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## DECLARATIONS

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**Conflict of interest**: No declaration

**Ethical Approval:** Before the survey, ethical approval for the study was obtained from Research Ethics Committee. Individual written consent was also obtained.

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**Table 1.** Educational content of radiologic technologist schools.

| **Educational contents** | | **Number of credits** |
|---|---|---|
| Basic field | Foundations of scientific thinking<br>People and life | 14 |
| Specialized basic fields | Structure and function of the human body and the origin of disease<br>Science and technology in health and welfare and radiation science and technology | 13<br>18 |
| Specialized field | Medical imaging technology and clinical imaging<br>Nuclear medicine technology<br>Radiotherapy technology<br>Medical imaging informatics<br>Radiation safety management<br>Medical safety management<br>Practical clinical imaging<br>Clinical practice | 18<br>6<br>7<br>6<br>4<br>2<br>2<br>12 |
| Total credits | | 102 |

**Table 2.** Content and number of hours of notified training.

| **Actions that can be performed** | **Basic training (minutes)** | **Practical training (minutes)** | |
|---|---|---|---|
| | | clip | craft |
| 1. Securing an intravenous line for a contrast medium or RI test, or removing the needle and stopping bleeding after the administration of RI test drugs is completed | 200 | 20 | 110 |
| 2. Connecting a device for injecting RI test drugs for RI testing and operating said device | 100 | 35 | 10 |
| 3. Connecting a contrast medium injection device to an arterial channel (except for securing the arterial channel), or operating a contrast medium injection device to administer contrast medium into an artery. | 200 | 50 | 45 |
| 4. Aspiration of injected contrast media and air for lower gastrointestinal tract examination (including CT colonography) | 100 | 45 | 25 |
| 5. Injection of contrast medium through a nasal catheter inserted for upper gastrointestinal tract examination, and removal of the nasal catheter after completion of administration of the contrast medium. | 100 | 15 | 30 |
| Total amount | 700 | 165 | 220 |
| | | 385 | |

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