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原　著

Student issues based on the results of clinical training of radiological technologists

臨床実習教育の成績に基づく診療放射線技師を目指す学生の課題

MUTO Hiroe, NAKAYA Koji, MATSUURA Kanae

Department of Radiological Technology, Faculty of Health Science, Suzuka University of Medical Science

Key words: Clinical training education, radiological technologist, student assignments, COVID-19

【Abstract】

The purpose of this study was to analyze the results from a 3-year clinical training evaluation conducted at the authors' university and to identify problematic issues in training education for students who aim to become radiological technologists. Participants were 325 university students who were in their fourth year of clinical radiological technologist training between 2019 and 2021. The clinical training evaluations of these students comprise a series of items and sub-items. We asked clinical training instructors to grade each item. Students had little knowledge about the cost of radiological examinations, and some students were unable to write training reports sufficiently. An analysis of clinical training evaluations indicated that some radiological technologist students had little knowledge about the cost of radiological examinations and showed poor report writing ability. Future clinical training should seek to strengthen the guidance offered to students on these topics in pre-education before conducting clinical training. We believe our findings can help facilitate further improvements in the development of clinical training.

【要 旨】

本学の3年間の臨床実習評価の結果を分析し，診療放射線技師を目指す学生の臨床実習教育の課題を特定することを目的とした．2019年から2021年までに臨床実習を行った325人の学生を対象とした．臨床実習の成績評価表の各項目に対し，全学生の各評価項目の点数を比較検討した．学生は診療報酬の知識がほとんどなく，一部の学生は臨床実習のレポートの書き方が不十分であった．臨床実習の評価の分析により，臨床実習教育の課題を見いだした．今後の臨床実習前に，これらの項目の事前教育を強化する必要がある．今後の臨床実習のさらなる発展に役立てたい．

Introduction

University training for radiological technologists in Japan follows a four-year curriculum. In those four years, students acquire the specialized knowledge necessary for practicing as a radiological technologist. In addition to classroom lectures, university education involves clinical skills training to prepare radiological technologists to work at a hospital. X-ray photography education, moreover, is continuously advancing, and thus clinical training education is indispensable for the production of aspiring radiological technologists[1]. At our university, clinical training is provided in the first half of the fourth year; during this training phase, students are taught by radiological technologists working in hospitals. The clinical training is conducted in a general hospital, and our aim is for students to acquire the clinical skills for the modality in which a given radiological technologist practitioner is engaged: general radiography, computed radiography, magnetic resonance imaging, angiography, ultrasonography, nuclear medicine, and radiotherapy. The Department of Radiation Technology Science at our university attracts more than 100 students from all over Japan every year. Therefore, because it is impossible to provide clinical training in a hospital near the university for all the students, we ask students to conduct their clinical practice at their local hospital. In the past, clinical training centered on the tour type has been conducted. However, in recent years, participatory clinical training has begun to be adopted to help students acquire more clinical skills[2]. At this point in their training, students do not yet have a radiological technologist license; therefore, they are not allowed to irradiate patients, although they have acquired other clinical

武藤 裕衣，中舎 幸司，松浦 佳苗

鈴鹿医療科学大学　保健衛生学部　放射線技術科学科

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skills through clinical training (e.g., patient treatment, image analysis processing, and understanding of examination content).

As part of our clinical training grade evaluations, hospital-based clinical training instructors engaged in student guidance are asked to rate the grade evaluations created by our university. On the basis of the grade evaluations provided by the clinical instructors, the credits for clinical training are approved or rejected. However, we realized the potential usefulness for clinical training development (and thus for students) of identifying potentially problematic issues from among the grade evaluation data. Therefore, the purpose of this study was to analyze the past 3 years' grade evaluations for clinical training at our institution in Japan and to identify problems in clinical training education for students.

Materials and Methods

Targets

A total of 325 participants comprised: 100 students (69 male, 31 female) who underwent their fourth-year university clinical training in 2019; 108 students (61 male, 47 female) who underwent their fourth-year university clinical training in 2020; and 117 students (69 male, 48 female) who underwent their fourth-year university clinical training in 2021. The prescribed duration for clinical training set by our university is 57 days (training time per day is 8 hours). However, in 2020 and 2021, the clinical training period for some students was shortened owing to the response of the local hospital in which they were training to the effects of coronavirus disease 2019 (COVID-19) infection. This study was approved by our University's Conflict of Interest Management Committee and its Clinical Research Ethics Review Committee.

Grade evaluations for clinical training

Table 1 shows the items that comprise the clinical training evaluation for our university. The main items used for evaluation are as follows: item 1 evaluates the acquisition of basic practical radiological technologist skills; item 2 evaluates the development of knowledge about and analytical ability for operating the hospital radiation department; item 3 evaluates the ability to respond appropriately to patients; and item 4 evaluates the development of responsibility and awareness as a member of the medical team. To assess the topics covered in the main items in more detail, seven sub-items were set for each main item, as shown in Table 1. After clinical training is completed, the clinical training instructor evaluates all the sub-items for each student on a 4-point scale (1 point: inferior, 2 points: standard, 3 points: good, 4 points: excellence). From FY2019 to FY2021 the clinical training evaluations were conducted using the same method described above. The setting and evaluation method for these clinical training evaluation items were created by the university's clinical training instructor and have been used for 3 years to evaluate the university's clinical training program.

Comparison of clinical training evaluation scores (comparison of sub-items)

The sub-item scores (average value ± standard deviation (SD)) for the clinical training evaluation for all students (total students from 2019 to 2021) were calculated. The score for each sub-item (average value ± SD) was calculated for each year, and a comparison was made to see if there were differences in each sub-item score in each year.

Comparison of clinical training evaluation scores (comparison of main items)

The average values ± SDs of the main items were calculated from the average sub-item values for all students, and the overall scores

Table 1 Main and sub-items for clinical training evaluation

Items for grade evaluation in clinical training
Main item 1: Acquire basic practical skills as a radiological technologist
Sub-item 1-1. You can work on pre-learning and take part in practical training.
Sub-item 1-2. You can record what you experienced in training in the report and use it in future training.
Sub-item 1-3. You can clarify your own tasks from daily reports and study to gain knowledge that you lack.
Sub-item 1-4. You can work on the tasks you have been instructed to do and give feedback on the next day's training.
Sub-item 1-5. You know the structure and installation of the hospital that considers patient safety (including infection prevention and accident prevention) and comfort, and you can explain these in the report.
Sub-item 1-6. You understand the structure and installation of hospitals with staff safety (including infection prevention and accident prevention) and comfort in mind, and you can write down their characteristics in a report.
Sub-item 1-7. You can correlate and analyze the knowledge and theory learned in the classroom with the experience and situations in clinical practice.
Main item 2: Develop knowledge about and analytical skills for the operation of the hospital radiation department
Sub-item 2-1. You comply with the rules set by the training facility.
Sub-item 2-2. You do not view electronic medical records without the permission of the leader.
Sub-item 2-3. You do not record any personally identifiable information in the report.
Sub-item 2-4. During training, you do not leave your records or belongings on the desk in the imaging room or elsewhere.
Sub-item 2-5. You understand the functions and roles of the Radiology Department members (chief radiological technologist, sub-chief radiological technologist, chief radiological technologist of each modality, etc.).
Sub-item 2-6. You understand the role of the chief for each modality.
Sub-item 2-7. You understand the medical fees that are required for each radiological examination.
Main item 3: Learn how to respond appropriately to patients
Sub-item 3-1. Your appearance is suitable for medical personnel, and you can perform clinical training.
Sub-item 3-2. You can greet patients, staff, and leaders, etc.
Sub-item 3-3. You use polite language, such as using honorifics, when talking to patients.
Sub-item 3-4. You give an honorific title to your surname when you call a patient.
Sub-item 3-5. You try to read the patient's emotions in their facial expressions and wording.
Sub-item 3-6. You can respond to the patient with a clear and easy-to-hear voice.
Sub-item 3-7. You can flexibly adapt to children and elderly patients.
Main item 4: Develop responsibility and awareness as a member of the medical team
Sub-item 4-1. You are not late for clinical training.
Sub-item 4-2. You can keep the time you have promised to your teacher or clinical practice leader.
Sub-item 4-3. You reveal your whereabouts to the clinical practice leader and act (i.e., do not take a break without permission).
Sub-item 4-4. You can meet deadlines for submitting clinical training reports and other assignments.
Sub-item 4-5. You strive to improve what has been noted by clinical practice leaders and teachers.
Sub-item 4-6. You take care of your own health.
Sub-item 4-7. If you have any questions, you ask or consult with the medical team leader.

for each main item were compared. The average values ± SDs of the main items for each year were calculated from the average value of the sub-items for each year, and the overall scores for the main items were compared to identify differences.

Statistical analysis

The Kruskal-Wallis test of one-way ANOVA was used to test for significance. The significance level was set to $p<0.05$. The P-value used a two-sided test. When a significant difference was observed between groups, the p-value-corrected Dann-Bonferroni test was used to determine which group differed significantly. Again, the significance level was $p<0.05$. We used Statistical Package for the Social Sciences (SPSS), version 26.0 (SPSS Inc., Chicago, IL, USA) for these analyses.

Results

Comparison of clinical training evaluation scores (comparison of sub-items)

Figure 1 shows the results of the clinical training evaluation scores for each sub-item for all students (total students from 2019 to 2021). The scores for each sub-item were as follows: 1-1 was 3.13 ± 0.62, 1-2 was 3.23 ± 0.60, 1-3 was 3.15 ± 0.60, 1-4 was 3.23 ± 0.59, 1-5 was 3.07 ± 0.53, 1-6 was 3.05 ± 0.53, 1-7 was 3.04

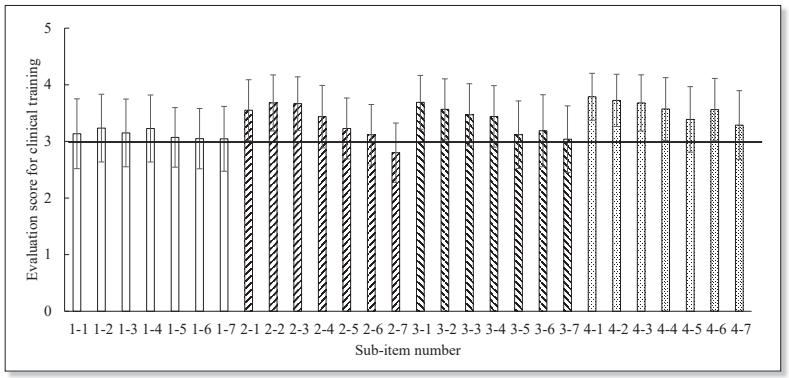

Figure 1 Scores for sub-items in the clinical training evaluations for all students (total students from 2019 to 2021). The horizontal black line indicates the average score of 3 points (good).

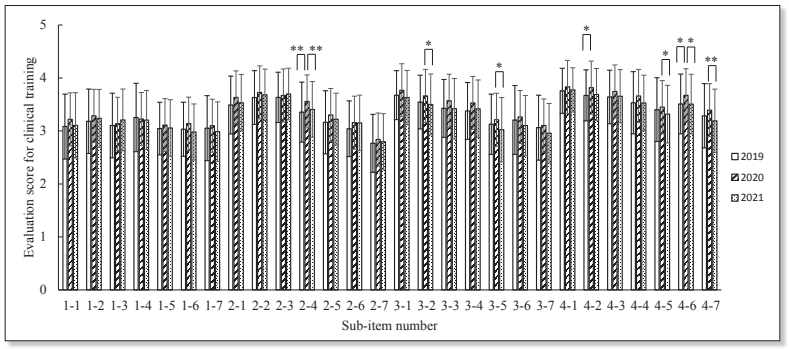

Figure 2 Scores for sub-items in the clinical training evaluations for each year. The Kruskal-Wallis test was used to test for significant differences between other groups. The significance level was set to P<0.05. When a significant difference was found, the P-value-corrected Dann-Bonferroni test was used to determine which group differed significantly.
*P<0.05, **P<0.01.

± 0.57, 2-1 was 3.55 ± 0.54, 2-2 was 3.68 ± 0.50, 2-3 was 3.67 ± 0.47, 2-4 was 3.44 ± 0.55, 2-5 was 3.23 ± 0.54, 2-6 was 3.12 ± 0.54, 2-7 was 2.80 ± 0.52, 3-1 was 3.69 ± 0.48, 3-2 was 3.57 ± 0.54, 3-3 was 3.47 ± 0.55, 3-4 was 3.44 ± 0.54, 3-5 was 3.12 ± 0.60, 3-6 was 3.19 ± 0.64, 3-7 was 3.04 ± 0.59, 4-1 was 3.79 ± 0.41, 4-2 was 3.72 ± 0.46, 4-3 was 3.68 ± 0.50, 4-4 was 3.57 ± 0.55, 4-5 was 3.39 ± 0.58, 4-6 was 3.56 ± 0.55, and 4-7 was 3.29 ± 0.61.

Figure 2 shows a graph comparing each sub-item of the clinical training evaluation classified in 2019–2021. The Kruskal-Wallis test revealed significant differences between the years for the sub-items 2-4, 3-2, 3-5, 4-2, 4-5, 4-6, and 4-7 (sub-items 3-2, 3-5, 4-2, and 4-5 were $p<0.05$, and sub-items 2-4, 4-6, and 4-7 were $p<0.01$). The results of the Dann-Bonferroni test were as follows: $p<0.05$ was seen between 2020 and 2021 in 3-2, between 2020 and 2021 in 3-5, between 2019 and 2020 in 4-2, between 2020 and 2021 in 4-5, between 2019 and 2020 in 4-6, and between 2020 and 2021 in 4-6. We observed $p<0.01$ between 2019 and 2020 in 2-4, between 2020 and 2021 in 2-4, and between 2020 and 2021 in 4-7.

Comparison of clinical training evaluation scores (comparison of main items)

Figure 3 shows the scores for each of the main items for all students; they were: 3.13 ± 0.08 for 1, 3.35 ± 0.32 for 2, 3.36 ± 0.25 for 3, and 3.57 ± 0.18 for 4. The Kruskal-Wallis test showed a significant difference between groups ($p<0.05$). The Dann-Bonferroni test showed a significant difference between main items 1 and 4 ($p<0.01$).

Figure 4 shows a graph comparing each main item in the clinical training evaluation classified in 2019–2021. Scores for main item 1 were: 3.11 ± 0.08 in 2019, 3.17 ± 0.07 in 2020, and 3.11 ± 0.11 in 2021. Scores for main item 2 were: 3.30 ± 0.32 in 2019, 3.41 ± 0.33 in 2020, and 3.36 ± 0.32 in 2021. Scores for main item 3 were: 3.35 ± 0.22 in 2019, 3.44 ± 0.25 in 2020, and 3.29 ± 0.26 in 2021. Finally, scores for main item 4 were: 3.54 ± 0.26 in 2019, 3.65 ± 0.17 in 2020, and 3.52 ± 0.21 in 2021. The Kruskal-Wallis test showed no significant difference between the years in any of the major items (n.s.).

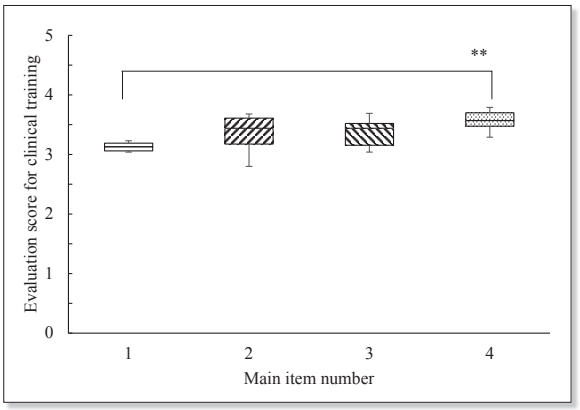

Figure 3 Scores for main items in the clinical training evaluations for all students (total students from 2019 to 2021). The Kruskal-Wallis test was used to test for significant differences between other groups. The significance level was set to $P<0.05$. When a significant difference was found, the P-value-corrected Dann-Bonferroni test was used to determine which group differed significantly.
**$P<0.01$.

Discussion

The purpose of this study was to analyze the grade evaluations for clinical training for the past three years at our institution and to identify problems in clinical training education for students. For students who aim to become medical professionals, clinical training education can give them the necessary skills for clinical practice. Therefore, this research attempts to identify and highlight problematic issues in students' clinical training to inform and facilitate the further development and improvement of clinical training education.

First, the method used for clinical training evaluation will be mentioned. The Likert scale is used for the clinical training evaluation of this study. In order to easily evaluate the comparison of clinical training evaluation items and the comparison of each year, the analysis was performed by quantifying the Likert scale. In addition, we asked clinical

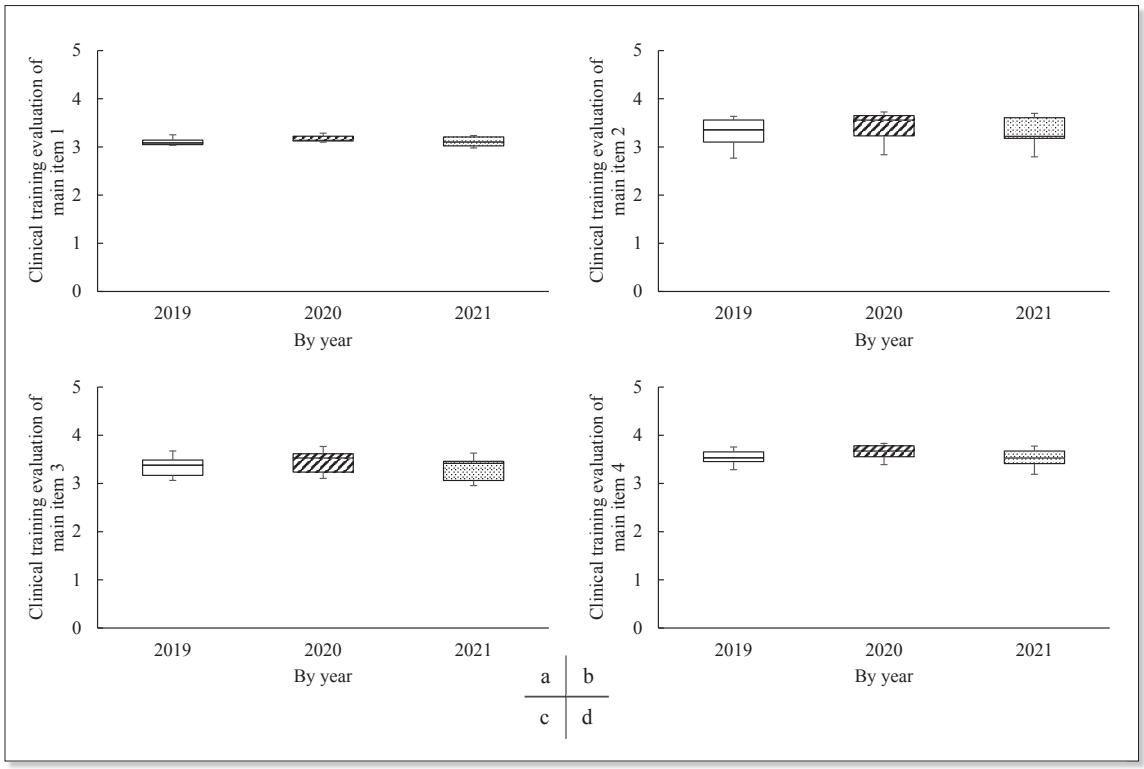

Figure 4 Scores for main items in the clinical training evaluations for each year. (a) Main item 1 score. (b) Main item 2 score. (c) Main item 3 score. (d) Main item 4 score. The Kruskal-Wallis test was used for the significance test between other groups. The significance level was set to $P<0.05$. No significant difference was found in any of the Main items (n.s.).

training instructors to evaluate the Likert scale in four stages without using the median. This is because the absence of an intermediate value makes it possible to remarkably evaluate the quality of each item of students and facilitate future student guidance.

The first notable outcome from this study is the consistently satisfactory average scores for the clinical training results among all students across all 3 years. The average score for most of the sub-items was 3.0 or higher, which indicates that students were able to perform clinical training well in the areas and topics covered by the evaluation items. Only sub-item 2-7 had an average score of less than 3. This item addresses medical fees. Clinical training instructors mainly provide information and direction about how to handle medical devices and how to communicate with patients during clinical work. While some clinical training instructors also inform students about medical fees, most do not. Additionally, even in university classes, there are no official lectures that explain medical fees for each type of medical examination. This can help explain why these students' understanding of this item was the poorest, and the associated scores the lowest. However, when a student becomes a radiological technologist and works at a hospital, knowledge about medical fees is always essential. Patients often ask medical staff about the cost of their tests. Therefore, it is necessary to introduce classes to improve students' knowledge about medical fees.

The second outcome to underscore is the higher grades observed for some of the sub-items in 2020 compared with other years. Furthermore, no differences were observed in the average scores for the sub-items in 2019 and 2021. In 2020 and 2021, students' clinical training underwent changes influenced by the COVID-19 pandemic. Recent clinical training education has shifted to address COVID-19 infections[3]. More specifically, the clinical training curriculum was unexpectedly changed in some cases, and/or the clinical training period shortened, to prevent students from contracting COVID-19, and to protect students' mental health[4, 5]. Moreover, students whose clinical training period was shortened were also expected to study independently when they were not engaged in clinical training. Thus, although many facilities were forced to change some aspects of their clinical training teaching methods, some of the evaluation items were scored the same or better than before the changes were enacted. Currently, to improve clinical training, workshops are also held to further educate clinical training instructors. Some reports indicate that clinical training instructors have low participation rates in these workshops[6], despite bearing all the responsibility for their students during the clinical training period[1]. In addition, the quality of the instructor's teaching ability has a substantial impact on student learning[6-9]. Therefore, in Japan, to improve the leadership skills of clinical training instructors who train radiological technologists, the number of facilities participating in these workshop is increasing. Furthermore, university faculty members continue to work well with students and hospital-based clinical training instructors to improve clinical training. Therefore, even during the period of restricted clinical training owing to COVID-19, the students were able to receive high-quality clinical training education. The reasons why we were able to carry out sufficient clinical training even with COVID-19 disasters are "sufficient guidance on infection control in pre-education of clinical training", "thoroughness not to go out unnecessarily", "students will be on standby at home from 2 weeks before the start of clinical training", and "Students and clinical training instructors and faculty members will be in close contact", etc. In addition, the students themselves kept a high awareness of infection prevention, and they wanted to acquire clinical techniques, so we think that they were successful in the

clinical training during the prevalence of COVID-19.

Here, we will describe the attendance of student education guidance in order to improve the leadership of clinical training instructors. On September 30, 2021, the Ministry of Health, Labor and Welfare of Japan revised the guidelines for guidance at radiological technologist training centers. As part of the amendment, it is stated that hospitals that conduct clinical training should have radiological technologists who have completed the radiological training instructor training course[10]. Improving the leadership of clinical training instructors is a very important item, and we hope that this revision will lead to the further development of clinical training education.

A comparison of the main items for all grades showed that the acquisition of basic practical abilities as a radiological technologist was the lowest scoring item. This main item was, moreover, considerably lower than the item that addresses fostering responsibility and awareness as a member of the medical team; its content deals mainly with sub-items that evaluate the technological knowledge required to complete a report. The clinical training instructor requires students to write their own thoughts in their own words in their reports, including their experiences and activities on a given day of clinical training. However, some students find it difficult to express in their own words what they were involved in during medical examinations on the day. Such students rather describe the contents of the textbook as if it were their report. Therefore, we would like to offer proper guidance on how to write a report through pre-education in clinical training.

In our comparison of main items in the clinical training evaluations for each student cohort, we used the same evaluations for each year. While some sub-items differed considerably across cohorts, a comprehensive assessment of the main items indicated there were no differences in evaluations across cohorts.

On the basis of the foregoing analyses, we noted that students lacked knowledge about medical fees and that some students could not write reports well. To improve these aspects in future, we would like to enhance the relevant instructions in pre-education courses and in-person clinical training. Clinical training education is necessary for preparing students to play active roles as radiological technologists. We want students to be at the forefront of the medical field when they become radiological technologists and engage in clinical work. Thus, the problems identified in this research can facilitate improvements in those areas to produce higher quality radiological technologists.

One limitation of this study is that the clinical training evaluation we analyzed was only a four-stage evaluation (i.e., 1 point: inferior, 2 points: standard, 3 points: good, 4 points: excellent). If the evaluation stages were extended, differences may appear in other items. Therefore, in the future, we would like to review the scoring criteria for evaluations. A further limitation is the absence of evaluation for each modality in the clinical training evaluation we studied; rather, it is an evaluation of the entire clinical training process. Importantly, students have likes and dislikes and various weaknesses in different modalities. Therefore, a separate assessment should be conducted for each modality's clinical training evaluation. Additionally, reports indicate that remote lectures have been adopted in various school settings in response to the spread of COVID-19, and that they have had a positive educational effect for students[11-14]. Furthermore, education that incorporates e-learning into existing lessons has been shown to be effective[5, 15, 16]. The e-learning system is not introduced in this research. we would like to create an e-learning

program for distance learners whose clinical training has been interrupted or shortened because of COVID-19. Finally, another study reported on the creation and effective use of a video recording of a radiological technologist's work for student education[17]. We wish to contribute to the further development of clinical training education by incorporating the trials of those previous reports.

Conclusion

The findings from our analysis of the grade evaluations for clinical training for the past three years at our institution show that some students' knowledge about medical fees was weak and their reports poorly written. It is, therefore, essential to improve students' knowledge and skills in the areas in which they are weakest by including a pre-education phase for clinical training and by enhancing the future development of clinical training education.

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Conflicts of Interest / Funding Statement

The authors declare no conflicts of interest associated with this manuscript.

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