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Improving Radiographers' Knowledge Through the Dissemination of Research Findings on Brain CT Examination Techniques for Emergency Patients to Overcome Motion Artifacts

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ABSTRACT

This community service activity aimed to improve radiographers' knowledge and understanding of how to manage motion artifacts in computed tomography (CT) examinations and how to apply a fast-scan protocol to emergency patients. Motion artifacts are image distortions caused by patient movement during data acquisition, and they can reduce diagnostic image quality. They are a particular concern in emergency patients, especially those with head trauma, reduced consciousness, or difficulty maintaining position during the examination. The activity was designed as an educational intervention with a one-group pre-test–post-test evaluation. It consisted of a dissemination session on research findings concerning brain CT examination techniques, followed by an assessment of participants' knowledge using a 15-item questionnaire covering the concept of motion artifacts, their causes, preventive measures, radiographer–patient communication, and the fast-scan protocol for head CT. Eleven radiographers at the Radiology Installation of RSI Siti Rahmah Padang took part. The mean proportion of correct answers was 37.6% in the pre-test and 100% in the post-test, a descriptive increase of 62.4 percentage points. These results indicate that the dissemination session had a positive effect on participants' knowledge of motion artifact prevention and of the importance of applying a fast-scan protocol in emergency patients. The activity is expected to support radiographers' competence in optimizing image quality, examination efficiency, and patient safety. Further evaluation through practice observation and image quality assessment is needed to determine whether this knowledge is applied in radiology services.

Keywords : brain CT; motion artifacts; fast scan; emergency patients; radiographers; community service

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INTRODUCTION

Radiology services, particularly brain computed tomography (CT), play an important role in establishing the diagnosis of emergency patients with conditions such as traumatic brain injury, stroke, intracranial hemorrhage, reduced consciousness, and other acute neurological disorders. Non-contrast head CT is the primary imaging modality in these situations because it produces images of brain anatomy quickly and accurately and is highly sensitive in detecting acute abnormalities that require immediate management [1,2]. In hospital radiology installations, radiographers are the main personnel responsible for patient preparation, setting examination parameters, selecting imaging techniques, and controlling image quality. However, examining emergency patients is challenging because many of them are clinically unstable, restless, uncooperative, in pain, have reduced consciousness or seizures, or are unable to follow instructions during the examination.

These conditions lead to a high incidence of motion artifacts, that is, image distortions caused by patient movement during CT data acquisition. Motion artifacts reduce image quality and appear as blurring, streaks, and poorly defined anatomical structures of the brain, which may affect diagnostic interpretation [3,4]. In a survey of CT technologists, motion was the most frequently encountered type of artifact, and patient-related factors were the most commonly reported cause, while patient preparation was the most widely used preventive measure [3]. Various reconstruction and deep learning–based methods have been developed to estimate and compensate for head motion in CT [4–7], but these methods are not yet routinely available in most clinical settings. Prevention at the time of scanning therefore remains the radiographer's main responsibility.

Initial observations and discussions with the partner institution revealed that brain CT techniques for reducing motion artifacts were applied inconsistently, including the use of patient immobilization, the timing of acquisition, the selection of examination parameters, and strategies for communicating with patients and their families. In addition, research findings on motion artifact management had not been fully disseminated to practicing radiographers. Based on these conditions, the partner faced the following problems: (1) radiographers had limited knowledge of recent research findings on brain CT techniques for overcoming motion artifacts in emergency patients; (2) research findings had not been optimally used as a basis for evidence-based radiological practice; (3) brain CT techniques varied, especially in the use of immobilization methods, patient positioning, exposure parameter settings, and the timing of acquisition; (4) emergency patients carried a high risk of motion artifacts because they were uncooperative, restless, in pain, had reduced consciousness, or made involuntary movements; (5) there had been no regular dissemination or capacity-building activities on strategies for managing motion artifacts in brain CT; and (6) degraded image quality due to motion artifacts could lead to repeat scans, higher patient radiation doses, delayed diagnosis, and lower quality of radiology services.

Image rejection and repeat examinations are recognized quality indicators in radiology, and patient-related factors such as positioning and movement are among the leading reasons for rejected images [8]. At the same time, studies of radiology practitioners show that limited time, supervision, and research skills hinder the use of research evidence in daily practice [9]. Faster acquisition protocols have been shown to maintain diagnostic image quality while shortening scan time and reducing radiation exposure in patients who cannot remain still [10], which makes them relevant to emergency head CT. Structured educational activities for radiology personnel, evaluated with pre-tests and post-tests, have consistently improved participants' knowledge in areas such as effective communication, radiation protection, X-ray equipment calibration, and CT quality control [11–14].

Disseminating research findings to radiographers is also in line with the Merdeka Belajar Kampus Merdeka (MBKM) policy, which emphasizes the downstreaming of research results so that they can be used by the community and by industry. Therefore, this community service activity aimed to improve radiographers' knowledge of brain CT examination techniques for emergency patients, particularly the prevention and management of motion artifacts and the application of a fast-scan protocol, through the dissemination of research findings.

METHODOLOGY

Activity Design

This community service activity used an educational approach in the form of a dissemination (socialization) session on research findings, combined with a one-group pre-test–post-test evaluation design. The design was chosen to describe changes in participants' knowledge before and after the intervention, as is commonly done in educational community service activities for radiology personnel [11–14].

Time, Location, and Participants

The activity was held on Monday, 28 September 2026, at the Radiology Installation of RSI Siti Rahmah Padang, West Sumatra, Indonesia. The participants were all 11 radiographers working at the hospital who attended the activity (total sampling).

Stages of the Activity

The activity was carried out in three stages:

a. **Preparation.** The team coordinated with the partner hospital to identify problems in brain CT examinations through initial observation and discussion with radiographers. The team then prepared dissemination material based on research findings on brain CT examination techniques for emergency patients, covering the concept and causes of motion artifacts, their effect on image quality, preventive measures before scanning,

radiographer–patient communication, management of patients who cannot follow instructions, considerations for pediatric patients, and the fast-scan protocol for head CT. The team also developed the evaluation questionnaire.

b. **Implementation.** Participants first completed the pre-test to measure their baseline knowledge. The team then delivered the dissemination material on the research findings, after which participants completed the post-test using the same questionnaire.
c. **Evaluation.** Participants' pre-test and post-test answers were scored and compared to determine the change in knowledge for each item and overall.

Instrument

Knowledge was measured with a 15-item multiple-choice questionnaire. Items 1–10 covered the definition and causes of motion artifacts, the effect of patient movement on image quality, patients at risk, preventive measures before scanning, radiographer–patient communication, measures to reduce movement, management of patients unable to follow breath-hold instructions, measures for pediatric patients, and key principles for managing motion artifacts. Items 11–15 covered the definition and purpose of fast scanning, patient conditions that warrant a fast-scan protocol, the importance of scan time in emergency patients, and correct statements about fast scanning in emergency head CT.

Data Analysis

Data were analyzed descriptively. For each item, the number and percentage of correct answers were calculated for the pre-test and post-test, and the change was expressed in percentage points. The overall mean percentage of correct answers was calculated as the total number of correct answers divided by the total number of answers (15 items × 11 participants = 165 answers). Because of the small number of participants and the ceiling effect in the post-test, no inferential statistical test was performed.

RESULTS AND DISCUSSION

The community service activity was carried out at the Radiology Installation of RSI Siti Rahmah Padang on Monday, 28 September 2026, with 11 radiographers working at the hospital as participants. The activity began with the pre-test, followed by the dissemination of research findings on brain CT examination techniques for emergency patients, and ended with the post-test (Figure 1).



Figure 1. Dissemination session with radiographers at the Radiology Installation of RSI Siti Rahmah Padang

The pre-test and post-test results for each questionnaire item are presented in Table 1. In the pre-test, the participants gave 62 correct answers out of 165 (mean 37.6%). In the post-test, all participants answered all 15 items correctly (165 of 165; 100%), an increase of 62.4 percentage points.

Table 1. Pre-test and post-test results by questionnaire item (n = 11)

No.	Questionnaire item	Pre-test correct, n (%)	Post-test correct, n (%)	Change (pp)
1	Definition of motion artifacts in CT	11 (100.0)	11 (100.0)	0.0
2	Main cause of motion artifacts	11 (100.0)	11 (100.0)	0.0
3	Effect of patient movement on image quality	3 (27.3)	11 (100.0)	+72.7
4	Patients at highest risk of motion artifacts	5 (45.5)	11 (100.0)	+54.5
5	Preventing motion artifacts before scanning	3 (27.3)	11 (100.0)	+72.7
6	Importance of good radiographer–patient communication	4 (36.4)	11 (100.0)	+63.6
7	Measures to reduce motion artifacts caused by patient movement	2 (18.2)	11 (100.0)	+81.8
8	Action to take when the patient cannot follow breath-hold instructions	2 (18.2)	11 (100.0)	+81.8
9	Measures for pediatric patients who have difficulty maintaining position	3 (27.3)	11 (100.0)	+72.7
10	Key principle in managing motion artifacts	5 (45.5)	11 (100.0)	+54.5
11	Definition of fast scan in head CT	1 (9.1)	11 (100.0)	+90.9
12	Main purpose of fast scan in emergency patients	1 (9.1)	11 (100.0)	+90.9
13	Patient conditions that warrant a fast-scan protocol	2 (18.2)	11 (100.0)	+81.8

No.	Questionnaire item	Pre-test correct, n (%)	Post-test correct, n (%)	Change (pp)
14	Why scan time matters in emergency patients	5 (45.5)	11 (100.0)	+54.5
15	Most accurate statement about fast scan in emergency head CT	4 (36.4)	11 (100.0)	+63.6
	Total correct answers / mean (%)	**62/165 (37.6)**	**165/165 (100.0)**	**+62.4**

pp = percentage points.

DISCUSSION

Participants' Baseline Knowledge

The pre-test results for the 11 participants show that their baseline knowledge of motion artifacts in CT and of the fast-scan protocol varied. Some topics were already well understood, but most participants had difficulty with the prevention of motion artifacts, communication with patients, and the application of a fast-scan protocol in emergency patients. For items 1 and 2, all participants (11; 100%) correctly answered the questions on the definition of motion artifacts and their main cause. This indicates that the participants already had basic knowledge of motion artifacts and their causes. However, this basic understanding was not yet matched by the ability to determine appropriate preventive and corrective measures.

For items 3 to 10, the pre-test results show that participants' knowledge still needed improvement. For example, only 3 participants (27.3%) correctly answered the question on the effect of patient movement on image quality, while 8 (72.7%) answered incorrectly. Only 3 participants (27.3%) correctly answered the question on preventing motion artifacts before scanning, and only 2 (18.2%) correctly answered the question on measures to reduce motion artifacts caused by patient movement.

These results indicate that participants needed a stronger understanding of the relationship between patient movement and reduced image quality, patient preparation before the examination, the indicated use of immobilization devices, and the delivery of clear, easily understood instructions. This is consistent with the finding that patient preparation is the measure most widely used by CT technologists to avoid artifacts [3]. Effective radiographer–patient communication is also important in helping patients maintain their position during the examination [11]. Baseline knowledge of the fast-scan protocol was also relatively low. Only 1 participant (9.1%) correctly answered each of items 11 and 12, which concerned the definition of fast scanning and its main purpose in emergency patients, and only 2 participants (18.2%) correctly answered item 13. These findings show the need for dissemination on the concept of fast scanning, its indications, and the role of scan time in managing emergency patients. Overall, the pre-test results show that although participants understood the basic concept of motion artifacts, their practical knowledge of preventive strategies,

management of patient movement, and the fast-scan protocol needed to be strengthened through education and training.

Change in Knowledge after Dissemination

In the post-test, all 11 participants answered all 15 items correctly. Each item received 11 correct answers and no incorrect answers, so the percentage of correct answers reached 100% for every indicator assessed. All participants answered the questions on the definition of motion artifacts and their main cause correctly, showing that their basic understanding remained good after the educational session.

Improvement was also seen in knowledge of the effect of patient movement on image quality, the identification of patients at risk of motion artifacts, and preventive strategies before CT scanning. All participants correctly answered the questions on radiographer–patient communication, measures to reduce movement, management of patients who have difficulty following breath-hold instructions, and measures that can be considered for pediatric patients. The largest gains (90.9 percentage points) occurred in items 11 and 12 on the definition and purpose of fast scanning, which were the topics least understood at baseline.

These results show that, based on the post-activity measurement, participants understood the material on patient preparation, effective communication, instruction delivery, and measures to reduce movement. In practice, these measures must still be adapted to the patient's clinical condition, standard operating procedures, and patient safety principles. All participants also correctly answered the questions on the definition of fast scanning, its purpose in emergency patients, the conditions that warrant its use, and the importance of scan time in emergencies. This indicates a good understanding of the role of an efficient head CT protocol in emergency patients after the session. The magnitude of the improvement is greater than that reported in comparable educational activities for radiology personnel, in which mean scores rose from 58.4 to 86.7 [11] and from 53.8% to 89.5% [13]. However, the post-test results reflect knowledge measured by a questionnaire. They do not directly demonstrate that participants' technical skills in reducing motion artifacts or applying the fast-scan protocol have improved. Assessing these skills requires additional evaluation through practice observation, simulation, or CT image quality assessment.

Strategies for Preventing Motion Artifacts

The dissemination material presented strategies for preventing motion artifacts at three points in the examination: before, during, and after scanning.

Before the examination. The radiographer assesses the patient's condition by identifying the level of consciousness, ability to follow instructions, airway, breathing, pain, seizures, and the potential for involuntary movement. Stabilization according to emergency procedures takes priority. If the patient is

conscious and cooperative, the radiographer gives short, clear instructions, for example: "Sir/Madam, this examination will be short. Please try to keep your head still until it is finished." The head is positioned correctly in the head holder, appropriate pads or immobilization devices are used, and the radiographer ensures that the head is not tilted or excessively rotated, while avoiding pressure that could harm a trauma patient. The radiographer also checks that the scanner, protocol, table position, patient communication, intravenous lines, and monitoring equipment are ready, and avoids delays once the patient has been positioned.

During the examination. The radiographer uses a fast brain CT protocol appropriate to the indication and selects an acquisition mode with a short rotation time or scan duration according to the scanner's capabilities and the diagnostic needs. The field of view (FOV) must be appropriate: unnecessary coverage should be avoided, but important anatomy must not be missed. The patient is monitored from the console for head movement, coughing, vomiting, seizures, or changes in clinical condition; patient monitoring must never be sacrificed for the sake of a faster examination. A fast-scan protocol can be used when available, provided it has been validated to produce adequate diagnostic images and not merely to shorten scan time [2,10]. Scans should not be repeated automatically; the radiographer should first determine whether the artifact actually interferes with clinical assessment.

After the examination. The radiographer evaluates the axial images and any other reconstructions available according to the protocol, and checks whether key anatomy can be assessed, especially the brain parenchyma, ventricles, skull, and the area of clinical concern. If the images are inadequate to answer the clinical question, the radiographer consults the radiologist to decide whether a repeat scan is needed. Artifacts, corrective actions, the reason for any repeat scan, and the radiation dose are documented according to local procedures. Systematic documentation of repeated or rejected images supports quality monitoring and the setting of local reference levels [8].

Fast-Scan Protocol in Emergency Head CT

A fast-scan protocol is a CT examination approach that optimizes image acquisition time so that the examination can be performed quickly and efficiently, especially in emergency patients who need an immediate diagnosis. In head CT, this approach is important for identifying life-threatening conditions such as intracranial hemorrhage, traumatic brain injury, mass effect, and other acute abnormalities [1]. Fast scanning is not simply a matter of scanning faster; it means optimizing the examination protocol while maintaining diagnostic image quality, patient safety, and adequate anatomical coverage [2]. Applying a fast-scan protocol in emergency patients can:

1. speed up the examination so that diagnostic information is obtained without unnecessary delay;

2. reduce the risk of motion artifacts, especially in patients who are restless, in pain, have reduced consciousness, or have difficulty maintaining their position;
3. support rapid diagnosis, particularly in head trauma and suspected intracranial hemorrhage;
4. support timely patient management by providing diagnostic images that can be evaluated promptly by the radiologist and the clinical team; and
5. maintain patient safety by taking into account radiation dose, clinical condition, and the indicated examination [10].

Limitations

This activity has several limitations. The number of participants was small and came from a single hospital. The post-test was given immediately after the session using the same questionnaire as the pre-test, so the results reflect short-term knowledge retention and may be influenced by familiarity with the questions. The uniform post-test score of 100% also indicates a ceiling effect, meaning that the questionnaire could not distinguish further differences in knowledge. Finally, the evaluation measured knowledge only and did not assess changes in practice, motion artifact rates, or image quality.

CONCLUSION

1. The post-test results show that all participants answered all 15 items correctly, with 100% correct answers. Descriptively, there was an increase of 62.4 percentage points between the pre-test (37.6%) and the post-test. This indicates that the dissemination activity had a positive effect on participants' understanding of motion artifact prevention and of the importance of applying a fast-scan protocol in CT services for emergency patients.
2. The improved knowledge of motion artifact prevention and the fast-scan protocol is expected to support radiographers' competence in optimizing image quality, examination efficiency, and patient safety.

RECOMMENDATIONS

Based on the pre-test and post-test results of this community service activity on managing motion artifacts in CT and applying a fast-scan protocol in emergency patients, the following recommendations are made:

1. **Continuous competence development.** Radiographers should continue to improve their knowledge and skills in identifying, preventing, and managing motion artifacts through ongoing training, dissemination, and practice.
2. **Application of the fast-scan protocol.** The fast-scan protocol should be applied in head CT examinations of emergency patients according to

clinical indications, hospital standard operating procedures, and scanner capabilities, while maintaining diagnostic image quality and radiation protection principles.

3. **Optimization of patient preparation and communication.** Patient preparation, clear instructions, effective communication, and the appropriate use of immobilization devices should be strengthened to reduce the risk of movement during the examination.
4. **Regular evaluation and monitoring.** The radiology installation should regularly evaluate the incidence of motion artifacts, the need for repeat examinations, acquisition time, and image quality as part of efforts to improve service quality.

Follow-up evaluation. Future activities should include delayed post-tests, practice observation or simulation, and image quality assessment to measure knowledge retention and its application in clinical practice.

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