Identification of Factors For Repeating *Thorax* Photos in Dr Modality at Pertamina Central Hospital (RSPP)

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ABSTRACT

Although the Radiology Installation of Pertamina Central Hospital (*RSPP*) has used Digital Radiography (*DR*), repetition of thorax photos still occurs frequently due to various factors. This study aims to identify the factors causing repetition of thorax photos in the *DR* modality at Pertamina Central Hospital (*RSPP*), to minimize patients' radiation exposure risk. This study employed a descriptive mixed-methods approach. Data were collected through observation, documentation, and literature review. The sample consisted of data on thorax photo examinations over a 2-month period, from January 12 to March 12, 2025. The survey revealed 166 repeated thorax photos at the Radiology Installation of Pertamina Central Hospital (*RSPP*), with a repetition rate of 9.36%—4.6 times higher than the standard set by Decree of the Minister of Health Number 129/Menkes/SK/II/2008. Solutions are therefore needed to reduce thorax photo repetitions, based on the identified causative factors, to ensure patient safety.

INTRODUCTION

The development of digital technology in the world of health has had a significant impact on improving the quality of medical services, including in the field of radiology. Digital Radiography (DR) is one of the important innovations in the diagnostic imaging process, replacing the conventional method that previously used film cassettes. DR utilizes digital detectors to capture X-ray images directly and convert them into digital files, thereby speeding up the processes of acquisition, processing, and storage of medical data (Marimón Muñoz, 2019; Ng et al., 2015; Shakor & Khaleel, 2024). In various hospitals, including Pertamina Central Hospital (RSPP), the use of DR is increasingly widespread because it is considered more efficient, accurate, and able to minimize human error in radiological image processing (Hermawan, 2017).

However, the reality on the ground shows that the use of advanced technologies such as DR does not completely eliminate challenges in radiology practice (Corradini et al., 2019; Lastrucci & Giansanti, 2024; Recht et al., 2020; Susanti & Suyatno, 2024). One of the problems that is still often encountered is the high rate of repeat radiographic images (repeat images), especially in thorax examinations (Bwanga, 2020; Kidwai et al., 2015; Rochmayanti et al., 2023; Rosenkrantz et al., 2017). This repetition has serious implications in terms of time efficiency, resource use, and the risk of increased radiation exposure for patients. Based on the minimum service standards of the Ministry of Health (Permenkes Number 54 of 2015, 2015), the image repetition rate should be ≤ 2%, but in practice, there are still repetition rates that exceed these standards due to various technical and non-technical factors (Maesaroh, 2019).

The gap phenomenon that occurs shows a mismatch between technological capabilities and expected results in the field. Factors that cause the recurrence of thorax images include patient positioning errors, movement during exposure, inappropriate exposure technique

settings, interference with the hardware system, and lack of technical understanding or training by radiology operators. This condition indicates that the existence of high technology does not necessarily guarantee the quality of image results if it is not accompanied by optimal Quality Control (QC) and Quality Assurance (QA) (Iman & Lena, 2017). This represents a major challenge in efforts to improve patient safety and the efficiency of radiology services.

This issue is becoming increasingly important, as image repetition not only increases the workload of staff but also has a direct impact on the increased risk of unnecessary radiation exposure in patients. In the context of diagnostic radiology, the ALARA (As Low As Reasonably Achievable) principle should always be a priority to ensure that radiation exposure is kept to a minimum. Therefore, it is necessary to conduct an in-depth investigation into the factors that cause the recurrence of thorax images in the DR modality, as a basis for implementing system improvement strategies and human resource training (Al-qaness et al., 2024; Kumar et al., 2024; Mostafa et al., 2022; Rugut, 2016).

Previous research, such as that put forward by Pramita (2018) and Papp (2018), emphasizes the importance of quality control in DR systems as part of the QA and QC approach to reduce image repetition rates. QA systems include planning, implementation, and evaluation of the overall quality of services, while QC focuses more on monitoring and technical control of imaging systems. The state of the art of this study lies in the identification of factors for repeating thorax photos in DR modality at Pertamina Central Hospital (RSPP), which has not been widely researched locally. Thus, the novelty of this study is the approach to identify the factors that cause repeat images based on the local context, the results of which are expected to serve as a basis for improving technical and operational policies for radiology services in the hospital.

This study aims to identify the factors that cause the recurrence of thoracic photos in radiography examinations using the Digital Radiography (DR) modality at Pertamina Central Hospital (RSPP). This research is expected to add to the scientific literature in the field of radiography, especially related to quality control and radiation safety in thoracic examinations using the Digital Radiography system.

RESEARCH METHODS

This study employed a mixed methods approach combining quantitative and qualitative descriptive methods to identify and analyze factors causing repetition of thorax photos in the Digital Radiography (DR) modality at the Radiology Installation of Pertamina Central Hospital (RSPP). This approach was chosen to quantify repetition frequency and types while confirming results through qualitative field observations and documentation. The research was conducted over two months, from January 12 to March 12, 2025, within the RSPP Radiology Installation.

The research design utilized structured observation and documentation to gather factual data on thorax photo repetitions. Observations were conducted directly by the researcher, who monitored thorax radiography practices in the DR modality, identified image recurrences, determined causes, and noted handling procedures. Documentation recorded recurrence events, patient characteristics, technical parameters, and radiographer involvement. This design provided a comprehensive overview of recurrence events and a basis for analyzing improvements in radiology service quality (Hermawan, 2017; Papp, 2018).

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The population comprised all patients who underwent thorax examinations using DR during the study period. Samples were selected purposively from patients experiencing repeated thorax photos, deemed representative for identifying dominant patterns and causative factors. Data collection involved three main techniques: literature review, field observation, and documentation. Literature reviews strengthened the theoretical foundation and enabled comparisons with prior studies (Maesaroh, 2019; Pramita, 2018). Observations captured radiographers' technical and procedural actions, while documentation logged recurrences, technical/non-technical causes, and equipment details.

Data were analyzed descriptively, presented as frequency tables, thematic diagrams, and explanatory narratives highlighting causative factor trends. Conclusions were drawn from emerging patterns to elucidate relationships between factors and repetition intensity, yielding data-driven recommendations to minimize radiation exposure, enhance service quality, and support Quality Assurance (QA) and Quality Control (QC) principles in radiology practice (Iman & Lena, 2017; Wiyono, 1999).

The researchers adhered to ethical standards, including informed consent where required, confidentiality of patient and staff identities per Personal Data Protection Law No. 27 of 2022, and professional codes of ethics. The process was conducted objectively and responsibly to ensure result validity and reliability.

RESULTS AND DISCUSSION

The following are the results of the survey, the calculation of the factors that cause the recurrence of thorax photos in the form of frequency distribution tables and pareto diagrams from the period of January 12 – March 12, 2025 at the Radiology Installation of Pertamina Central Hospital (RSPP). The formula used to determine the number of photo repetitions, is as follows:

$$\frac{\text{Number of repetitions performed}}{\text{Number of examinations performed}} \times 100$$

To determine the number of photo repetitions of each category using the formula, it is as follows:

$$\frac{\text{Number of repetitions for a specific reason}}{\text{Number of repetitions performed}} \times 100$$

From the 2 formulas above, the results will be compared with the tolerance limit set by the Decree of the Minister of Health Number 129/Menkes/SK/II/2008 concerning the minimum service standards of hospitals, which states that the rate of photo damage or repetition is $\leq 2\%$, while according to Jeffrey Papp (2011) the repetition rate should not be more than 4% to 6%.
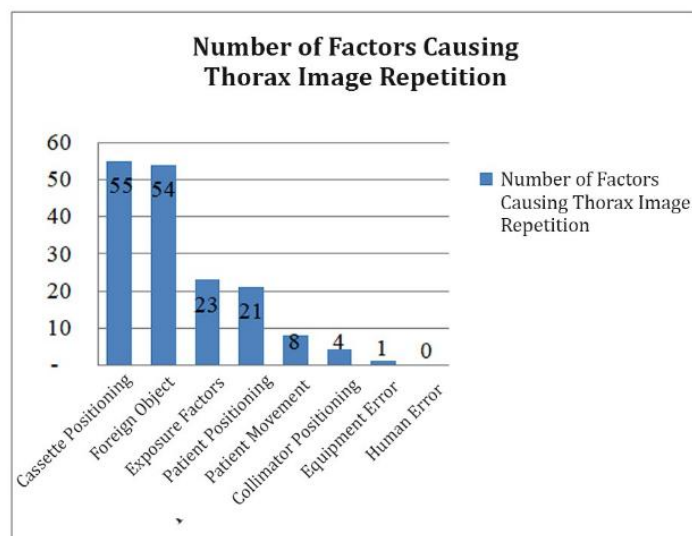
Table 1. Thorax Image Repetition

No	Causing Factors of Thorax Image Repetition	Number of Thorax Image Repetitions	Percentage of Thorax Image Repetition
1	Patient Positioning	21	12,65%
2	Collimator Positioning	4	2,41%
3	Cassette Positioning	55	33,13%
4	Patient Movement	8	4,82%
5	Foreign Object	54	32,53

No	Causing Factors of Thorax Image Repetition	Number of Thorax Image Repetitions	Percentage of Thorax Image Repetition
6	Exposure Factors	23	13,86%
7	Equipment Error of Malfunction	1	0,6%
8	Human Error	0	0%
	Total	166	100%

Based on the table above, it shows that the most dominant cause of repetition is errors in the position of the tape, which is as many as 55 cases or 33.13% of the total repetitions. This reflects an inconsistency in the placement of the digital detector (Flat Panel Detector) which can cause important anatomical parts to not be recorded perfectly. These errors can be caused by a lack of precision of the radiographer or technical constraints such as a device that is not properly calibrated. The second factor that most often appears is the presence of foreign objects, which is as many as 54 cases (32.53%). Foreign objects such as metal clothing, jewelry, or medical cables left behind during the examination indicate a weak patient preparation process and a lack of optimal communication between medical personnel and patients before the procedure is performed.

The exposure factor occupies the third position with 23 cases (13.86%), indicating that errors in the determination of imaging technique parameters such as kVp, mAs, or exposure factors are still frequent. This inaccuracy causes suboptimal image quality, such as overexposed or underexposed images, so it is not suitable for diagnostic purposes and needs to be repeated. In addition, other factors such as patient positioning error (21 cases, 12.65%), patient movement (8 cases, 4.82%), collimation error (4 cases, 2.41%), tool error (1 case, 0.6%), and human error (1 case, 0.6%) showed a smaller but still important contribution to pay attention to because it also increased the risk of repeated radiation exposure to patients.

Figure 1. Number of Factors Causing Thorax Image Repetion

Based on the analysis of the pareto diagram, it was found that the three main factors that contributed the most to the repetition of thorax photographs in the Digital Radiography (DR)

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modality at the RSPP Radiology Installation during the period from January 12 to March 12, 2025 were cassette position errors, the presence of foreign bodies, and exposure errors, which cumulatively accounted for about 80% of the total recurrence cases. These factors reflect technical and procedural weaknesses, such as inaccuracies in positioning, lack of optimal patient preparation, and errors in the selection of imaging techniques.

Although other factors such as patient position, movement, tool error, and human error have a smaller contribution, they are still important because they risk increasing cumulative radiation exposure and increasing workload. Therefore, comprehensive improvements are needed through improving the accuracy of radiographers, implementing strict SOPs, technical training, and a continuous quality control system to reduce the number of recurrences and improve the quality of radiology services.

Table 2. radiology services

Number of Thorax Imaitges	Number of Repetitions	Percentage
1.773	166	9,36%

Based on the results of the research conducted for two months, starting from January 12 to March 12, 2025, a total of 1,773 thorax photo examinations were recorded at the Radiology Installation of Pertamina Central Hospital (RSPP). Of these, 166 cases of recurrence were found, resulting in a recurrence rate of 9.36%. This figure far exceeds the tolerance limit set by the Decree of the Minister of Health of the Republic of Indonesia Number 129/Menkes/SK/II/2008, which is a maximum of $\leq 2\%$, even exceeding international standards according to Jeffrey Papp (2011) which states that the maximum limit of repetition ranges from 4% to 6%. This indicates that there are significant problems in the implementation of thorax radiography procedures, which have the potential to reduce the quality of service and increase the risk of repeated radiation exposure in patients.

The results of frequency distribution analysis and pareto diagrams showed that the dominant cause of thorax photo repetition was cassette position error in 55 cases (33.13%), followed by the presence of foreign bodies in 54 cases (32.53%), and exposure factor errors in 23 cases (13.86%). These factors cumulatively account for about 80% of total recurrences. The mispositioning of the tape reflects a lack of precision in the placement of the digital detector (Flat Panel Detector) which has an impact on the loss of important anatomical parts in the image. The presence of foreign objects such as metal on clothing, jewelry, or medical cables indicates weaknesses in patient preparation and communication between officers. Meanwhile, exposure errors are related to improper imaging technique parameters, such as the selection of kVp, mAs, or exposure time values, which cause the image to be not diagnostically feasible because it is overexposed or underexposed.

In addition to these three main factors, other factors such as patient position (21 cases, 12.65%), patient movement (8 cases, 4.82%), collimation errors (4 cases, 2.41%), and tool errors (1 case, 0.6%) also contributed although in smaller amounts. Human error is recorded at 0%, but it remains a concern in the context of quality management. In some cases, patients experience more than one repetition in a single examination, indicating the possibility of a combination of errors in a single procedure.

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The recurrence of these thorax photos was analyzed on a monthly basis, with results in the period January 12 – February 11, 2025 showing 81 repetitions of 944 examinations (8.58%), and the period of February 12 – March 12, 2025 showing 75 repetitions of 829 examinations (9.05%). The frequency distribution per category also shows the consistency of the cause, namely the position of cassettes and foreign objects as the largest contributors in both periods.

Based on these findings, it is necessary to make comprehensive improvements to work procedures at the RSPP Radiology Installation. Improving radiographer accuracy, regular technical training, strict implementation of standard operating procedures (SOPs), and continuous quality control are very important steps to reduce the number of repetitions. The goal is not only to improve work efficiency and lower the workload due to repetition, but also to protect patients from the risk of excessive radiation exposure and ensure optimal image quality for diagnostic purposes.

Thus, the results of this study reinforce the importance of periodic evaluation of the recurrence rate and its causative factors in radiology practice. A monthly repetition analysis that is recapped every three months, as recommended by Jeffrey Papp (2011), has proven to be an effective approach to identify technical and procedural weaknesses, as well as a basis for decision-making in improving the quality of radiology services in hospitals.

Based on the limitations of this study, data can only be taken from January 12, 2025, because some of the data has been deleted, while according to information obtained by the author from one of the radiographers at the Radiology Installation of the Pertamina Central Hospital (RSPP), the period of data deletion at the Radiology Installation of the Pertamina Central Hospital (RSPP) is every 2 months.

CONCLUSION

This study found a high thorax image repetition rate of 9.36% among 1,773 examinations in the Digital Radiography (DR) modality at the Radiology Installation of Pertamina Central Hospital (RSPP) from January 12 to March 12, 2025, surpassing national (≤2%) and international (≤6%) standards and raising risks of unnecessary radiation exposure. Employing a mixed-methods approach, it identified cassette positioning errors (33.13%), foreign objects (32.53%), and exposure errors (13.86%) as primary causes, accounting for ~80% of repeats, and revealed gaps in technical execution, procedural adherence, and patient communication. While advanced DR technology offers potential, it requires robust Quality Control (QC) and Quality Assurance (QA), alongside operator training, strict SOP enforcement, and periodic evaluations, to boost efficiency, patient safety, and ALARA compliance. For future research, longitudinal studies could assess the long-term impact of targeted training interventions on repetition rates across multiple Indonesian hospitals.

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