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RADIATION DOSE EVALUATION IN THORAX RADIOGRAPHY EXAMINATION

EVALUASI DOSIS RADIASI PADA PEMERIKSAAN RADIOGRAFI THORAX

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ABSTRACT

The radiation dose received by patients during Thorax examination can vary from one hospital to another. For this reason, the Indonesian government through BAPETEN has set the Indonesian Diagnostic Reference Levels in 2021 as a reference for radiation doses in medical imaging. This study aims to determine whether there is a comparison of these doses with the IDRL 2021 reference. This study is a quantitative study with an experimental and survey approach conducted at Tlogorejo Hospital, Semarang. The radiation dose value in the form of Entrance Surface Air Kerma (ESAK) was collected at Tlogorejo Hospital, Semarang. The ESAK value was obtained through simulation or measurement using a digital dosimeter placed on the surface of the water phantom for Thorax examination. The examination parameters used are standard parameters for adult Thorax examination in patients weighing 50-70 kg. Overall, 87 ESAK values were collected from Tlogorejo Hospital, Semarang. The results showed significant variations in the radiation dose of Thorax examination in hospitals with an average dose of 0.145 mGy. While the median ESAK value is 0.095 mGy. However, the study showed that the median ESAK value of Thorax examination at the hospital where the study was conducted was still within the IDRL 2021 recommendation limit, which was below 0.4 mGy. This study shows the importance of continuous optimization efforts to ensure radiation safety in patients undergoing diagnostic radiology examinations.

Keywords: Radiation dose; ESAK; Thorax PA, IDRL.

Introduction

X-ray radiation has been widely used in the world of medicine, especially for imaging organs in the human body. However, behind the benefits, X-rays are included in the category of ionizing radiation that can cause harmful effects on the human body (Fauber, 2017; Ferrero et al., 2019). Therefore, optimization efforts are needed, namely efforts to reduce radiation exposure to workers, patients and the community so that it is as minimal as possible but still considers the

quality of images with diagnostic value (BAPETEN, 2011).

In practice, a patient undergoing a type of radiology examination can get a different dose of radiation if the examination is done in different hospitals by different operators. This variation in dosage is caused by various factors such as the radiographic tools and techniques used to produce images (Seeram & Brennan, 2017). In fact, a study conducted by the National Radiological Protection Board in the UK found that the dose for Thorax PA examination in one hospital can be 50 times higher than the dose in other hospitals. Of course, such significant variations in radiation doses cannot be justified (Seeram & Brennan, 2017). For this reason, the Indonesian government through the Nuclear Energy Supervisory Agency (BAPETEN) has implemented a national dose reference standard known as the Indonesian Diagnostic Reference Level (IDRL), as an optimization effort so that the dose received by patients is not excessive (American College of Radiology, 2018; BAPETEN, 2011; Determination of Indonesian Diagnostic Reference Level for General CT Scan and Radiography X-ray Modalities, 2021). Since the IDRL was established nationally in 2021, every radiographer is required to evaluate the radiation dose received by the patient during the examination and compare it to the IDRL standard. So, if it is found that patients who receive radiation doses exceed the IDRL 2021 reference, then further analysis can be carried out to determine the factors that cause the overdose. Thus, corrective steps can be applied to optimize radiation protection for patients (BAPETEN, 2019).

Based on preliminary studies, many radiographers are not familiar with the IDRL concept and have not evaluated radiation doses in their respective hospitals, especially for simple examinations such as Thorax. Thorax PA is the most frequently performed radiological examination. According to the literature, more than 80% of radiological examinations performed in the field are Thorax PA examinations (Asada & Ichikawa, 2019; Bontrager & Lampignano, 2014). In the Thorax PA examination, the area exposed to radiation is also relatively wider than other radiological examinations, and includes radiation-sensitive organs such as the thyroid and breast (Asada & Ichikawa, 2019).

Previous research by Anggarini, et al. has reviewed the radiation dose in the Thorax PA examination at Buleleng Hospital, Bali (Anggarin et al., 2022). However, the scope of the study is still at the local level, and has not yet compared the dose with the 2021 IDRL, nor with the dose at other hospitals. Thus, the description of the variation in doses between hospitals is not yet known. Based on the above, this study aims to (1) find out the radiation dose received by patients at the Thorax PA examination, especially at two Tlogorejo Semarang hospitals; (2) compare the dose with the dose reference (IDRL 2021) set by BAPETEN. Through this study, the author wants to increase radiographers' "awareness" of radiation hazards and to strengthen efforts to optimize radiological examinations. By comparing the doses received by patients at the hospital, it can be a reflection for each hospital regarding the quality of radiology services in that place. With a dose evaluation like this, if a radiation dose is found that is not in accordance with BAPETEN standards, the hospital can take corrective steps.

Methods

This study is a quantitative research with a survey approach carried out at Tlogorejo Semarang hospital. From this hospital, a total of 86 samples were taken from Thorax radiographic examination data for Postero-Anterior (PA) projections. Only data related to the Thorax PA examination in the standard adult patient category were included in this study. The patient in question is a patient over 15 years old with a standard body size (weight 60 + 10 kg). The data collected was in the form of gender, age and weight of patients. Data related to radiographic tools and techniques were also collected in this study, such as patient position, FFD (Focus Film Distance), kV, mAs, irradiation area area (cm2). The data is then used as a basis for simulating the Thorax PA examination on the water phantom, so that the radiation dose received by the patient can be measured. The dose measured in this study was in the form of Entrance Surface Water Kerma (ESAK). The ESAK value was obtained through a Thorax PA examination simulation using parameters that had been collected previously.

The simulation was carried out using a digital dosimeter attached to the water phantom. Phantom was then exposed with the exact same technique as the previous Thorax PA examination data, then the dose recorded on the dosimeter was used as the Thorax examination dose data. The ESAK values from the simulation were then processed using the SPSS program to determine the distribution of data and to find out if there was a significant difference between radiation doses in one hospital and another. The median value of ESAK reflecting the local DRL value is also compared to IDRL 2021. The dose is said to be in accordance with the IDRL standard if the median value of ESAK < 0.4 mGy for adult Thorax PA examination.

Results and Discussion

A study has been conducted that aims to evaluate the radiation dose received by patients during the Thorax PA examination. A total of 87 data related to the Thorax PA examination and the dose received by the patient in the form of Entrance Surface Air Kerma (ESAK) values have been collected from Telogorejo Semarang hospital. The research was carried out using a radiology aircraft found in the hospital where the research was conducted, namely Philips x ray – Fluoroscopy. The characteristics of the exposure factors used for the Thorax PA examination in this study can be seen in table 1.

Table 1. Characteristics of exposure factors for Thorax PA examination at Tlogorejo Hospital Semarang

Category	Kv	gold	FFD
Min	70 kV	1 mAs	121 cm
Max	125 kV	28 mAs	182 cm
Average	122 kV	3 mAs	154 cm
Median	125 kV	1 mAs	151 cm

Meanwhile, the radiation dose value (ESAK) in this study was obtained by simulation or measuring directly using a dosimeter on a water phantom. This simulation produced 87 ESAK data at Tlogorejo hospital Semarang. The characteristics or dose profile of Thorax PA examination at the study site hospital are shown in table 2.

Table 2. Characteristics of ESAK values for Thorax PA examination at Tlogorejo Hospital Semarang

Category	FUN
Min	0.047 mGy
Max	0.87 mGy
Average	0.145 mGy
Median	0.095 mGy

From the table above, it is known that the distribution of radiation dose values in Thorax PA examinations in hospitals varies from one another, with a median ESAK value of 0.095 mGy

The use of ionizing radiation in the field of radiology holds potential radiation hazards, especially if not used correctly. This study was conducted to evaluate the radiation dose received by patients during the Thorax PA examination at Tlogorejo Semarang hospital.

One of the indicators of radiation dose received by patients during diagnostic radiology examinations is the Entrance Surface Air Kerma (ESAK). ESAK takes into account the scattering factor of the object (BAPETEN, 2019). Therefore, this study uses an object in the form of a water phantom as a substitute for the patient so that the dose read on the simulated dosimeter is close to the actual dose received by the patient. In addition, the reason for the use of phantom is related to research ethics, where the direct use of the patient as a research object is not possible due to the dosimeter artifacts that can appear on the radiograph.

The results showed that there was a difference in the median value of Entrance Surface Air Kerma (ESAK) at Tlogorejo Hospital Semarang (0.095 mGy). This variation is natural because the dose value is highly dependent on the tools, exposure factors, and radiographic techniques used by the radiographer in taking images (Hart D, Hillier MC, 2012; Rusyadi et al., 2021; Seeram & Brennan, 2017). This can be seen in table 1 where for the category of patients with the same weight range (BB 60+10kg), there are variations in kV

and mAs used to produce the image. The kV range used at Telogorejo Semarang hospital varies from 70 kV-125 kV. The use of kV is not much different from previous studies (Anggarin et al., 2022; HAA & HA, 2020; Hart D, Hillier MC, 2012).

In addition, Telogorejo Semarang Hospital uses a combination of relatively higher kV with lower mAs, This is theoretically possible because to produce a radiograph of relatively the same quality, when a higher kV is used, it must be compensated for by a decrease in mAs. This variation in exposure factors is what causes dose variations in Thorax PA examinations (Rusyadi et al., 2021). Although dosage variations are natural, optimization efforts must still be carried out in radiography examinations. Therefore, it is very important for every radiology service facility to conduct an audit regarding the radiation dose given to patients. One of the efforts that can be made is to compare the local DRL value (median dose value) with the national reference, namely the Indonesian Diagnostic Reference Levels set in 2021.

Based on the results of the study, the median value of ESAK for Thorax PA examination at Togorejo Semarang hospital is still within the standard limit of the dose reference set by IDRL 2021, which is 0.4 mGy. Apart from the difference in local DRL values at Tlogorejo Semarang hospital, the results of the study show that the hospital has been working on optimization measures. The results of the dose in accordance with the National DRL can also indicate that the X-ray aircraft used to produce the radiograph is still in good condition (Hiswara & Kartikasari, 2015). However, to confirm this, it is necessary to conduct further research related to the feasibility and quality of X-ray aircraft at the hospital where the study was conducted.

Although the results of the study show that the dose of Thorax PA examination at the study site is still within the IDRL standard, it does not mean that optimization efforts stop here. Continuous optimization measures are needed to ensure radiation safety in patients. Moreover, the results of the study showed significant dosage variations between the two hospitals. This significant variation remains unjustifiable. Further efforts are needed for hospitals to evaluate the services provided to patients, especially for hospitals that produce relatively higher radiation doses than other hospitals. The first step that can be taken by hospitals is to evaluate the quality of the images according to diagnostic needs (HAA & HA, 2020; Seeram & Brennan, 2017). Furthermore, radiation dose monitoring also needs to be carried out routinely using the Exposure Index, Dose Area Product (DAP) indicators, as well as ESAK and INAK. As an effort to implement continuous optimization, the Indonesian government has developed a national dose survey portal called SI-INTAN or Patient Dose Data Information System. Each radiology service facility is expected to actively fill in patient dose data through SI-INTAN in an effort to optimize radiology examinations

and IDRL development (BAPETEN, 2019). However, not all hospitals, especially at Tlogorejo Hospital Semarang, have conducted internal audits in the radiology environment and reported dose data on the SI-INTAN portal. Therefore, the findings in this study are expected to be able to be the basis for other hospitals in the Semarang area to be able to conduct routine evaluations related to radiation doses and be actively involved as contributors to the SI-INTAN portal.

Conclusion

The results of the radiation dose evaluation at the Thorax PA examination at Tlogorejo Semarang hospital showed a significant ESAK value. However, the median value of ESAK in the Thorax PA examination at the research site hospital was in accordance with the dose reference set in the Indonesian Diagnostic Reference Levels in 2021, which was below 0.04 mGy. Although the dosage has been in accordance with the IDRL reference, the significant variation in dosage between hospitals is not easy to justify. This emphasizes the importance of continuous optimization efforts in radiological examinations, one of which is through internal dose audits to ensure radiation safety in patients.

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