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Diagnostic Reference Level of Radiation Dose of General Radiography Examination of Dr. Moewardi Hospital

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ABSTRACT

The local DRL for Dr. Moewardi Hospital is used as a control of patient radiation safety and to measure the quality of radiological examinations conducted at the Radiology Installation of Dr. Moewardi Hospital. The study conducted an assessment on a conventional examination with a General Radiography X-ray plane. The research methodology used was a quantitative approach by using a sample of 30 patients in each examination. X-ray machine data collection was conducted by looking for the Entrance Surface Air Kerma (ESAK) equation, then inputting the patients' data of kV, mAs, FSD, and BSF into the ESAK equation to obtain Entrance Surface Dose (ESD) value of each patient. From ESD data, DRLs were made for each examination using the 3rd quartile data. The results of the study indicated that the local DRL of Dr. Moewardi Hospital was lower than the National DRL of BAPETEN (Bapeten, 2020)

Keywords: Radiation Dose Reference Level, Dr. Moewardi Hospital, Safety

Introduction

Based on BAPETEN Regulation No. 4 of 2020, radiation protection is an action taken to reduce the harmful effects of radiation due to radiation exposure. In the use of ionizing radiation sources, they must meet the requirements of radiation protection, namely

1. Justification
   The purpose of justification is to avoid unnecessary radiological procedures, which will result in losses for the patient. Justification for medical exposure for patients must be conducted by means of consultation and communication between medical practitioners who refer to doctors and are proven by referrals. This referral indicates that the patient has been observed by a doctor and needs diagnostic information for the need for follow-up medical care.
2. Optimization
   After justification, the radiological procedure must be optimized and carried out in such a way that exposure to the patient can be carried out to achieve medical goals in accordance with the ALARA principle (as low as reasonably achievable). Radiation doses that are too low are just as bad as radiation doses that are too high. As a result, the images taken do not have the appropriate diagnostic quality. Medical exposure should always lead to the necessary clinical outcomes. The implementation of optimization is carried out including :
   a) Consideration of the selection of modalities to be used
   b) Consideration of the chosen procedure
   c) Calibration
   d) Patient dosimetry (calculation or measurement of patient dose)
   e) Diagnostic Reference Level or DRL
   f) Quality assurance program for medical exposure
3. Limitation
   Dose limitation or dose limit is performed for radiation workers and the public. Dose limitation is performed by providing a dose limit or dose limit value (DLV) of 20 mSv/year for radiation workers and 1 mSv/year for the public. Patients have no dose limit.

In accordance with the elucidation of Article 37, paragraph (1) of Government

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Regulation No. 33 of 2007, what is meant by the reference level is the reference value that should be achieved through the implementation of medical activities with tested methods. The reference value for diagnostic radiology activities is stated in dose values or dose rates. The purpose of DRL is to optimize radiation protection and safety for patients and prevent unnecessary radiation exposure. It is called a means of optimization because it is a process to get optimal towards the lowest possible dose that can be achieved while still paying attention to adequate image quality for diagnostic needs. As a process towards optimality, the DRL must be reviewed regularly.

For the implementation, whenever a patient's dose exceeds the DRL, it needs to be recorded and reviewed to recognize possible causes and appropriate corrective action options, unless the dose is unavoidable and must be medically justified. There are corrective actions taken so that the dose from time to time can be reduced, which results in a more dynamic DRL value and heading towards the lowest possible direction. In addition, DRLs can be used as a means to create a mutually agreed radiation protocol. The creation of joint protocols can be carried out in cross-professional organizational collaborations related to dosage and image. DRLs can be determined nationally or locally. Healthcare facilities such as hospitals can have their own local DRL values

Method

This study was conducted using a GE brand radiography X-ray machine with the Proteus type at the Radiology Installation section of Dr. Moewardi Hospital. This machine has a capacity of 500 mA/ 150kV. The equipment used were a Multimeter set, collimator test tool, and water pass.

This study began by conducting QC on the radiography machine to determine the condition of the X-ray machine used was in reliable condition. The QC performed was a collimation test, illumination test, beam straightness test, and kV accuracy test (Trikasjono et al., 2009)

To obtain an X-ray machine output chart or a chart of Incident Air Kerma (INAK) and Entrance Surface Air Kerma (ESAK), it collected data on the output of radiation dose mGy/mAs with kV variations from 50 – 120 kV, an interval of 5 kV and an FSD of 100 cm. So that an equation was obtained

$$\mathrm{INAK}\left(\frac{\mu\mathrm{Gy}}{\mathrm{mAs}}\ @100\mathrm{cm}\right) = \mathrm{a}\ \times \mathrm{kVp}^{\mathrm{b}}$$

$$\mathrm{ESAK} = \mathrm{INAK}\ \times \mathrm{mAs}\ \times \left(\frac{100}{\mathrm{FSD}}\right)^2 \times \mathrm{BSF}$$

With Back Scatter Factor (BSF) data using BSF Petoussi-Hens table data with PMMA phantom (IAEA - Secondary Standards Dosimetry Laboratories, 2013).

The target population of this study was general patients of Radiography examination who come to the Radiology Installation of Dr. Moewardi Hospital Surakarta. The accessible population of this study was General patients of Radiography examination who came to the Radiology Installation from May 2023 to September 2023 in the adult category (17 years and above). The type of examination to be performed for DRL data collection was a type of examination with more than 100 patients based on the Radiology Installation activity report in November 2022, December 2022 and January 2023. The examinations were Abdomen Ap, Cervical AP, Cruris AP, Femur AP, Genu AP, Skull AP, Manus AP, Pelvis AP, Thorak Lat, Thorak AP, Pedis AP with a sample of 30 patients each. The data used were kV, mAs, and FSD. The patient data were subsequently substituted to the ESAK equation to get the Entrance Surface Dose (ESD) of each patient. From the ESD data, the 3rd quartile value of each type of examination was taken as DRL

Results

The equation of the ESAK chart of the radiation output of the GE Proteus General Radiography X Ray machine obtained from the kV chart to the radiation output is

$$\mathrm{ESAK} = (6e - 6\,x^2 + 0{,}0002x - 0{,}0107) \times \mathrm{mAs} \times \left(\frac{100}{\mathrm{FSD}}\right)^2 \times \mathrm{BSF}$$

Table 4.6 Comparison of BAPETEN DRLs with Local DRLs

No	Types of Examination	DRL BAPETEN (mGy)	DRL local (mGy)	Standard Deviation (mGy)	Highest ESD (mGy)
1	Cervical	0,7	0,89	1,04	1,93
2	Abdomen AP	2	1,55	0,26	1,81
3	Thorak Lat	0,17	0,17	0,20	0,37
4	Cruris AP	0,3	0,17	0,27	0,44
5	Thorak AP	0,4	0,13	0,00	0,13
6	Femur AP	0,5	0,36	0,19	0,55
7	Manus AP	0,2	0,12	0,03	0,15
8	Pelvis AP	1,8	1,19	0,51	1,70
9	Pedis AP	0,2	0,08	0,01	0,09
10	Genu AP	0,4	0,21	0,10	0,31
11	Skull AP	1,3	0,99	0,18	1,17
12	Thorak PA	0,4	0,08	0,02	0,09

Discussion

The table above shows that the local DRL value of Dr. Moewardi Hospital was still below the national DRL value of BAPETEN except for the examination of the local Cervical DRL of Dr. Moewardi Hospital above the national DRL value of BAPETEN. This was due to some patients from orthopaedic poly who required cervical examination up to C7 superposition visible of 2 left and right shoulders, causing high exposure factors

For several types of examinations, the highest ESD value was still under the national DRL of BAPETEN, namely for examination of AP Abdomen, Thoracic AP, Thoracic PA, Manus AP, Pelvis AP, Pedis AP, Genu AP and Skull of AP. As for cervical examination, Thorak Lat, Cruris AP and Femur AP, the highest ESD value was greater than the national DRL value of BAPETEN. However, this did not indicate that the quality of Radio diagnostic services at Dr. Moewardi Hospital did not meet the quality of service. Several factors may affect the amount of ESD received by patients such as age, weight, and height because these factors will affect the administration of kV and mAs, the greater the thickness of the object to be examined, the greater the kV and mAs used, the patient's absorbed dose will also be higher. Patients may receive doses exceeding the DRL if medically justified and recipients of the dose cannot be avoided.

After evaluating the radiography results, it was concluded that although the local DRL value was lower than the national DRL, the quality of the radiographic images produced with a relatively low dose range still met the diagnosis needs, namely the radiographic images was still readable and verified by the Radiologist.

The local DRL value indicated that Dr. Moewardi Hospital has implemented radiation protection optimization, namely by applying the ALARA (As Low As Reasonably Achievable) principle with the lowest possible dose of medical exposure, optimal radiographic imagery can be achieved and the local DRL value can be used as a reference value to evaluate the quality of the examination.

Conclusion

A. Conclusion

From the results of the study conducted on 12 types of conventional radiography examinations at the Radiology Installation of Dr. Moewardi Hospital, it can be concluded that The results of the study showed that the local DRL of Dr. Moewardi Hospital was lower than the national DRL of BAPETEN, this shows that conventional radio diagnostic examinations at Dr. Moewardi Hospital are safe to perform. Dr. Moewardi Hospital has optimized radiation by applying the ALARA (As Low As Reasonably Achievable) principle with the lowest possible dose of medical exposure to achieve optimal radiographic images. The Dr. Moewardi Hospital Local DRL can be used as a reference for evaluating the quality of radio diagnostic examinations at the Radiology Installation of Dr. Moewardi Hospital

B. Recommendations

1. This research was only carried out for 12 types of examinations, it is necessary to make DRLs for other types of examinations
2. It is possible to conduct data collection for 12 months so that the data collected is more numerous and diverse
3. It is necessary to prepare a system so that all patients can have a medical record of the amount of radiation that has been received during the examination at Dr. Moewardi Hospital
4. If there is a patient's dose that significantly exceeds the DRL value, it is necessary to evaluate the examination
5. It is necessary to update the DRL value every year, and subsequently perform an evaluation.

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