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Monitoring of Patients Using Radiodiagnostic Dosage EI (*Exposure Index*) on CR (*Computed Radiography*)

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Abstract

Most of the current radiographic examinations have used digital technology, one of which is for image readers and image processing using the CR (Computed Radiography) modality. The use of CR is more advantageous than film-screen systems because it has faster image acquisition and processing, a wide dynamic range, easy contrast adjustment, brightness, and electronic cropping. Unfortunately, the amount of exposure radiation is difficult to assess when using digital imaging compared to screen-film systems. Based on field observations, a radiographer tends to ignore the EI (Exposure Index) value in the application of the CR modality. The success of the radiographer in the radiography process is limited to the image that is not repeated. Even though the image quality factor is not merely a matter of repeated images or not, but also those who have the breadth of information and also must maintain protection principles for patients, in this case, is the acceptance of the dose due to radiography. So it is necessary to monitor the patient's dose using the EI value.

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1 Introduction

Most of the current radiographic examinations have used digital technology, one of which is the image reader and image processing using the Computed Radiography (CR) modality. The use of CR is more advantageous than film-screen systems because it has faster image acquisition and processing, a wide dynamic range, easy contrast and brightness adjustment, and electronic cropping. Unfortunately, the amount of exposure radiation is difficult to assess when using digital imaging compared to screen-film systems (Akhadi, 2000; Anaisa, 2012).

Based on field observations, a radiographer tends to ignore the IE and ID values in the application of the CR modality. Their success in the radiographic process was limited to unrepeatable imagery. Even though the image quality factor is not merely a matter of repeated images or not, but also those who have the breadth of information and also must maintain protection principles for patients, in this case, is the acceptance of the dose due to radiography (AAPM, 2009; Adler et al., 1992). No IE standard matches the condition of the X-ray instrument and the object of the examination, so the IE range tends to be too wide so that the patient's dose is not well controlled. Another problem that often occurs is related to the problem of very varied post-processing images, so there is no standard quality CR image that can be referred to by a radiologist/radiographer.

The exposure index is calculated on each image obtained and can vary between various examination objects. For medical images, the part of the object in the ROI (region of interest) is identified by an image processing algorithm. The mean coded value of the area is known as the exposure index. IE will be used as an exposure indicator that is used for certain examinations. This can be a dose management Quality Control (QC) program that is useful as a diagnostic tool for monitoring exposure values. IE is not an absolute number, even though it is part of the same object (Fahmi et al., 2008; ICRP, 2007).

2 Materials and Methods

The research was conducted at the Radiology Unit of the Kasih Ibu Hospital Kedonganan. Meanwhile, data analysis was carried out at the Biophysics and Medical Physics Laboratory at Bukit Jimbaran Campus. The tools used in this study were X-ray aircraft, CR (Computer Radiography), Lux meter, Humidity meter, thermometer, and patient medical records (Jenkins, 1988; Rochmayanti et al., 2016; Shepard & Pei-Jan, 2002).

To identify the amount of dose received by the patient, diagnostic and interventional radiology patients were taken at an age range ranging from 18-65 years. Patient identification information needed other than age range is gender. The data taken in this study were 28 patients regardless of gender (Sikumbang, 2018; Susilo et al., 2012). If the facility can estimate the patient workload per type of examination for each modality, then the required patient sampling size is at least 30% of the workload.

In this study, an X-ray plane was used with a range of variations ranging from 55-70 kV, tube currents per second ranging from 5-12.5 mAs. The medical record data taken is for thoracic examination because this examination most often occurs in the radiology unit (Brealey et al., 2005; Snaith & Hardy, 2008; Hardy & Snaith, 2009). Furthermore, the IE value was measured at 5 measurement points for each chest photo of the voltage variation on the CR. The research data is quantitative data that is analyzed comparatively and statistically, namely by looking at and comparing the results of observations from the research conducted (Sutapa et al., 2018; Wilks, 1987). Data from medical records, especially kV and mAs, as well as the results of measurement of the IE value were then analyzed to determine the dose of chest X-ray patients. The statistical analysis used was ANOVA (Analysis of Variance). The ANOVA test results were significantly different ($P \leq 0.05$) followed by the LSD test so that a significant difference could be seen between the EI value and the patient dose.

3 Results and Discussions

The results of the examination of thoracic patients consisted of 2 categories, namely female and male patients with an age range of 20-65 years. Data on the results of the thoracic patient examination of the IE value can then be determined the radiation exposure received by the patient using the equation:

$$X = P\frac{V^2 It}{d^2}$$

Then converted into mGray to determine the patient's absorption dose. The following is an example of calculating the absorption dose in a female patient aged 30 years at 65 kV, 5 mAs with a 150 cm SSD and a comparison constant (P) 15 $cm^2/kg\ kV^2$, it can be determined that the exposure dose received by the patient is 14.083 mR. Then the exposure dose is converted to determine the absorbed radiation dose using the equation:

$$D = 14{,}083\ mR\ (8{,}77 \times 10^{-3}\ mGy/mR)$$
$$D = 0{,}124\ mGy$$

The results of the calculation of the radiation absorption dose received for all thoracic patient examinations can be represented in a graph to determine the relationship between IE and the exposure factor in the form of tube tension (kV) given to thoracic examination patients with an age range according to adult categories, namely 20-65 years (Sarayati, 2016). The data used are kV and IE data as shown in the graph shown in Figure 1. Based on Figure 1, the 55-75 kV tube voltage range gets an IE of 1364.4. In the 61-65 kV range, you get an IE of 1411. In the 66-70 kV tube voltage range you get an IE of 1560.75. In the tube voltage range, 71-75 kV get IE of 1926.5. If the kV is higher then the resulting IE will be bigger. Whereas IE with an exposure factor in the form of a load (mAs) given to thoracic examination patients with an age range according to the adult category, namely 18-65 years (Sarayati, 2016), as shown in Figure 2 on the 3-5 mAs load range, it gets IE of 1450 range 6-8 mAs to get an IE of 1499.7. In the range of 9-11 mAs, IE obtained decreased to 1493.5. In the range 12-14 mAs, you get an IE of 1534. When the mAs is higher, the IE is also getting higher, but there are times when the IE obtained shows a decrease.

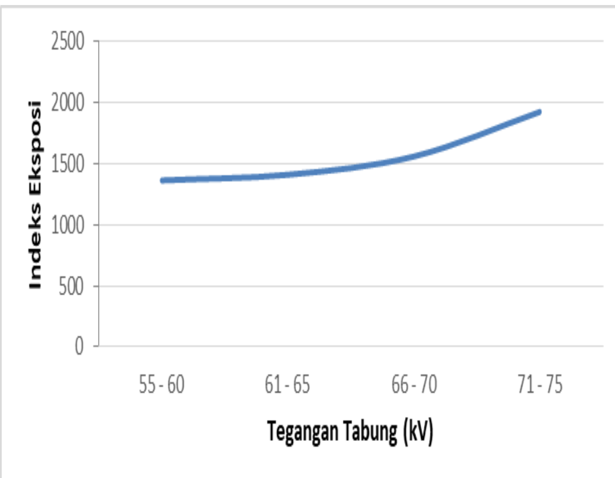

Figure 1. Graph of IE against kV

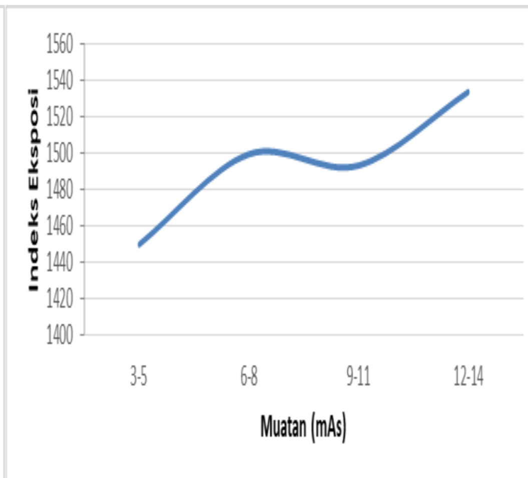

Figure 2. Graph of IE against mAs

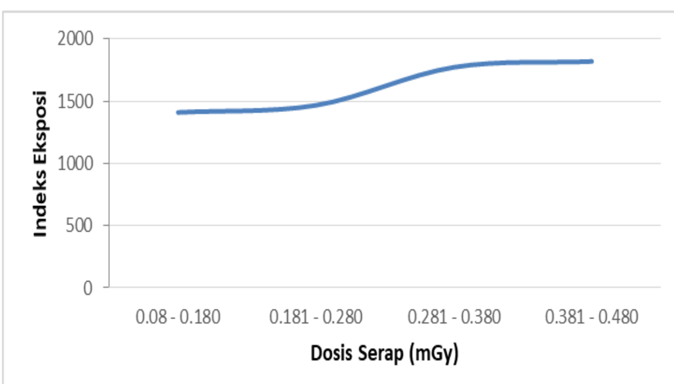

Figure 3. IE graph of absorption dose (mGy)

To determine the relationship between IE and the absorption dose given to patients with age range thoracic examination, it can be seen that the resulting graph is increasing. In the absorption dose range of 0.08-0.180 mGy, the IE is 1410.6. In the range, 0.181-0.280 mGy gets an IE of 1468. In the range, 0.281-0.380 mGy gets an IE of 1774.3. In the range of 0.381-0.480 mGy, the IE is 1820.5. It can be explained that the higher the absorption dose received by the patient, the higher the EI.

Results of the radiographic image of the chest examination at Kasih Ibu Kedonganan Hospital can be shown in Figure 4. as follows. As Figure 4, it has been shown how the results of the radiographic images of the chest examination. In (a) you can see the results of an under-exposed radiographic image, where there is a decrease in density and are affected by scattered radiation, so the resulting image becomes opaque or blurry and the resulting IE is 1250. In (b) with an IE value of 1601 results, The image is good, so it can be seen that in the results of this image the level of blackness and sharpness of the resulting image are good for the accuracy of diagnosis by doctors (Gill et al., 2018; Fitousi, 2017; Suryatika et al., 2019). In (c) with an IE value of 1955, it can be seen that the radiographic image results are overexposed which causes the image to become blacker, causing a decrease in the quality of the resulting image.

(a) (b) (c)

Figure 4. The results of the radiographic images of the chest examination, (a) the results of the chest image underexposure, (b) the results a good chest examination image, (c) overexposing chest examination results.

4 Conclusion

The result of this research is that the IE value of 1601 is the IE value which produces the optimum dose. The optimum patient dose can easily be monitored using the IE value on a radiographic image. With this IE value, a quality radiographic image can be obtained with the right exposure dose.

Conflict of interest statement
The authors declared that they have no competing interests.

Statement of authorship
The authors have a responsibility for the conception and design of the study. The authors have approved the final article.

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References

AAPM. (2009). An Exposure Indicator for Digital Radiography.

Adler, A., Carlton, R., & Wold, B. (1992). A comparison of student radiographic reject rates. *Radiologic Technology*, *64*(1), 26-32.

Akhadi, M. (2000). Basics of Radiation Protection. *Jakarta: Rineka Reserved*.

Anaisa, I. (2012). Optimization of phantom images using CR head examination of the PA, Medical Physics Thesis, University of Indonesia, Jakarta.

Brealey, S., Scally, A., Hahn, S., Thomas, N., Godfrey, C., & Coomarasamy, A. (2005). Accuracy of radiographer plain radiograph reporting in clinical practice: a meta-analysis. *Clinical radiology*, *60*(2), 232-241. https://doi.org/10.1016/j.crad.2004.07.012

Fahmi, A., Firdausi, K. S. & Wahyu, S. B. (2008). The Effect of Exposure Factors on Abdomen Examination on Radiograph Quality and Radiation Exposure Using Computed Radiography, Periodic Physics ISSN: 1410 - 9662 *11*(4), 109-118

Fitousi, N. (2017). Patient dose monitoring systems: a new way of managing patient dose and quality in the radiology department. *Physica Medica*, *44*, 212-221. https://doi.org/10.1016/j.ejmp.2017.06.013

Gill, H. S., Elshahat, B., Kokil, A., Li, L., Mosurkal, R., Zygmanski, P., ... & Kumar, J. (2018). Flexible perovskite based X-ray detectors for dose monitoring in medical imaging applications. *Physics in Medicine*, *5*, 20-23. https://doi.org/10.1016/j.phmed.2018.04.001

Hardy, M., & Snaith, B. (2009). Radiographer interpretation of trauma radiographs: issues for radiography education providers. *Radiography*, *15*(2), 101-105. https://doi.org/10.1016/j.radi.2007.10.004

ICRP. (2007). Recommendations of the International Commission on Radiological Protection Publication 103, Annals of the ICRP, Elsevier Publications, Oxford, UK.

Jenkins, D. (1988). Radiographic, Photographic and Imaging Process.

Rochmayanti, D., Sugiyanto, & Wibowo, G. N. (2016). Adjustment of exposure index for optimization of radiographic quality on CR of Thoracic organs, Poltekkes Kemenkes Pedalangan; Banyumanik; Semarang

Sarayati, S. (2016). *Analisis Faktor Perilaku Seksual Pada Anak Sd Di Sdn Dukuh Kupang Ii–489 Kecamatan Dukuh Pakis Kelurahan Dukuh Kupang Surabaya* (Doctoral dissertation, UNIVERSITAS AIRLANGGA).

Shepard, S. J., Pei-Jan, P. L. (2002). Quality Control In Diagnostic Radiologymembers. AAPM Report No. 74, Published For The American Association Of Physicists In Medicine By Medical Physics Publishing.

Sikumbang A.S. (2018). Analysis of Radiation Doses on Mobile X-rays of Emergency Patients in the ICU Room, University of North Sumatra, Medan.

Snaith, B., & Hardy, M. (2008). Radiographer abnormality detection schemes in the trauma environment—An assessment of current practice. *Radiography*, *14*(4), 277-281. https://doi.org/10.1016/j.radi.2007.09.001

Suryatika, I. B. M., Sutapa, G. N., & Kasmawan, I. G. A. (2019). Radiology patient dosage monitoring for local diagnostic reference level. *International research journal of engineering, IT & scientific research*, *5*(5), 26-31.

Susilo, Sunarno, Setiowati, Lestari. (2012). Application of Digital Radiography Tools in Photorontgen Service Development, Journal of Mathematics and Natural Sciences, State University of Semarang, *35*(2), 145-150.

Sutapa, G. N., Yuliara, I. M., & Ratini, N. N. (2018). Verification of dosage and radiation delivery time breast cancer (Mammae Ca) with ISIS TPS. *International journal of health sciences*, *2*(2), 78-88.

Wilks, R. J. (1987). *Principles of radiological physics*. Churchill Livingstone.