Exposure Factor Control with Exposure Index Guide As Optimizing Efforts in Chest Pa Examination

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Abstract. Participation between radiographers and medical physicists is needed in optimizing efforts to control the selection of exposure factors by the required clinical radiographic examination. This research is descriptive quantitative by analyzing of exposure index results used in the chest PA examination as an effort to optimizing radiation dose. Also, statistical analysis was carried out to determine the relationship between exposure and the exposure factor using the Spearman test. Results the Spearman test results for underexposure to kV 0.207, and mAs 0.012, meanwhile for overexposed to kV -0.283 and mAs 0.166, the radiographer can make efforts to optimize radiographic examinations by considering the optimal selection of exposure factor parameters which can use a combination of exposure index by assessing the deviation index indicator and maximizing use post-processing or windowing to improve image quality.

1. Introduction

The whole world is focused on dealing with the respiratory disease caused by the novel coronavirus, this disease was first reported in the city of Wuhan, China. Then it became a worldwide pandemic. On February 11, 2020, the World Health Organization or WHO gave a special name for the respiratory disease caused by coronavirus to become coronavirus disease 2019 or COVID-19. Is a threat to the entire world community, this is the flu that can spread from human to human transmission and droplet [1] [2]. At the time of the COVID-19 pandemic, radiographic imaging was one of the screening diagnoses for suspected COVID-19 patients, cooperative adult, and pediatric patients could be carried out with a Posterior-Anterior (PA) examination [3] [4].

Chest radiograph imaging (CXR) has an important role in assisting the diagnosis and development of care in COVID-19 patients, which is the imaging modality most commonly used for diagnosing COVID-19 [5]. One of the advantages of CXR is the equipment available in every health facility, low radiation dose, and speed of image acquisition [6] [7]. Also, several research results recommend CXR as a supporting tool for diagnosing COVID-19 [8] [9] [10] [11]. CXR examination in confirmed COVID-19 patients can provide the same diagnostic information as CT scan examination, CXR examination on days 6-11 shows an 80% percentage of success in diagnosing with a sensitivity of 69% [12].

Radiographers are responsible for producing image quality which can provide accurate diagnostic information by considering the lowest possible radiation dose according to the As Low As Reasonably Achievable (ALARA) principle [13]. It is difficult for the radiographer to determine the optimal exposure factor in some cases. This is related to the size of the organ thickness, the use of imaging equipment, and experience as a practitioner in the field of radiography. The provision of the exposure factor affects image quality. One of them is noise, this can be defined as the intensity of radiation...
received by the image receptor. The effect of image noise can reduce the clear boundaries between one organ and another [14].

The task of medical physicists is to control the dose of radiation and maintain the quality of radiographic images [15]. Participation is needed between radiographers and medical physicists in optimizing efforts to control the selection of exposure factors by the clinical radiographic examination required [16] [17]. In the Computer Radiography (CR) imaging system, the indicator that shows the response of the imaging plate to radiation exposure is called the exposure index is proportional to the radiation exposure given by the selection of the exposure factor, therefore exposure index can be used as a guide in making optimizing efforts related to image quality and radiation dose [18] [19] [20] [21]. Also, the exposure index can assess the acceptance of overexposure, optimizing exposure, underexposure [22]. The problem that occurs is that chest PA radiographic examinations in the COVID-19 pandemic conditions have increased significantly where patients carry out examinations not only for the diagnosis but also used as an indicator of treatment, this causes optimizing efforts so that radiographers make the selection exposure factor parameter can provide the lowest possible radiation dose while maintaining the quality image of radiographic to be able to provide diagnostic information properly. So this research aims to provide information to radiographers in controlling the selection of exposure factors as an effort to optimizing while maintaining image quality and providing the lowest possible radiation dose on chest PA examinations with suspected COVID-19 patients.

2. Methods

This study used secondary data consisting of exposure factors and exposure index with a total of 1071 patient data on chest PA examination. This research is descriptive quantitative by analyzing the percentage of exposure index results used in the chest PA examination as an effort to optimizing radiation dose. Also, statistical analysis was carried out using IBM SPSS version 24th to determine whether there was a relationship between exposure index and exposure factors at the time of clinical examination for chest PA using the Spearman Test with the correlation coefficient 0.00-0.25, the level of the relationship was weak, 0.26-0.50 the level of the relationship was sufficient, 0.51-0.75 the level of the relationship was strong 0.76-0.99. very strong relationship level 1 perfect relationship level.

3. Results

This research was conducted on 1-30 June 2020 at the department of radiology of COVID-19 emergency hospital in Wisma Atlet Jakarta, using secondary data taken from the exposure factor data used by each radiographer when carrying out chest PA examination on patients with suspected COVID -19 and without any intervention to the patient, the exposure factor used was based on the habitual selection of the exposure factor by several radiographers.

The Table 1 shows the mean value of the use of the exposure factor and the exposure index value generated by the radiographer during chest PA radiographic examinations, where the exposure index indicator for optimizing imaging is 108.5 ± 39.2 with parameters of the exposure factor for kV 75 ± 4.5 and mAs 7.3 ± 2.52, for underexposure image 47.9 ± 8.03 with the parameter of exposure factor for kV 73.8 ± 5.27 and mAs 6.5 ± 3.23, for underexposure image (noise) 22.3 ± 5.76 with exposure factor parameter for kV 71.6 ± 6.42 and mAs 6.2 ± 2.85, for overexposure image 288.1 ± 35.7 with the exposure factor parameter for kV 75.43 ± 8.64 and mAs 8.15 ± 3.55, for the image overexposure (noise) 693.5 ± 231.22 with the exposure factor parameter for kV 67.5 ± 17.67 and mAs 6.25 ± 5.30. The results it is known that there is no significant difference from the use of the exposure factor parameter to the radiographic image.

| Exposure index | Exposure factor | Image description |
|----------------|-----------------|-------------------|
| 108.5 ± 39.2   | 75 ± 4.5        | Optimizing exposure|
| 47.9 ± 8.03    | 73.8 ± 5.27     | Underexposed      |
In practice, in the chest PA radiography examination for COVID-19 at the COVID-19 Emergency Hospital in Wisma Atlet Jakarta, many images experience underexposure and overexposure, but no repeat examinations are carried out due to the COVID-19 handling situation so that for consideration of potential factors for infection from patients, apart from that patients will undergo continuous chest PA examinations for the observation of COVID-19 treatment, so as to optimize the radiation dose given to patients. Radiographer optimizes can be post processing, especially in the use of windowing, by consulting a radiologist about the resulting radiographic image [23] [24].

4. Discussion

The Spearman Test analysis was performed for the exposure index criteria underexposed and overexposed to determine whether there was a relationship between the exposure index and the exposure factor. The results of the spearman test analysis for underexposure to kV 0.207, and mAs 0.012, meanwhile for overexposed to kV -0.283 and mAs 0.166, so there is no significant relationship between exposure index for underexposure or overexposure to the exposure factor show in Table 2.

| Exposure index | Coefficient correlation kV | Coefficient correlation mAs |
|----------------|----------------------------|-----------------------------|
| Underexposure  | 0.207                      | 0.012                       |
| Overexposure   | -0.283                     | 0.166                       |

So that it can be ascertained that in determining the estimated radiation dose received by patients in clinical practice it is not enough to use the exposure factor parameter, but the radiographer should consider several factors including, the patient's body size, focus film distance used, the radiographic technique used and the patient's age, then from some of these factors combined with the use of optimal exposure factor parameters. In addition, in this study, the protocol for radiographic examination of chest PA focus cassette CR distance was 150 cm, the size of the CR cassette used was 43 cm x 35 cm, with the standard of exposure for chest PA radiographs as a guide for the X-ray mobile unit, namely 65 kV 5-15 mAs. X-ray mobile unit with a capacity of 100 kV and 100 mAs, the condition of the radiological installation electric current and voltage affects the performance of the mobile unit, especially the X-ray output, this is because the installation preparations are carried out in an emergency for handling COVID-19 pandemic.
Figure 1. Frequency exposure index to the selection of exposure factors

Figure 2. Shows the use of the exposure factor and exposure index generated during 1-30 June 2020, for the mean value of exposure index 94.82 ± 59.28, for kV 75.08 ± 5.09 and mAs 7.09 ± 2.78 with this value also having the same value with the optimal exposure index criteria. From these results, it can also provide information that the radiographer has tried to optimizing the image by selecting the exposure factor that is adjusted to the patient's condition and maximizing post-processing or windowing to improve image quality. Also, the radiographer's clinician experience determines the selection of exposure factors and can analyze the quality of the resulting image, where the radiographer can make efforts to optimize radiographic examinations by considering the optimal selection of exposure factor parameters which can use a combination of exposure index by assessing the deviation index indicator and maximizing use post-processing or windowing to improve image quality.

5. Conclusion

Results the Spearman test results for underexposure to kV 0.207, and mAs 0.012, meanwhile for overexposed to kV 0.283 and mAs 0.166, so there is no significant relationship between exposure index for underexposure or overexposure to the exposure factor. The radiographer can make efforts to optimize radiographic examinations by considering the optimal selection of exposure factor parameters which can use a combination of exposure index by assessing the deviation index indicator and maximizing use post-processing or windowing to improve image quality.

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