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# Implementation of Deviation Index to Optimization Procedures on Radiography Examination Using Digital Radiography

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**ABSTRACT**

In the development of radiographic imaging technology at digital radiography (DR) is not accompanied by an increase in radiographers' awareness and knowledge of optimization procedures. The aim of this research will focus on the implementation of the deviation index to optimize procedures using digital radiography. The research method is descriptive and analytical by giving questionnaires to radiographers regarding awareness and knowledge of optimization procedures in radiographic examinations using deviation index (DI) on digital radiography (DR), This research was conducted on radiographer respondents with the research time being conducted between August - October 2023. Statistical analysis using SPSS 27 with prior data coding. After that, the measurement of the percentage of awareness and knowledge about optimization procedures using DI on DR will be categorized as <60%: bad, 60-75%: moderate, and>75: good. Then for the value determination p-value using test chi-squere to determine the correlation between knowledge of region, age, gender, education, and experience in optimization procedures using DI in DR. The study's findings regarding the use of optimization procedure demonstrate that radiographers' awareness and knowledge in applying DI on DR optimization methods is still lacking, with a percentage value of less than 60%. The results of the test chi-square demonstrate that there is no correlation between respondent data characteristics and knowledge p-value > 0.05. Therefore, attending radiation protection training and course is a crucial step toward raising radiographers awareness and knowledge of radiation protection on patient. because the radiology department's quality assurance and service quality measures are linked to initiatives to optimize procedures.

**Keywords:** Awareness, Knowledge, Deviation Index (DI), Digital Radiography (DR)

## I. INTRODUCTION

Over the past 20 years, there have been extremely quick advancements in imaging system technology for radiography modalities. These include the use of radiographic film, computer radiography (CR), and direct-digital radiography (DDR), also commonly referred to as digital radiography (DR). However, radiographers' awareness and knowledge of radiographic examination procedures using CR and DR have not kept pace with this development. Instead, radiographers frequently overlook optimization procedures for choosing the right exposure factors for each type of radiographic examination. [1], [2].

The digital radiography imaging system has reduced radiation exposure for patients, and reports of repeated exams and exposure factor determinations as a result of technical errors have dropped as well. [3]. Because of this, radiographic pictures derived from radiographic examination findings need to be able to accurately diagnose patients by weighing the potential advantages against any associated hazards. This is a sign of "good practice" in the field of radiology. [4], [5].

Utilizing an image acquisition system for pre-processing and a wide latitude range to increase image quality, digital radiography imaging offers several advantages for the radiographic assessment of patients. Additionally, radiation exposure has no influence on the quality of the radiographic image. The best possible control over radiation exposure is achievable with digital radiography imaging equipment. because the imaging system can generate images with comparable quality in both high and low-exposure levels [6].

The use of digital radiography does not eliminate the chance that mistakes may be made when performing radiographic exams. One of the most important variables, particularly when assessing exposure factors for health, is technical mistake, which increases the amount of radiation that patients are exposed to. Consequently, technical factors including equipment use, examination protocols, and ongoing education can aid in lowering technical errors in radiography exams [7]–[11].

The ALARA principle (as low as reasonable achievable), which states that radiation exposure should be as low as reasonably attainable while retaining image quality, must be taken into account by radiographers when exposing patients to radiation. In order to accomplish this, digital radiography imaging has an indication known as the deviation index (DI) that gives details on the appropriateness of radiation exposure on DR equipment. According to a research paper, keeping an eye on the DI value is one way to minimize radiation exposure. However, the deployment of DI use is rarely carried out adequately due to radiographers' ignorance of and lack of knowledge about DI. [12], [13]. Thus, the application of the deviation index to digital radiography will be the main emphasis of this study to maximize radiographic exams.

## II. METHODS AND MATERIAL

### A. Research design

The research method is descriptive and analytical by giving questionnaires to radiographers regarding awareness and knowledge of optimization procedures in radiographic examinations using deviation index (DI) on digital radiography (DR), This research was conducted on radiographer respondents with the research time between August – October 2023.

### B. Data collection

Data gathering through the use of surveys The first section of the Google form asks for demographic information, including area, gender, age, education level, and work experience. A total of thirteen items on a Likert scale of 1: never, 2: seldom, and 3: often make up the second section of the questionnaire, which focuses on awareness behavior. The higher the assessment, the better the optimization behavior during radiographic exams. After that, the result will be divided by the maximum value and multiplied by 100 to get a percentage value. The third section consists of a knowledge questionnaire with ten questions overall that include value descriptions and a 1 for the right answer and a 0 for the incorrect responseThe greater the number of accurate responses, the more proficient one is at optimizing radiography examinations, and vice versa. Subsequently, the total value will be divided by the maximum value multiplied by 100 to transform the resultant number into a percentage. The findings regarding the awareness and knowledge of optimization processes employing DI in DR will be divided into three categories: poor (<60%), moderate (60–75%), and good (>75%) [14].

### C. Statistic analysis

Data coding in SPSS 27 was utilized for statistical analysis. The frequency, distribution, percentage, average, and standard deviation of the data were then determined by processing it using descriptive statistics. In order to ascertain the correlation between knowledge of the area, age, gender, education, and experience in the optimization process using DI on DR, the p-value was then calculated using the test chi-square. If the p-value was greater than >0.05, there was no correlation between the two variables, but if it was less than <0.05, there was.

## III.RESULTS AND DISCUSSION

The results of research conducted on radiographer respondents totaling 29 people with the characteristics of the respondent data are shown in Table 1. The percentage of radiographer respondents with data for the JABODETABEK region was 62.1% and outside JABODETABEK 37.9%, then for respondents aged < 40 years 75.9% and > 40 years 24.1%, for men 62.1% and women 37.9%, diploma education 79.3% and bachelor's degree 20.7%, then for work experience 1-5 years 17.2% and 6 to more than 10 years 82.8%.

**Table 1**. Respondent characteristics data

| Data | n | Percentage (%) |
|---|---|---|
| Region | | |
| JABODETABEK | 18 | 62.1 |
| Outside JABODETABEK | 11 | 37.9 |
| Age | | |
| < 40 years | 22 | 75.9 |
| > 40 years | 7 | 24.1 |
| Gender | | |
| Man | 18 | 62.1 |
| Woman | 11 | 37.9 |
| Education | | |
| Diploma | 23 | 79.3 |
| Bachelor degree | 6 | 20.7 |
| Work experience | | |
| 1-5 years | 5 | 17.2 |
| 6 to more than 10 years | 24 | 82.8 |

The results of the awareness and knowledge questionnaire about optimization procedures using DI in DR are shown in Table 2 and Table 3. The results of the awareness questionnaire in Table 2 show the average percentage value for never 22%, rarely 26.5 and often 51.5%. Apart from that, the results of the knowledge questionnaire in Table 3 show an average percentage value of 39.31. So, based on the results of the awareness and knowledge questionnaire, it shows that the level of awareness and knowledge of radiographers is still low in carrying out optimization procedures using DI on DR with a percentage value of <60%.

Next, Table 4 illustrates the degree of correlation between the knowledge variable and the attributes of the responder data. The findings of the chi-square test indicate that there is no correlation between knowledge and the respondent data's characteristics, with p-values of 0.331, 0.706 for age, 0.868 for gender, 0.947 for education, and 0.075 for job experience. Radiographer participation in radiation safety training and seminars is therefore a significant aspect that can raise awareness and knowledge. Nonetheless, this study's 41.4% percentage results for the uncommon criterion were the greatest. It is therefore hoped that the hospital would be able to inspire, teach, and include radiographer in each seminar. because the radiology department's quality assurance and service quality measures are linked to initiatives to optimize procedures.

In addition to its advantages over radiographic film, computer radiography produces images with a larger dynamic range, or CR exposure response range. However, it has drawbacks such as poor X-ray exposure detection efficiency, a CR spatial resolution of 6 lp/mm, which is less than that of radiographic film, and an extremely fragile Imaging Plate (IP). As a result, digital radiography (DR) systems have evolved from digital imaging systems. The utilisation of amorphous silicon and amorphous selenium materials, which have the ability to convert light or X-rays into electrons, is the foundation of the DR image acquisition system. Additionally, compared to computer radiography and film screen imaging technologies, the image quality produced by selenium material is superior. The flat-panel detector component in the DR imaging process is a device that includes an ADC, internal memory, switch control, preamplifier, and center logic circuit. This means that everything is handled by the flat-panel detector during the signal digitization and X-ray detection processes. Nowadays, direct radiography, commonly referred to as digital radiography, involves the use of flat-panel detectors. Depending on the kind of X-ray absorption, detectors fall into two categories: direct detectors that use thin-film transistors (TFT) and indirect detectors that use charge-coupled devices. Technical components that transform light into electrical impulses are both kinds of detectors. [15].

The dynamic range of digital radiography is high. As a result, when imaging data demonstrate consistency under or overexposure situations, other issues occur.

Radiographers find it challenging to determine the level of exposure provided to patients as a result. Therefore, increasing the exposure factor values in order to obtain an acceptable image frequently results in a rise in dosage, or what is known as dose creeping. The imaging system offers an exposure indicator, commonly referred to as an exposure index (EI), to help solve this issue by giving information on the proper lighting strategy. To address the issue of disparate nomenclatures used by vendors, the American Association of Physicists in Medicine (AAPM) and the International Electrotechnical Commission (IEC) have standardized all DR imaging systems. One measure of the EI standardization utilized in clinical practice is the deviation index (DI), which compares the actual exposure index value to the target exposure index value (EI target). The key point to remember is that the radiology department, not the vendor, sets the target EI. DI provides radiographers with a range of values to help them distinguish between acceptable and undesirable images. It can also reveal whether the exposure settings chosen for dose administration and image quality are adequate. It is advised to repeat the examination in the event that the anatomy is cut or arises because if the DI range value is larger than +3, double exposure will occur, and if it is +1 to +3, overexposure will occur. burned out. The image is best for readings between -1 and +1; for values between -1 and -3, speaking with a radiologist or doing the test again is advised. [15], [16].

The study's awareness and knowledge questionnaire about DI optimization methods in disaster recovery reveals that, on average, respondents' levels of

**Table 2.** Results of the awareness questionnaire

| Question | Percentage (%) | | |
|---|---|---|---|
| | **Never** | **Seldom** | **Often** |
| Do you know information about whether the X-ray equipment in your hospital is regularly calibrated? | 0 | 17.2 | 82.8 |
| Do you know about dose optimization procedures for radiographic examinations? | 6.9 | 27.6 | 65.5 |
| Has your hospital established typical dose/Local DRL values for radiographic examinations? | 24.1 | 31 | 44.8 |
| Do you always compare the typical national dose/DRL-National value with the dose from the radiographic examination you performed? | 48.3 | 24.1 | 27.6 |
| Do you record patient data in a log book documenting exposure parameters (such as type of examination, patient position, age, gender, body weight, distance from source to image receptor, exposure factor, and collimation area)? | 13.8 | 24.1 | 62.1 |
| Do you always record the Deviation Index (DI) value on every radiographic examination? | 48.3 | 27.6 | 24.1 |
| Do you always compare the DI value from the radiographic examination you have done with the optimal DI? | 48.3 | 44.8 | 6.9 |
| Do you consider the patient's weight when selecting exposure factors? | 13.8 | 6.9 | 79.3 |
| Do you consider the area of the collimation field before exposing it? | 0 | 3.4 | 96.6 |
| Do you use DI as a guide in selecting appropriate exposure factors? | 31 | 31 | 37.9 |
| Do you use the high kV technique on PA chest radiography examinations? | 3.4 | 37.9 | 58.6 |
| Are you aware of the use of DICOM data for optimization procedures? | 20.7 | 27.6 | 51.7 |
| Have you ever attended training or course on radiation protection on patients? | 27.6 | 41.4 | 31 |
| Mean ± standard deviation | 22 ± 17.9 | 26.5 ±12 | 51.5 ± 25.9 |
| Min-max | 0-48.3 | 3.4-44.8 | 6.9-96.3 |

awareness were never 22%, seldom 26.5, and frequently 51.5%. The average percentage value for the knowledge level results is 39.31. According to the awareness and knowledge questionnaire answers, radiographers still have a low level of awareness and knowledge when it comes to performing optimization processes employing DI on DR, as evidenced by the percentage value of less than 60%. Next, with a p-value > 0.05, the chi-square result demonstrates that there is no association between knowledge and the respondent data's attributes. The radiographer is in charge of delivering the radiation dose, according to Bawazeer. As a result, the degree of awareness and knowledge demonstrates the radiological services that patients receive. According to the study's findings, 60.6% of people were knowledgeable. It could not, however, be described theoretically and used in practical settings. Then, there is no correlation between knowledge and, region, gender [17]The study's findings demonstrated that throughout radiological examination procedures, radiographers failed to assess and oversee radiation dosage reporting. Furthermore, insufficient awareness and knowledge can affect how radiation doses are administered to patients during radiology operations and suggest that optimization proceduress have not been carried out. [18].

**Table 3.** Results of the knowledge questionnaire

| Question | Answer | Percentage (%) |
|---|---|---|
| What is the phenomenon of increasing the patient's radiation dose when using digital radiography technology? | Dose creeps | 21 |
| The amount of radiation dose used to determine radiographic optimization procedures if KAP (kerma area product) dose information is not provided? | ESAK (entrance surface air kerma) | 41.4 |
| Overexposure deviation index value >100% (double exposure)? | > 3 | 51.7 |
| Ideal deviation index value? | - 1 to 1 | 48.3 |
| Underexposure deviation index value <50%? | - 1 to -3 | 31 |
| The relationship between kV and radiation exposure? | Quadratic | 55.2 |
| The relationship between mAs and radiation exposure? | Linear | 51.7 |
| The relationship between distance and radiation exposure? | Inverse | 48.3 |
| Typical national dose values for PA chest radiography examinations based on the BAPETEN report in the 2019 National Diagnostic Guide or diagnostic reference level (DRL) Preparation Guidebook? | 0.6 mGy | 6.9 |
| Descriptive statistical analysis to determine typical local dose/DRL-Local values? | 75th percentile | 27.6 |
| Mean ± standard deviation | | 39.31 ± 15.1 |
| Min-max | | 6.9-55.2 |

**Table 4.** Test chi-square knowledge of data characteristics

| Chi-square | p-value |
|---|---|
| Region | 0.331 |
| Age | 0.706 |
| Gender | 0.868 |
| Education | 0.947 |
| Work experience | 0.075 |

Subsequently, the study findings by Sripusanapan, that awareness and knowledge levels indicate the capacity to implement optimization procedures for patients. In addition, lack of course about optimization procedures during on program's continuing professional development, which was centered on treatment approaches. Lack of awareness and information regarding radiation safety and the utilization of clinical procedures during university education is one of the causes of this ignorance. [19] . The same study findings were also discovered by Daqqaq, students, radiologists, and radiographers continue to have inadequate levels of awareness and knowledge. in particular being aware of radiation hazards and doses [20]. According to a research report by Alchallah, there is no difference in the average knowledge values of men and women with a p-value of 0.942. Furthermore, the majority of radiographer are unable to apply optimization procedures, So it is best to carry out a screening method by distributing awareness and knowledge questionnaires. So that the radiology departments can conduct this survey to schedule training sessions or course for each radiographer [21].

Not knowledge the diagnostic reference level (DRL) value of radiographic examinations is one of the challenges radiographers face when doing optimization operations. Consequently, in order to give radiographers internal training and improve their awareness and knowledge of optimization procedures in radiographic examinations, cooperation between medical physicists and radiology physicians is required. [22]. According to Kada, creating learning experiences during laboratory practicums that are tailored to clinical demands in hospitals and providing sufficient internship time in hospitals are two ways to increase awareness and knowledge of radiological examination optimization proceduress during the educational period. [23]. Thus, a number of crucial elements must be taken into account, including striking a balance between the theory and practice of studying radiation protection for patients, using the most recent advancements in radiology to inform radiographic examination proceduress, and introducing technology in the field of radiology while providing learning materials that emphasize interactive problem-solving as an alternative to books, journals, and online modules [24].

A limitation of the research is that there is no collaboration between the researcher and respondents [25]. The availability and knowledge questionnaire will then need to be evaluated by a preliminary pilot study. Aside from that, there are issues with the study approach that uses Google Forms for monitoring test answers because test takers can utilize the media and the internet to their advantage when responding questions that gauge their level of knowledge.

## IV. CONCLUSION

The study's findings regarding the use of optimization procedure demonstrate that radiographers' awareness and knowledge in applying DI on DR optimization methods is still lacking, with a percentage value of less than 60%. The results of the test chi-square demonstrate that there is no correlation between respondent data characteristics and knowledge p-value > 0.05. Therefore, attending radiation protection training and course is a crucial step toward raising radiographers awareness and knowledge of radiation protection on patient. because the radiology department's quality assurance and service quality measures are linked to initiatives to optimize procedures.

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