

# Evaluation of Radiographers Experience and Knowledge Related to Estimation, Radiation Dose Comparison, and CT Parameters in Kota Medan, Indonesia

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## Abstract

**Introduction:** In patient examination, the role of a radiographer is very important especially in applying appropriate techniques and procedures to minimize exposure received by patients as needed or optimization. Given this, radiographer knowledge of CT parameters is very important, especially the impact on radiation and the quality of the image produced. Perception of the risk and estimation of CT radiation doses also need to be radiographer's knowledge because in the service, radiographers are the most frequently interacted with patients.

**Purpose:** To assess the opinion, experience and knowledge of radiographers regarding radiation risk and CT parameters in Kota Medan, Indonesia.

**Materials and Methods:** a survey study was conducted on 33 radiographers from three hospitals in Kota Medan using a 60-question questionnaire consisting of three parts: characteristics, experience, and knowledge. Data were analyzed using Excell and SPSS version 25.

**Results:** the calculation of 48 knowledge problem questions answered, the total value of each respondent is then calculated. Average knowledge value of respondents 56.3% (poor category) with correct value range 14 - 32 with an average value of 26.1 + 4.2. None of the respondents answered all the questions correctly

**Conclusion:** the score of the radiographer's knowledge of estimation, dose comparison and CT parameters is still low. Review of knowledge, training or further courses related to CT optimization techniques need to be attempted again in the hospital for radiographers.

**Keywords :** Radiographers, CT parameters, optimization, radiation protection

## Introduction

CT is an imaging modality in radiology services whose use is increasing nowadays. In the city of Medan,

North Sumatra, Indonesia, until 2020 there are about 28 hospitals that have CT scan service facilities.

The trend in the number and use of CT for diagnostic purposes also has an impact on increasing the radiation dose used. National Commission on Radiation Protection and Measurement (NCRP) data shows that in 2006 it was estimated that in the United States the percentage contribution of doses from medical exposure from various radiological examination techniques was CT by 49%, Nuclear Medicine by 26%, Interventional Fluoroscopy by 14%, and Conventional radiography was

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11%<sup>1</sup>. This condition is reinforced by previous studies, that radiographers' knowledge is still low regarding CT parameters which have an impact on image quality and patient dose<sup>2,3,4,5</sup>. From various research studies, the problem of CT radiation dose received by patients so far is more related to the main principle of radiation protection, namely: justification. This principle states that examination of patients using ionizing radiation should take into account the principle of benefits compared to its impacts<sup>6,7,8</sup>.

In patient examination, the role of a radiographer is very important especially in applying appropriate techniques and procedures to minimize exposure received by patients as needed or optimization<sup>9</sup>. Training in the operation of CT Scans by radiographers was mostly carried out during the initial installation carried out by equipment suppliers (vendors) and some hospitals were taught by seniors to junior staff. Training largely only focused on the purpose of routine clinical examinations, and it is still rare to be trained to optimise a patient's dosage.

Given this, radiographer knowledge of CT scan parameters is very important, especially the impact on radiation and the quality of the imagery produced. To ascertain how deep the level of knowledge related to radiation risk and CT Scan parameters, a more detailed assessment is needed in order to improve radiographer education. Perception of the risk and estimation of CT Scan radiation doses also need to be radiographer knowledge because in the service, radiographers are the most frequently interacted with patients. Radiographers play an important role in patient safety in CT Scan services. In addition to asking about knowledge issues, the survey also asked about experiences and opinions on important issues of radiation protection such as justification and cancer in children due to CT scans.

## Materials and Methods

The design of this research is Cross Sectional which was conducted using a survey in February - April 2020. Questionnaires were distributed to three hospitals in Medan that have CT facilities. All respondents stated that they were willing to follow the research by signing informed Consent. Any kind of information related to

research respondents becomes confidential. The number of samples of this study was 33 radiographers selected by purposive sampling method.

The questionnaire used in this study is a modified questionnaire from previous studies<sup>10,2,5</sup>. The total number of questions in the questionnaire was 60. The questionnaire is divided into three parts, namely first, questionnaires about the characteristics of respondents, second, questionnaires about opinions and experiences; third, questionnaires on knowledge (estimation and comparison of doses, and parameters of CT). Number of questions of opinion and experience issues (12 questions), estimation and comparison of CT radiation doses (9 questions), and CT parameters (39 questions).

All questions answered correctly are rated 1 while the wrong answer is rated 0. During the filling out of the questionnaire, radiographers are not allowed to open books or other sources of information. They fill in based on the knowledge they have. The time required to complete the entire questionnaire question is about 20-40 minutes. Of all respondents there were 5 respondents (15.2%) complete answers to questionnaires.

Data analysis in this study used Excell and spss version 25 to obtain descriptive statistics and Mann-Whitney U test at the level of meaning ( $P < 0.05$ ). The value category is divided into poor (<60%), enough (61-70%), good (71-80%) and very good (>80%)<sup>11</sup>.

## Results

Thirty-three radiographers from three hospitals in Medan were involved in filling out questionnaires. Demographic characteristics of radiographers covering gender, age, working period, level of education, and radiation protection training are shown in Table 1. Male respondents as many as 12 people (36.4%) and 21 women (63.6%) with an age range of 24 - 54 years with an average of 31.2 (SD = 8.0) years. Respondents' work experience is between 1-22 years with an average of 7.4 (SD = 5.1) years. Respondents were predominantly working age of less than 5 years 33.3% (n = 11) while respondents whose working period was more than 20 years 3.0% (n = 1). Most respondents had a diploma equivalent education of 78.8% (n=26) and only 21.2% (n=7) were undergraduates. Out of a total of

33 respondents, related to radiation protection training that had been followed, 63.6% (n = 21) never and the remaining 36.4% (n = 12) had participated.

The results of respondents' opinions and experiences during CT service are shown in Table 2. The average respondent conducted CT per week < 5 times (9.1%), 5 - 10 times (21.2%), 10 - 15 times (42.4%) and more than 15 times (27.3%). The type of CT scan that is often done during the respondent's work in the hospital is a brain examination of 97.0 % (n = 32) and the rest is a

chest of 3.0% (n = 1). When asked if they had the right to justify the examination, 63.6% (n=21) answered yes, 24.2% (n=8) answered no, and 12.1% (n=4) answered no idea. A total of 33.3% (n = 11) think the professions responsible for justifying CT examinations are all professions (ranging from referring doctors to PPR). The main cause of unjustified CT according to respondents was 59.3% of examinations without useful diagnostic information (n = 17), examinations carried out too early 18.2% (n = 6).

**Table 1. Characteristics of the participants**

Characteristics of the participants		n	%
1. Gender			
A.	Male	12	36,4
B.	Female	21	63,6
2. Age			
A.	< 30 years	21	63,6
B.	30 - 40 years	6	18,2
C.	41 - 50 years	5	15,2
D.	50 < years	1	3,0
3. Qualification			
A.	Diploma	26	78,8
B.	Undergraduate	7	21,2
4. Experience			
A.	< 5 years	11	33,3
B.	5 - 10 years	13	39,4
C.	11 - 20 years	8	24,2
D.	20 < years	1	3,0
5. Attended radiation protection training			
A.	Yes	12	36,4
B.	No	21	63,6

The results of respondents' opinions and experiences during CT service are shown in Table 2.

**Table 2. Opinions and experiences**

<b>Opinions and experiences</b>		<b>n</b>	<b>%</b>
<b>1. Examinations CT per week</b>			
A.	< 5	3	9,1
B.	5 - 10	7	21,2
C.	10-15	14	42,4
D.	15 <	9	27,3
<b>2. Most CT examination done</b>			
A.	Brain	32	97,0
B.	Chest	1	3,0
<b>3. Are you entitled by law to justify CT examinations?</b>			
A.	Yes	21	63,6
B.	No	8	24,2
C.	I don't know	4	12,1
<b>4. With which professional do you consider lies the responsibility of justifying an CT examination?</b>			
A.	Referring physician	4	12,1
B.	Radiologist	5	15,2
C.	Radiographer	4	12,1
D.	Medical Physicist	6	18,2
E.	Radiation Protection Officer	2	6,1
F.	All the above	11	33,3
G.	I don't know	1	3,0
<b>5. Which of the following causes contribute the most to non-justifiable use of CT ?</b>			
A.	Repeating examinations	4	12,1
B.	Examinations without any useful diagnostic information	17	51,5
C.	Examinations performed too early	6	18,2
D.	Wrong examinations	1	3,0
E.	Examinations of the wrong patient	1	3,0
F.	Failure of referrer to provide appropriate clinical information	2	6,1
G.	I don't know	2	6,1
<b>6. Who had the main responsibility of identifying the pregnancy prior to the examination?</b>			
A.	Referring physician	5	15,2
B.	Person justifying the examination	1	3,0
C.	Person performing examination (operator/radiographer)	3	9,1
D.	All the above	23	69,7
E.	I don't know	1	3,0

**Table 2. Opinions and experiences (continued)**

Opinions and experiences		n	%
<b>7. Are you aware of issues “ Radiation from CT in children linked to cancer” ?</b>			
A.	Yes	28	84,8
B.	No	5	15,2
<b>8.Years of CT experience</b>			
A.	< 3 years	10	30,3
B.	3 - 6 years	10	30,3
C.	6 -9 years	8	24,2
D.	9 < years	5	15,2
<b>9. Who decides on the routine CT protocol in your department?</b>			
A.	Radiologist	9	27,3
B.	Radiographer	14	42,4
C.	Application specialist	3	9,1
D.	Medical physicist	6	18,2
E.	I don't know	1	3,0
<b>10.Have you changed any CT protocols in the last two years?</b>			
A.	Yes	5	15,2
B.	No	28	84,8
11. Confidence level to alter the CT parameters correctly in order optimization (max. score: 5) Average score : 2.91+ 1.53			
12. How adequate CT optimization training your department has provided ? (max score :10) Average score : 6.45 + 2.98			

Respondents' experience working in CT services was < 3 years 30.3% ( n = 10), 3 - 6 years 30.3% ( n = 10), 6 - 9 years 24.2% ( n = 8 ), and more than 9 years 15.2% ( n = 5). Determining routine CT Scan protocol according to respondents are radiology specialist 27.3% (n=9), radiographer 42.4% (n=14), medical physicist 9.1% (n=3), application specialist 18.2% (n=6), not knowing 3.0% (n=1). In the last 2 years respondents answered that they had never changed the CT Scan protocol by 84.8% (n=28) and the rest stated that it had

been 15.2% (n=5).

Most respondents who responded were responsible for identifying a female patient's pregnancy prior to the examination, 69.7% (n=23) were referring physicians, people who justified the examination, and those who performed the examination (operator/radiographer) and only 15.2% (n=5) who stated the referrer physician as the one who identified the female patient's pregnancy before the examination. On the question of concern or interest in the issue of cancer in children patients as a

result of CT radiation, respondents answered yes 84.8% (n = 28) and answered no 15.2% (n = 5).

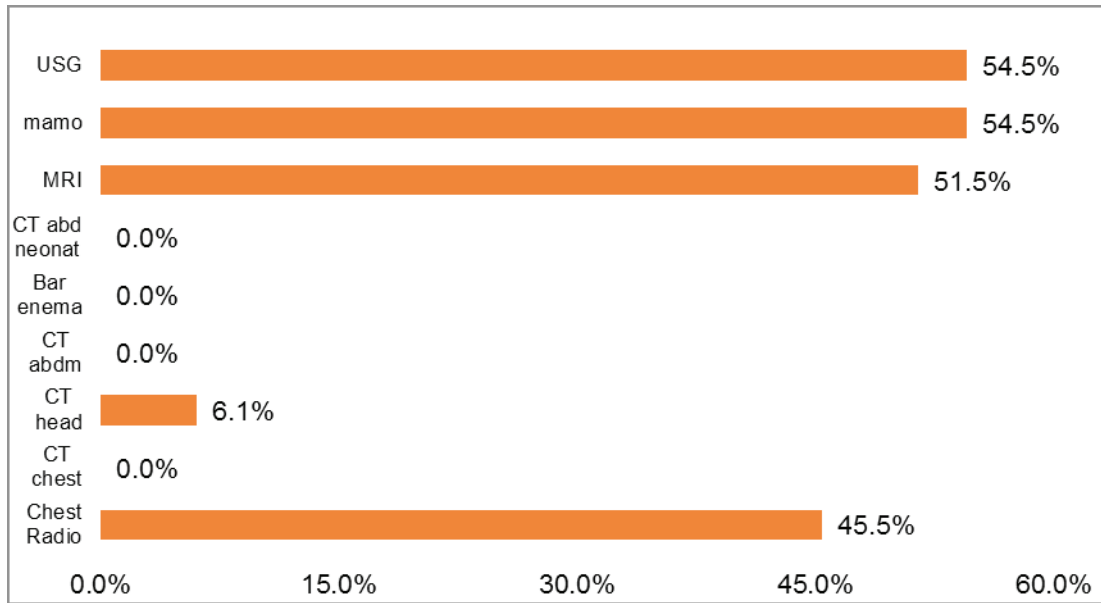


Figure 1. Estimation and comparison of CT radiation doses correct knowledge response

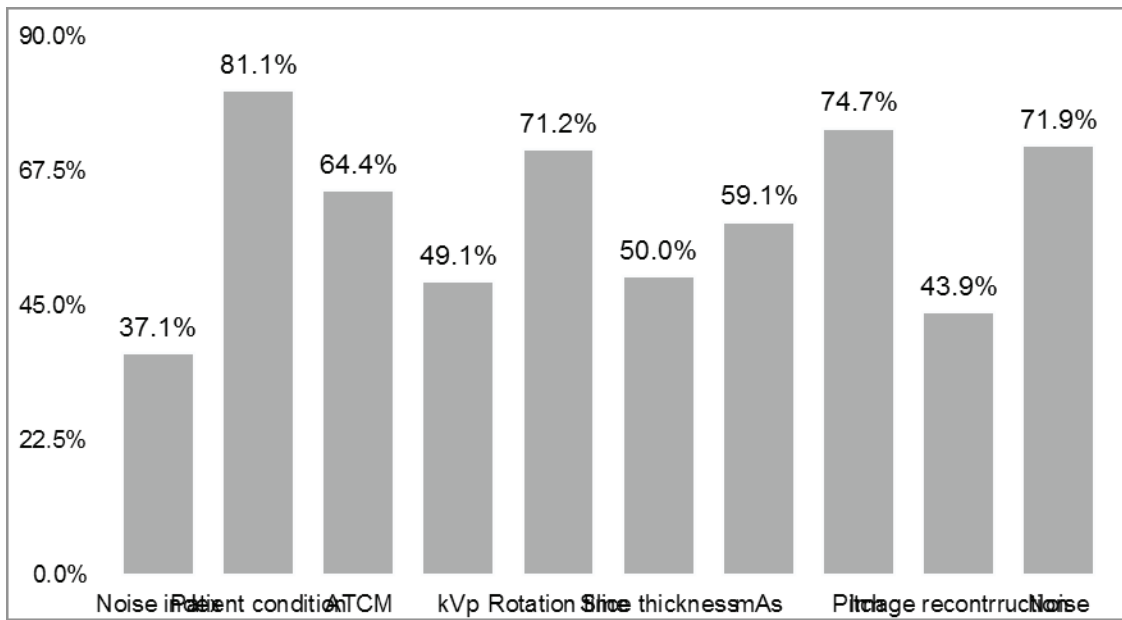


Figure 2. CT parameters correct knowledge response

A high level of confidence of respondents changed the CT parameter in order to optimization (maximum score of 5), obtained an average value of 2.91 +1.53. How adequate the training given to respondents related to optimization of CT parameters (maximum score of 10), respondents answered an average of 6.45 + 2.98.

The results of respondents' answers about estimation and comparison of CT radiation doses are shown in

figure 1. In this section, only 15 respondents (45.5%) which answers the correct effective dose of adult chest radiography examination. For chest radiography dose comparison questions against CT chest, Abdominal CT, Barium Enema, Abdominal CT (neonatal) none of the respondents were able to answer correctly (0.0%). The dose ratio to CT Head was only 7.4% of respondents (n=2) who answered correctly. Comparison with non

ionization modalities (MRI and ultrasound) not all respondents can answer correctly. Compared with MRI, only 63.0% of respondents answered correctly (n=17) and compared with ultrasound only 66.7% of respondents answered correctly (n=18). Comparing dosage with mammography, 66.7% of respondents answered correctly (n=18). Of the 9 questions, the average of all respondents who answered correctly was 23.6% (poor category) with the correct value range of 0 - 5 with an average score of 2.5 +1.6.

The number of questions related to CT parameters amounted to 39 questions with the following details: Noise Index (4), Patient condition (4), Automated Tube Current Modulation or ATCM (4), kVp (4), rotation time (2), slice thickness (4), mAs (2), Pitch (3), image reconstruction (2) noise (9). The results of respondents' answers to each of the topics above are shown in figure 2. In the Noise index the average answering is 37.1%, the Patient condition is 81.1%, ATCM 64.4%, kVp 49.1%, rotation time 71.2%, slice thickness 50.0%, mAs 59.1%, Pitch 74.7%, image reconstruction 43.9%, and noise 71.9%. Of the 39 CT parameter questions, respondents averaged 54.3% (poor category) with the correct value range of 14 - 29 with an average value of 23.3 + 4.6.

From the calculation of 48 knowledge problem questions answered, the total value of each respondent is then calculated. Average knowledge value of respondents 56.3% (poor category) with correct value range 14 - 32 with an average value of 26.1 + 4.2. None of the respondents answered all the questions correctly

## Discussion

So far the problem of justification is in the role of referring physicians, but with the increasing radiology services, especially CT but a small number of radiologists, the role of justification is now starting to be transferred to radiographers<sup>12</sup>. The results of the survey of 33 respondents in this study stated that they are entitled to do justification in CT examination (63.6%). But according to respondents, currently the profession responsible for justifying CT examinations is 18.2% medical physicists and radiology specialists only 15.2%.

In radiology services, it is the radiographers who interact directly with the patient. The radiographer is

responsible for notifying the radiologist in the event of an alleged unjustified referral and the radiographer may also discuss a request for a radiology examination with the referrer<sup>13</sup>. Radiologist and radiographer's knowledge of radiation is better than of physicians. Regarding radiation safety, radiographers consider radiation doses to be more important than radiologists and physicians<sup>14</sup>.

Based on the results of recent epidemiological studies in the population of children showed a positive relationship between radiation exposure received from CT and the occurrence of cancer. This is due to the current lack of optimization, the use of body size protocols for examination of children in the health service as a result of which children patients get excess radiation exposure<sup>15-18</sup>

The survey also asked respondents about the issue. Respondents answered that 84.8% were interested or concerned about cancer-related issues in children caused by CT Scan radiation exposure, the remaining 15.2% expressed disinterest. This means that most respondents already understand the need for awareness of children patients who are vulnerable to radiation.

The problem of estimated doses and comparison of CT scan doses became part of the respondents' knowledge questions in this survey. This is in view of the results of previous studies<sup>14,19,20</sup>. The results of the survey showed that for the comparative question of chest radiography dose to ct chest dose, Abdominal CT, Barium Enema, Abdominal CT (neonatal) none of the respondents could answer correctly. The dose ratio against CT Head was only 6.1% answered correctly. This means that respondents' knowledge is still low on the estimated amount of CT Scan radiation dose.

The results showed that in general, respondents' knowledge related to CT Scan parameters was still low. The highest respondent value is only on routine parameters. This means that the respondent's CT Scan parameter knowledge is only limited to routine operation, not yet have adequate knowledge related to changing the parameters for the optimization process. While the lowest value of respondents on questions related to Noise index. This result is the same as the previous study<sup>5</sup>.

## Conclusion

The results showed low radiographer knowledge related to dose estimation and CT scan parameters. Further training or courses related to CT Scan optimization techniques need to be pursued again in hospitals for radiographers.

**Ethical Clearance:** This study was approved by Ethic Committee in Faculty of Nursing, Airlangga University, Indonesia with Ethical Approval number : 1913-KEPK

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**Conflict of Interest :** Nil

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