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ANALYSIS OF COMPUTED TOMOGRAPHY DOSE INDEX (CTDI) AND DOSE LENGTH PRODUCT (DLP) DOSE VALUES ON NON-CONTRAST HEAD, CHEST AND ABDOMINAL CT SCAN EXAMINATION AT RSUD ULIN BANJARMASIN

Kartika Puspa Fitriana[1], Rini Indrati[2], Andrey Nino Kurniawan[2]

[1]RSUD dr. H. Soemarno Sostroatmodjo Kapuas, Kalimantan Tengah, Indonesia
[2] Poltekkes Kemenkes Semarang, Indonesia

*E-mail: kartikapuspafitriana@gmail.com

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ABSTRACT

Background: CT scans produce the largest dose of radiation compared to other radiology modalities. The parameters for measuring the amount of radiation dose from the CT Scan aircraft are the Computed Tomography Dose Index (CTDI) and the Dose Lenght Product (DLP). One form of Bapeten supervision in controlling radiation protection is to optimize the Diagnostic Raference Level (DRL). At RSUD Ulin Banjarmasin, the CT Scan modality has never been measured for CT Scan dose on CT Scan examination of the Head, Thorax and Abdomen Non Contrast which are the most frequent examinations. Dosage parameters are important to see the values exposed to the patient. The purpose of this study was to determine the amount of radiation dose of patients on CT Scan examination of the Head, Thorax and Non-Contrasting Abdomen. Method: The research design used is quantitative descriptive. The method of collecting data is observational and uses secondary data. Data processing uses the descriptive hypothesis test method one sample t-test, by analyzing the value of radiation dose and comparing the DRL value set by Bapeten as a means to monitor the dose given α=0.05. Results: The dose value for CT Scan of Non-Contrast Head CT examination is 33.90±3.66 mGy for CTDIvol and 933.07±415.63 mGy.cm for DLP, there are 4 patients with total DLP values above DRL due to the greater number of scans due to patient movement so that repeated examinations are carried out. Non Contrast Thorax CT Scan 5.83±1.90 mGy for CTDIvol and 179.80±63.72 mGy.cm for DLP, there was 1 patient with CTDIvol values above DRL due to longer scan width. Non Contrast Abdominal CT Scan 10.88±2.30 mGy for CTDIvol and 528.70±137.75 mGy.cm for DLP. Conclusion: The dose value at RSUD Ulin Banjarmasin in each CT Scan examination of the Head, Thorax and Abdomen Non Contrast is still below the National DRL value set by BAPETEN.

Keywords: *CT Scan, CTDI, DLP, DRL*

INTRODUCTION

Computed Tomography Scan (CT Scan) is one of them tools used for diagnose disease on the part in body man with utilise X- Rays . CT scan machine used for inspection is CT Scan Multi Slice, results the image obtained can processed in accordance with diagnosis disease so that obtained optimal picture to achieve a diagnosis accurate and thorough. (1)(2)(3)(4).

Measurement parameters big dose radiation from aircraft CT Scan known with term Computed Tomography Dose Index (CTDI). CTDI is also a parameter of the magnitude of the exposure dose in the adjacent scan area. CTDI is an appropriate estimate of the actual dose given to the patient. DLP is a simple number to describe the total radiation energy deposited in the body. The Dose Length Product (DLP) value is obtained by multiplying the CTDI and the length of the axial area exposed to radiation. (5)

The dose received by the patient on a CT Scan can be estimated by using CTDI. CTDI is useful in the evaluation of patient doses and examination protocols as part of a quality assurance program and can also be used as a metric to compare the protocols of a facility from different CT scanners and is related to the quality of the images produced.(6)

The safety factor is important to minimize the risks and impacts that arise due to the use of radiation (7). One form of supervision that can be carried out is to analyze the patient's radiation dose on a CT scan using the Patient Dosage Data Information System (Si-INTAN) application. Si INTAN is used as a means to monitor the doses given to patients and for the preparation of DRLs at the local and national levels (8). The data input to the Si INTAN application is CTDIvol and DLP which can be obtained from a scan CT machine. In inputting Si-INTAN data, 20 patient data are used with the exception of types of examination where patients are rare, 10 patients are allowed. So far, the Ulin Banjarmasin Hospital has never reported data into the Si-INTAN application (1). From the data entered, the average dose value will be obtained. The average dose value can be used as a basic reference for determining local DRL values (9)(10)(11)(12).

RSUD Ulin Banjarmasin, which has a CT Scan modality, namely multislice computed tomography 64 slices, this modality has never been measured for CT Scan dose parameters,

namely by looking at CTDI and DLP values, especially on non-contrast head, thorax and abdomen examinations, which are the most frequent examinations. This dose parameter is important to see the value exposed to the patient, so that it can be seen and compared with the DRL value set by the authorities (13), whether it is in accordance with the guidelines or not. This test has the benefit that officers can find out whether the dose used is still within the safe threshold or not. (14)(15)(16)

RESEARCH METHODS

The research design is descriptive quantitative using secondary data. The population in this study were all non-contrast CT Scan of the Head, Thorax and Abdomen at the Ulin Hospital in Banjarmasin with a sample of 30 patients with adult age criteria (15 years and over), in the sampling period from January to May 2023. Observational data collection method. The CTDI and DLP values were recorded on a non-contrast CT Scan of the head, thorax and abdomen. Measuring the value of the dose by calculating the average value. The average value obtained is a typical representative value of the dose used for each examination. In order to be able to compare the analysis of dose results at the Ulin Hospital in Banjarmasin with the National DRL values from BAPETEN, a one sample t-test was carried out with a 95% confidence level.

RESULTS AND DISCUSSION

Non Contrast Head CT Scan Examination Results.

Non contrast head CT Scan examination at Ulin Hospital, Banjarmasin, uses scanning parameters set by the device manufacturer. In 30 samples with a Non-Contrast CT Scan Head examination, the selection of protocols and parameters used by each radiographer was different. The kV value used is 100-120 kVp, while for mAs using auto mAs because it uses a caredose application. The total value of mAs used varied from a lowest value of 1818 mAs to a maximum of 8531 mAs, the number of scans in this examination was 2 times, namely topogram and Non Contrast Head CT, and the age range was above 15 years, can be seen in table 1.

Table 1 Table of CTDIvol values and total DLP values on a Head CT Scan examination

No	Gender	Age	kVp	Total mAs	Number of scans	Scan Time	CTDIvol	Total DLP
1	M	15 TH	100	1818	2	3,7	34,15	303
2	M	49 TH	100	8007	3	4,7	34,87	1400*
3	M	30 TH	120	4313	2	3,7	37,95	1259
4	M	62 TH	100	4460	2	3,7	30,99	779
5	F	55 TH	100	5353	2	3,7	37,51	947
6	M	68 TH	100	4039	2	3,7	32,33	709
7	F	43 TH	100	4461	2	3,7	34,79	784
8	M	56 TH	120	7607	3	4,7	31,83	2211*
9	F	58 TH	100	4105	2	3,7	32,38	710
10	M	69 TH	100	5953	3	4,7	31,33	1043
11	F	54 TH	100	3425	2	3,7	29,12	597
12	M	55 TH	100	5549	2	3,7	35,49	981
13	M	32 TH	120	7266	3	4,7	37,07	2165*
14	F	39 TH	120	3312	2	3,7	44,14	937
15	F	59 TH	100	4451	2	3,7	34,79	784
16	F	19 TH	100	4989	2	3,7	30,72	891
17	F	33 TH	100	4230	2	3,7	36,40	740
18	F	15 TH	100	3171	2	3,4	25,05	554
19	M	42 TH	100	4904	2	3,7	33,39	861
20	M	64 TH	100	4065	2	3,7	32,37	704
21	M	60 TH	100	4390	2	3,7	31,83	774
22	M	77 TH	100	3690	2	3,7	30,60	645
23	F	47 TH	100	5831	2	3,7	41,58	1033
24	F	33 TH	120	5699	2	3,7	35,13	835
25	M	72 TH	100	4669	2	3,7	32,20	828
26	M	55 TH	100	8531	3	4,7	31,57	1498*
27	M	59 TH	100	4522	2	3,7	36,27	795
28	M	78 TH	100	4785	2	3,7	35,13	835
29	F	59 TH	100	4109	2	3,7	31,83	723
30	M	46 TH	100	3883	2	3,7	34,15	667
$\bar{x}$±SD		49,50±18,55	103,33±7,59	273,16±1496,15	2,17±0,38	3,86±6,39	33,90±3,66	933,07±415,63

Note: * = value exceed National DRL value

The National DRL value determined by BAPETEN for Head CT examination Non Contrast of 60 mGy For CTDIvol and 1275 mGy.cm for DLP. Based on table 1 on examination CT Scan Head Non Contrast , obtained No There is mark CTDIvol exceeded _ National DRL value from BAPETEN. Head CT Scan patient Non Contrast that has DLP value exceeded National DRL value of 4 patients, kindly whole mark received dose patient

on examination scan CT Head of Non Contrast at the Ulin Hospital in Banjarmasin more low from the set DRL(13).

Measurement Results Non Contrast Thorax CT Scan Examination

Non contrast CT Scan examination at the Hospital Ulin Banjarmasin uses the scanning parameters set by the manufacturer tool. In 30 samples with Non contrast Thorax CT Scan examination, the selection of protocols and parameters used by each radiographer was different. The kV value used is 80-120 kVp, while for mAs using auto mAs because it uses a caredose application. The total value of mAs used varied from a lowest value of 1048 mAs to a maximum of 3551 mAs, the number of scans in this examination was 2 times, namely topogram and CT Chest, and the age range was above 15 years, can be seen in table 2.

The National DRL value set by BAPETEN for Non contrast CT Chest examination is 11 mGy for CTDIvol and 430 m.cm for DLP. Based on table 2 on the Non-Contrast CT Scan Chest examination, it was found that there was 1 patient whose CTDIvol value exceeded the National DRL value from BAPETEN. CT Scan Chest Non contrast patients do not have a DLP value that exceeds the National DRL value. overall, the value of the dose received by the patient on a Non contrast Thorax CT Scan examination at Ulin Hospital, Banjarmasin, is still lower than the set DRL (13).

Table 2 Table of CTDIvol values and total DLP values on Thorax CT Scan examination

No	Gender	Age	kVp	Total mAs	Number of scans	Scan Time	CTDIvol	Total DLP
1	M	52 TH	100	2891	2	4,9	6,06	229
2	F	45 TH	120	1574	2	4,7	6,35	203
3	M	69 TH	100	2490	3	7,7	4,86	193
4	M	56 TH	80	1271	2	4,3	2,79	46
5	M	50 TH	120	2964	2	5	11,68*	397
6	M	67 TH	100	2254	2	4,6	4,69	177
7	F	61 TH	100	2436	3	7,1	6,36	186
8	F	21 TH	100	1276	2	3,9	4,64	169
9	F	24 TH	100	5206	2	3,7	6,04	192
10	M	62 TH	80	3335	2	4,2	3,46	140
11	F	58 TH	100	1741	2	5	4,95	133
12	F	58 TH	100	2849	2	3,4	7,82	226
13	M	44 TH	100	3012	2	4,4	6,66	224

No	Gender	Age	kVp	Total mAs	Number of scans	Scan Time	CTDIvol	Total DLP
14	M	71 TH	100	1859	2	4,7	3,76	145
15	M	46 TH	100	2899	2	3,8	8,10	302
16	F	40 TH	80	3335	2	4,1	3,19	128
17	M	47 TH	100	4651	2	4,1	4,78	161
18	M	29 TH	80	2385	2	5,4	2,13	92
19	M	62 TH	100	1896	2	5,8	3,78	147
20	M	68 TH	100	2000	2	4,4	4,80	173
21	F	54 TH	100	2384	2	3,8	6,10	200
22	F	55 TH	120	1398	2	3,3	6,79	182
23	F	62 TH	80	2821	2	3,1	4,79	145
24	M	47 TH	100	1475	3	6,1	3,95	133
25	M	52 TH	100	3162	2	4,3	7,05	225
26	M	60 TH	100	2437	2	3,3	5,73	167
27	M	60 TH	120	1048	2	4	5,01	131
28	M	31 TH	100	2977	2	4,8	6,60	236
29	M	34 TH	100	1860	2	4	5,04	174
30	F	76 TH	80	3551	2	4,2	3,49	138
$\bar{x}$±SD		52,03±14,023	98,67±11,67	2167,24±693,87	2,10±0,31	4,54±1,05	5,83±1,89	179,80±63,72

Note: * = value exceed National DRL value

Measurement Results Non Contrast Abdominal CT Scan Examination

Non contrast abdominal CT scan examination at Ulin Hospital, Banjarmasin, uses scanning parameters set by the device manufacturer. In 30 samples with Non contrast Abdominal CT Scan examination, the selection of protocols and parameters used by each radiographer was different. The kV value used is 120 kVp, while for mAs using auto mAs because it uses a caredose application. The total value of mAs used varied from a lowest value of 2374 mAs to a maximum of 8652 mAs, the number of scans in this examination was 2 times, namely topogram and abdominal CT, and the age range was above 15 years, can be seen in table 3.

Table 3 Table of CTDIvol values and total DLP values on an abdominal CT scan

No	Gender	Age	kVp	Total mAs	Number of scans	Scan Time	CTDIvol	Total DLP
1	M	55 TH	120	3270	2	5,6	8,98	443
2	M	59 TH	120	4494	2	5,7	12,02	617
3	M	77 TH	120	8044	3	6	11,02	515
4	M	38 TH	120	4196	2	5,7	10,76	575
5	M	50 TH	120	2791	2	5,8	8,76	375

No	Gender	Age	kVp	Total mAs	Number of scans	Scan Time	CTDIvol	Total DLP
6	M	38 TH	120	5724	2	5,7	15,26	790
7	F	68 TH	120	4328	2	5,7	12,12	591
8	M	50 TH	120	4790	2	5,7	13,74	656
9	F	55 TH	120	5197	2	5,7	14,28	696
10	F	46 TH	120	4950	2	5,7	13,61	680
11	M	39 TH	120	3773	2	5,7	10.15	514
12	M	41 TH	120	4260	2	5,7	12,18	581
13	F	63 TH	120	2729	2	5,7	8,34	365
14	F	40 TH	120	8652	3	5,6	11,91	532
15	F	70 TH	120	2249	2	5,7	6,98	299
16	F	67 TH	120	4165	2	5,7	11,55	569
17	M	59 TH	120	4450	2	5,7	11,45	612
18	M	54 TH	120	4526	2	5,7	12,66	620
19	M	61 TH	120	2447	2	5,6	7,14	327
20	F	55 TH	120	3636	2	5,8	11,20	492
21	F	78 TH	120	3275	2	5,7	9,55	443
22	F	40 TH	120	3755	2	5,7	11,04	512
23	M	72 TH	120	4240	2	5,7	12,15	579
24	M	58 TH	120	2384	2	5,6	6,50	317
25	M	72 TH	120	3698	2	5,7	9,77	504
26	M	25 TH	120	6279	2	5,6	14,75	870
27	F	48 TH	120	2374	2	5,7	7,36	316
28	M	64 TH	120	3146	2	5,7	9,45	424
29	M	58 TH	120	3797	2	5,7	10,41	515
30	M	68 TH	120	4042	2	5,7	11,20	532
$\bar{x}$±SD		55,6±13,234	120,00±0,00	4188,70±149,71	2,07±0,25	5,07±0,07	10,88±2,30	528,7±137,75

The National DRL value set by BAPETEN for Non-Contrast Abdominal CT examination is 17 mGy for CTDIvol and 885 mGy.cm for DLP. Based on table 3, in the Non-Contrast Abdominal CT Scan examination, there were no patients whose CTDIvol values exceeded the National DRL value from BAPETEN. Non-contrast abdominal CT scan patients do not have a DLP value that exceeds the National DRL value. Overall, the value of the dose received by the patient on a non-contrast abdominal CT scan at Ulin Hospital, Banjarmasin, is still lower than the set DRL (13).

From table 1, 2 and 3, the dose values for the Non-Contrast Head Scan CT examination were 33.90 ± 3.66 mGy for CTDIvol and 933.07 ± 415.63 mGy.cm for DLP. Non-contrast Thorax CT Scan examination obtained 5.83 ± 1.90 mGy for CTDIvol and 179.80 ± 63.72 mGy.cm for DLP. Non-contrast abdominal CT scan examination of 10.88 ± 2.30 mGy for CTDIvol and 528.70 ± 137.75 mGy.cm for DLP. In the DLP CT Scan Head, the standard deviation has a high value of 415.63 because there are 4 CT Scan Head patients who have a DLP value above the set DRL value (13). One sample t-test statistical test to be able to compare the CTDI and DLP dose values at the Ulin Banjarmasin Hospital with the National DRL values from BAPETEN as a means of monitoring the doses given. It also aims to be able to test hypotheses against research with a confidence level used of 95%.

Table 4 Comparative Test Using One Sample t-test on total CTDIvol and total DLP CT Scan Examination of the Head, Thorax and Abdomen Non Contrast

	Non contrast CT Head		**Non contrast CT Chest**		**Non contrast CT Abdominal**	
	Comparison value	**p Value**	**Comparison value**	**p value**	**Comparison value**	**p value**
Mean CTDIvol (mGy)	60	0,01	11	0,01	17	0,01
Total DLP (mGy.cm)	1275	0,01	430	0,01	885	0,01

Based on table 4 above for the CT examination of the head at Ulin Banjarmasin Hospital, the smallest level of significance was obtained so that the statistical test value being observed was still significant, with a p-value of 0.01 (<0.05), the basis for the decision was concluded that Ha was accepted, Ho rejected. The dose values for CT Scan Non-Contrast Heads at Ulin Hospital Banjarmasin for CTDIvol 33.90 mGy and DLP 933.07 mGy.cm are different or below the standards set by BAPETEN 2021, namely CTDIvol 60 mGy and DLP 1275 mGy.cm.

Thorax CT examination at Ulin Hospital Banjarmasin obtained the smallest level of significance so that the statistical test value being observed was still significant, with a p-value of 0.01 (<0.05), the basis for the decision was concluded that Ha was accepted, Ho was

rejected. The dose value for CT Scan Thorax Non-Contrast at Ulin Hospital Banjarmasin for CTDIvol 5.85 mGy and DLP 179.80 mGy.cm is different or below the standard set by BAPETEN 2021, namely CTDIvol 11 mGy and DLP 430 mGy.cm.

Abdomen CT examination at Ulin Hospital Banjarmasin obtained the smallest level of significance so that the statistical test value being observed was still significant, with a p-value of 0.01 (<0.05), the basis for the decision was concluded that Ha was accepted, Ho was rejected. The dose value for CT Scan Abdomen Non-Contrast at Ulin Hospital Banjarmasin for CTDIvol 10.88 mGy and DLP 528.70 mGy.cm is different or is below the set standard, namely CTDIvol 17 mGy and DLP 885 mGy.cm.(13)

Analysis of Dosage Value of Non-Contrast Head CT Scan Examination

The results of the study stated that the dose value for Non-contrast Head CT examination for CTDIvol was lower than the DRL value set by BAPETEN. There were no patients whose CTDIvol values exceeded the DRL values set by BAPETEN. This indicates that the Ulin Hospital in Banjarmasin has complied with the radiation safety protocol by paying attention to the number of slices and scan width.

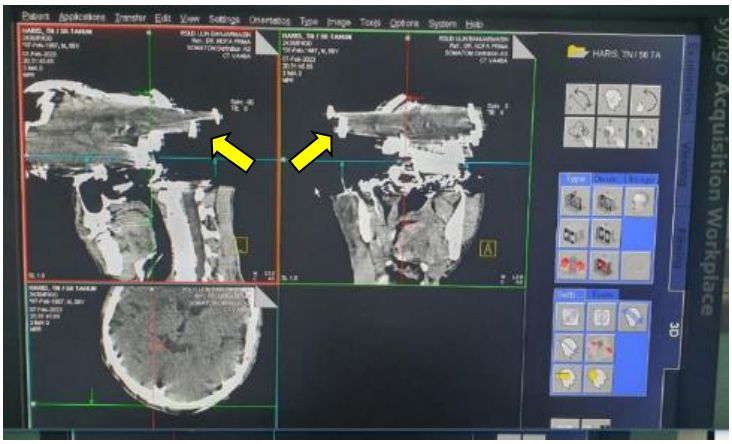

Figure 1 Image on a head CT scan 2nd Patient show exists move patient so that happen fuzziness in the results image

The DLP dose received at the Non-Contrast Head CT Scan examination at the Ulin General Hospital, Banjarmasin was 933.07 ± 415.63 mGy.cm lower than the DRL value set

at 1275 mGy.cm. However, there are still 4 patients with a total DLP value above the set DRL (13). Things that show the analysis of the causes of DLP on Non-Contrast Head CT examination are higher than the DRL set by BAPETEN shown in Figures 1-4 as follows:

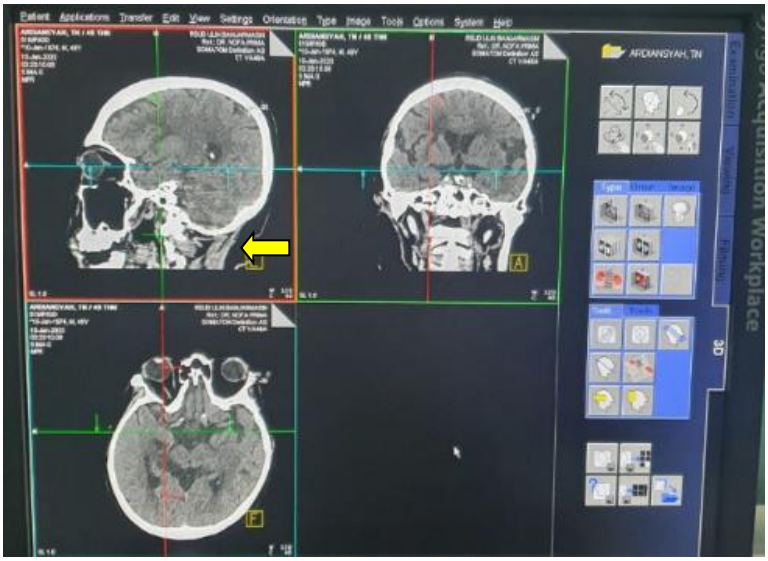

Figure 2 The image of the 8th patient's head CT scan shows the patient's movement resulting in blurring of the image results

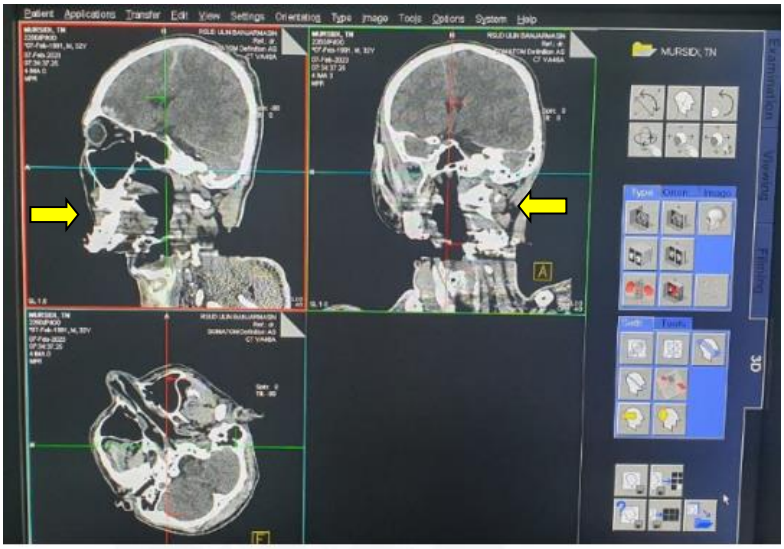

Figure 3. The image on the CT scan examination of the 13th patient's head shows the patient's movement resulting in blurring of the image results

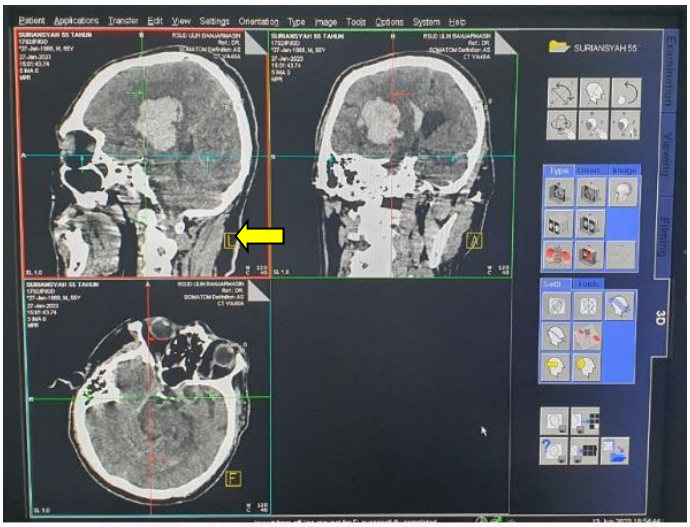

Figure 4 The image on the CT scan examination of the 26th patient's head shows the patient's movement resulting in blurring of the image results

DLP is affected by CTDIvol and scan length. CTDIvol is also affected by the number of topographic slices in one rotation and the width of the scan(5). After being analyzed, this was due to movement because the patient was uncooperative post KLLD with CKB clinically unconscious. So that repeated checks were carried out, causing a greater number of scans which resulted in a higher DLP value compared to BAPETEN's DRL value. Suggestions from researchers that the radiographer should install a fixation device to prevent patient movement.

Dosage Value Analysis Non- contrast CT Scan Chest Examination

Research results This state dose Non- contrast CT Thorax examination For CTDIvol 5.83 ± 1.90 mGy more low compared to set DRL value (13) which is 11mGy . However, there was 1 patient whose CTDIvol value exceeded the set DRL value. CTDIvol is affected by the average distributed CTDI, number of slices, and scan width (5). Things that show the analysis of the causes of CTDIvol on Non Contrast Thorax CT examination is higher than the set DRL is shown in Figure 5.

After analysis, the CTDIvol value was higher because the width of the scan on the Thorax CT Scan exceeded the limit that should have only reached the upper liver, but the

scan length was made with the lower limit to the middle of the kidney. This happened due to radiographer's human error. The radiographer's advice before carrying out the scan is to re-check the parameters of the Thorax CT Scan examination in an effort to minimize the radiation dose received by the patient to reduce stochastic effects.

The DLP dose value received by a Non-Contrast Thorax CT Scan at Ulin Banjarmasin Hospital was 179.80 ± 63.72 mGy.cm lower than the DRL value set by BAPETEN, which was 430 mGy.cm. No There is patient with the total DLP value is above the set DRL (13). DLP is affected by CTDIvol and scan length. CTDIvol is also affected by the number of topographic slices in one rotation and the scan width (5). So the lower the dose value on the CT Scan Chest examination compared to the set DRL value. This indicates that the Ulin Hospital in Banjarmasin has complied with the radiation safety protocol by paying attention to the number of slices and scan width.

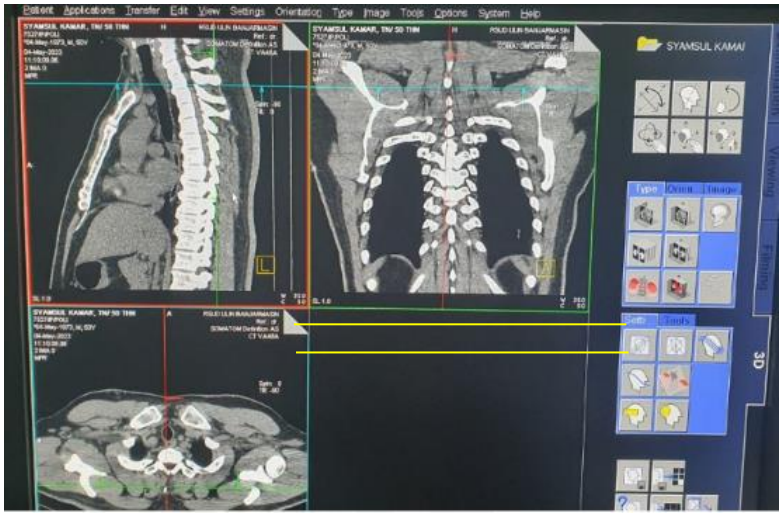

Figure 5 Image of Thorax CT Scan Examination of Patient 5 show Longer scan width so make mark dose CTDIvol more tall

Analysis of the Dose Value of Non-Contrast Abdominal CT Scan Examination

The results of the study stated that the dose for non-contrast CT Abdomen CTDIvol was lower than the DRL value set by BAPETEN. There were no patients whose CTDIvol values exceeded the set DRL values (13). This indicates that the Ulin Hospital in Banjarmasin

has complied with the radiation safety protocol by paying attention to the number of slices and scan width.

The DLP dose received by a non-contrast abdominal CT scan was 528.70 ± 1.90 mGy.cm lower than the DRL value set at 885 mGy.cm. There were no patients with a total DLP value above the established DRL(13). DLP is affected by CTDIvol and scan length. CTDIvol is also affected by the number of topographic slices in one rotation and the width of the scan (5). So the lower the dose value on the Abdomen CT Scan examination compared to the set DRL value. This indicates that the Ulin Hospital in Banjarmasin has complied with the radiation safety protocol by paying attention to the number of slices and scan width.

Comparison of Non-Contrast Head, Thorax, and Abdomen CT Scan Dose Values at Ulin Hospital, Banjarmasin with DRL Values Set by BAPETEN

Comparison of the value of the non-contrast head CT scan for CTDIvol of 56.5% and DLP of 73.18% is still below the National DRL value set by (Bapeten, 2021). This indicates that the Ulin Hospital in Banjarmasin has carried out radiation hazard safety protocols that are still being considered.

The comparison of the dose value for CT Scan Thorax Non-Contrast for CTDIvol of 53% and DLP of 41.81% is still below the National DRL value set by Bapeten. This indicates that the Ulin Hospital in Banjarmasin has carried out radiation hazard safety protocols that are still being considered. Comparison of the value of the non-contrast CT Scan Abdomen examination dose for a CTDIvol of 64% and a DLP of 59.74% is still below the National DRL value set by Bapeten. This indicates that the Ulin Hospital in Banjarmasin has carried out radiation hazard safety protocols that are still being considered.

CONCLUSION

Non-contrast head CT scan dose values were 33.90 ± 3.66 mGy for CTDIvol and 933.07 ± 415.63 mGy.cm for DLP. CT Scan Thorax Non Contrast 5.83±1.90 mGy For CTDIvol and 179.80±63.72 mGy.cm for DLP. Abdomen CT Scan Non- Contrast 10.88±2.30 mGy For CTDIvol and 528.70±137.75 mGy.cm for DLP. Comparison mark dose at the Ulin

Hospital in Banjarmasin during examination CT Scan Non Contrast Head CTDIvol of 56.5% and DLP of 73.18%; Thorax Non Contrast CTDIvol by 53% and DLP by 41.81%; and Abdomen Non Contrast CTDIvol by 64% and DLP by 59.74%, still under the National DRL value determined by BAPETEN. All inspection CT Scan Head , Non- Contrast Thorax and Abdomen at Ulin Hospital concluded has fulfil standard For protection radiation to patient in accordance Bapeten National DRL Decree .

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