ANALYSIS OF QUALITY CONTROL COMPUTERIZED TOMOGRAPHY SCAN (CT SCAN) RESULTS IN INDONESIA BASED ON NATIONAL AND INTERNATIONAL STANDARDS

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ABSTRACT
The purpose of this study is to assess the results of the implementation of Quality Control Computerized Tomography Scan (CT Scan) in Indonesia based on national and international standards. The method used is a literature study of quality control CT scan research results from 2012 to 2020 with various types of CT scans in Indonesia. The data obtained from the literature study carried out an in-depth analysis of compliance with national and international standards. The results of the analysis show that the standard implementation of QC CT Scan in Indonesia has a more complex parameter test than the ACR and IAEA standards. Based on the 2018 Bapeten Standard (RS3), the QC CT1 Implementation Rate is above 50%. Whereas in the ACR standard (RS1) there are 2 types of CT that are above 50% and in the IAEA standard (RS3) there are 7 CTs that are above 50%. The result of the parameter test based on RS3 standard, CT1 passed the test, CT2 there were 4 parameters that did not pass the test, namely PT2, PT5, PT14 and PT17. CT3 to CT 8 and CT 10 the QC results passed the test, while CT9 parameter PT9 did not pass the test. However, for CT2 to CT10, many QC parameters were not implemented. Based on the data analysis above, it can be concluded that the level of QC implementation based on national and international standards are very low.

Keywords: quality control CT scan, CT implementation rate, standard

1. INTRODUCTION

Computerized Tomography Scan (CT Scan) is a tomography imaging technique with a digital process that doctors use in diagnosing a patient's disease. For this reason, the CT Scan tool used must be reliable and reliable in order to produce the right diagnosis in detecting the patient's disease. In addition, the administration of X-ray radiation doses when diagnosing must be in accordance with the dose acceptance standards for the patient's body.

In the medical world, CT scans are included in the radiological equipment group. Dick (2021) states that there is a very large diversity of radiology equipment quality assurance in its implementation. He also explained that based on the American College Radiology (ACR) standard, the frequently reported Quality Control (QC) parameters were image quality (91.7%) and radiation dose (75%). Factors affecting quality assurance based on International Atomic Energy Agency (IAEA) standards in Izewska (2018) are; dosimetry; quality control; radiation protection; human resources, In Delas Lara (2017) radiation output, image quality, noise, spatial resolution, dosimeters, low contrast resolution, geometric precision, and voxel density values. The quality assurance standards of CT in Iran apply the Parsi-based dose survey method (2018) with CTDIvol 750, 650 and 300 mGy.cm, Sohrabi (2018).

The quality assurance of CT Scan tools in Indonesia is known as the CT Scan Conformity Test. A suitability test is a series of testing activities to ensure the X-ray aircraft is in reliable condition. In the international standard the Conformity Test is also known as the Quality Control Process of the CT Scan Tool. Quality Control CT scans are performed on a daily, weekly, monthly and yearly basis. The implementation of the CT scan quality control tool is carried out by equipment technicians, medical physicists and radiographers. Each of them has a different main task and function in ensuring the reliability of the CT Scan tool.

The implementation of the quality control process of the CT Scan tool in Indonesia refers to the Republic of Indonesia's Nuclear Energy Supervisory Agency (BAPETEN) Regulation Number 2 of 2018 concerning the Conformity Test for Diagnostic and Interventional Radiology X-Ray Aircraft. This regulation is the result of a revision of the 2011 regulation. Currently the Bapeten is drafting the latest regulations regarding the X-ray Aircraft Conformity Test with the issuance of a draft regulation regarding the 2020 Diagnostic and Interventional Radiology X-ray conformance test. Quality control for CT Scan tools is the book of the American College of Radiology (ACR) 2017 and the International Atomic Energy Agency (IAEA) Human Health Series No. 19.

According to BAPETEN No.2 of 2018, the guarantee parameters on this CT Scan tool include the suitability test for the generator and X-ray tube, the estimated skin surface dose, image quality, table position indicators and laser markers. The suitability test of CT scan tools has been carried out on various types and brands of CT scans used in Indonesia, but no one has yet assessed the overall results of the implementation of quality control for CT scan tools that are in accordance with national and international standards. Thus this study aims to assess the level of conformity of the results of the implementation of quality control (QC) of various types of CT Scan tools in Indonesia based on national and international standards. It is expected that the results of this study can be used as a reference in the future in assessing the level of compliance with the quality assurance (QA) of CT Scan tools by various parties.

2. MATERIALS AND METHODS

The equipment used in this study were 11 types of CT Scan, namely Optima CT520, Philips Brilliance 6, Philips, Siemens 8402062, Toshiba CT Scan type Aquilion 128 Slice, Toshiba activation type 16 slice, Hitachi type eclos 16 slice, Siemens type somatom emotion 16 slice. 128 Slice CT Revolution EVO, CT scan of Toshiba Auklet TSX-003A. The reference standards used in analyzing the results of the CT Scan conformity test consist of 2 types, namely the national regulations of Bapeten Regulation Number 2 of 2018 and international regulations consisting of the 2017 ACR standard and the IAEA Series No. 19.

The research method used was a literature study, by collecting various conformity test results from 10 CT scan brands in Indonesia. The results of the quality control analysis were carried out on the conformity test values based on national and international standards. To facilitate analysis, each type of CT scan is given a symbol as in table 1.

Table 1. Types of CT Scan

Author	Symbol	Type of CT Scan
Rizka Novita Suryani, 2018	CT1	Optima CT520
Ivonne Chirsnia 2013	CT2	Philips Brilliance 6
Khairunnisak 2017	CT3	Philips CT Scan 64 Slice
Hasnani & Syamsidar 2017	CT4	Siemens 8402062
Hambali,A.P, 2017	CT5	CT Scan Toshiba tipe Aquilion 128 Slice,
Hambali,A.P, 2017	CT6	Toshiba tipe activision 16 slice

Hambali,A.P, 2017	CT7	Hitachi tipe eclos 16 slice
Hambali,A.P, 2017	CT8	Siemens tipe somatom emotion 16 slice
Linda permana komala sari, 2017	CT9	128 Slice CT Revolution EVO,
Muhammad Ilyas, 2017	CT10	CT scan Toshiba Auklet TSX-003A

3. RESULT

The quality control parameters analyzed include the suitability test for generators and X-ray tubes, skin surface dose estimates, image quality, table position indicators and laser markers. Table 2 is the standard reference for Bapeten Regulation No.2 of 2018, ACR 2017 and IAEA Series 19. Based on Bapeten Standards (2018) there are 17 Test Parameters (PU) to be analyzed. Whereas in the ACR standard (2017) there are 6 parameters and 3 parameters for the IAEA standard. To facilitate the mention of the ACR standard, abbreviated as SA1, IAEA with SA2 and BAPETEN with SA3.

Table 2. Standard References

No	Parameters TEST (PT)	Reference		
		ACR 2017 (RS1)	**IAEA seri 19 (RS2)**	**BAPETEN 2018 (RS3)**
1	Reproducibility, coefficient of variance (CV) of radiation output	-	-	≤ 0,05
2	linearity, Coefficient of Linearity (CL) Radiation output	-	-	≤ 0,1
3	CTDI 100 air 120 kVp	-	-	≤ 45 mGy/100 mAs
4	X-ray beam quality (HVL) 120 kVp	-	-	3,8 mmAl
5	CT dose index (CTDI) w and (CTDI) v for head (mGy)% deviation CTDI	35 mGy	20%	<20%
6	CT dose index (CTDI) w and (CTDI) v for body (mGy)	-	-	<20%
7	ROI (region of interest) mean centered (CT number air)	± 5 - ± 7 HU	0±5 HU	

8	Uniformity of center and edge, ΔCT: maximum value of difference in average ROI at the center with average ROI around the edges.	± 5 - ± 7 HU	± 10 HU	
9	Uniformity of noise, ΔSD: the difference in standard deviation (SD) Maximum ROI with SD Minimum ROI at 120 kVp, 300 mAs, and slice thickness 8 mm	-	-	ΔSD ≤ 2 CT
10	CT-Number linearity with the object's electron density	-	-	R ≥ 0,99
11	High contrast resolution MTF cut off, at 512 reconstruction matrix	-	-	≥ 1,0/mm
12	High contrast resolution spatial (Res. Spatial), on reconstruction matrix 512, adult	6 lp/cm	-	≥ 5lp/cm
13	High contrast resolution of hole diameters, on 512 reconstruction matrix	-	-	≤ 0,5/mm
14	Suitability of slice thickness with all slice settings, both axial and helical scanners	-	-	Δslice ≤ 0,5 mm
15	Match table position with indicator	-	-	Δz ≤ 0,5 mm
16	Reproducibility of table positions	2 mm	-	Varz ≤ 1 mm
17	Matches of the laser marking center to the slice center	± 0,15	-	Δlaser ≤ tebal slice minimum

Table 3. Analysis results from quality control CT scan

PT	**RS1**	**RS2**	**RS3**	**CT1**	**CT2**	**CT3**	**CT4**	**CT5**	**CT6**	**CT7**	**CT8**	**CT9**	**CT10**
PT1	-	-	≤ 0,05	-	-	-	-	-	-	-	-	-	-
PT2	-	-	≤ 0,1	0,000251	0,7204165	0,01	-	-	-	-	-	-	-
PT3	-	-	≤ 45 mGy/100 mAs	-	0,01761	15,0536	-	-	-	-	-	-	-
PT4	-	-	HVL ≥ 3,8 mmAl	7,46	8,4	-	-	-	-	-	-	-	-
PT5	35 mGy	20%	<20%	17,29±40 %	54,89	-	-	-	-	-	-	-	-
PT6	-	-	<20%	8,64±40 %	-	-	-	-	-	-	-	-	-
PT7	± 5 - ± 7 HU	0±5 HU	-4 ≤ CT ≤ 4	-	-	-	-3,8	-2,5 & 1,5	-0,37 & 0,14	1,6 & 1,5	2,2 & 3,2	-5,18	2.12

PT8	± 5 - ± 7 HU	± 10 HU	ΔCT ≤ 2 CT	1,547 CT	-	-	0,3	0,2 & 2,2	-1 & 0,8	0,2 & 0,1	0,2& 0,1	0,46	-
PT9	-	-	ΔSD ≤ 2 CT	0,27 CT	-	-	-	-	-	-	-	13.62	3,72
PT10	-	-	R ≥ 0,99	-0,971 CT	-	-	-	-	-	-	-	-	-
PT11	-	-	≥ 1,0/mm	-	-	-	1,58	-	-	-	-	-	-
PT12	6 lp/cm	-	≥ 5lp/cm	7	-	-	6	-	-	-	-	-	-
PT13	-	-	≤ 0,5/mm	-	-	-	-	-	-	-	-	-	-
PT14	-	-	Δslice ≤ 0,5 mm	0,385	1,5 mm	-	0	-	-		-	-	-

Table 3 shows the comparison results of quality control from the standard references and the 10 CT scans analyzed. Based on table 1, quality control CT1 was conducted by Rizka (2018), CT2 by Ivonne (2013), CT3 by Khairunnisak (2017), CT4 by Hasnani (2017), CT5 to CT8 by Hambali (2017), CT9 by Linda (2017), CT10 by M. Ilyas (2017). Of the 17 parameters analyzed, parameters 1, 11, 13, 16 were not subject to quality control at 10 CT.

4. DISCUSSION

Implementation of quality control (QC) CT Scan based on Bapeten 2018 consists of generators and x-ray tubes with Test Parameters (PT) 1 to 4, PT Doses 5 and 6, Citra quality PT 7 to 14, PT table position indicators 15 and 16, laser marker PT17. Whereas in the 2017 ACR standard, testing of generators and X-ray tubes was not carried out. It is seen in Table 2. that the implementation of QC in the ACR standard includes test parameters (PT) 5 for dose, 7, 8, 12 for image quality, 16 for table indicators and 17 for laser markers. IAEA standards carry out QC including PT 5 for radiation dose and 7,8 for image quality control. From the above analysis, the implementation of QC CT Scan in Indonesia has a more complex parameter test than the ACR and IAEA standards. Here it shows that Bapeten is more detailed in determining policies in guaranteeing the quality of CT Scan in Indonesia.

The level of QC implementation of 10 types of CT Scan can be seen in Table 4. When compared with the number of parameters set by Bapeten 2018, it shows that the QC CT Scan implementation data obtained from this literature study is still low where only CT1 is above 50%. Whereas in the ACR standard (RS1) there are 2 types of CT that are above 50% while in the IAEA standard there are 7 CTs that are above 50%. The low level of QC implementation will result in a decreasing in the quality assurance (QA) of the CT Scan tool.

Table 4. QC CT Scan Implementation Rate (%)

RS	CT1	CT2	CT3	CT4	CT5	CT6	CT7	CT8	CT9	CT10
RS1	66,67	33,33	66,67	16,67	33,33	33,33	33,33	33,33	33,33	33,33
RS2	66,67	33,33	0,00	66,67	66,67	66,67	66,67	66,67	66,67	33,33
RS3	64,71	41,18	23,53	29,41	17,65	11,76	11,76	11,76	17,65	23,53

Furthermore, when viewed from the results of the QC parameter test, all types of CT analyzed based on the Bapeten 2018 CT1 standard passed the test, there were 4 CT2 parameters that did not pass the test, namely PT2, PT5, PT14 and PT17. CT3 to CT 8 and CT 10 the QC results passed the test, while CT9 parameter PT9 did not pass the test. However, for CT2 to CT10, many QC parameters were not implemented. So that, in the assessment study of the conformity of QC parameters with national and international standards only CT1 met the criteria for passing the test.

6. CONCLUSIONS

Based on the data analysis above, it can be concluded that the level of QC implementation based on national and international standards is still low. As input for the next researcher to carry out QC of all parameters that have been set, at least all the parameters on RS1 and RS2.

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