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Evaluation of Diagnostic Radiology Department in Term of Quality Control (QC) of X-Ray Units at Khartoum State Hospitals

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Abstract: ***The mean objective in diagnostic radiology is to in provide high qualitydiagnostic image while keeping the patients and workers dose in the lower limit according toALARA principle, (Maria Lucia Nana et al 2009). To optimize the practice of diagnostic radiology, adequatequality assurance (QA) program should be in place.18 hospitals with 18 x-ray units distributed in Khartoum state were evaluated inthis study.Each x-ray unit was tested for Kvp andtimeReproducibility , accuracy of Kvp and time , mAs linearity, and coincidence between light beam and radiation beam. The dark rooms were alsoevaluated to assess the fog level.CONNY II QC Dosimeter made by PTW company were use to for this study. The analysis of the results showed that two out of eighteenunit had a problem in mAs linearity, also two out of eighteen unit had a problem in kVp accuracy and one had a problem inkVp reproducibility. three devices have defects concerning adaptation with optical fieldand radiation field. More than 50% of the darkrooms had a problem in fog level; time accuracy and time reproducibility were in the acceptable limit.The quality control of the radiologicaldevices should be performed periodically and regularly and the defects of the devices should be removed in order to beassured of the appropriate function of the devices. many of these machines need service because of lack ofimplementing the quality control program regularly, which indicates that the quality control programs should be extendedregularly.because the dark rooms is very important place specially in conventional radiology departmentlike in Sudan so it need to periodic review to monitor the fog.***

Keywords: X-ray, Radiology, quality control, quality assurance

1. Introduction

The principle goal of quality assurance of x-ray machine is minimization of radiation exposure and obtains high image quality. This can be assess by performance the x-ray machine by optimum operating parameters such as reproducibility of tube voltage, dose output, time , x-ray tube efficiency ,Accuracy of kVp , mA , time , focal spot size and half value layer (T.M.Taha 2010).

AAPM report 74describes quality assurance protocol for diagnostic x-ray equipment at the radiologictechnologist level. also The World Health Organization (WHO) defines a quality assurance (QA) program in diagnostic radiology as an organized effort by the staff operating a facility to ensure that the diagnostic images produced are of sufficiently high quality so that they consistently provide adequate diagnostic information at the lowest possible cost and with the least possible exposure of the patient to radiation(Stephen Inkoom et al).

Quality assurance actions include both quality control (QC) techniques and quality administration procedures. QC is normally part of the QA programme and quality control techniques are those techniques used in the monitoring (or testing) and maintenance of the technical elements or components of an X-ray system. The quality control techniques thus are concerned directly with the equipment that can affect the quality of the image i.e. the part of the QA programme that deals with instrumentation and equipment(Stephen Inkoom et al).

The quality assurances of diagnostic x-ray are based on the Basic Safety Standard –BSS(4) and International Commission of Radiological Protection, the use of diagnostic reference levels (DRL for patients, ICRP- Report No.46 , 1966(T.M.Taha 2010)

The aim of the present study is to evaluate some of x- ray machine distributed at Khartoum state hospitals in terms of quality control and some factors affecting on image quality and patient dose of conventional x-ray such as reproducibility of tube voltage, dose out put, time , Accuracy of kVp , time , and check the Coincedence of light field with radiation field and chech the fog level in darkroom.

The problems of QC in Sudan is on increase; this is the case because the ministry of health does not have qualified personale to do quality control As well as thelack ofequipment forthe work ofquality controlandthis is because oflack of financial resourcesat the Ministry ofHealth.

2. Material and Method

Reproducibility of dose, time and high voltage setting-parameters were measured with CONNY II QC Dosimeter, which were placed on the couch inside the selected field size and sixexposures were made.The Coefficient of variance was calculated using the formula.

CV = SD /av . 100%Where : SD is the estimator of standard deviation of a series of measurements dose[mGy],time [ms] or voltage [KV] , av is the means value of the parameters measured [dose[mGy],time[ms] or voltage [KV] .

Accuracy of tube voltage and time setting were examined for each machine. Three exposures were recorded for KV and time accuracy. The % error was calculated using the formula.

% Error= |Xm-Xn/Xn| .100 %

Where: Xm is the measured value of time [ms] or voltage [KV], and Xn is the nominalvalue of time [ms] or voltage [KV]Extensive measurements c made to assess of changes in KVp, and time onreproducibility and linearity of radiation output. It formed over a range of clinical settings.

Calibrated ionization chamber used to measure output expressed as uGy per mAs, at a setdistance, without backscatter. The linearity was checked using the following equation.

$$|X1-X2|/X1+X2 .100$$

Where X1 and X2 are two successive readings.

The Coincidence of radiation beam and light beam were measured by putting the loaded film on the couch and determine the light field with coins, then we measure the coins poisoning as it's appear in the image after processing, (Professor D van der Merwe 2002). Fog level in darkroom is evaluated by sensitized the unloaded film in darkroom, positioned the film in a typical work area, partially covered with opaque paper, which shields half of the film from the darkroom ambient light. The film and paper are left out in the ambient light for 2 min. The film is then developed normally and the border is observed corresponding to the bisected section of the film, then darkroom fog is presentby measuring the difference in optical density for covered side and uncovered side of the film(AAPM report 74).

3. Results and Discussion

3.1 Reproducibility

Reproducibility for high voltageand time, foreighteenth x-ray machines numbered from 1-18 and presented as shown in table (1)

hospital	FFD	Reproducibility (CV%)	
		Time	kVp
1	100 cm	0.16	0.61
2	100 cm	0.15	0.24
3	100 cm	0.15	0.54
4	100 cm	0.15	0.73
5	100 cm	0.5	0.5
6	100 cm	0.57	0.57
7	100 cm	0.31	0.8
8	100 cm	1.15	0.71
9	100 cm	4.56	9.8
10	100 cm	1.04	1.04
11	100 cm	0.57	0.57
12	100 cm	0.51	0.51
13	100 cm	0.1	0.62
14	100 cm	3.22	1.42
15	100 cm	1.05	0.88
16	100 cm	2.43	0.82
17	100 cm	0.89	0
18	100 cm	1.56	0.59

Reproducibility of time was ranged from 0.1 to 4.56 % which is lower than the tolerance(<5%), and of high voltage was ranged from 0.24% to 1.42% except machine no 9 which have 9.8 CV% which is higher than the tolerance (<5%), (oluwafisoye et al 2005-2009).

3.2 KVp and Time Accuracy

KVp accuracy for different settings of eighteen x-ay machines voltage was examined by setting the source to detector distance at 100 cm of exposure,20 mAs for different KV intervals from 50-110 KV and average of KV accuracy(error%) was presented as shown in table 2. Inaddition Time accuracy for x-ray machines was checked by variation the time interval from
16-500 ms as shown in table 2

Hospitals	Mean kVp % Error	Mean time % Error
1	6.25	2.85
2	5.00	2.05
3	3.83	2.05
4	3.29	1.31
5	3.19	1.39
6	2.38	1.41
7	1.28	1.41
8	3.95	6.35
9	34.62	0.13
10	3.22	0.13
11	3.40	0.93
12	2.43	1.30
13	2.94	1.74
14	2.64	0.75
15	2.56	2.76
16	4.45	1.67
17	1.48	2.76
18	2.50	2.49

KVp accuracy is good for all the machines except two machines which gave %error equal to 6.25% and 34.62% which is higher than the tolerance limit.(± 5%). That mean this machines needs calibration. Time accuracy is good at all time settingsstations for all examined machine which is lower than the tolerance limit. (± 10%), (T.M.Taha 2010, **JafarFatahi 2012**)

3.3 mAslinarity

this test was done using 80 kVp, and mAs vary from 2 – 63mAs, at 100 cm FFD and linearity coefficient is calculated(LC%) for each machine as shown in table 3

Hospital	Linearity Coefficient(LC%)
1	4.28
2	1.41
3	5.81
4	0.81
5	0.50
6	4.28
7	1.34
8	17.24
9	3.48
10	0.73
11	2.00
12	1.50
13	2.29

14	3.80
15	3.77
16	2.27
17	0.06
18	1.41

The mAs linearity in this study for sixteen x-ray units is vary from 0.06 to 4.28 which was in the tolerance limit(5%),(T.M.Taha 2010, M. Begum 2011) for the other two units the linearity is out of the limit (5.81, 17,24) which indicate that this two unit need urgent calibration.

3.4 Coincidence of light beam and radiation beam:

This test was done using 50 KvP, 5mAs, 100 cm FFD, 20x20 field size and the result shown in table 4

Hospital	Difference beteen light field and radiation field
1	**2.5**
2	0.5
3	1
4	1
5	0.6
6	1
7	0.7
8	2.8
9	0.5
10	1.5
11	0.5
12	0.4
13	1
14	2.4
15	0.3
16	1
17	0.8
18	0.5

The result shown good alignment between radiation beam and light beam for 15 x-ray unit which is below the limit (2% of FFD or ±2cm), (Yesaya Y. Sungita 2006, M. Begum 2011), the other three units we couldn't do the test because there is no light field appear in the machine which indicate for very bad condition in this units and In urgent need ofmaintenance.

3.5 Darkroom evaluation

Darkroom was evaluated by measuring fog level in darkroom for each hospital and the result shown in table 5

Hospital	Fog level in darkroom
1	0.16
2	0.04
3	0.62
4	0.02
5	0.01
6	0.22
7	1.32
8	0.35
9	0.64
10	0.1
11	0.08
12	0.02
13	0.62
14	0.04
15	0.04
16	1.82
17	0.02
18	0.19

The result shown that most of the darkrooms had a fog above the tolerance limit (0.05 OD), (D van der Merwe 2002) which is needed an urgent treatment.

4. Conclusion

In conclusion, the radiographs image quality could be improved by improving the working condition of film processing mainly darkroom. The results confirm the need for the propagation of quality assurance (QA) in all SUDAN. The Ministry of health should invest some money to purchase QA tools and train people to do QC.

Reference

[1] AAPM REPORT NO. 74, QUALITY CONTROL IN DIAGNOSTIC RADIOLOGY July 2002.
[2] International Commission Of Radiological Protection , ICRP-No-46 1966.
[3] International Commission Of Radiological Protection" Basic Safety Standard for ionizing radiation " Safety Series: BSS115-1994.
[4] JafarFatahi- Asl1, Mohsen Cheki, VahidKarami, Quality control of diagnostic radiology devices in the selected hospitals of Ahvaz city, Jentashapir J Health Res, 2013; 4(5).
[5] M. Begum, A. S. Mollah, M. A. Zaman and A. K. M. M. Rahman, QUALITY CONTROL TESTS IN SOME DIAGNOSTIC X-RAY UNITS IN BANGLADESH, Bangladesh Journal of Medical Physics Vol. 4, No.1, 2011.
[6] Maria Lucia Nana I Ebisawa, a Maria de Fatima A Magon, Yvone M Mascarenhas, Evolution of X-ray machine quality control acceptance indices, JOURN AL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 10, NU MBER 4, FALL 2009.
[7] Mohammad JavadKeikhai Farzaneh1, Mahdi Shirin Shandiz1, Mojtaba Vardian2,Mohammad Reza Deevband3 and Mohammad Reza Kardan3, The quality control of diagnostic radiology devices in hospitals of Sistan and Baluchestan, Iran, Indian Journal of Science and Technology Vol. 4 No. 11 (Nov 2011) ISSN: 0974-6846.
[8] OLUWAFISOYE, P.A, OLOWOOKERE, C.J, OLUWAGBEMI, M.A AND ADEOLA, O.F, MONITORING AND QUALITY CONTROL TESTS OF NIGERIAN NATIONAL PETROLEUM CORPORATION (NNPC) DIAGONSTIC FACILITIES: PART OF QUALITY ASSURANCE PROGRAMME OF RADIOLOGY IN NIGERIA, Journal of Theoretical and Applied Information Technology, 2005 - 2009 JATIT.
[9] Professor D van der Merwe, Certificates course for radiographers quality assurance diagnostic radiology, university of the wit watersrand, Johannesburg, South Africa 2002.
[10] Stephen Inkoom, Cyril Schandorf, Geoffrey Emi-Reynolds1 and John Justice Fletcher, Quality Assurance and Quality Control of Equipment in

Diagnostic Radiology Practice - The Ghanaian Experience, Wide Spectra of Quality Control, www.intechopen.com.

[11] T.M.Taha, Study the Quality Assurance of Conventional X-ray Machines Using Noninvasive KV meter, Tenth Radiation Physics & Protection Conference, 27-30 November 2010, Nasr City - Cairo, Egypt.

[12] Yesaya Y. Sungita, Simon S.L. Mdoe, and Peter Msaki, Diagnostic X-ray facilities as per quality control performances in Tanzania, JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS, VOLUME 7, NUMBER 4, FALL 2006.