

## Quality control of diagnostic radiology devices in the selected hospitals of Ahvaz city

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### Abstract

**Background:** X-ray, is one of the oldest, and yet the most widely used form of medical photographing. X-ray is a valuable tool to diagnose and examine many diseases such as arthritis, spinal injuries, pneumonia, bronchitis and even cancer. Running a quality control program of the radiology devices can reduce the absorbed dose in the patients. The aim of this study is to take the quality control test on the diagnostic radiology devices in the selected hospitals of Ahvaz city.

**Materials and Methods:** In this study various parameters of quality control programs were measured by the researchers, including voltage accuracy, accuracy of irradiation time, voltage repeatability, repeatability of irradiation time, output repeatability of X-ray tube, conformity of the optical field with radiation field, being the radiation field perpendicular to the film, the maximum leakage of tube and the light intensity of collimator.

**Results:** Evaluating the voltage accuracy revealed that the radiology devices in the hospitals (A) and (C) fell below an acceptable standard. An Assessment of the maximum leakage of the tube showed that all selected radiology devices were of a good standard. Assessing the conformity of optical field with radiation field also showed that radiology devices fell below acceptable standard in the hospitals (D) and (C).

**Conclusion:** In this study, all radiology devices in the selected educational hospitals of Ahvaz city made errors in some quality control tests except the radiology devices of hospital (B). The devices are required to be calibrated and their defects to be repaired.

**Keywords:** Radiology Devices, Quality Control, Hospital.

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## Introduction

Ionizing rays specially X-rays and rays resulting from radioactive materials play a very vital and developing role in medicine whether in diagnosing diseases and lesions, or treating them. Currently, it is estimated that from  $\frac{1}{3}$  up to half of serious and decisive medical decisions are made based on X-ray examinations and diagnosis. In addition, the primary diagnosis of some diseases completely depends on experiments carried out by X-ray (1), the remarkable development of human knowledge regarding the biological effects and subsequently the incidence of lesions and diseases resulting from radiation exposure in the human body enhanced the importance of producing x-ray devices for diagnostic examinations (2).

Systematic implementing of quality control programs of radiology devices and eliminating their defects could lead to the reducing of dose absorbed by the patients, increasing the efficiency and the long-life of devices, and improving image quality (3). According to the experience we have gained, the physical parameters of the active radioactive devices do not have the desired radiation quality; thus, if the problem is not resolved by a systematic and regular program of the quality control and quality assurance, it is caused to raise the risk of exposure to radiation in all people of a society; hence, having a comprehensive program of quality assurance to evaluate the equipment efficiency is essential for radiologists (4).

Considering the importance of quality control of radiology devices, numerous studies have been carried out in this field. In a study conducted by Keikhai *et al.* in 2011, regarding the quality control of radiology devices in the hospitals of Sistan and Baluchestan Province. The results showed that implementing the quality control programs reduce the dose absorbed by patients and increase the image quality (5).

In another study conducted by Shahbazi to control the quality of radiology devices in

the hospitals of Chaharmahal-e-Bakhtiari Province, the results revealed that implementing the quality control programs reduce about 40% of the dose absorbed by patients during chest radiography (6).

In another study entitled "A quality assurance program of x-ray devices", conducted by Godechal *et al.*, the efficiency of specifications of x-ray devices was measured systematically. The main problem was related to the inadequate filtration of devices (7). In another study that was conducted by Servoma *et al.*, entitled "Quality control and the patient dose from x-ray examinations in some Estonian hospitals", measurements were focused on the technical efficiency of the device, the quality of the image, patient doses and film processing (8).

The purpose of the study was to carry out the quality control tests regarding the importance of the quality control programs implementation on radiology devices in the selected hospitals of Ahvaz city. Taking these tests can reduce the concern of radiation workers and prevent the harmful physical effects on patients and radiation workers.

## Materials and Methods

In order to test the quality control of radiology devices, five hospitals of Ahvaz city (A, C, D, B, and E) were selected and investigated in 2011. The tests including voltage accuracy, accuracy of irradiation time, voltage repeatability, repeatability of irradiation time, repeatability of tube output were performed by using the device Mult-O-Meter made by Unfors, a Swedish company.

The researchers used the other equipments such as Geiger Muller detector made in Japan (SUM-AD8, Ricken Fine, Japan), to test the tube leakage, test tools of being perpendicular radiation (Gammex 161B, US) to test the degree of being perpendicular radiation, lux meter made in Taiwan (RTES -1339, Taiwan) to test the intensity of collimator light and an

equipment of testing the conformity of optical field with radiation field in the present study.

To test the voltage accuracy of each radiology devices, the difference amount between the adjusted voltage of the radiology devices and the amount of voltage measured (by the Unfors device) was obtained about 320 mA and 63ms in a stable condition at the voltages of 60, 70, 80 and 100.

1-In order to test the accuracy of irradiation time in a stable condition, the difference peak between irradiation time set on the radiology device and the amount measured over the times of 50, 100, 200, and 300 ms. was obtained about 200mA and 70 kV.

2-The repeatability assessment of voltage means that in a stable peak of 1 kV set on the radiology device with the changes in the irradiation conditions in terms of MAH, and the irradiation time, the amount of the voltage measured by Mult-O-Meter is equal to the amount adjusted on the device (stable peak of kV) and its amount is not affected by the making changes in the conditions of radiation.

The repeatability assessment of irradiation time means that in a fixed radiation time set on the radiology device with changes in radiation conditions in terms of mA and peak kv, the radiation time measured by Mult-O-Meter is equal to the amount set on the radiology device (fixed radiation time) and its amount is not changed by making changes in the radiation conditions.

The repeatability assessment in the output of x-ray tubes means that producing the same amounts of radiations in a radiology device in a stable radiation conditions.

The other quality control tests were performed according to fixed guidelines on the quality control of radiology devices drawn up by Iran's Atomic Energy Organization titled as "the quality control criteria of diagnostic radiology devices" in 2008.

## Results

The assessment of the voltage accuracy (Figure 1) showed that the radiology device of hospitals (A) and (C) in all ranges of kV and the radiology device of hospital (E) in the ranges of 80 and 100 kV contained errors above an acceptable standard level.

Assessment of the accuracy of irradiation time of the tube (Figure 2) showed that the radiology devices of the hospitals (A), (C), and (E) contained errors above an acceptable standard level in the irradiation times, as follows: (A), 300ms; (C), 50 and 300ms; (E), 200 and 300ms.

Figure 3. shows the values obtained from evaluating the voltage repeatability, repeatability of irradiation time and repeatability of X-ray tube.

Table 1. shows the maximum values of tube leakage, conformity of the optical field with radiation field, being the radiation field perpendicular to the film, assessment of the light intensity of collimator for all investigated radiology devices.

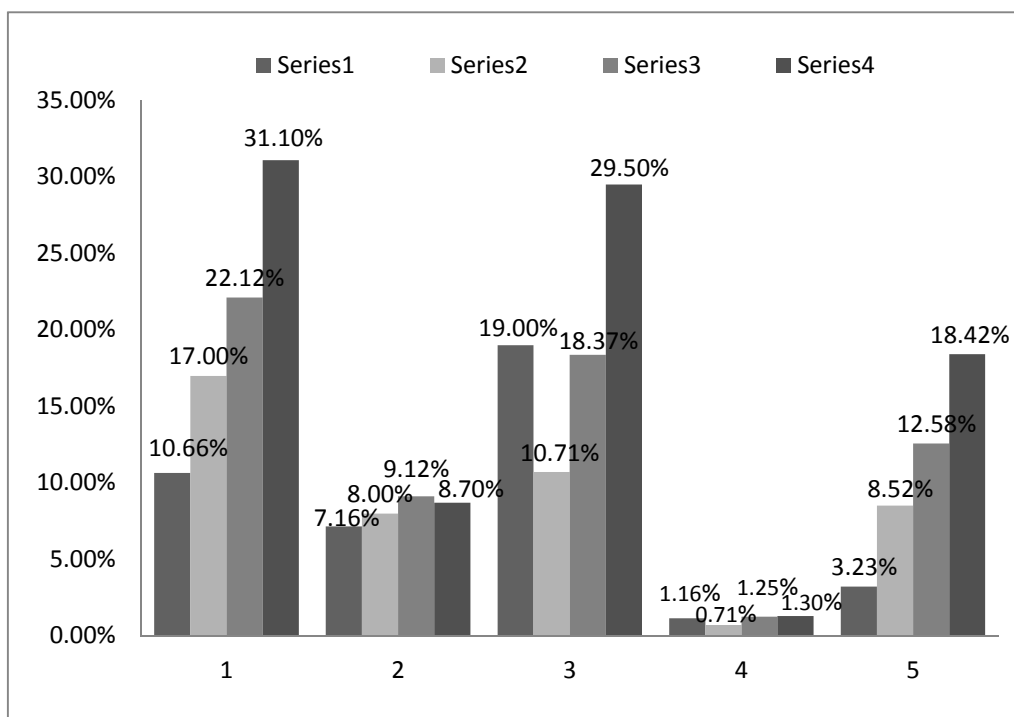


Figure1. The percentage of difference between the measured value and its measured voltage

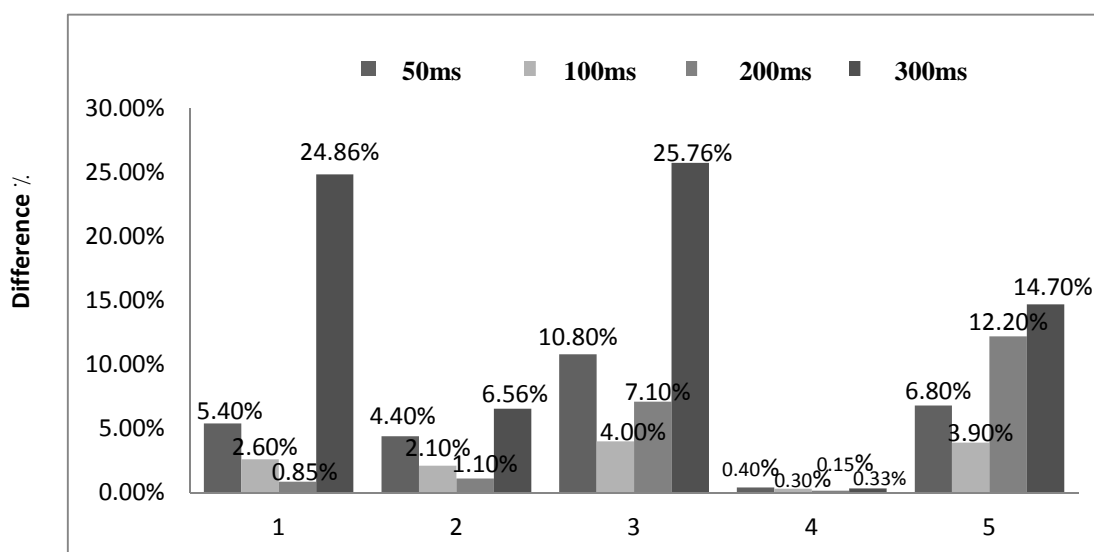
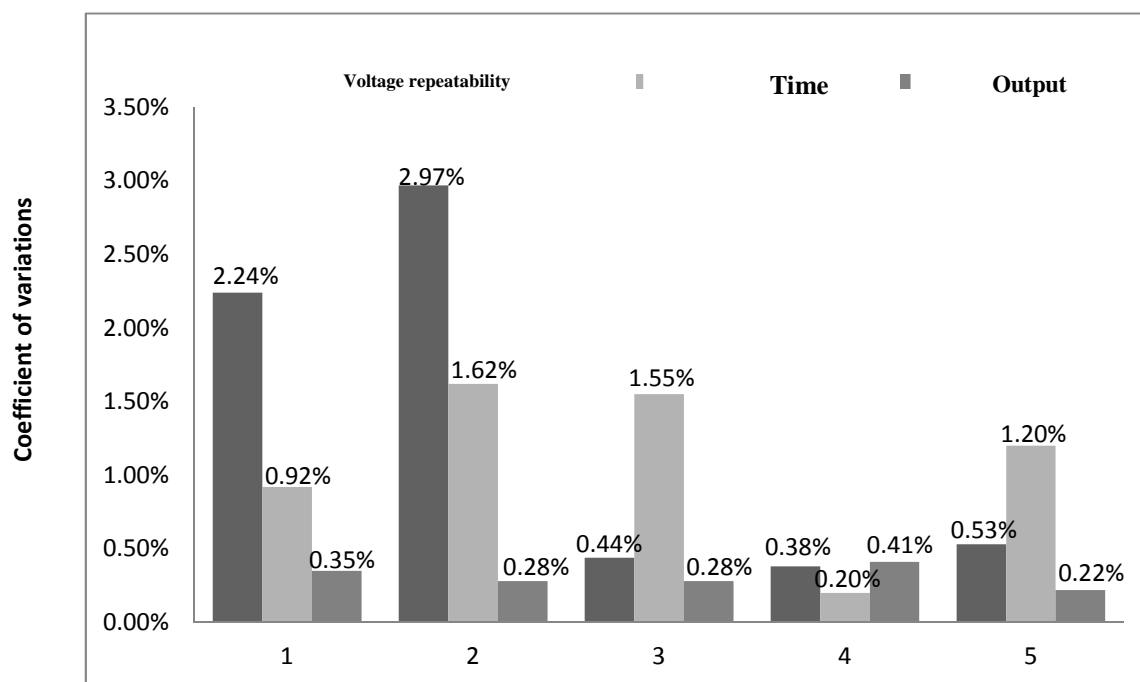


Figure2. The percentage of difference between the amount of radiation time and its measured voltage



**Figure 3. The values of the changes coefficient of voltage repeatability, time repeatability and output repeatability in different radiology devices of educational hospitals of Ahvaz**

**Table 1. The maximum amounts of tubes leaking, the conformity of optical field with radiation field, the light intensity of the collimator and being the radiation field perpendicular to the film in the different radiology devices of Ahvaz educational hospitals**

Hospital	Device	The maximum amounts of tubes leaking (mGy/h)	optical field alignment on the radiation field (cm)	the light intensity of the collimator (lux)	being the radiation field perpendicular to the film (degree)
(A)	Toshiba	0.0354	Less than 1	5.38	0
(E)	Shimadzu	0.0256	Less than 1	32	3.5
(C)	Shimadzu	0.0839	More than 1	40.7	3.9
(B)	Shimadzu	0.0333	Less than 1	99.4	2.1
(D)	Varian	0.0839	More than 1	110	1.7

## Discussion

People are exposed considerably to X-rays using diagnostic radiology so that this exposure can be reduced extremely by avoiding unnecessary tests and/or repeated examinations as well as improving the performance of equipment.

On the other hand, by using radiology both patient being treated and radiographer should be protected against radiation. Because of increasing use of ionizing radiation in each year (the reason is both increasing of population and increasing of confidence to the accuracy of radiology in

detecting diseases), the decrease in dose received by patients of societies necessitates more attention to dangers caused by X-rays.

Non standard performance of radiology devices not only can increase the dose absorbed by patients and radiographer but also can cause biological effects and radiation sickness either in the patients being treated or radiographers. Studies conducted by Hollins, Jankowski et al. showed that proper running of the quality control programs on radiological devices

reduces the dose absorbed by patients by 30-50 percent (9, 10).

According to the fixed standard forms of the quality control of radiology devices drawn up by Iran's Atomic Energy Organization titled as "the quality control criteria of diagnostic radiology devices" in 2008. Standard values for quality control tests are as follows:

1-Voltage accuracy test: A difference less than or equal to 10% between the values of voltage adjusted on the device and measured values is acceptable.

2-Accuracy of irradiation time test: A difference less than or equal to 10% between the amount of irradiation time adjusted on the device and the measured values is acceptable.

3-The assessment of the voltage repeatability and repeatability of irradiation time and output repeatability of x-ray tube. The coefficient of variations less than or equal to 5% in the measured values are acceptable.

4- Maximum leakage of the tube (mGy/h), intensity of Collimator light (lux), being the radiation field perpendicular to the film (degree) and the conformity of optical field with radiation field (cm), less than or equal to 1 mGy / h , 100 lux, 3 degrees and 1cm, respectively are acceptable.

In most quality control tests, the radiology device of hospital (C) has performed outside the standard range, and has had the maximum errors; the long life of radiology device tube in this ward can be one of the most important reasons of it. It must be specifically focused on the device. The study of quality control of radiology devices in the hospitals of Chaharmahal and Bakhtiari showed that the non-standard performance of radiology devices was due to the longevity of their tubes (6). Considering that most of the errors in tests of voltage accuracy and accuracy of irradiation time of this study have occurred in peak of 100 KV and irradiation time of 300mA, the necessary measures should take place to calibrate the voltage and irradiation time of these devices especially

in the peak of 100 KV and irradiation time of 300 MS.

The results of the study conducted by Bahreyni Toossi *et al.* on the accuracy of the potential of the tube showed that in the range of 320 mA or 300 mA, there is a difference more than 5% between tube potential adjusted on the device and its measured value in nearly 44% of the devices (11), while in this study, the radiology devices of hospitals (A) and (C) contained errors above an acceptable standard level in mAh equal to 320 and all ranges of kv; and the radiology devices of hospital (E) contained errors above an acceptable standard level in mAh equal to 320 and kVs of 80 and 100.

The results of the study showed that almost in all devices with increasing irradiation time, the difference between the set time and its measured value increases; while the results of the study conducted by Bahreyni Toossi *et al.*, showed that the irradiation chronometers work more accurate at longer times. The results of this test showed that the radiology devices of hospitals (C) and (B) and (E) contained errors above an acceptable standard level in the irradiation time of 300 ms.

All quality control tests conducted in this study show that the radiology devices of hospital (B) reached an acceptable standard and radiology devices of hospital (A) in all tests except for "the conformity of optical field with radiation field" and "intensity of Collimator light" met the accepted standard. This could be due to the lower workload of the ward and thus the health of tube device. With the exception of radiology devices of hospitals (D) and (B), the rest of the devices have had intensity of Collimator light less than the desired and standard level that needs to be modified.

We hope that this study as a basic and initial action leads to the beginning of correct performance of the quality control programs in all wards of radiology in Khuzestan province, and in addition to the using the existing radiology devices, it

leads to the reduction of dose absorbed by the patient during different radiographies. Method Limits of the study The basic problem with the implementing of this project was the lack of quality control devices that would have led to the rest of the quality control factors, which we hope the university provides them in the near future.

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### References

- 1-Bushong S. Computer-assiated quality assurance for radiographic equipment. *Med Phys* 1980;7(4):386-9.
- 2-Elgazzar AH, Elsaid M. Biological effects of ionizing radiation. In: Elgazzar AH, editor. *The pathophysiologic basis of nuclear medicine*. Berlin: Springer-Verlag; 2001. P. 369-70.
- 3-Darby SC. The genetically significance dose from diagnostic radiology in Great Britain in 1997. *NRPB* 1997;9(1):106.
- 4-Declan R, Kyrio J, Edward J, Andrew CMF. Radiation protection in interventional radiology. *Clin Radiol* 2001;56:99-106.
- 5-Keikhai Farzaneh MJ, Shirin Shandiz M, Vardian M, Deevband MR, Kardan R. Evaluation of image quality and patient dose in conventional radiography examinations in radiology centers in Sistan and Baluchestan, Iran and comparing with that of international guidelines levels. *Indian J Sci Technol* 2011;4(11):1429-33.
- 6-Shahbazi-Gahrouei D. [Quality control of diagnostic radiology devices in hospitals of Chaharmahal and Bakhtiari province]. *Iran Med Univ J* 2003;4(5):11-18. ( Persian)
- 7-Godechal D, Delhove J, Mambour C, Coomans J, Wambersie A. A quality assurance programme for medical X ray diagnostic units carried out in Belgium. *Radiat Prot Dosimetry* 1995;57(1-4):309-13.
- 8-Servomaa A, Rannikko S, Parviainen T, Holmberg P, Kuss E, Muursepp T, et al. Quality control and patient dose from X-ray examinations in some hospitals in Estoina. *Radiat Prot Dosimetry* 1995;94(1-2):297-300.
- 9-Hollins M. Measuring and controlling radiation. In: Hollins M. *Medical Physics*. London; 1990. P. 145-58.
- 10-Jankowski J, Stainszewka MA. Methodology for the set-up of a quality control system for diagnostic X-Ray units in Poland. *Radiat Protect Dosimetry* 2000;90(1-2):259-62.
- 11-Bahreyni Toossi MH, Assadi-nejad M. [Study of chest radiographs in Iran and recommended national reference dose for it]. *Iran Med Phys J* 2003;8(3):11-22. (Persian)