Sudan University Of Science and Technology

College of Graduate Studies

Quality Control of conventional diagnostic x-ray unit

ضبط الجودة لوحدات الاشعة السينية التشخيصية التقليدية

A Thesis submitted in partial fulfillment of the Requirement for the M.SC. Degree Medical Physics.

BY
Rofida Saeed Ibraheem

Supervisor
Dr: Hussein Ahmed Hassan

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الآيـــــــة

بسم الله الرحمن الرحيم

قال تعالي:

(اقرا باسم ربك الذى خلق (1) خلق الانسان من علق (2) اقرا وربك الاكرم (3) الذى علم بالقلم (4) علم الانسان ما لم يعلم (5)).

سورة العلق(الاية1-5)

Dedication

First , thanks to Allah for giving me the strength to complete this work , thank my family , parent , sisters and friends

Thanks for everyone who helped me during the path .

Acknowledgments

I would like to express my gratitude to my supervisor professor Hussein Ahmed Hassan for invaluable help and fruitful suggestion I thank the academic staff of physics department at college of science , Sudan University of Science and Technology (SUST) for multi supports.

Abstract

The main objective of this study to assess the performance of x-ray equipments in three radiology department.

The study was conducted at radiology department, performed the basic quality control tests Kv accuracy, x ray tube reproduciability, timer accuracy, mAs linearity and half value layer.

The results of this study showed that, KVp accuracy, x ray reproducibility, timer accuracy, timer reproducibility, mAs linearity and half value layer were within acceptable limits to two x.ray mashines, thrid mashine   fail on most of the QC test.

The study recommended that, routine checking and quality testes to x-ray be perform in regular and opertaor should be caution when units should dealing with radiography devices during operation and storage to identify any faults.

المستخلص

الهدف الرئيسى لهذه الدراسة تقييم اداء اجهزة الاشعة التقليدية،اجريت هذه الدراسة في ثلاثة مستشفيات وقد استخدمت ثلاثة ماكينات اشعه سينية وجمعت البيانات تم إجراء اختبارات ضبط الجودة الاساسية لاجهزه الاشعة السينية التقليدية ,دقة فرق جهد انبوب الاشعة، وثبات التيار، وخطيةكثافة الشعاع وقيمة الطبقة المنصفة للإشعاع وكانت النتيجه ان هنالك جهازين تعمل في الحد المسموح به من قبل الطاقة الذرية ام الجهاز الثالث كانت نتائيجة غير مطابقة .

توصي الدراسه بعمل اختبارات دورية لضبط الجودة للاجهزه التي تعمل ف المستشفيات , واخذ الحيطه والجذر عند التعامل مع اجهزه الاشعاع خصوصا عند التشغيل وذلك لمعرفة الاعطال التى تؤثر على اداء الجهاز.

Table of contents

List of figures

List of Abbreviations

IAEA : Standard Atomic Energy Agency.
HVL : Half Value Layer .
MeV: Mega electron Volt .
KeV: Kello electron Volt .
QC: Quality Control .
KE : Kinetic Energy .
CV : Coefficient Variation

Chapter one
Introduction

Chapter One

Introduction

1.1 Introduction :

Quality control is the regulatory process through which the actual quality performance is measured , compared with existing standards , and the actions necessary to keep or regain conformance with the standards .

Quality control of equipment used for the medical exposure of patient to ionizing radiation and ancillary equipment such as film processors , are legal requirement placed on all radiology department and other users of such equipment.

x-ray is one of the three categories of ionizing radiation within the electromagnetic spectrum, which can be subcategorized based on the frequency (from highest to lowest) into: Gamma rays, X rays, Ultraviolet, Visible light, Infrared, Microwaves, Radio waves.

Since its discovery in 1895 by the German physicist Wilhelm Rontgen it has been widely developed and used in various fields such as scientific researches and medical applications among others (THOMMASS.CURRY, 1990).

In the medical field the application of X-ray is in both the diagnostic and therapeutically usage with energies ranging from (20-45) KV for diagnostic mammographies to (50-140) KV for the rest of the diagnostic procedures and finally (6-30) MeV for the therapeutical usages.

And as for any other toll it involves a certain amount of risk to the patients and workers alike. Hence a quality program is established and carried out periodically to ensure the parameters of the machine under question.

These quality control (QC) procedures measures the machines output (Kilo Voltage (KV) tube current (mAs)) mechanical performance and any other factors that may help to determine the level of risk.

In this study, the focus is on the diagnostic usage of X-ray , and the study is carried out in three national institutes, to achieve the study we focused on the dosemetric (output measurements) aspect of the quality control (QC) process which including:

Reproducibility , KVp Accuracy(%error) , Half value leary (HVL) , Linearity Time reproducibility ,Time Accuracy.

1.2 statement of the problem :

Quality control test for x –ray devices not applied in all the hospital , hence exposure to x-ray may result severe damage in human body.

1.3 Objectives of the Research:

1.3.1 General objective:

Quality control of conventional diagnostic x-ray unit.

1.3.2 Specific objectives:

-To evaluate Kvp Reproducibility .

-To evaluate Kvp Accuracy .

-To evaluate half value layer.

-To evaluate Linearity.

-To evaluate time reproducibility.

-To evaluate time Accuracy.

Chapter Two
Literature Review

Chapter Two

Literature Review

2.1 Introduction:

Wilhelm Conrad Roentgen, German physicist discovered X-ray on (November 8\1895) (THOMAS .CURRY ,1990).

Several fortunate coincidences set the stage for the discovery ; Roentgen was investigating the behavior of cathode rays (electrons) in high energy cathode ray tubes , which consisted of a glass envelope from which as much air as possible had been evacuated.

A short platinum electrode was fitted into each end and when a high-voltage discharge was passed through this tube , ionization of the remaining gas produced a faint light. Roentgen had enclosed his cathode ray tube in black cardboard to prevent this light from escaping to block any effect the light might have on experiments he was conducting , he then darkened his laboratory room to be sure there were no light leaks in the cardboard cover. On passing high-voltage discharge through the tube, he noticed a faint light glowing on a work bench about (3 ft) away , he discovered that the source of the light was the fluorescence of a small piece of paper coated with barium platinocyanide , because electrons could not escape the glass envelope of the tube to produce fluorescence , and because the cardboard permitted no light to escape from the tube , he began placing objects between the tube and the fluorescent screen : a book, a block of wood and a sheet of aluminum.(Hollins,M(2001)).

The brightness of the fluorescence differed with each, indicating that the penetrated some objects more easily than other, then he held his hand between the tube and the screen and to his surprise the outline of his skeleton appeared on the screen.

Figure (2.1) the image of roentgen's skeleton appeared on the screen

By (December 28/1895) he had thoroughly investigated properties of the rays and had prepared a manuscript describing his experiments, In recognition of his outstanding contribution to science .

Wilhelm Conrad Roentgen was awarded the first Nobel prize for physics in 1901.(THOMASS. CURRY, 1990)

2.2 Definition of X-ray:

It is form of electromagnetic radiation, similar to light but of shorter wavelength and capable of penetrating solids and of ionizing gases, such radiation having wavelengths in the range about (0.1-10 nm) .

Approximately, generally X-ray it is not found in the nature, but it can be produced.

2.3 X-ray machine:

2.3.1 Diagnostic X-ray tubes:

X-ray is produced by energy conversion when a fast-moving stream of electrons is suddenly decelerated in the "target" anode of an X-ray tube.

The X-ray tube is made pyre glass that encloses a vacuum containing two electrodes (this is diode tube).

The electrodes are designed so that electrons produced at the cathode (Negative electrode or filament) can be accelerated by high potential difference toward the anode (Positive or target electrode).

The basic elements of an X-ray tube are show in figure (2.2):

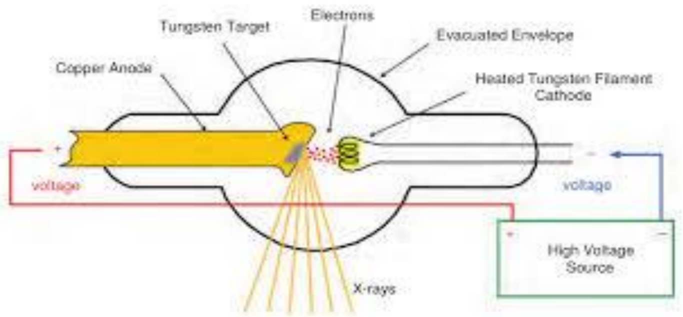

Figure:(2-2) X-ray tube and its power supplies

A diagram of a stationary anode X-ray tube. Electrons are produced by the heated tungsten filament and accelerated across the tube to hit the tungsten target, where X-ray are produced.

This section will describe the design of the X-ray tube and will review the way in which X-ray are produced.(Holt ,Rinehart ,(1900)).

Glass enclosure:

It is necessary to seal the two electrodes of X-ray tube in a vacuum if gas were present inside the tube, the electrons that were being accelerated toward the anode (target) would collide with the gas molecules, lose energy, and cause secondary electrons to be ejected from the gas molecules, by this process (ionization), additional electrons would be available for acceleration toward the anode, obviously this production of secondary electrons could not be satisfactorily controlled. Their presence would result in variation in the number and more strikingly, in the reduced speed of the electrons impinging on the target, this would cause a wide variation in tube current and in the energy of the X-ray produced. The purpose of the vacuum in the modern X-ray tube is to allow the number and speed of the accelerated electrons to be controlled independently the shape and size of this X-ray tubes and electrodes.

The connecting wires must be sealed into the glass wall of the X-ray tube heated , this differences in expansion would causes the glass-metal seal to break not taken, because of this problem, special alloys, having approximately the same coefficients of linear expansion as pyre glass, are generally used in X-ray tube.

Cathode:

The negative terminal of the X-ray tube, in addition to the filament, which is the source of electron for the X-ray tube, the cathode has two other elements, these are the connecting wires, which supply both the voltage (average about 10 v) and the ampere (average about 3 to 5 A) that heat filament, and metallic focusing cup, The number(quantity) of X-ray produced depends entirely on the number of electron that flow from the filament to the target (anode) of the tube, the X-ray tube current measured in mill amperes (1mA=0.001A).

Anode:

Anodes (positive electrodes) of X-ray tubes are of two types:

Stationary anode , Rotating anode .

Stationary anode:

The anode of a stationary anode X-ray tube consists of a small plate of Tungsten (2 or 3 mm thick), that is embedded in a large mass of copper.

The tungsten plate is square or rectangular in shape, with each dimension usually being greater than 1cm, the anode angle is usually 15 to 20 degree.

Rotating anode:

With the development of X-ray generators capable of delivering large amounts of power, the limiting factor in the output of an X-ray circuit become the X-ray tube itself.

The ability of the X-ray tube to achieve high X-ray outputs is limited by the heat generated at the anode, The rotating anode principle is use to produce X-ray tube capable of withstanding the heat generated by large exposures (Griepink ,B.(1990)).

2.4 X-ray production:

X-ray are produced by energy conversion when fast-moving electrons from the filament of the X-ray tube interact with tungsten anode (target) , the Kinetic energy (E) of the electron in passing across the voltage(V) is increased by

E=e V

Where (e) is the electronic charge, because the electric charge (e) of the electron does not charge (1.6×10-19), it is apparent that increasing the voltage across the X-ray tube will increase the Kinetic energy of the define the electron volt as energy a single electron obtains when crossing one volt we can write:

E=1.6×10-19c×1V

=1.6×10-19 J

The high-speed electrons striking the target do not have the same energy, X-ray are generated by two different processes:

2.4.1 General radiation or (Bremsstrahlung):

When the high-speed electrons lose energy in the target of the X-ray tube, on involves reaction of the electrons with the nucleus of the tungsten atoms.

When an electron passes near the nucleus of the tungsten atom, the positive charge of the nucleus acts on the negative charge of the electron, the electron is the attracted toward the nucleus and is thus deflected from its original direction the electron X-ray tube(s) and table may lose energy and be slowed down when its direction changes, the Kinetic energy lost by the electron emitted directly in the form of a photon of radiation.

The radiation produce by these processes is called general radiation or Bremsstrahlung (from the German for breaking radiation).figure (2.3):

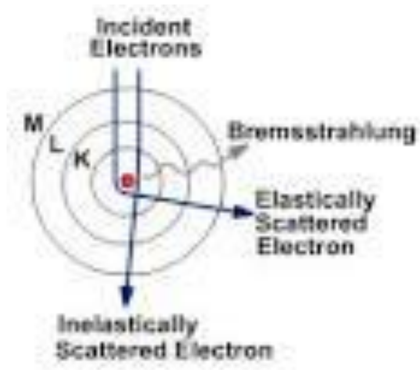

Figure (2-3) : The X-ray generation by Bremsstrahlung (breaking radiation)

Must electron that strike the target give up their energy by interactions with a number of atoms, the electron gives up only part of its energy in the form of radiation each time it is “braked”, electron penetrate through many atoms layers before giving up all their energy, therefore not all X-ray are produced on the surface of the target, occasionally the electron will collide head-on with a nucleus.

These two factor cause a wide distribution in the energy of the radiation produced by this breaking phenomenon, most of the radiation will have little energy and will appear as hest, few X-ray will appear because over 99% of all reactions produce heat, and the energy of the radiation in amount of energy lost by the electrons.

The wavelength of X-ray photons produced when the electron is broken by the tungsten nuclei in the target is related to the energy (KeV) of the electron, the energy of the electron is related to the potential difference (KVP) across the X-ray tube.(Holt ,RINEHART ,(1990)).

Consider the case of a head on collision between the electron and nuclei all the energy of the electron is given to the resulting X-ray photon, the minimum wavelength (in angstroms) of this X-ray photon can be calculated:

=12.4/KVP

The wavelength of X-ray in the continuous spectrum varies, the variation is produced by the different energies with which the electron reach the target, and by the fact that most electrons give up their energy in stages.

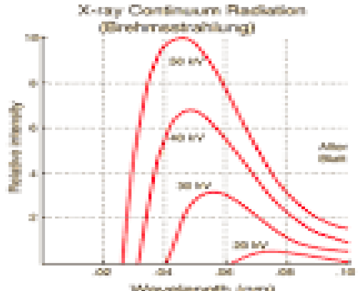

Figure (2.4) X-ray continuum radiation (Bremsstrahlung)

2.4.2 Characteristic radiation:

Involves collision between the high-speed electron and the electron in the shell of the target tungsten atoms, characteristic radiation results when the electrons bombarding the target eject electrons form the inner orbits of the target atoms, removal of an electron form a tungsten atom causes the atom to have an excess positive charge and the atom thus becomes a positive ion.

In the process of returning to its normal state, the ionized atom of tungsten may get rid of excess energy in one of two ways, an additional electron (called an auger electron) may be expelled by the atom and carry off the excess energy.

The ejection of auger electron does not produce X-ray, and so is not of much interest for this discussion , an alternative way to get rid of excess energy is for the atom to emit radiation that has wavelengths within the X-ray range, tungsten atom with an inner shell vacancy is much more likely to produce an X-ray than to expel an electron, X-ray produced in this manner are called characteristic X-ray because the wavelength of the X-ray produced are characteristic of the atom that has been ionized.

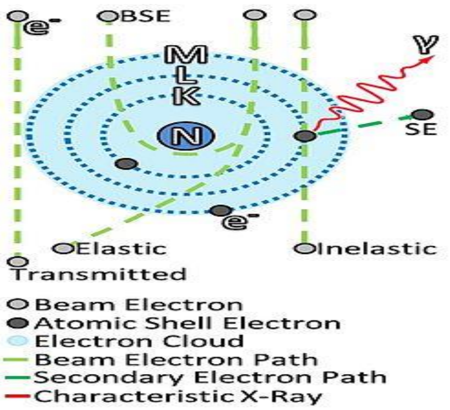

Figure (2.5) : The X-ray generation by characteristic radiation

For the purposes of illustration we will discuss ejection of an electron from the (K) shell of tungsten and then apply the principle to electron in other shells of the tungsten atom.

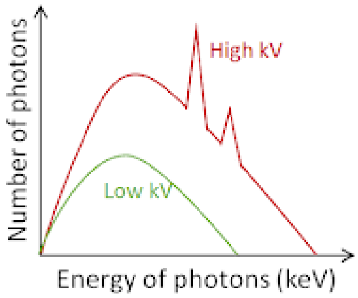

Figure (2.6) :x-ray spectrum of characteristic radiation

2.5 Intensity and Spectral Spread of X-ray:

The effect of X-ray radiation depend both on the Intensity of an X-ray beam (is defined as the number of photons in the beam multiplied by the energy of each photon) and the spectral spread of an X-ray (depend on wavelength).

The intensity is commonly measured roentgens per minute (R\min, C\Kg in the SI system), the effect of intensity and spectral spread of X-ray depend on (target material , tube voltage ,tube current , filters).

Target material as the proton number (Z) of the target material, the following effects is observed.

Energy maximum (Emax) remains constant, the total intensity increases because there is a greater probability of collision between the bombarding electrons and the layer, more positively charged target nuclei, and the characteristic line spectra are shifted to higher photon energies.

The target material needs to have a high proton number (Z) but also a high melting point because of the heat generated , tungsten is the ideal material as it has (Z=74) and a melting point of (3650K).

Tube voltage As the tube voltage in increased the following changes occur, Energy maximum(Emax) increases and wavelength minimum (λmin) decreases , the peak intensity of the continuous spectrum move to higher energies , the total intensity which is given by area under the curve increases rapidly it is proportional to (V20) , and more characteristic lines may appear in the spectrum.

In addition the beam will be affected by variation in the supply of the tube voltage over time ,some X-ray generators have an alternating power supply which results in a greater proportion of low energy radiation.

Tube current As the tube current is increased more electrons are emitted from the cathode which results in the following change:

Energy maximum (Emax) remains unchanged as the peak value of voltage (V0) is constant, the shape of the spectrum remains unchanged and the total intensity increases it is proportional to the tube current.

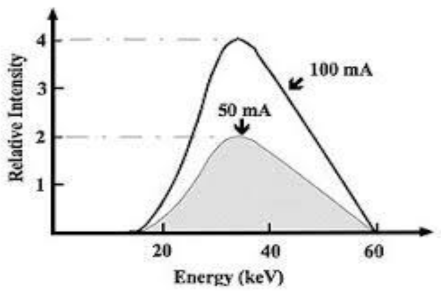

Figure (2.7) : Relationship between energy (KeV) and Relative intensity

Filters is a thin sheet of material placed in the beam and selectively absorb more low energy photons than high energy photons resulting in a change of the kind (HOLLINS,2001).

2.6 The interaction of X-ray with matter:

The interaction of X- ray with matter is by described three methods:

Transmitted pass through unaffected as primary or direct radiation.

Absorber transferring to the matter all of their energy (the photon disappearing completely).

Scattered diverted in a new direction with or without loss of energy transferring to the matter and so may leave the material as scattered or secondary radiation (Williams,2008).

2.7 Attenuation mechanism:

Four processes can result in loss of energy from an X-ray beam to soft tissue:

Scatter the energy of X-ray photon is smaller than the energy required to remove an electron from its atom (this is binding energy).

Photoelectric effect the photon with energy slightly greater than binding energy (Eb) ejects an electron from its atom, another electron in the atom then drops into the vacancy with the emission of characteristic photons.

Compton scatter the photon has much more energy than the binding energy so that a photon of reduced energy is scattered from the interaction with the ejected electron which is known as a recoil electron.

Pair production at very high photon energy the photon can interact with the nucleus of an atom the photon disappears and an electron and positron emerge this to particles lose their energy by ionization until a positron is annihilated by an electron with the generation of two identical photon.(HOLLINS,2001).

2.8 Quality control:

There are lot of experiments which are carried out on medical devices and equipment to cope with the standard international specifications and to realize the extent of the quality of these devices.

Some of their experiment are carried out on therapeutic diagnostic X-ray devices and it is found out that not carrying out there experiment leads to a great deal of damage including the following:-

The patient may be exposed to a high X-ray over dose that over comes the ability of that particular organ which leads to negative side effects on the rest of the organs and causes a number of illnesses such as erythematic and cancer that damage may affect the technical worker on the device.

The damage of the device is possible.

2.9 Radiation protection:

Many somatic dangers of radiation became evident a few months after X-ray were discovered , Roentgen announced his discovery in December of (1895) in (1896) 23 cases of radio dermatitis were reported in the world literature , between (1911) and (1914) three review articles identified (54) cancer deaths and (198) cases of radiation induced malignancy(Thomas's.curry).

2.10 Population exposures:

The average annual effective dose equivalent to people in the United States is estimated to be 3.6mSv (360m ram), most of this exposures is from natural background radiation (3.0mSv). The radiation sources are divided into:

1-Natural radiation:

Natural radiation exposure arises from external and internal sources, **the external sources** are cosmic radiation from outer space the average cosmic ray annual dose equivalent is about 0.26 mSv (26 m rem) and gamma radiation the average annual gamma ray effective dose equivalent is about 0.28 mSv (28m rem), **the internal sources** internal exposure comes from radio nuclides within the body, there are two groups of this radio nuclides those that are ingested in food and water and those that are inhaled.

2-Medical radiation:

The concept of effective equivalent particularly useful when describing medical x-ray there are two categories of medical radiation:

Diagnostic medical X-ray the estimated annual effective dose equivalent is (0.39 mSv) (39 m rem).

And in nuclear medicine, the estimated annual effective dose equivalent is 0.14mSv (14 m rem).

2.11 Occupational exposure:

The occupational exposure individual accept some risk, since we have already discussed effective dose equivalent, we can go directly to:

Stochastic effect of radiation exposure is defined as an effect which the probability of occurrence increases with increasing absorbed dose but the severity of the effect dose not depend on the magnitude of the absorbed dose, stochastic effect is an all-or-none phenomenon and is assumed to have no dose threshold, examples of stochastic effect that may be caused by radiation exposure are cancers and genetic effect.

Non stochastic effect of radiation exposure is defined as a somatic effect that increases in severity with increasing absorbed does, non stochastic effect are usually degenerative effect severe in enough to be clinically significant, example of radiation exposure are lens opacities, blood change and decreased sperm production (Thomas's. Curry 2012).

2.12 Protective barriers:

Three methods can be used to control radiation exposure levels: distance, time and barriers. Distance is obviously an effective method, because beam intensity is governed by the inverse square law.

Barriers are designated as either primary or secondary depending on whether they protect from primary radiation (the useful beam) or stray radiation (a combination of leakage and scatter radiation).

2.13 Methods of calculating primary barrier thickness:

Having determined the amount of radiation reaching the ear in question, we must reduce this exposure to an acceptable level that depends on the category of the ear, this is accomplished by interposing a barrier either lead or concrete, two methods are commonly used to calculate barrier requirements for diagnostic installations:

Half-value layers(HVL).

Precalculated shielding requirement tables.

2.13.1 Half-value layers(HVL):

The first method for calculating barrier requirements, and the simplest to understand, is with half-value layers (HVL), the concept of HVL was first used in radiation therapy to express the quality of an X-ray beam.

The half-value layers is the thickness of a specific substance that, when introduced into the path of a beam of radiation, reduces the exposure rate by one half, abeam with a HVL of 0.2 mm of lead is more penetrating than a beam with a HVL of 0.1 mm of lead.

Barrier thickness is calculated by repetitively halving the exposure until it reaches a permissible level, and then multiplying the number of halves times the HVL of the beam.

A problem arises in using half-value layers with heterochromatic radiation, remember and filtration change the quality of diagnostic beam as it passes through a barrier, the beam increases in mean energy, or is hardened, so if we use its initial HVL we could underestimate barrier requirements.

2.13.2 Precalculated shielding requirement tables:

All me need is to determine the effective workload by multiplying the actual workload (W) by the use factor(U) and occupancy factor (T) the effective workload is still in mA .min/wk , because the use and occupancy factors have no units, Knowing the KVp and distance (THOMMS'S. CURRY,1990).

2.14 Radiology Department Infrastructure:

This must include:

Electrical power, air conditioning or ventilation, floor space and floor loading, links to other critical areas e.g. emergence, for a safe radiation environment, there are certain principles and considerations:

“Separation” of different functional areas helps control access:

((Public areas (waiting, change etc.), staff areas (offices, meeting room etc.), work areas(radiation room, dark rooms, labs))

Restriction control of public access, to work areas will normally be controlled areas, therefore public can only access when being examined or treated, flow of staff to form and within work areas-separate from public areas. consideration of spaces adjacent to radiation areas, including above and below storage space required, lab teaching, meeting areas, film processing storage, location relative to radiation areas, chemical storage and disposal, ventilation (glutaraldehyde fumes), silver recovery and bulk film storage(Taylor ,JK.(1993)).

2.15 Previous Studies:

-Jomehzadeh .Z

Quality Control Assessment Radiology devices in Kerman Province , Iron .

Objective of study :

To perform QC test on stationary radiographic x-ray machines , installed in 14 hospital of Kerman province Iron.

Conclusion:

Application of quality control programs at diagnostic radiology department is of great significance for optimization of image quality and reduction of patient dose.

-Tagh .M.

Quality control Assessment of Conventional Radiology devices in Iron

Objective of study :

To conduct QC tests on randomly selected radiology devices , installed in diagnostic image department of Iron.

Conclusion:

QC of radiology devices plays a significant role in reduction of medication dose and optimization of image quality.

-Yesaya .Y

Diagnostic x-ray facilities as per quality control performances in Tanzania.

Objective of study:

To report on the current statues of diagnostic x-ray machines in Tanzania in order to produce the data needed formulate QC policies and strategies .

Conclusion :

QC to ensure that patient receive the lowest possible radiation risk and maximum health benefits from x-ray examination.

Chapter Three
Material and Methods

Chapter three

Material and Methods

3.1 Material

Devices used in practical:

1- multi- function meters:

Manufacture date :2013.

Power of device : 3000series.

Provenance: china.

2-X-ray machine number (1) :

Name of machine :SHEMADZU MOBILE.

Manufacture date: 2003 .

Provenance: Japan .

Power of device: 120Kvp.

Test :Kvp Reproducibility , Kvp Accuracy ,Half value later ,Linearity ,Time reproducibilty , Time Accuracy .

Result : this device work in acceptable level.

X-ray machine number (2):

Name of machine: Yz -200B

Manufacture date: 2011.

Provenance : chine.

Power of device : 100Kvp.

Test: All testes.

Result : this device work in unacceptable level.

X-ray machine numer(3):

Name of machine: SHEMADZU Corporation.

Manufucture date : 2014.

Provenance : Japan .

Power of device : 150Kvp .

Test : All testes .

Result: this device work in acceptable level.

3.2 The method:

3.2.1 Quality Contral procedure:

There are number of quality control performed on the X-rays devices and tests them:

1-KVp Reproducibility:

Used to measure the distance between the rays exit from X-rays and a multi-function device (100Cm) and then introduced into the value of the voltage (80 KV) was measure outside the voltage in the device and multi-function steps repeated three time was to find the average standard deviation values (by fixed current).

2-KVP Accuracy:

Fixed current (20mAs) and measuring KVp from about (50-120 KVp) see table (3-1): (50,60,70), table(3-2) : (50,60,72), table(3-3) : (50-60-70-90) and calculate error between set and measured value.

The used equipment and device: multi-function Meters .

3-Half volue layer(HVL):

Place the detector at 100 cm from the focus, on some lead or lead or lead vinyl the value voltage 80 KVp , fixed mAs (20 mAs), collimate X-ray beam to size of detector, addition 1mm aluminum to beam (at collimator is best), and measure the dose add another 1mm (AL), measure again, and repeat until the dose has fallen to below 50% of the initial , un attenuated value.

The used equipment and device: lead sheet, copper, Tape measure and spirit level.

4-Linearity:

Used fixed 80 KVP , by change current (mA s) table (3-1,3-3) :(4,8,16,32) table (3-2) : (4,8,15,30), and measured dose.

Calculate the radiation output (µGy/ mAs) remains constant as the mA is varied.

The used equipment and device: Multi-function Meter.

5-Time reproducibility:

Fixed time (mS) table (3-1,3-3) : (200mS), table (3-2): (60mS), and measured time (mS) {should be value output equal or near value input same equipment used in KVP reproducibility}.

6-Time Accuracy:

Value change of the time table (3-1 , 3-3) : (40,80,160,320 mS) table (3-2) :

(40,80,150,300mS), measure time (mS) {should be value output equal or near value input} and calculate time different and time error.

Form another test in quality control : Coincidence of radiation beam and light beam, focal spot size (large), fog level.

Chapter Four
Results

Chapter four

Results

4.1 Results:

The following tables show the results of quality control tests carried out on X- ray machines for a number of hospitals (three).

Table (4-1)

1-Reproducibility (%CV)

Set mAs:20

Set KVp 80	Measured KVP	Result	Dose(µGy)	Result
1	83.9		1024	
2	83.8		1024	
3	83.9		1025	
Average	83.85			
SD	0.05			
%CV(5%)	0.0225	Accept		Accept

2-KVP Accuracy

mAs set : 20

Set KVP value	Measured KVP	%Error	Result
50	50.9	1.8	Accept
60	61.1	1.8	Accept
70	71.8	2.5	Accept

3-HVL

Set 80 KVP ,20mAs

AL(mm)	Dose (µGY)
0	1030
1	849.6
2	714.4
3	606
3.5	559.9
4	514.9

4-Linearity

Set 80 KVP

mAs	Dose (μGy)	μGy/mAs	%LC	Result
4	195.5	48.88	0	Accept
8	398.7	49.83	2	Accept
16	802.2	50.13	2	Accept
32	1608	50.25	2	Accept

5-Time Reproducibility

Set time (ms)	Measured time (ms)	Result
200	200.3	
200	200.3	
200	200.3	
Average	200.3	
SD	0.3	
CV	0.15	Accept

6-Time Accuracy

Set time (ms)	Measured time(ms)	Time Diff	Time %error	Result
40	40.6	0.6	1.5	Accept
80	80.2	0.2	0.25	Accept
160	160.4	0.4	0.25	Accept
320	320.4	0.4	0.12	Accept

HVL

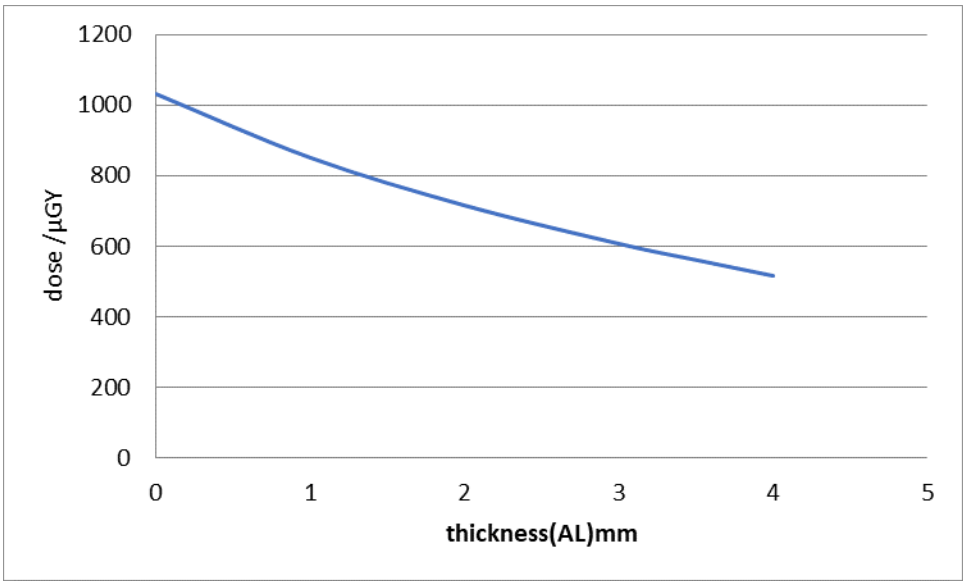

Diagram explain relationship between thickness (AL/mm) and dose (µGY).

Linearity

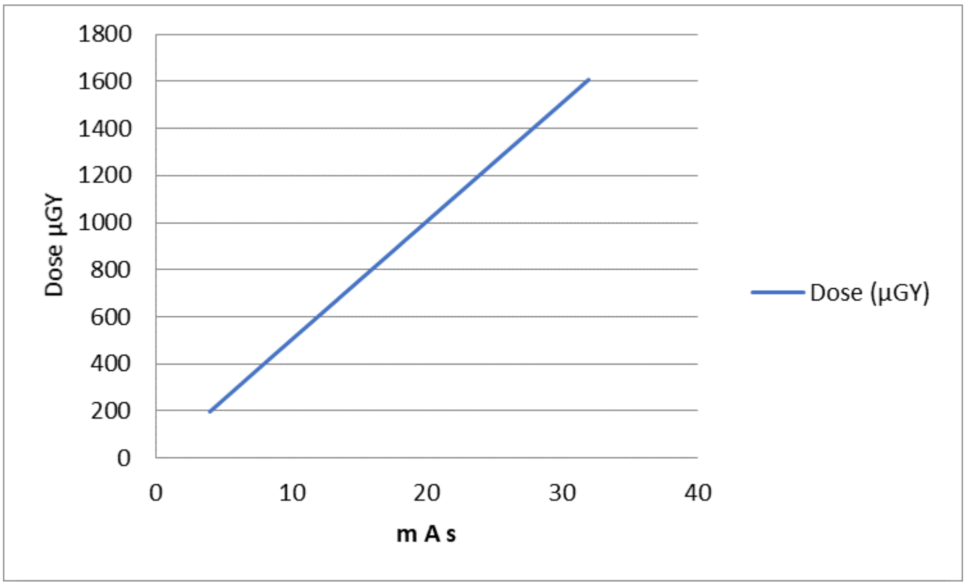

Diagram explain relationship between time (m A s) and dose (µGY).

Table (4-2)

1-Reproducibility (%CV)

Set mAs:20

Set KVP 80	Measured KVP	Result	Dose(µGy)	Result
1	87.5		1230	
2	85.6		1270	
3	86.1		1270	
Average	86.4			
SD	2.5			
%CV(5%)	6.25	Not Accept		Not Accept

2-KVP Accuracy

mAs set :20

Set KVP value	Measured KVP	%Error	Result
50	54.9	8.1	Not accept
60	64.9	8.1	Not accept
72	81.8	16.1	Not accept

3-HVL

Set 80 KVP , 20mAs

AL(mm)	Dose(µGy)
0	1230
1	925.5
2	713.1
3	634.3
3.5	555

4-Linearity

Set 80 KVP

mAs	Dose (µGy)	µGy\mAs	%LC	Result
4	258.1	64.5	0	Accept
8	503.5	62.9	-2.4	Accept
15	868.6	57.9	-10.2	Accept

30	1735	57.8	-10.3	Accept

5-Time Reproducibility

Set time (ms)	Measured time (ms)	Result
60	55	
60	54.7	
60	55	
Average	54.9	
SD	5.1	
CV%	8.5	Not accept

6-Time Accuracy

Set time (ms)	Measured time (ms)	Time Diff	Time %error	Result
40	39	-1	-2.5	Accept
80	75.3	-4.7	-5.8	Not accept
150	139.5	-10.5	-7	Not accept
300	288.5	-11.5	-3.8	Not accept

HVL

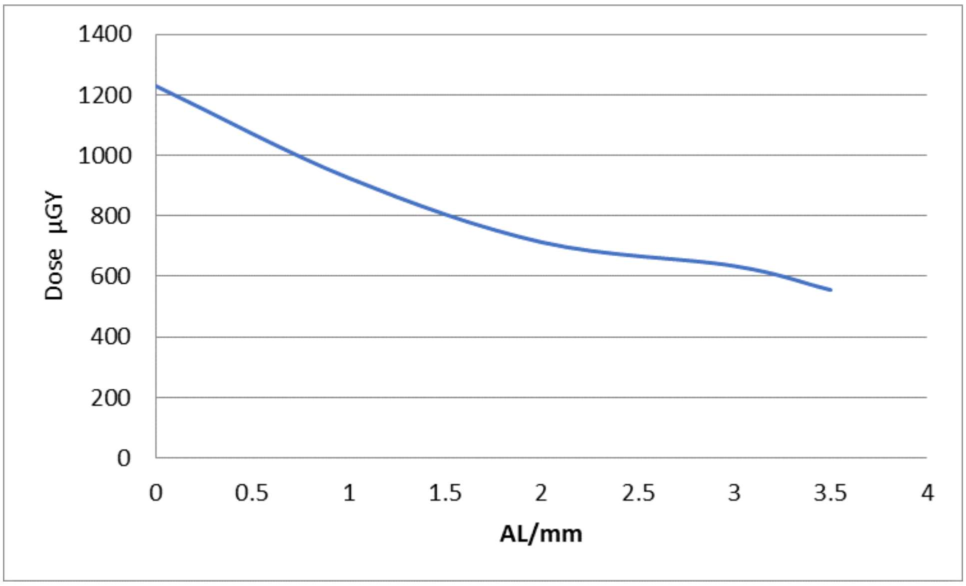

Diagram explain relationship between thickness (AL/mm) and dose (µGY) .

Linearity

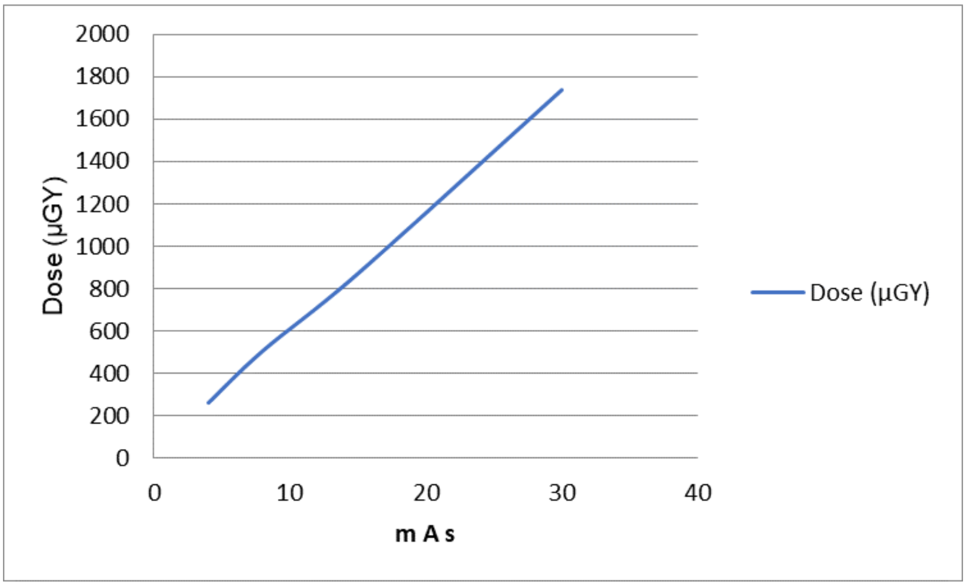

Diagram explain relationship between time(m A s) and dose (μGY).

Table (4-3)

1-Reprodcibility (%CV)

Set mAs:20

Set KVP 80	Measured KVP	Result	Dose(μGy)	Result
1	80.3		620	
2	81.7		634	
3	80.2		650	
Average	80.73			
SD	1.93			
%CV(5%)	3.7	Accept		Accept

2-KVP Accuracy

mAs set : 20

Set KVP value	Measured KVP	%Error	Result
50	49.5	-1	Accept
60	58.2	-3	Accept
70	68.7	-1	Accept
90	89.5	-0.6	Accept

3-HVL

Set 80 KVP ,20mAS

AL(mm)	Dose(μGy)
0	515.7
1	478.8
2	386.4
3	316.2
3.5	277.8

4-Linearity

Set 80 KVP

mAs	Does(μGy)	μGy/mAs	%LC	Result
4	126.5	31.6	0	Accept
8	285.1	35.6	12.7	Not accept
16	522.0	32.6	3.1	Accept
32	974.6	30.4	-3.7	Accept

5-Time Reproducibility

Set time (ms)	Measured time (ms)	Result
200	210.3	
200	212.0	
200	212.0	
Average	211.5	
SD	0.1	
CV%	0.05	Accept

6-Time Accuracy

Set time(ms)	Measured time(ms)	Time Diff	Time % error	Result
40	42.6	2.7	6.7	Not accept
80	80.2	22	2.7	Accept
160	102.0	21.9	1.3	Accept
320	333.0	13	4	Accept

HVL

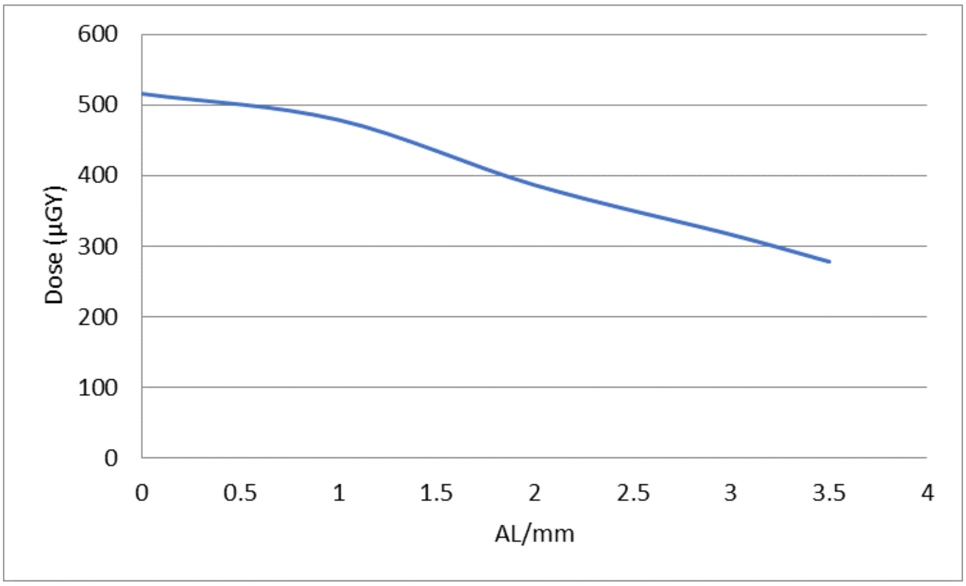

Diagram explain relationship between thickness (AL/mm) and dose (µGY) .

Linearity

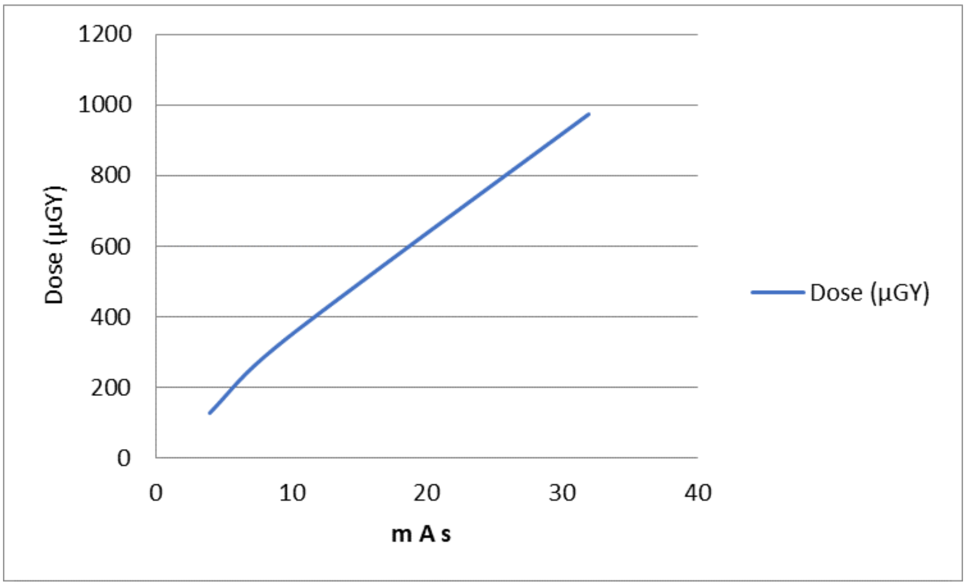

Diagram explain relationship between time (m A s) and dose (µGY) .

Chapter Five

Discussion, Conclusion and Recommendations

Chapter five

Discussion , conclusion and Recommendations

5.1 Discussion:

Coefficient of variation (CV) should be within ±5% .

In the above graphs is shown the relationship between the thickness of the aluminum (AL) and absorbed dose, note that the inverse relationship between them and the thickness of half subtend to half the value of the dose adjusted . Basically, it is found that the first half of the scale thickness is (4mm), second drawing (3mm), and final drawing (3.5mm).

The other graphs show the relationship between the exposure time and dose, this relation is a direct proportionality .

The relationship between the thickness of aluminum and absorbed dose the Negative Correlation , increase aluminum thickness decrease absorbed dose while the realationship between the exposure time and dose the Postive Correlation , increase the exposure time increase dose.

The previous studies agree with this study.

5.2 Conclusion:

The quantity of radiation measured from X-ray revealed that some devices have passed the criteria standard tests accordingly to Sudanese standards and metrology organization , The result shows that there is no leakage on these X-ray devices. But one devices did not pass the tests successfully which means that there is some leakage from this device. Generally , X-ray equipments in our local hospitals works well with a consistent safety.

5.3 Recommendations:

We recommend the following points:

- A routine checking and quality testes to the X-ray apparatuses should be maintained .

- Caution when dealing with radiography devices during operation and storage.

- Advanced research should be carried out to sustain more safety.

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