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يقول الله في محكم  
تنزيله:

(قل رب زدني علما)

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## **Abstract**

Hospitals nowadays rely on the department of radiology almost entirely. This led to continuously improving and studies to increase safety and affiance statistical result clinic. Diagnosis equipment's can cause seriously harmful biological effects such as cancer and death ; although it cannot be dispensed with, because of its benefit in decisions making about treating patient .

This research is an assessment of patient safety procedures in radiology departments of many Khartoum state hospitals that were achieved with mainly concentration on X-Ray scanning rooms and MRI scans, following international protocols in patient safety and data analysis methods according to scientific and statistic methodology , with multiple parameters : operators , institutions , safety officers , government organizations.

The result percentage of protection procedures in Al-Khartoum state hospitals is approximately 60%, at the end of this research recommendations connected with international rules were given to increase the efficiency of protection procedures.

## **المستخلص**

قسم الأشعة من أكثر أقسام المستشفيات أهمية وإزدحاما ، ففي الوقت الحالي ينذر أن يدخل مريض مستشفى بدون أن يجري فحص في قسم الاشعة الذي يحوي أجهزة متعددة، وهو مجال دائم النمو والتطوير، إلا ان أجهزة التشخيص هذه قد تؤدي لحدوث مشاكل وتعقيدات صحية على جسم المريض

حيث أن آثارها البيولوجية قد تكون مضرّة للغاية بل قد تصل إلى الموت في حالات التعرض لجرعات كبيرة من الأشعة . هذه الأخطار المتزايدة دفعت العالم إلى التخوف و زيادة إجراءات السلامة في مجالات أجهزة الأشعة بشقيها التشخيصي والعلاجي و سن تشريعات لتحقيق السلامة وتخفيف الآثار البيولوجية على المرضى . وهذا المشروع الذي بين يديكم هو تقييم لإجراءات السلامة والشروط المتبعة من أجل حماية المريض من الإشعاع في مستشفيات ولاية الخرطوم مبني على زيارات ميدانية وإستبيانات وبرتوكولات عالمية في مجالات السلامة الإشعاعية وكان التركيز الأساسي على غرف وجهاز التصوير بالرنين X-Ray الأشعة(جهاز التصوير بالأشعة السينية (MRI)المغناطيسي).

نتيجة التقييم نصت على ان الاجراءات المتبعة في مجال حماية المريض من الاشعاع كانت محققة بنسبة تقريبيه 60% وتم اقتراح حلول لرفع نسبة اتباع الاجراءات بأعطاء توصيات موافقة للقوانين العالمية في مجال الحماية من الاشعاع.

# **Chapter one: Introduction**

## 1.1 **General view**

Medical devices cover a variety of products designed to diagnose and treat Patients. However different their composition may be, medical devices are all designed with the purpose of improving patient care. But unfortunately there are so many risks with wrong using them.

Hazard in radiological department may cause serious problems in human body, such as: cancer, cell damage, it may even cause death.

## 1.2 **Problem Statement**

Biological effect of radiation hazard leading to tissue damage .this research will concern an evaluation on the safety procedures in radiology department to insure safety for the patient.

Because the project is assessment so that the solution will be recommendations and advices.

## 1.3 **Objectives**

### 1.3.1 **General Objectives**

- Evaluation the radiation hazard in some Khartoum state hospitals (public and private).
- Increase the healthcare performance
- Application of the knowledge.
- Link between the institute and all parts of the hospital or company .

## **Specific Objective**

- To check that ALARA (keep exposures As Low As Reasonably Achievable).
- To check that all sign for protection should be followed.
- To be sure that all department workers concerned with the radiation protection rules
- Give an advices to how they be attention for radiation hazard

### **1.4 Methodology**

Collecting information about this research subject from many recourses such as books, references, internet and, published papers, then running interviews in hospitals, ministry of health, and Sudan atomic energy commission plus asking them with the aid of questioner. The scope of this research is hospitals in Al-Khartoum state (private and public), the questioner is made following standard base of questions about patient safety parameters, the questioner were answered by technicians, administrators, engineers and safety radiation officers, the next step is to collect the questioner and analyze the data by a standard statistical method (stacked columns in 3D) to reach suitable results, the last step here is to discuss results in order to give recommendations.

### **1.5 project layout**

This research includes six chapters. Chapter one contains the general review, problems and objectives of the research. Theoretical fundamental was reviewed in chapter two. Chapter three contains background studies. Methodology and analysis were explained in chapter four. Chapter five includes results and discussions. Chapter six includes conclusions and recommendations of the research.

## **Chapter two:**

# Theoretical Fundamental

**Hazard** is a situation that poses a level of threat to life, health, property, or environment. With only a theoretical risk of harm; however, once a hazard becomes "active", it can create an emergency situation.[1] the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard is called risk.

**Factors that influence the degree of risk include:**

- How much a person is exposed to a hazardous thing or condition,
- How the person is exposed (breathing in a vapor, skin contact)

- How severe are the effects under the conditions of exposure.

## **2.1 X- Rays:**

Ionizing radiation (photons) in electromagnetic spectrum that can be emitted from radio-nuclides or from certain types devices X-Rays are a type of radiation used in medical imaging much like a camera uses visible light to create an image. X-Rays pass through the body and create an image on film based on how many x-rays get absorbed and how many pass through. These films are commonly referred to as X-Ray image , but X-Rays are actually the type of radiation that is used to produce the image.[2].

### **2.1.1 X-Ray machine:**

Is a equipment that uses high voltages and frequencies to generate x-ray in radiography.which directs a stream of electrons into a vacuum, and an anode, which collects the electrons and is made of copper to evacuate the heat generated by the collision. When the electrons collide with the target, about 1% of the resulting energy is emitted as X-Rays, with the remaining 99% released as heat.

An X-Ray imaging system consists of an X-Ray source or generator (X-Ray tube), an image detection system which can be either a film (analogue technology) or a digital capture system.

*Figure(2.1): X-Ray machine*

### **2.1.2 Hazard in X-Ray.**

Although that no one can doubt about X-Ray benefits but being exposed to X-Ray photon got an effect on biological creatures

1. X-Ray may cause damage to the cells in your body. This is usually very minor and does not cause any serious damage, however, large doses may cause the cells to become cancerous. A very low dose X-Ray, such as a chest X-Ray, has a tiny risk. CT scans, which use higher doses of X-Rays, have a higher risk.

X-Ray like any type of EMR Radiation risks for future generations If the ovaries or testes are exposed to radiation there is a possibility that hereditary diseases or abnormalities may be passed on to future generations.

There is scientific disagreement about whether the small amounts of radiation used in diagnostic radiology can actually harm the

unborn child, Pregnant women specially at the first three month is forbidden from X-Ray scans; but it is known that the unborn child is very sensitive to the effects of things like radiation, certain drugs, excess alcohol, and infection.

This is true, in part, because the cells are rapidly dividing and growing into specialized cells and tissues. If radiation or other agents were to cause changes in these cells, there could be a slightly increased chance of birth defects or certain illnesses, such as leukemia, later in life. It should be pointed out, however, that the majority of birth defects and childhood diseases occur even if the mother is not exposed to any known harmful agent during

pregnancy. Scientists believe that heredity and random errors in the developmental process are responsible for most of these problems.[7]

2. having an X-Ray dye for your CT scan or a radioactive tracer for nuclear medicine scan, there is a small risk of:

- An allergic reaction or Infection at the site of an injection.

3. Acute effect : is getting Heavy dose in short period of time, this may cause:

Cerebral-convulsions, blurring, headache, Gastric-nausea, vomiting, Anemia, and many hematology diseases, bone marrow diseases.

4.Chronic effect: Due to continuous short exposure, after reaching a specific level patient may have:

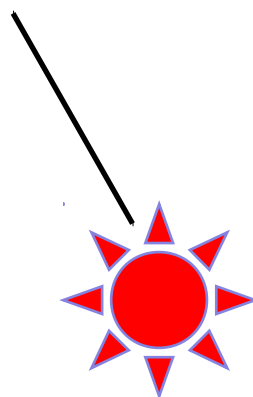
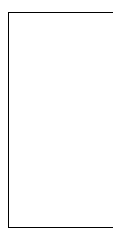
**Base damage: 1000-2000 per 1 Gy**

**Single-strand breaks**

**Double strand breaks**

**500-1000 per 1 Gy**

**40-50 per Gy**



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Figure(2,2): The most important types of radiation induced lesions in DNA

Skin loss of hair, burns, brittle nails, amputation fingers, Blood-anemia, leukemia, leucopenia, Eye-cataract, iridous cyclists, Others-Sterility, obesity, cancer.

There is scientific disagreement about whether the small amounts of radiation used in diagnostic radiology can actually harm the unborn child, but it is known that the unborn child is very sensitive to the effects of things like radiation, certain drugs, excess alcohol, and infection. This is true, in part, because the cells are rapidly dividing [4].

The radiation risks for simple X-Ray examinations of the teeth, chest or limbs, can be seen to fall into this negligible risk category (less than 1 in 1,000,000 risk). More complicated examinations carry a minimal to low risk.[5]

Generally speaking, all medical procedures and tests carry both risks and benefits, and any consideration of radiation risk must be balanced against the benefits. Media reports generally focus on the risks of radiation, but there are substantial [benefits](#) to these tests that must be considered in any balanced discussion of risk versus benefit. After a radiation dose of 10 mSv (which is the kind of dose associated with many CT scans) the estimated risk of developing a fatal cancer is one in 2,000, but that risk

must be considered in the context of the good that comes from receiving a dose of radiation. Undue anxiety about the cancer risks of radiation could potentially expose patients to far greater risks from delayed diagnosis or incorrect management. [11]

## **2.2 *Magnetic resonance imaging (MRI):***

Is a medical imaging procedure that uses strong magnetic fields and radio waves to produce cross-sectional images of organs and internal structures in the body. Because the signal detected by an MRI machine varies depending on the water content and local magnetic properties of a particular area of the body, different tissues or substances can be distinguished from one another in the study image. MRI can give different information about structures in the body than can be obtained using a standard x-ray, ultrasound, or computed tomography (CT) exam. For example, an MRI exam of a joint can provide detailed images of ligaments and cartilage, which are not visible using other study types. In some cases, a magnetically active material (called a contrast agent) is used to show internal structures or abnormalities more clearly.[10]

Figure(2.3): *Magnetic resonance imaging (MRI)*

### **2.2.1 Hazard in MRI:**

MRI is a continuously developed, generally it's not harmful like X-Ray but like any kind of medical equipment that expose patient to energy it has biological effects, such as:

1. Magnetic hazard: This effect is generally attendant upon ferromagnetic materials and the static field generated by an MRI system, A hairpin or paper clip within the 5-10 gauss line range could reach a velocity of 40 mph and will be attracted to the centre of the MRI generated field, all pacemakers and implantable cardioverter/defibrillators should be considered contraindicated under any circumstance. When these devices are exposed to an MRI environment, a life-treating condition may be created within the five-gauss line.[9]
2. THERMAL HEATING : the human body is electrically conductive by nature and small RF fields will generate current that will be absorbed by the body as heat. The specific absorption rate (SAR) for the patient will depend on weight and body radius.[9]
3. During the [MRI scan](#) an augmentation of waves is observed at fields used in standard imaging but this possible [MRI](#) side effect is completely reversible upon removal from the [magnet](#). A [field strength](#) dependent increase in the [amplitude](#) of the ECG in rats has been observed during exposure to high homogeneous stationary magnetic fields, but this side effect is not transferable to standard imaging situations for humans.[9]
4. Patient discomfort: Closed bore MRI machines can cause a patient discomfort if the patient is claustrophobic to any degree. Loud noises, light flashes and other sensory input may be perceived by the patient.[9]

5. **QUENCHING:** MRI is cooled by super-cooling fluid (liquid helium)The release of the super-cooling fluid into the atmosphere is called quenching, and unintentional and intended magnet It will collect at the top of the room, because helium is lighter than air, and work it's way down as the room fills. A white fog will form from the cold helium freezing the water vapor in the air. Helium is odorless, non-flammable and non-toxic, but the patient should be removed at once from the examination room since oxygen depletion ,temperature danger from the very cold gas.[9]
6. **CONTRAST AGENTS:** Contrast agents, sometimes injected into patients as part of the MRI procedure, pose a distinct set of risks. Agent administration, reaction issues, contrast agent toxicity and post-procedure renal complications/renal disease.[9]

## **2.3 Safety in radiological department:**

Due to risks that may occur to human being as a result having scan image in radiology department safety issue should be followed, improved, monitored and evaluated to protect the facility.

### **2.3.1 X-Ray:**

X-Ray photon is a part of EMR spectrum with amount of energy enough to ionize biological cell, also can penetrate body. A strict safety rules must be followed there. Main parameters in X-Ray safety is:

### **1-Time:**

Physicians operating X-Ray equipment should keep the X-Ray “beam-on time” to the minimum necessary. This saves dose to patients and to personnel.

### **2-Distance:**

To the extent consistent with appropriate medical care, maximize the distance between you and the area of the patient that is actively being x rayed

### **3-Shielding:**

X- Rays are easily shielded by a thin layer of dense material, like lead. As with other medical procedures; X-Rays are safe when used with care. Radiologists and x-ray technologists have been trained to use the minimum amount of radiation necessary to obtain the needed results. Properly conducted imaging carries minimal risks and should be performed when clinically indicated. The amount of radiation used in most examinations is very small and the benefits greatly outweigh the risk of harm.[3]

## 2.3.2 MRI safety :

Which include:

**1- Magnetic safety:** In general there is no hazard for patient if the total exposure is between 2-5T, for the patient scanned with static magnetic field greater than 2T, the International Radiation Protection Association (IRPA) has suggested that the patients should be monitored for symptoms referable to the nervous system.

- In order to prevent accidents caused by projectile, all equipment brought into the scanning room such as aesthetic trolleys, wheelchairs, and patient trolleys, must be ensured to be non-ferromagnetic.
- The installation of a metal detector which everybody has to pass through before entering the MRI suite is highly recommended.

### **2- Radiofrequency Field(overheating issue)**

- In MRI exposures up to 1 hour, the total body exposure should be limited to a total energy deposition of 120 W min kg-1 in order not to overload the thermoregulatory system.

(SAR) The Specific Absorption Rate is defined as the RF power absorbed per unit of [mass](#) of an object, and is measured in watts per [kilogram](#) (W/kg). The SAR describes the potential for heating of the patient's tissue due to the application of the RF [energy](#) necessary to produce the MR signal.

To avoid overheating of any local area, the product of time and local SAR should not exceed:

FDA SAR limits:

Whole body: 4W/kg/15-minute exposure averaged;  
Head: 3W/kg/10-minute exposure averaged;  
Head or torso: 8W/kg/5 minute exposure per gram of tissue;  
Extremities: 12W/kg/5 minute exposure per gram of tissue.[9]

**3-Quench** :Evacuate all patients, and remove any patient undergoing an MRI diagnostic procedure from the machine bore quickly and safely. The entire MRI suite should be evacuated and everyone moved to a designated safe area. Within the machine frame nearer the quench pipe, icing and condensed oxygen may form. This may create a very localized oxygen-rich environment, increasing the fire risk near the machine. Ventilation of the Zone IV room will minimize this hazard.

**4- Claustrophobic issue:** It is common at all to feel anxious or claustrophobic during an MRI scan. Until recently, the procedure involved sliding your body into a tight fitting tube. Recent developments in the technology however, have widened these tubes, created new space to all sides and in some cases, allowed the patient to sit or even stand with nothing in front of them. However, with many people will still feel some levels of anxiety with the procedure. And it is widely accepted that there are no known ways to completely prevent claustrophobia.

**General issues in MRI safety:**

- All MRI staff must take responsibility for providing an MRI-safe environment for staff and patient alike.
- No one enters the magnet room without the approval of the MRI technologist – without exception.
- No one enters the magnet room (Zone IV) without being prescreened or being certified at MRI Safety Level Two status – without exception.
- Everyone must know that the machine is always on.
- All equipment and devices brought into scan room must be either MRI-safe or compatible.
- Patient care and safety are at core of all MRI procedures and MRI staff actions.
- Direct verbal and written communications between MRI staff and attending physicians are critical to maintaining patient care and safety.[9]

### **2.3.3 ALARA POLICY**

Compliance with dose limits ensures that working in a radiation laboratory is as safe as working in any other safe occupation.

The goal of the radiation safety program is to ensure that radiation dose to

workers, members of the public, and to the environment is as low as reasonably achievable (ALARA) below the limits established by regulatory agencies.

The program also ensures that individual users conduct their work in

accordance with university, state, and federal requirements. In the preface to this manual, management has committed to an ALARA policy.[3]

### **2.3.4 Measuring radiation dosage:**

The scientific unit of measurement for radiation dose, commonly referred to as effective dose, is the [millisievert \(mSv\)](#). Other radiation dose measurement units include rad, rem, roentgen, Sievert, and gray.

Because different tissues and organs have varying sensitivity to radiation exposure, the actual radiation risk to different parts of the body from an x-ray procedure varies. The term effective dose is used when referring to the radiation risk averaged over the entire body.

The effective dose accounts for the relative sensitivities of the different tissues exposed. More importantly, it allows for quantification of risk and comparison to more familiar sources of exposure that range from natural background radiation to radiographic medical procedures.[8].

Designing radiology department should follow distinct rough rules in order to ensure patient, occupation, and public safety from radiation hazards.

Also a good design rise the efficiency of the outcomes(medical images)

### **2.4 General specification and location of radiology department :**

Radiological department is Preferably to be in ground floor, but The optimum location of the radiology department is the

underground; away from traffic, easy to reach and near emergency, orthopedic dept, outpatient clinic .Ground floor location can often avoid the problem of providing protection for the floor but may introduce difficulties to the irradiation of the buildings outside the area.

### **2.4.1 Size:**

The size of department depends on the hospital size, Types of services provided number of machines to be installed and the number of scans to be made, Generally the number of doors should be kept minimum. The unit should be placed so that it's not possible to direct radiation towards areas of high occupancy.

- **X-Ray**

- Combined Radiography and Fluoroscopy space requirement is at least 20 meters square. Separate toilets with hand-washing stations shall be provided with direct access from each fluoroscopic room.
- Rooms used only occasionally for fluoroscopic procedures shall be permitted to use nearby patient toilets if they are located for immediate access.
- Patient gowning area with safe storage for valuables and clothing shall be provided in the facility.
- At least one space should be large enough for staff-assisted dressing.
- Dark room should be located near the x-ray room.

- **MRI**
  - The MRI room should be permitted to range from (30.19 square meters) to (57.60 square meters), depending on the vendor and magnet strength.
  - A control room should be provided with full view of the MRI
  - Patient gowning area with safe storage for valuables and clothing should be provided.
  - Power conditioning should be provided.
  - Magnetic shielding should be provided.
  - Adequate space for coils storage based on the on these anatomic applications.
  - Magnetic door interlock.
  - MRI warning light and signs.

Figure(2.4):Radiological department layout

## **2.5 For protecting staff many rules should be followed for X-Ray room**

- Distance between control panel and unit minimum 3 meters.
- Radio protection aprons, lead gloves and mask.

- Use of radiation monitoring devices TLD badges/ films
- Must locate the operator's console where the primary beam will NEVER be directed towards it, but where the patient can be easily observed
- Radiation beam should be directed.
- Lead glass window between operator and X-ray tube must be applied
- Distance between X-ray table and consol table should be as far as possible between 10 feet to 15feet.
- Should have radiation warning lights outside for fluoroscopy, angiography and CT
- X-Ray tube should never point towards the control unit, not point towards dark room,It should not point towards, door, window or towards corridor wall.
- 3mm al equivalent thickness lead rooms for x-ray rooms.
- Monitoring of radiation exposure every month.

Figure (2.5): X-Ray scan room layout

## **2.6 MRI suite highly recommended specification.**

- Must be large enough for the equipment
- Should have at least one patient change cubicle accessible from outside the room
- Must be able to accommodate large beds/trolleys, and any aesthetic equipment likely to be used
- Must locate holes in floors for cables away from radiation beams, or be shielded
- Must have radiation warning signs on all doors
- The installation of a metal detector which everybody has to pass through

figure (2.6): MRI scan room layout.

# **Chapter three:**

# **Background Studies**

Kwan-Hoong Ng, et al ., in (2003) reviews the health effects and current safety issues related to MRI environment for both the Patients as well as the staff members. Injuries from MRI accidents are occurring more frequently now and there is an urgent need for MRI facilities to implement safety guidelines the patient scanned with static magnetic field greater than 2T, the International Radiation Protection Association (IRPA) has suggested that the patients should be monitored for symptoms referable to the nervous system .Although no deleterious

biologic effects from the static magnetic fields used in MRI have been definitively associated with MRI's static magnetic fields, there is no conclusive answer yet for this effect. In order to prevent accidents caused by projectile, all equipment brought into the scanning room such as anesthetic trolleys, wheelchairs, and patient trolleys, must be ensured to be non-ferromagnetic. The installation of a metal detector which everybody has to pass through before entering the MRI suite is highly recommended ∴ Several incidents and accidents had already occurred in Malaysia. The authority must establish MRI safety guidelines for all MRI centers. MRI facilities should have their own set of local rules, identify a safety officer responsible for ensuring that procedures are effective to increase safety in MRI environment, an easily recognized and standardized warning signs is very important in MRI environment [6].

[ValentinaHartwig](#), et al ., In this review, based on the results of a pioneer study showing *in vitro* and *in vivo* geotaxis effects of MRI scans, we report an updated survey about the effects of non-ionizing EMF employed in MRI, relevant for patients' and workers' safety. Suggests a need for further studies and prudent use in order to avoid unnecessary examinations, according to the precautionary principle .there are intrinsic hazards that must be understood, acknowledged and taken into consideration. These hazards are relative to all three types of fields which can affect patients, staff and other persons within the MR environment is divided in three sections, according to the three sources of EMF utilized in MRI procedures. In each

section, the risk assessment related to each field component is summarized. We focus only on mammalian/human biological systems for their obvious strict correlation with human health [13].

Mike Hanley.MD Radiation is best described as energy moving through space, and it can take many forms, including visible light, x-rays, gamma-rays, microwaves, and radio waves. Radiologists use low dose radiation in the form of x-rays to create images of different parts of your body. High doses of radiation can also be used to treat certain types of cancer. Radiations all around us. The two main sources of ionizing radiation are from natural background radiation and medical exposure (CT scans and x-rays). X-rays are a type of radiation used in medical imaging much like a camera uses visible light to create an image. the potential health benefits almost always outweigh the potential risks of radiation exposure .Great effort has been made throughout the medical community to ensure patient safety while providing quality diagnostic images. However, there is data to suggest that high doses of radiation increase your future risk of cancer[2].

ST.James's hospital ,. Patients are sometimes concerned about the possible harmful effects of x-rays, so this leaflet will explain the risks and put them into perspective. X-rays are only used if the benefit to the patient outweighs the small risk involved . Using x-rays for diagnosis can bring very real benefits to patients. The overriding concern of your doctor and the hospital radiology department is to ensure that when x-rays are used, X-

rays are used when they are judged to be the most suitable method of assisting diagnosis. the radiation doses used for X-ray examinations are many thousands of times too low to produce immediate harmful effects, such as skin burns or radiation sickness .increase in the chance of cancer occurring many years or even decades after the exposure .radiation risks for older people tend to be lower than for others. This is because there is less time for a radiation-induced cancer to develop, children may be at twice the risk of middle-aged people from the same X-ray examination. A baby in the womb may also be more sensitive to radiation than an adult, so we are particularly careful about X-rays during pregnancy[12].

# **Chapter four: Methodology and analysis**

## **4.1 Methodology:**

Data collection of all information needed in this research from various sources such like books and internet.

Visiting general government hospitals , some private hospitals and institutions to see the attention and safety procedures on the radiation department .

Interviews with operators, technicians and superintendents .

Distributing questioner consist of things that related with radiation protection for example tools, safety lows and safety particles.

Analyzing the questioner to make a suitable results.

Design of an ideal X ray and MRI room regarding to hazard safety.

## **4.2 Data Analysis:**

Below figures shows the results which gained after data analyzing:

Figure (4.1):shows the percentages of applying patient instructions in hospitals ( A 92 %, B 100%, C 100%, D 80%, E 60%)

Figure (4.2): shows the percentages of perfect dose in hospitals  
( A 100 % , B 100% , C 100% , D 80% , E 60%)

Figure (4.3): shows the percentages of protection lead in  
hospitals ( A 60 % , B 92% , C 75% , D 40% , E 60%)

Figure (4.4): shows the percentages of previous exposed in  
hospitals ( A 100 % , B 92% , C 63% , D 100% , E 100%)

Figure (4.5): shows the percentages of woman's periods in  
hospitals ( A 100 % , B 100% , C 63% , D 100% , E 100%

Figure (4.6): shows the percentages of immobilization kits in  
hospitals  
( A 33 % , B 58% , C 38% , D 60% , E 60%)

Figure (4.7): shows the percentages of co-patient in hospitals  
( A 100 % , 92% , C 75% , D 100% , E 100%)

Figure (4.8): shows the percentages of department protection  
in hospitals ( A 67% , B 83% , C 75% , D 100% , E 100%)

Figure (4.9): shows the percentages of radiation room location in hospitals ( A 83 % , B 67% , C 75% , D 80% , E 80%)

Figure (4.10): shows the percentages of enough department area in hospitals ( A 60 % , B 92% , C 75% , D 40% , E 60%)

Figure (4.11): shows the percentages of TLD's in hospitals ( A 8 % , B 33% , C 13% , D 0% , E 20%)

Figure (4.12): shows the percentages of technician qualification in hospital A 100% , B 83% , C 75% , D 100% , E 100%

Figure (4.13): shows the percentages of cubic window glass lead in hospitals ( A 60 % , B 92% , C 75% , D 40% , E 60%)

Figure (4.14): shows the percentages of Darkroom location hospitals ( A 67 % , B 83% , C 88% , D 60% , E 60%)

Figure (4.15): shows the percentages of Standard processing solution in hospitals ( A 100% , B 83% , C 88% , D 100% , E 100%)

Figure (4.16): shows the percentages of light filter in hospitals ( A 25 % , B 50% , C 50% , D 100% , E 100%)

Figure (4.17): shows the percentages of accurate output power in hospitals ( A 50 % , B 50% , C 63% , D 100% , E 100%)

Figure (4.18): shows the percentages of protection lead in hospitals ( A 67 % , B 17% , C 25% , D 100% , E 100%)

Figure (4.19): shows some safety procedures in MRI room , the percentages of Patient Brief is 92% , ear buds 75% , magnetic signs 100% and pregnant ladies 100%

- Figure (4.20): shows percentages of some safety procedures in organizations:
- Q.C examination 100%
- workshop trainings 100%
- indicators 100%
- certain laws authorization 80%
- global laws 100%
- disorder sanctions 80%
- periodically observation 100%
- expert monitors 100%

# **Chapter five:**

# **Result and discussion**

## **5.1 Results:**

From the analysis it's clearly that the difference is significant in following patient safety procedures:

Most of the hospitals are providing instructions for patients and co- patients, getting information about previous scans, asking women for the last period and the possibility of pregnancy.

Technicians in administrative hospitals are well qualified and trained well.

Private hospitals got more sophisticated conventional x-ray devices.

As clinical engineering view government hospitals are better than private in design according to enough area and room locations.

Acidification room(dark room) location and requirements are not good enough.

Acidifications liquid are standardized.

Most of Radiological departments are well shielded using protecting lead and lead glass. (Checked by the authority of radiation activities).

In some cases control rooms were separated from scanning room.

Absence of governmental support for general hospitals.

MRI equipment's are too expensive that's why they aren't available in most hospitals especially on the public hospitals.

75% of the available MRI are inoperative; because of the high cost for maintenance.

Good to know that MRI rooms are prepared well and the operators make sure to give instructions to the patients.

Also there is absence to the change room at most hospitals and that may cause waste on time and money.

## **5.2 Discussions:**

This project is knocking on the patient safety in radiological department especially in x-ray and MRI sections. We knew the importance of patient safety from radiation hazard and how to develop and apply safety procedures .

We all know about hazard of radiation department on human being, so we looking for how to safe patient and operator from it.

By visiting to the government and private hospitals we found careless from personnel because most of them do not considerate laws and instructions, above of that they have not enough experiences.

Patients have no enough knowledge about radiation risks ,so they need awareness.

Equipment are very old and there is no periodically maintenance and that may hurt patient and operator .

# **chapter Six:**

# **Conclusion and**

# **recommendations**

## **6.1 Conclusion**

Radiobiological department are one of the most important section in the hospital, that why must care about its design, protection, equipments, operators and patients.

Commitment of laws and instructions provide safety for patient and operator from radiation risks.

Periodically maintenance is very necessary to avoid radiation hazards and maintains equipment life time.

Good design for radiological department has major role in reducing hazards.

## **6.2 Recommendations:**

- Radiation department is preferred to be in the basement to avoid hazards.
- Hospitals must have safety officers.
- Individual measurement tools that should be wired all the time specially (TLDs), must be provided in every hospital and monitored periodically
- Waiting room should be far enough from radiation rooms.
- Biomedical engineer should be member staff of hospital design.
- Operators must follow the safety rules and must be more awareness.
- Operator should be trained well by advance offices, workshops and seminars.
- Staff should be aware about acquired radiology dose.

- X-Ray tube should never point towards the control unit, not point towards dark room, It should not point towards door, window or towards corridor wall.
- Equipment must be calibrated periodically.
- Corrective and preventive maintenance should be applied regularly to MRI equipment's.
- Solutions must be checked and calibrated to insure that they are standard.
- Radiation hazard cases should be documented (risk management).
- Standard authority for import and supply diagnostic equipments .
- Medical devices specially MRI preferred to be new ,well known brand and brought from supplier that provide service contracts.
- Control and monitoring should follow more dynamic ,effectiveness approaches rather than annual checkup (license approval ).
- Give more attention to private clinics scanning operations .
- Governmental hospitals have acted lack in the number of MRI machines.

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*APPENDEX:*

**Sudan university of science  
and technology  
Biomedical engineering  
The patient safety  
Questioner**

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*MRI*

1-Do you explain to the patient what exactly happen inside the room?

a. Yes  b. No

2-Do you give the patient ear buds to protect him from the noise?

a. Yes  b. No

3-Magnetic signs are it available?

a. Yes  b. No

4- Do you care about pregnant lades? How?

a. Yes  b. No

**Sudan university of science  
and technology  
Biomedical engineering  
The patient safety  
Questioner**

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X-Ray

1-Do you give the patient any instruction?

- a. Yes  b. No  c. sometime

2-Do you make sure of the perfect dose that must be taken?

- a. Yes  b. No

3-Do you protect the patient with protection lead if needed?

- a. Yes  b. No

4-Do you ask the patient about the previous time that he got radiation?

- a. Yes  b. No

5-Do you ask ladies about their last period time?

- a. Yes  b. No

6- Do you use impolization kits?

- a. Yes  b. No

7-Do you care about co-patient?

- a. Yes  b. No

8-Is the department well protected?

- a. Yes  b. No

9-Is the location of the radiation room safety?

- a. Yes  b. No

10-Is the department area quite enough regarding to the radiation protection?

- a. Yes  b. No

11-Do you use TLDs?

- a. Yes  b. No

12-Is it proceed periodically ?

- a. Yes  b. No

13-Are you trained well for this job?

- a. Yes  b. No

14-Is the cubic window made of glass lead?

- a. Yes  b. No

15-Do you care about the dark room location?

- a. Yes  b. No

16- The processing solution are standard?

- a. Yes  b. No

17-Do you change the solution periodically?

- a. Yes  b. No

18-Are the environment conditions suitable?

- a. Yes  b. No

19-Safe light filter is it standard and checked from time to time?

- a. Yes  b. No

20-Is the output power of the equipment accurate?

- a. Yes  b. No

21-are you awareness about the lifetime of the equipment?

a. Yes

b. No