

Chapter one

:1-1Introduction

Radioactivity is a natural phenomenon and natural sources of radiation are .features of the environment

Radiation and radioactive substances have many beneficial applications,

.(ranging from power generation to uses in Medicine. (IAEA et al ,2011

An accident is (any unintssended event including operating errors, equipment failures or other mishap, the consequences or potential consequences of which

.(are not negligible from the point of view of protection and safety

(Abu-Eid et al ,2011)

Radiation accidents primarily occur with radiation devices, such as sealed sources (^{192}Ir , ^{60}Co , ^{137}Cs) or X-ray devices for material testing (mainly radiography), in irradiation facilities or X-ray and radiotherapy devices (used in medicine or research). About one third of radiation accidents occurs in the industry, roughly each eighth of them in connection with the medical application of sources of ionizing radiation, while close to one third of them has unclear origin. Radiation accidents are the rarest in the transport and waste management or military application of radioactive materials or devices. About one half of radiation accidents are caused by ^{192}Ir , and one quarter of them by ^{60}Co , while the remaining 23% is due to ^{137}Cs , radium, uranium, transuranic . elements or unknown isotopes

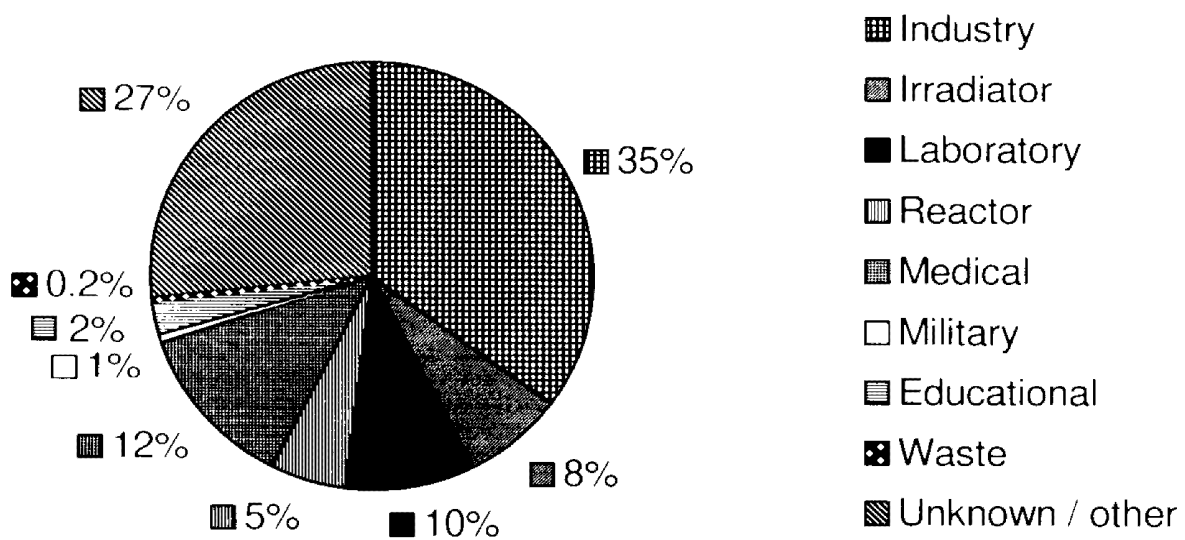


Fig.1- 1. Distribution of radiation accidents according to the type of facility involved, 1945–2000

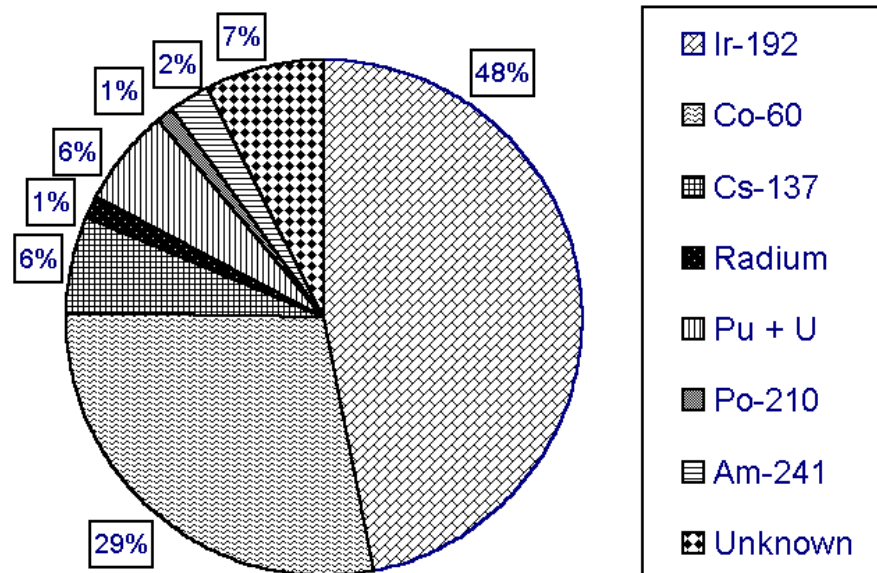


Fig.1-2. Distribution of radiation accidents according to the type of the radioisotopes involved, 1945–2000

During the last 15 years 20 radiation accidents occurred world-wide leading to significant overexposure with clinical manifestation in at least one person per single event (*Table1- 1*) see the appendices . Acute clinical consequences of overexposure could be detected in 494 radiation accident patients, severe radiation injuries were observed in 316 cases that caused fatal outcome in 66 persons. Hence, radiation accidents during the last 15 years appeared with more severe consequences, as half of the cases of fatal outcome were observed .in this interval within the 55-year period of observation

A non-routine situation that necessitates prompt action, primarily to mitigate a hazard or adverse consequences for human health and safety, quality of life, property or the environment. This includes nuclear or radiation emergencies and conventional emergencies such as fires, release of hazardous An emergency :in which there is, or is perceived to be, a hazard due to The energy resulting from a nuclear chain reaction or from the decay of the- products of a chain reaction; or

(Radiation exposure.(Abu-Eid et al,2011-

This is particularly important for therapy patients containing large amounts of radioactivity. medical personnel should proceed with emergency care for example, when a patient has suffered a stroke), while taking precautions) .against spread of contamination and minimizing external exposure The staff should avoid direct contact with the patient's mouth, and all members of the emergency team should wear impermeable protective gloves. Medical staff . are to be informed and trained on how to deal with radioactive patients (Abu-Eid, et al ,2011)

In nuclear medicine practice, the following individuals carry responsibility for protection and safety, by virtue of tasks involving decisions, operation or :handling of sources or equipment which could lead to an accidental exposure

Medical practitioners working with radionuclides (for example, nuclear medicine
;(physicians³ and other appropriately trained clinical specialists

Medical physicists in nuclear medicine (qualified experts in nuclear medicine
;(physics

Other health professionals involved in the clinical use of radionuclides
for example, radiopharmacists and nuclear medicine technologists⁴); Radiation)
protection officers (RPOs); Staff performing special tasks (for example,
.(contamination tests and some quality control tests) (Baldas, et al, 1999-2000

Investigation Of Accidental Medical Exposure

Any therapeutic treatment delivered to either the wrong patient or the wrong -
tissue, or using the wrong pharmaceutical, or with a dose or dose
fractionation differing substantially from the values prescribed by the
;medical practitioner or which may lead to undue acute secondary effects

Any diagnostic exposure substantially greater than intended or resulting in -
doses repeatedly and substantially exceeding the established guidance
levels; and

Any equipment failure, accident, error, mishap or other unusual occurrence -
with the potential for causing a patient exposure significant

. (Abu-Eid, et al, 2011)

:problem of the study 1-2

The most important amount of radiation exposure in the patient take the high
dose in nuclear medicine department by the radioactivity, and how apply
the radiation protection in the emergency stated in the nuclear medicine
department in the hospitals

:Objectives 1-3

The main objective of this study is to the radiation accident in nuclear medicine departments at Khartoum state hospitals by the radioactivity(TC-99,MO -99),and analysis by the Microsoft office excel .2007 programs

:1-3-1Specific objectives

- . To assessment of the type of accident radiation in nuclear medicine-
- . To determine the risk of high dose exposure and effect of health-
- To highlight the role of using radiation protection and safety-

:1-4significance of the study

This is an experimental study deal with propose new for estimate of radiation accident in nuclear medicine departments by radioactivity (Tc-99,Mo-99),in . addition to highlight the role of using radiation protection and safety

:Overview of the study 1-5

This study falls into five chapters, chapter one ,which is an introduction , deals with theoretical frame work of the study, it presents the statement of the study ,problems, objectives of the study

Chapter two, is divided into two sections ,section one deal with (Introduction and radiation protection)and (biological effect of ionizing radiation),section , two deals with literature review (previous studies), chapter three deal with material and method ,chapter four deal with (result)data presentation, chapter five discuss the data (discussion),analysis recommendations conclusion and .references

:Chapter two

Literature Review

Introduction 2-1

Ionizing radiation can actively interact with matter delivering its kinetic or electromagnetic energy to any solid, liquid or gas material it passes through. three possible outcomes can result from this interaction, depending on nature (of radiation and composition of the matter (Bowsner, et al 2006-Botelho, 2009

No effect- radiation traverses matter without losing its energy to the-

,surrounding medium and no interaction occur

,Radiation interacts with the matters atoms outer shell electrons-

.Radiation interacts with the matters atoms nuclei-

.Let us first differentiate electromagnetic waves from accelerated particles

The interaction between gamma-ray and x-ray photons (included in the former category) and matter results in a decrease in intensity (number of photons) of the primary beam which traverses' matter – a process called attenuation

((Bowsner, et al 2006

:Expressed by the following equation

$$I = I_0 \cdot e^{-\mu x} \quad \text{equation 2.1}$$

Where I is the photon beams intensity at the point where the beam exits the segment of matter where attenuation occurs and I_0 the beams intensity before it reached such segment. Additionally, attenuation depends on both the thickness (x) of the matters segment and the attenuation coefficient μ – a quantity that characterizes how easily the material constituting the matter is penetrated – depending on the photon beams intensity, thickness and average Z of the matter segment (Bernardes, 2009). Expectedly, this attenuation coefficient is greater for denser tissue (such as bone) one of the processes

through which radiation interacts with matter is excitation ,where an inner-shell electron migrates to an outer-shell of the atom, which is then said to be in an excited state .In ionization process ,however , an electron is ejected from the atom (Powsner ,et al 2006-Botelho,2009).A final aspect of radiation interaction with matter worth mentioning is the penetration power of radiation, that is , how deep radiation penetrates a material. Evidently, different types of radiation have different path lengths within matter. The linear energy transfer (LET)express the amount of transferred energy per unit of path length by a particle ,while it traverses a sample of matter this parameter, quantified in units of Kev/ μ m, is used to quantify the radiations efficiency in producing .biological damage

Alpha particle ,instance, due to their heavy mass and charge, rapidly interact with orbital electrons of the materials atoms thy traverse ,degrading their energy in short distances. In fact, they have a path length of about 3-10 cm in air and 25-80mm in biological tissues(or other solids in general)for this reason they are classified as high-LET type of radiation .Beta particle ,conversely ,are low LET radiation types, they are much more penetrating than alpha particle , having a path lengthen of about 0-15meter in air and several millimeters in biological tissue, Finally , x-ray and gamma –ray photon beams intensity decreases exponentially as it penetrates matter , as expressed in .(equation 2.1(Powsner, et al, 2006-Botelho,2009

: Biological effect of ionizing radiation 2-2

:epidemiological studies on radiation risks 2-2-1

There is currently plenty of information available on the biological effect of radiation ,as a result of the numerous experimental animal studies and human epidemiological studies performed in the past few decades .the growing understanding of the different mechanisms of cellular responses to irradiation ultimately leads to theoretical studies on radiation –induced damage, however ,the lack of definitive information force us to rely on human

experience (Bodansky, et al 2004). On the one hand, the aforementioned experimental studies, which comprise cellular, cytogenetic and molecular techniques, are often used to investigate radiation carcinogenesis, using rodent models. For instance, in what concerns leukemia and some solid tumors of the skin, bone, brain, lung, breast and gastro-intestinal tract, these animal studies provide evidence on how radiation induces carcinogenic processes, shedding light on the genetic mutations involved which are also present in humans (ICRP, 2007). On the other hand, the gathered epidemiological data is, for the most part, obtained from studies performed on the Hiroshima and Nagasaki atomic bomb survivors; the Japanese Radiation Effect Research Foundation (RERF) has been conducting, over the decade, follow-up studies on cohorts of (the Japanese's bombings survivors and their progenies (BEIR, 2005).

:2-2-2 interaction of ionizing radiation with cells and with the DNA

The eventual biological damage is caused by physical interactions between radiation and specific structures within the cell. The key reason why ionizing radiation has such detrimental effects on biological tissues is associated to the interaction of radiation with deoxyribonucleic acid (DNA) sequences existing inside of the cell's nucleus, which contain vital genetic information and represent the most critical target within the cell structures; when damaged, may also lead to functional complications (Powsner RA, et al 2006-website <http://www.naweb.iaea.org>). The radiation damage to the cell occurs mainly through direct and indirect processes.

Direct interaction-radiation directly interacts with a critical target within the cell. The atoms or molecules of the target are ionized or excited by means of coulomb interactions, a process that fuels a sequence of chemical events, which eventually provoke final biological damage. Direct interaction of radiation is the dominant process for extremely ionizing particles such as neutrons, protons and heavy particles (Botelho, 2009-website <http://www.naweb.iaea.org>).

Indirect interaction –radiation interacts with other molecules water, for instance within the cell (website <http://www.naweb.iaea.org>). This process results in the formation of free radicals, which are extremely reactive molecules because they have an unpaired valence electron. These free radicals, in turn, can later damage critical targets in the cell. In particular, when ionizing radiation interacts with water molecules, Free radicals such as water ions (H_2O^+) and hydroxyl radicals (oh). are created. Although short-lived, these radicals are highly chemically unstable, and can spread (through the cell and interact with distant critical targets (Botelho F,2009

:2-2-3Radiosensitivity

In 1906, J. Berogonie and L. Tribondeau observed the effects of ionizing radiation on cell, tissues and organ (website <http://www.keiserstudent.tripod.com>), and conclude that stem cell are more sensitive than differentiated cells. The greater the differentiation stage of the cell, the greater its resistance to radiation effects young organ and tissue are more radiosensitive than older, mature organs and tissues. superior metabolic activities are associated to greater levels of radiosensitivity a faster rate of cellular proliferation and tissue growth result in a greater (radiosensitivity (Botelho,2009

In addition, geneticist H.J. Muller, who studies the radiations role in mutation (mutagenesis) discovered in 1927 that the gentling mutation induced by radiation are very much similarly to the ones that naturally occur, only their (frequency is greater (Botelho,2009

Radiosensitivity is also dependent on the phase of the cellular cycle the cell is undergoing at the moment of irradiation: the most radiosensitive phase is the moment when mitosis occurs, and the most radioresistant cellular phase is phases (when the cells division process is temporarily latent). As for cellular

structures, the nucleus is more radio sensitivity than the cytoplasm and the . DNA is the most critical , radiosensitive structure within the cell .(Botelho ,2009)

:Radiation protection and dosimetry 2-3

: 2-3-1Radiatin protection principles

As mentioned earlier ,radiation interaction with matter is materialized by an energy transfer process, which can excite or ionize atoms and molecules .it is the ionizing property of radiation and previously discussed effects induced at the cellular and DNA level that potentially originate and induce the harmful and determined biological effects of ionizing radiation. The implementation of radiation protection principle aims at protection the individuals and the environment from such detrimental effect. When correctly implemented, these practices offer guidance to a safer us ionizing radiation the , the international system of radiation protection is articulated around three main principles, which are described on the 2007 recommendations of the ICRP publication 103 (ICRP ,2007). When applied to medical exposure, the radiation principles :can be summarized as

Principle of justification: all medical practices that imply patient-exposure to ionizing radiation must be justifications, there must be some .guarantee that the necessary exposure of patient

Will permit the subsequent image reconstruction of anatomical structures and \or physiological processes, specifically correlated to the patient diagnostic indications. Even the smallest exposure are potentially harmful ,so the radiation risk must always be offset by its benefits

(ICRP,2007-Waeb site [http\\ www.rpop.iaea.org](http://www.rpop.iaea.org))

: principle of optimization -

For diagnostic medical procedures ,once the exposure to ionizing radiation is justified each examination should be preformed according to ALARA (principle (ICRP,2007-Weabsite [http\\ www.rpop.iaea.org](http://www.rpop.iaea.org)

:principle of dose limitation -

The radiation exposure of patient , professionals and individuals of the public should be restricted to the established dose limits recognized by the responsible authorities on this matter. These limits aim to ensure that no individual exposed to a radiation risk level that is considered unacceptable for

medical procedures , normal cecum solar trances

. (ICRP,2007-Weabsite [http\\www.rpop.iaea.org](http://www.rpop.iaea.org))

:Dosimetericunits 2-3-2

In this section, some importune unit

Exposure (x): is defined as amount of ionizing produced in air by photon - radiation filed , and its SI unit is given as charge per mass of air :coulomb per kilogram (c|kg) (Cameron J,1991) exposure is, however, frequently (expressed in unit of roentgen (R)).(Botelho F ,2009

Absorbed dose (D):is the energy absorbed per unit mass by a given - (material form ionizing radiation (Botelho F ,2009

: Nuclear medicine 2-4

:An overview of nuclear medicine history 2-4-1

After radioactivity was first discovered in 1896, by Antoine Henri Becquerel ,radioactive suborns began to be used in many industrial applications and in medicine. Radium and polonium were one of the first radioisotopes being studied, by Pierre curie and Marie curie .(Stabin, 2006)

This is a branch of medicine that uses radiation to provide information .about the functioning of a person's specific organs or to treat disease

In most cases, the information is used by physicians to make a quick, accurate diagnosis of the patient's illness. The thyroid, bones, heart, liver and many other organs can be easily imaged, and disorders in their function revealed. In some cases radiation can be used to treat diseased organs, or tumors'. Five Nobel Laureates have been intimately involved with the use .of radioactive tracers in medicine

Over 10,000 hospitals worldwide use radioisotopes in medicine, and about 90% of the procedures are for diagnosis. The most common radioisotope used in diagnosis is technetium-99, with some 40-45 million procedures per year (16.7 million in USA in 2012, 550,000 in Australia), accounting .for 80% of all nuclear medicine procedures worldwide

In developed countries (26% of world population) the frequency of diagnostic nuclear medicine is 1.9% per year, and the frequency of therapy with radioisotopes is about one tenth of this. In the USA there are over 20 million nuclear medicine procedures per year among 311 million people, and in Europe about 10 million among 500 million people. In Australia there are about 560,000 per year among 21 million people, 470,000 of these using reactor isotopes. The use of radiopharmaceuticals in diagnosis .is growing at over 10% per year

The global radioisotope market was valued at \$4.8 billion in 2012, with medical radioisotopes accounting for about 80% of this, and is poised to reach about \$8 billion by 2017. North America is the dominant market for diagnostic radioisotopes with close to half of the market share, while .Europe accounts for about 20%

Nuclear medicine was developed in the 1950s by physicians with an endocrine emphasis, initially using iodine-131 to diagnose and then treat thyroid disease. In recent years specialists have also come from radiology, .as dual CT/PET procedures have become established

Computed X-ray tomography (CT) scans and nuclear medicine contribute 36% of the total radiation exposure and 75% of the medical exposure to the US population, according to a US National Council on Radiation

.Protection & Measurements report in 2009

The report showed that Americans' average total yearly radiation exposure had increased from 3.6 millisievert to 6.2 mSv per year since .the early 1980s, due to medical-related procedures

Industrial radiation exposure, including that from nuclear power plants,)

(.is less than 0.1% of overall public radiation exposure

An important nuclear medicine procedure is Magnetic Resonance Imaging (MRI), which uses powerful magnets and radio waves to create

.Cross-sectional images of organs and internal structures in the body

It does not use radioisotopes or ionizing radiation, but relies on nuclear

(magnetic resonance of hydrogen.(Website [http\\www.world.nuclear.org](http://www.world.nuclear.org)

:Diagnostic techniques in nuclear medicine 2-5

Diagnostic techniques in nuclear medicine use radioactive tracers which emit gamma rays from within the body. These tracers are generally short-lived isotopes linked to chemical compounds which permit specific physiological processes to be scrutinized. They can be given by injection, inhalation or orally. The first type is where single photons are detected by a gamma camera which can view organs from many different angles. The camera builds up an image from the points from which radiation is emitted; this image is enhanced by a computer and viewed by a physician

.on a monitor for indications of abnormal conditions

A more recent development is Positron Emission Tomography (PET) which is a more precise and sophisticated technique using isotopes produced in a cyclotron. A positron-emitting radionuclide is introduced, usually by injection, and accumulates in the target tissue. As it decays it emits a positron, which promptly combines with a nearby electron

resulting in the simultaneous emission of two identifiable gamma rays in opposite directions. These are detected by a PET camera and give very precise indication of their origin. PET's most important clinical role is in oncology, with fluorine-18 as the tracer, since it has proven to be the most accurate non-invasive method of detecting and evaluating most cancers. It is also well used in cardiac and brain imaging. (Website [http \\\nwww.world.nuclear.org](http://www.world.nuclear.org)

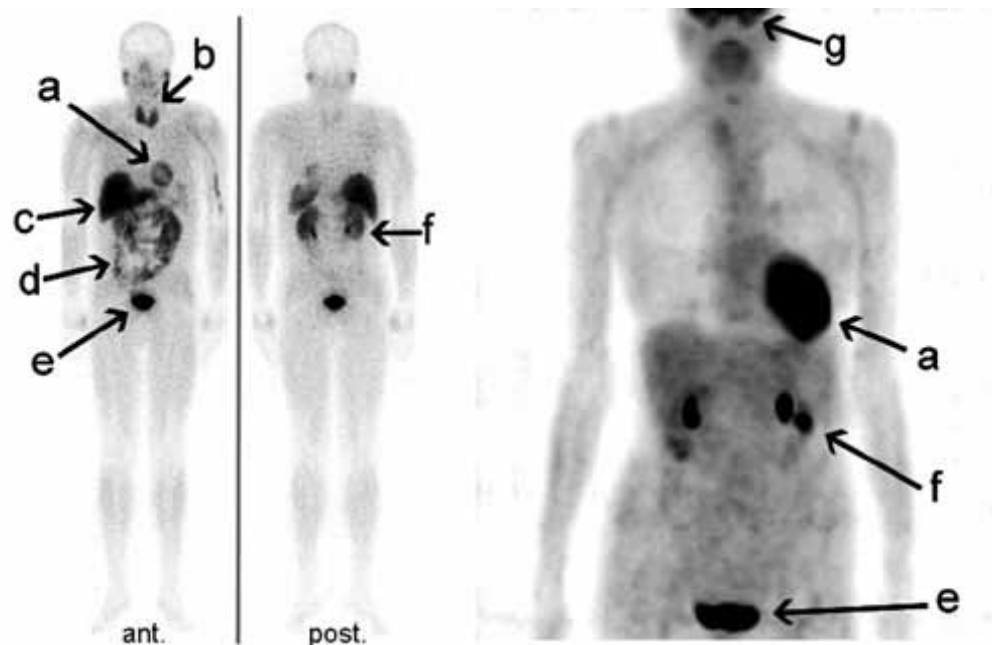


Fig 2-1 Biodistribution of radiopharmaceuticals. **A.** ^{99m}Tc -MIBI (myocardial perfusion study — SPECT); **B.** ^{18}F -fluorodeoxyglucose (myocardial viability study — PET); a — heart; b — thyroid; c — liver; d — intestines; e — urinary bladder; f — kidneys; g — brain (Website [http \\\nwww.polrradiol.com](http://www.polrradiol.com)

New procedures combine PET with computed X-ray tomography (CT) scans to give co-registration of the two images (PETCT), enabling 30% better diagnosis than with traditional gamma camera alone. It is a very powerful and significant tool which provides unique information on a wide variety of diseases from dementia to cardiovascular disease and .(cancer (oncology

Positioning of the radiation source within the body makes the fundamental difference between nuclear medicine imaging and other imaging techniques such as x-rays. Gamma imaging by either method described provides a view of the position and concentration of the radioisotope within the body. Organ malfunction can be indicated if the isotope is either partially taken up in the organ (cold spot), or taken up in excess (hot spot). If a series of images is taken over a period of time, an unusual pattern or rate of isotope movement could indicate malfunction in .the organ

A distinct advantage of nuclear imaging over x-ray techniques is that both bone and soft tissue can be imaged very successfully. This has led to its common use in developed countries where the probability of anyone .having such a test is about one in two and rising

The mean effective dose is 4.6 m Sv per diagnostic procedure
(Website [http \\\ www .world.nuclaer.org](http://www.world.nuclear.org))

:Diagnostic and Therapeutic 2-6

:2-6-1Diagnostic Radiopharmaceuticals

Every organ in our bodies acts differently from a chemical point of view. Doctors and chemists have identified a number of chemicals which are absorbed by specific organs. The thyroid, for example, takes up iodine; the brain consumes quantities of glucose, and so on. With this knowledge, radiopharmacists are able to attach various radioisotopes to biologically active substances. Once a radioactive form of one of these substances

enters the body, it is incorporated into the normal biological processes
and excreted in the usual ways

Diagnostic radiopharmaceuticals can be used to examine blood flow to the brain, functioning of the liver, lungs, heart or kidneys, to assess bone growth, and to confirm other diagnostic procedures. Another important use is to predict the effects of surgery and assess changes since treatment

The amount of the radiopharmaceutical given to a patient is just sufficient to obtain the required information before its decay. The radiation dose received is medically insignificant. The patient experiences no discomfort during the test and after a short time there is no trace that the test was ever done. The non-invasive nature of this technology, together with the ability to observe an organ functioning from outside the body, makes this technique a powerful diagnostic tool

A radioisotope used for diagnosis must emit gamma rays of sufficient energy to escape from the body and it must have a half-life short enough for it to decay away soon after imaging is completed

The radioisotope most widely used in medicine is technetium-99m, employed in some 80% of all nuclear medicine procedures – hence some 30 million per year, of which 6-7 million are in Europe, 15 million in North America, 15 million in Asia/Pacific (particularly Japan), and 0.5 million in other 6-8 regions. It is an isotope of the artificially-produced element technetium and it has almost ideal characteristics for a nuclear medicine scan. These are:

It has a half-life of six hours which is long enough to -
examine metabolic processes yet short enough to minimize the
radiation dose to the patient

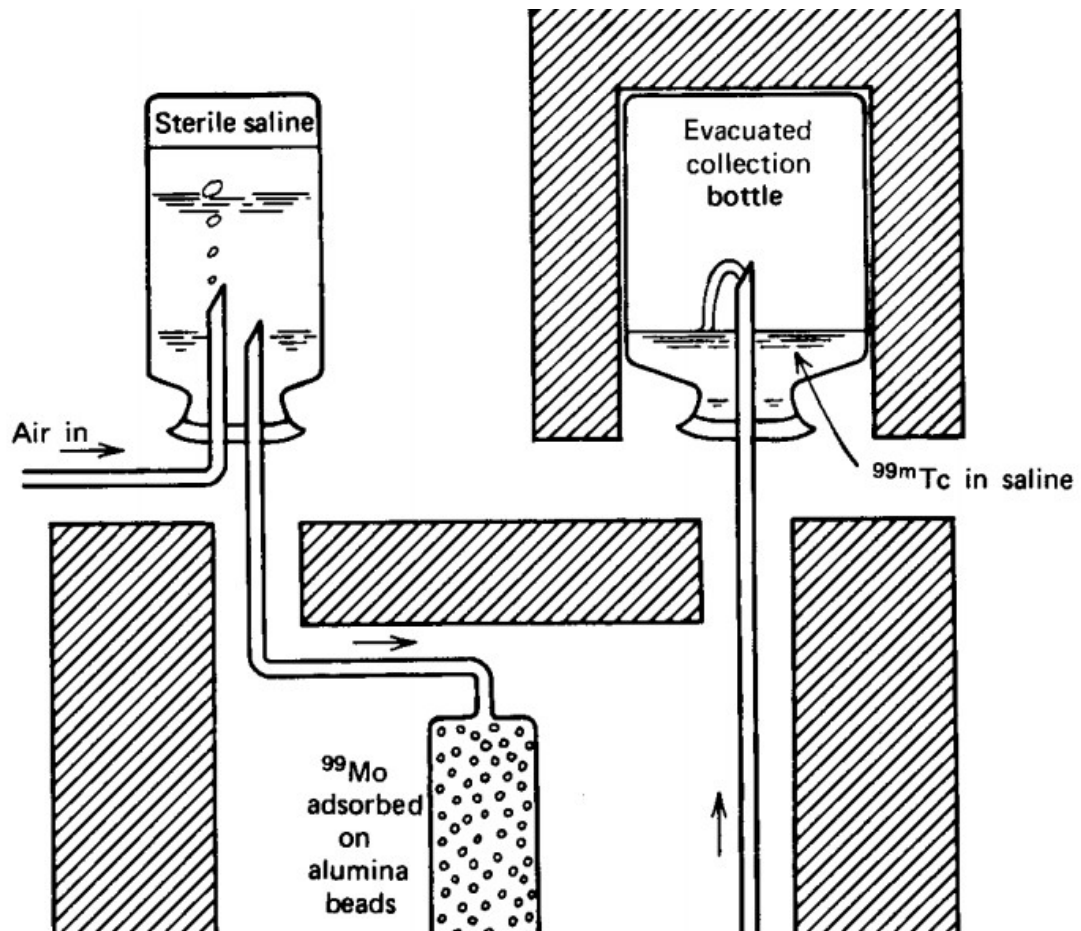
Technetium-99m decays by a process called "isomeric"; -
which emits gamma rays and low energy electrons. Since there
is no high-energy beta emission the radiation dose to the patient
.is low

The low energy gamma rays it emits easily escape the -
human body and are accurately detected by a gamma camera.
.Once again the radiation dose to the patient is minimized

The chemistry of technetium is so versatile it can form -
tracers by being incorporated into a range of biologically-active
substances to ensure that it concentrates in the tissue or organ of
.interest

Its logistics also favor its use. Technetium generators, a lead pot enclosing
a glass tube containing the radioisotope, are supplied to hospitals from
the nuclear reactor where the isotopes are made. They contain
molybdenum-99 with a half-life of 66 hours, which progressively decays
.to technetium-99

The Tc-99 is washed out of the lead pot by saline solution when it is
.required. After two weeks or less the generator is returned for recharging



(Fig 2-2 Technetium generators (Khalid ,2014

A similar generator system is used to produce rubidium-82 for PET imaging
 .from strontium-82 - which has a half-life of 25 days

Myocardial Perfusion Imaging (MPI) uses thallium - 201 chloride or
 technetium-99m and is important for detection and prognosis of coronary
 .artery disease

Canadian 2006 data shows that 56% of Tc-99 use there is in myocardial
 ischemia perfusion, 17% in bone scans, 7% in liver/hepatobiliary, 4%
 .respiratory, 3% renal, 3% thyroid

For PET imaging, the main radiopharmaceutical is Fluoro-deoxy glucose
 (FDG) incorporating F-18 – with a half-life of just under two hours – as a
 tracer. The FDG is readily incorporated into the cell without being broken
 .down, and is a good indicator of cell metabolism

In diagnostic medicine, there is a strong trend to using more cyclotron-produced isotopes such as F-18 as PET and CT/PET become more widely available. However, the procedure needs to be undertaken within two hours reach of a cyclotron, which limits their utility compared with Mo/Tc-99.

((website [http \ www. World.nucler.org](http://www.World.nucler.org)

:Therapeutic Radiopharmaceuticals 2-6-2

For some medical conditions, it is useful to destroy or weaken malfunctioning cells using radiation. The radioisotope that generates the radiation can be localized in the required organ in the same way it is used for diagnosis through a radioactive element following its usual biological path, or through the element being attached to a suitable biological compound. In most cases, it is beta radiation which causes the destruction of the damaged cells. This is radionuclide therapy (RNT) or radiotherapy. Short-range radiotherapy is

.known as brachytherapy, and this is becoming the main means of treatment. Although radiotherapy is less common than diagnostic use of radioactive material in medicine, it is nevertheless widespread, important and growing. An ideal therapeutic radioisotope is a strong beta emitter with just enough gamma to enable imaging, e.g. lutetium-177. This is prepared from ytterbium-176 which is irradiated to become Yb-177 which decays rapidly to Lu-177. Yttrium-90 is used for treatment of cancer, particularly non-Hodgkin's lymphoma and liver cancer, and it is being used more widely, including for

.arthritis treatment. Lu-177 and Y-90 are becoming the main RNT agents. Iodine-131, samarium-153 and phosphorus-32 are also used for therapy. Iodine-131 is used to treat the thyroid for cancers and other abnormal conditions such as hyperthyroidism (over-active thyroid). In a disease called Polycythemia Vera, an excess of red blood cells is produced in the bone .marrow. Phosphorus-32 is used to control this excess.

A new and still experimental procedure uses boron-10, which concentrates in the tumor. The patient is then irradiated with neutrons which are strongly

absorbed by the boron, to produce high-energy alpha particles which kill the
.cancer

For targeted alpha therapy (TAT), actinium-225 is readily available, from which the daughter bismuth-213 can be obtained (via 3 alpha decays) to label targeting molecules. The bismuth is obtained by elution from an Ac-225/Bi-213 generator similar to the Mo-99/Tc-99 one. Bi-213 has a 46-minute half-life. The actinium-225 (half-life 10 days) is formed from radioactive decay of radium-225, the decay product of long-lived thorium-229, which is obtained from decay of uranium-233, which is formed from Th-232 by neutron capture
.in a nuclear reactor

Another radionuclide recovered from thorium-232 is lead-212, with half-life of 10.6 hours, which can be attached to monoclonal antibodies for cancer treatment by TAT. A Ra-224/Pb-212 generator system similar to the Mo-99/Tc-99 one is used to provide lead-212 from radium-224 (via Rn-220 and Po-216). Pb-212 has a half-life of 10.6 hours, and beta decays to bismuth-212, then most beta decays to polonium-212. The alpha decays of Bi-212 and Po-212 are the active ones destroying cancer cells over a couple of hours. Stable Pb-208 results, via thallium-208 for the bismuth decay

Considerable medical research is being conducted worldwide into the use of radionuclide's attached to highly specific biological chemicals such as immunoglobulin molecules (monoclonal antibodies). The eventual tagging of these cells with a therapeutic dose of radiation may lead to the regression – or
.even cure – of some diseases

(Website [http\\www.world.nuclear.org](http://www.world.nuclear.org))

:Nuclear Medicine Wastes 2-7

The use of radioisotopes for medical diagnosis and treatments results in the generation of mainly low level waste. This waste includes paper, rags, tools, clothing and filters, which contain small amounts of mostly short-lived radioactivity. These types of waste often undergo decay storage for periods of .months to a few years before being disposed of at urban land-fill sites. When radiography sources have decayed to a point where they are no longer emitting enough penetrating radiation for use in treatments, they are considered as radioactive waste. Sources such as Co-60 are treated as short-lived Intermediate-Level wastes. Other sources such as Radium-226, used in cancer therapy, will however require long-term storage and geological disposal as low level Waste, as a result of their higher level of long-lived (radioactivity.(website [http \www .world. nuclear .org](http://www.world.nuclear.org)

Chapter three

Methods and Materials

:Area of study 3-1

This study was conducted In Aniline center and Royal care international .hospital in the period of Jan 2015 to May 2015

:Sample selection 3-2

The target population amount for this study was patients, public and source .present at the area of the study

:Method of data collection 3-3

For table in the write by the physician the center and show what happing with the patient (procedure, incident, frequency of accident, emergency plans), .what happen with sources and what happen with general public

Table 3-1 shows what happen –with patient

Emergency plans	Frequency of accident	incident	PROCEDURE
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1111

1111

555

Table 3-2 shows what happen –with sources

Emergency plans	frequency	incident	procedure
	of accident		

Unsatisfactor	Radioactive waste
y control ,loss	
of source	

Table 3-3 shows what happen –with general public

Emergency plans	frequency of accident	incident	PROCEDURE
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:Method of data analysis 3-4

.The data analyzed by using Microsoft office excel 2007 programs

:3-5Ethical issue

.Permission of medical physics department has been granted

.No patient data will publish

Chapter four

Result

:patient 4-1

Estimation of radiation exposure during radiation accidents in nuclear medicine found the information(5) procedure request and scheduling identification, administration of radiopharmaceutical (1,2),waiting .(procedure (5,4),leaving the department(1,(3,1-2%)

:general public 4-2

.(Found the radioactive patient (3%

.Fig 4-1: shows the Distribution of frequency in accident in al aniline

. Fig 4-2: shows the Distribution of accident

Chapter five

Discussions ,Conclusion ,Recommendation

:5-1Discussions

This study in Aniline center and Royal care international hospital, since the .Aniline center opening to the day also the Royal care international hospital The wrong patient incident the (1)time of accident the emergency plans the patient has rest for 2 days and the oncologist justify another test and the same of the identification and the misadministration but in royal time of accident 2.in the pregnancy or breast feeding is not happen any accident in the center due to the normal question in the identification but in royal happen the breast feeding 5 the emergency plans Stopping the feeding of 24 hour, waiting incidence contaminate, risk to public and non –occupationally is (1-2%) but in the royal time of accident 3the most happen between the patient the emergency plane decontamination survey , monitory pervert entering to the area ,procedure and poor quality image and data is 5 but the royal 4 the emergency plane is computerize problem and sold ,leaving the department or discharge from hospital the medical emergency death of patient is not happen in the center due to the diagnostic center but the royal happen the medical emergency the time of accident 1 the emergency planes the patient go the ER The source radioactive west , unsatisfactory control , loss of source that not happen in the center the emergency plane is tow storage one source and in the .department

The general public the radioactive patient uncontrolled exposure, contamination is (3%) within the department the emergency plane supervision .from the staff

:Conclusions 5-2

The study has shown an increase in the accident in the Sudan due to is not .available new device and place
And the using role of radiation protection in the center the American poured

:5-3Recomendtion

- The study proposed a new approach of accident in nuclear medicine departments and we hope from the other researchers to continue
- Staff should be regularly monitored for contamination, each time .radioactive materials are handled
- Concerning the radiation protection of members-of the public (family members)who accompany patients' during the examinations
- All of institution should include an exclusive toilet room for injection .patients, and the modern Labe, with special radiation protection

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