Article

JOURNAL OF UNIVERSITY OF BABYLON
For Pure and Applied Sciences (JUBPAS)

Vol.31; No.3.| 2023

Radiation Pollution Hazard Indices in Hospitals of Hilla City/Iraq

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مؤشرات مخاطر التلوث الإشعاعي في مستشفيات مدينة الحلة / العراق

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Accepted: 28 /7/2023 **Published:** 30/9 /2023

ABSTRACT

Background

High radiation is a double-edged sword, may be a treatment for some diseases also it may be dangerous when exposed to it in large doses for long periods of time, hospitals are a good example of this, hospitals are cure for patients and at the same time its considered a disease for their workers.

Materials and Methods:

Giger-Muller instrument counter was used to calculate the level of radioactivity emanating from three hospitals in Babel / Al-Hillah. Radioactivity was measured in different areas of each hospital, especially the X-ray departments, accelerators and CT-scan room.

Results:

The result is that the data we obtained were within the permissible exposure levels. Determine the most radioactive areas in the study area, the highest value was recorded in (0.90 mSv) in X-ray device in Hilla Surgical Hospital and the lowest dose was (0.015 mSv) in the X-ray device in Imam Al-Sadiq Hospital.

Conclusion:

Several samples investigated were less than the safe limits recommended by WHO in some respects.

Key words: Radiation, hazard, Imam Al-Sadiq hospital, Al-Hilla Surgical hospital.

ISSN: 2312-8135 | Print ISSN: 1992-0652

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INTRODUCTION

There are two types of radiation that humans are exposed, ionizing radiation and non-ionizing radiation. Ionizing radiation are X-rays, gamma rays, alpha particles, beta particles and cosmic rays and non-ionizing radiation is electromagnetic radiation such as radio waves, television, heat waves with short wavelengths (microwaves) and infrared waves, Infrared, ultraviolet and visible light [1].

People are exposed to natural radiation every day. Natural radiation comes from many sources found in soil, water and air, as well as by cosmic rays, (especially at high altitudes). Levels of background radiation exposure vary depending on geological differences [2],[3]

The level of exposure in some areas may reach high levels that differ from one region to another according to the nature of its geological structure [4],[5]. There are also man-made radioactive sources such as ionizing radiation in the most common devices today are X-ray machines and other medical devices, as well as in nuclear power plants and medical uses of radiation. In general, the people most exposed to these risks are those who work in the field of health care in hospitals, where it is estimated that there are about 2.3 million workers in the world working in devices containing radioactive materials and half of them are exposed to artificial ionizing radiation from man-made [6],[7], such as workers in x-ray laboratories and accelerators in hospitals. The type of damage caused by radiation to the tissues of the organs of the human body depends on the amount of radiation dose to which the organ and tissue are exposed and on the degree of sensitivity of these tissues and organs, so it is necessary to monitor the level of exposure to these radiations, especially those received by workers in the radiology department to protect them from the effect of radiation during and after Radiation examinations of patients and it must be within the internationally accepted safe limits. For example, exposure to x-rays for the patient should average 0.1 mSv, while the annual dose of the worker on this device is much less because of its presence behind radiation protection devices [8],[9]. The dangers resulting from exposure to radiation may be direct, such as direct exposure to radiation, which affects body fluids, as it causes a direct change on the cells body (one of the types of cancer) or the results of radiation exposure may be indirect and mean what happens to the partial ionization or instability of cells. Radiation affects RNA, DNA, chromosomes, prostate, enzymes, amino acids and all cells of the body, meaning that this poses a threat to the health of people, especially those working in this field [10],[11]. Which prompted the various governments and authorities and the General Assembly of the United Nations to form the International Atomic Energy Agency in 1957, which works to take care of everything related to this subject by enhancing safety from radiation hazards [12]. This agency has set safety standards to protect individuals from exposure to these doses and under these directives, it has become necessary to monitor health care workers exposed to this type of radiation on a daily basis to avoid the internationally recommended limits, For example, in the United States of America, all major sources of radiation contribute about 82% of the average annual exposure, and industrial, medical and consumer sources contribute about 18% [13],[14].

Numerous studies and researches were conducted in Iraq on different sites and samples concerned with studying and estimating the doses of radioactive materials within the samples, for example:

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Firas M. Aljomaily and others conducted a study on the concentration of radon in the Oncology and Nuclear Medicine Hospital in Mosul Governorate in different places of the hospital, where the uranium concentration was 59.32 $Bq.m^{-3}$. It was within the internationally permitted levels. [15]

Israa Kamil Ahmed also studied 14 samples of cement spread in the markets of Babylon using passive technic CR-39 track detector to calculate uranium and radon concentration its effect on humans because it may cause lung cancer, as the average value for uranium concentration was 0.025 ppm , the main value for radon concentration was 56.72 $Bq.m^{-3}$, which is within the internationally permitted levels [16]

Different samples of soil, rocks and water were taken from different locations in the Al-Amiriyah area in Baghdad to determine the concentration of radon gas in these samples to find out the amount of danger that threatens the residents of this area using a nuclear track detector CR-39. The rate of radon concentration was between 47.3 – 54.2 $Bq.m^{-3}$, within the internationally permitted levels.[17]

In this research, samples of rocks were taken in different regions of the Iraqi markets to determine the amount of radioactive nuclei emitted from these samples in order to know the danger to humans from exposure to these nuclei. it was found that, the average value of ^{222}Rn, ^{238}U, and ^{226}Ra concentrations in this samples were 48.75 ± 10.61 Bq/m^3, 0.084 ± 0.02 ppm, and 115.57 ± 29.60 mBq/kg, respectively. All within internationally permitted ranges. [18]

To studied area, the radioactivity of the devices available in the hospitals of Hilla city in Iraq, resulting from diagnostic devices such as X-rays and CT-scan devices, was measured. Al-Hilla Surgical Hospital the hospital is located in the center of the city of Hilla in a large medical complex that contains several wings and near the College of Medicine, the College of Pharmacy and the Dentistry Faculty affiliated to the University of Babylon. This hospital is considered one of the old hospitals that was built in 1972. Imam Sadiq Hospital It is one of the government hospitals in Babylon Governorate, built by a group of Turkish companies and opened in 2017. The hospital belongs to the Iraqi Ministry of Health. It is considered one of the largest government hospitals in Iraq. It is considered an integrated city because of its specialized centers, modern operating rooms, laboratories and patient lounges, all medical devices its Sophisticated and modern . The hospital consists of 492 inpatient beds, a number of clinics and specialized centers and 18 operating theaters. The hospital contains a special center for the diagnosis and treatment of cancerous diseases and the places containing the examination and treatment devices were far from the patient's inpatient lobbies and were very well protected to be less dangerous to patients and the staff working on them. Marjan Teaching Hospital It is a hospital located in the city of Hilla in the province of Babylon in Iraq. It was established in 1957, located on the eastern shore of the Hilla River. It is a public educational medical institution that includes many specialized centers that provide free services to the citizens of the province and neighboring areas. This hospital includes specialized medical centers dealing with the treatment of diseases of the digestive system, liver, physiotherapy, diabetes, oncological diseases, resuscitation, heart surgery and dialysis, the presence of a special emergency unit as well as multiple consulting suites in internal medicine, psychology, dermatology and more.

The aim of this research is to study the radioactivity emanating from the devices in the three main hospitals in the city of Hilla in the Babil Governorate and the extent of its impact and danger on the lives of those working on these devices.

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MATERIALS AND METHODS

Giger-Muller instrument count. It is known that radiation comes in three main types: alpha, beta particles and gamma rays. Alpha particles are slow and cannot travel more than a few centimeters. Beta particles are able to travel farther. Gamma radiation can travel long distances and penetrate several meters of solid concrete and it is the most dangerous. Types of ionizing radiation because it can penetrate the body, causing severe damage to the atoms inside the cells of the human body. Also referred to as a Geiger counter radiation detector, it is used to detect and measure radiation from ionized gases. The name Geiger counter is often associated with nuclear weapons and their aftermath, as these ingenious devices allow anyone to detect potentially harmful radiation around them, using the energy of electrons and the instability of radioactive atoms. It is also used to detect nuclear waste and its byproducts, exposure in nuclear power plants, hospitals and control In which [19]

This counter is widely used in applications such as radiation protection, dosimetry and experimental physics. A Geiger counter is made of a metal tube filled with a low pressure inert gas such as helium, argon or neon and a high voltage is applied to this gas to detect the emitted alpha, beta and gamma particles[20]. When the Geiger counter is exposed to ionizing radiation, the particles penetrate the tube and collide with the gas, the anode inside the Geiger tube records the amount of ionized particles that is directly proportional to the strength of the incident radiation and releases more electrons as the positive ions come out of the tube and the negatively charged electrons become attracted to a wire of appropriate voltage.

When more electrons accumulate around the wire it creates an electric current. This temporarily closes the switch and generates an electrical pulse recorded on the meter, either acoustically as a click that increases in intensity with increased ionizing radiation or visually with the movement of the needle pointer [21] The Geiger counter is the most widely used detector for the following reasons: It is relatively inexpensive. It only takes a few special electronics to make it work, unlike other types.

Ease of use. It does not require much experience in this field to work with it is very important to measure the radioactivity as well as classify the radioactivity background values. For example, terrestrial gamma radiation is measured according to general values .

The study includes a comparison between the results obtained for 2019 and the results obtained in 2022.The hospital consists of three separate departments:

RESULTS AND DISCUSSION

All doses are measured by Giger – Muller instrument made by Alerts Company manufactured in USA. The readings recorded in this research were divided into two parts Recorded readings from inside the control room. The highest reading from inside the control unit room , after operating the device was in the emergency unit at Hilla Surgical Hospital, the device recorded a dose of (0.9 mSv) in x-ray device, this high dose was due to the fact that the building was not designed to use this device, but rather a room Ordinary that has been maintained to run this scan, meaning that its security levels are poor The lowest reading it was in the newly built Al-Imam Al-Sadiq Hospital, so we find that the levels of safety in it are high for the workers on it, where it was (0.083 mSv). The readings recorded from outside the control unit in the places close to the examination room were less than the readings recorded from inside the control unit

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and this indicates the existence of a kind of protection that prevents radiation leakage to the outside, as it was the highest reading in the control unit of the x-ray device in Hilla Hospital The surgery in the emergency hall, which is characterized by being an old building and the protection system in it is not good. It was (0.858 mSv) As for the lowest reading, it was in Imam Al-Sadiq Hospital, which has a high protection, as the examination room was designed for this purpose. The meter recorded a reading of (0.063 mSv). A number of readings were also taken in different places of the study area, such as gardens, corridors, analysis rooms and patient lounges, all of which were within the level permitted globally by the organizations and bodies concerned with this issue [22]

Al-Hilla Surgical Hospital In 2022 year

This hospital is located in the center of the city of Hilla in a large medical complex that contains several wings and near the College of Medicine, the College of Pharmacy and the Dentistry Faculty affiliated to the University of Babylon. This hospital is considered one of the old hospitals that was built in 1972, so it was not designed according to modern engineering standards, so It does not contain special rooms for the diagnosis and treatment of cancerous diseases, but rather ordinary rooms for measuring x-rays and CT-scans that were later immunized. These devices were developed without taking into account the safety limits from the danger of these ray. For example, the X-ray devices do not contain protection panels or cement walls that prevent radiation leakage.

Table 1: The resulting dose of x-rays inside and outside the measurement room in millisievert(mSv) in 2022.

No.	Place	Before (mSv)	After (mSv)
1	**Inside the control room**	*0.30*	*0.90*
2	**outside the control room**	*0.07*	*0.858*

Samples were also taken from the hospital from different places in the hospital garden (0.138 – 0.038 – 0.107mSv)

Table 2: The resulting dose of X-rays inside and outside the measurement room in millisievert (mSv) in 2019

No.	Place	Before (mSv)	After (mSv)
1	**Inside the control room**	*0.029*	*0.159*
2	**outside the control room**	*0.011*	*0.040*

Noted from the table1 @ table 2 that there is a difference in the evaluations, as the reading outside the fitting room were very large after operating the device, which causes danger to patients and hospital workers, due to the absence of a protective shield surrounding the fitting room. In 2022, the dose ratio was lower, because the fitting room was surrounded by a protective shield of lead.

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Table3: The unit of magnetic resonance is located in the inpatient main building Multiple readings were taken inside and outside the CT-scan room in 2022.

No.	Place	Pollution rate before operation (mSv)	Pollution rate after operation (mSv)
1	Inside the control room	*0.06*	*0.05*
2	outside the control room	*0.173*	*0.119*

Table4: The unit of magnetic resonance is located in the inpatient main building Multiple readings were taken inside and outside the CT-scan room in 2019.

No.	Place	Pollution rate before operation (mSv)	Pollution rate after operation (mSv)
1	Inside the control room	*0.035*	*0.15*
2	outside the control room	*0.105*	*0.103*

2- Imam Sadiq Hospital

It is one of the government hospitals in Babylon Governorate, built by a group of Turkish companies and opened in 2017. The hospital belongs to the Iraqi Ministry of Health. It is considered one of the largest government hospitals in Iraq. It is considered an integrated city because of its specialized centers, modern operating rooms, laboratories and patient lounges, all medical devices its Sophisticated and modern

The hospital consists of 492 inpatient beds, a number of clinics and specialized centers and 18 operating theaters.

The hospital contains a special center for the diagnosis and treatment of cancerous diseases and the places containing the examination and treatment devices were far from the patient's inpatient lobbies and were very well protected to be less dangerous to patients and the staff working on them.

Table5: BOT-SCANE unit of magnetic resonance is located in the inpatient main building Multiple readings were taken inside and outside the CT- scan room in 2022 @ 2019.

No.	Place	Pollution rate before operation (mSv)	Pollution rate after operation (mSv)
1	Inside the control room	*0.077 (2022)* *0.077 (2019)*	*0.083*
2	outside the control room	*0.137 (2022)* *0.083 (2019)*	*0.063*

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Table 5: linear accelerator unit in 2022

No.	Place	Before (mSv)	After (mSv)
1	Inside the control room	*0.035*	*0.203*
2	outside the control room	*0.095*	*0.335*
3	In the adjacent lanes	*0.063*	*0.078*

The building consists of two identical floors including 12 halls and 380 inpatient beds with administrative offices and a doctor's house with a built-up area of 6000 m^2 and a total area of the hospital of 25000 m^2

The hospital has a unified place that contains two x-ray devices :

Table 6: X-ray device 1

No.	Place	Before (mSv)	After (mSv)
1	Inside the control room	*0.010*	*0.095*
2	outside the control room	*0.095*	*0.159*

Table7: X-ray device 2

No.	Place	Before (mSv)	After (mSv)
1	Inside the control room	*0.059*	*0.095*
2	outside the control room	*0.095*	*0.040*
3	In the adjacent lanes	*0.045*	*0.0151*

Table8: CT-Scan device :

No.	Place	Before (mSv)	After (mSv)
1	Inside the control room	*0.105*	*0.133*
2	outside the control room	*0.035*	*0.103*
3	In the adjacent lanes	*0.015*	*0.0181*

3- BABEL CANCER CENTER

It is one of the most important advanced centers for the treatment of oncology at the country level. It was opened in 2013, it is one of the governmental health institutions affiliated to the Iraqi Ministry of Health (It is located within the borders of Marjan Medical City), It includes many medical and health cadres specialized in this field, as this center provides many treatment services that are comparable to those in developed countries, The distinguished location in the center of the country and on the banks of the Hilla River, the modern medical equipment and trained medical staff, made this center attract patients from all the northern, central and southern governorates of the country.

Physicists from the medical staff, through the devices in the center, know the type of tumor, its size and location in the body and how to deal with it by choosing the type and amount of energy, if the type of tumor is in the skin or in the internal organs and protecting the healthy parts from the side effects of deep rays.

There are two devices inside the building for nuclear medicine :

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Table 9: CT- scan device 1 room in 2022

No.	Place	Before (mSv)	After (mSv)
1	Inside the control room	*0.128*	*0.140 in 2022*
			0.131 in 2019
2	outside the control room	*0.107*	*0.113 in 2022*

Table 10: CT- scan device 2 room in 2022

No.	Place	Before (mSv)	After (mSv)
1	Inside the control room	*0.117*	*0.140*
2	outside the control room	*0.101*	*0.138*

RESULTS

The result is that the data we obtained were within the permissible exposure levels. Determine the most radioactive areas in the study area, working to reduce radiation damage for workers in the health sector or the general public. Protecting people from ionizing and non-ionizing radiation, and knowing materials to block them, such as lead, concrete, iron and others. The readings recorded in each hospital were as follows:

Hilla Surgical Hospital contains an X-ray and CT-Scan devices. It was measured from inside the control room before operating the devices. The highest value was (0.30 mSv) in X-ray device and the lowest value was (0.06 mSv) in CT-Scan device. However, after running the devices, the highest value was (0.90 mSv) in X-ray device and the lowest value was (0.05 mSv) in a CT-Scan device.

Imam Al-Sadiq Hospital contains four devices for measuring radioactivity, two X-ray devices, BOT-can and a linear accelerator and the recorded readings at that time different according to the type of device. The readings were recorded from inside the control room before operating the devices, as the highest amount was (0.137 mSv) in CT-scan device and the lowest It was (0.01 mSv) in X-ray device and after turning on the devices, the highest amount was (0.335 mSv) in the linear accelerator device and the lowest amount was (0.015 mSv) in X-ray device.

Babel Cancer Center is located in Marjan Teaching Hospital. It contains two CT-scan devices, where the workers in this department identify the type of tumor, its size and location in the body. They were almost equal before and after operating the devices. This is a good indicator about the radiation protection system, as it had the highest amount (0.140 mSv) and the lowest its amount (0.101 mSv)

CONCLUSION

1- We conclude from this research that, after the devices tuner, the highest radiation dose was (0.30 mSv) in X-ray device in Hilla Surgical Hospital and the lowest dose was recorded (0.010 mSv) in X-ray device in Imam Al-Sadiq Hospital.

When the devices were working, the highest value was recorded in (0.90 mSv) in X-ray device in Hilla Surgical Hospital and the lowest dose was (0.015 mSv) in the X-ray device in Imam Al-Sadiq Hospital.

2- When comparing the results obtained in this research with the results obtained in 2019 and 2022, we find increase in the amount of dose leaked abroad, which indicates weak protection measures in Al-Hilla Surgical Hospital and Imam Al-Sadiq Hospital

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RECOMMENDATIONS:

Despite the low levels of radiation, we recommend the following:

1- Moving the measuring devices in Al-Hilla Surgical Hospital to other, more protected places
2- Providing examination rooms with protective walls or anti-shields that prevent radiation leakage to the outside, no matter how small, in order to protect workers in this field from exposure to radiation for long periods.
3- Replacing workers on this type of radiation in this place periodically to reduce the risk of continuous exposure to this radiation.

ACKNOWLEDGMENTS:

I would like to express my thanks and gratitude to everyone who helped me in this work, especially Dr. Sfeer AbdulKareem Alsaati and Dr. Entesser Salman from education faculty, Babylon university and I wish them success.

Conflict of interests.

There are non-conflicts of interest.

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الخلاصة

مقدمة:

الإشعاع العالي سيف ذو حدين ، قد يكون علاجًا لبعض الأمراض كما أنه قد يكون خطيرًا عند التعرض له بجرعات كبيرة لفترات طويلة ، المستشفيات خير مثال على ذلك ، المستشفيات تعالج المرضى وفي نفس الوقت يعتبر مرضًا لعمالهم.

طريقة العمل:

تم استخدام عداد أدوات كايكر مولر لحساب مستوى النشاط الإشعاعي المنبعث من ثلاثة مستشفيات في بابل / الحلة. تم قياس النشاط الإشعاعي في مناطق مختلفة من كل مستشفى ، وخاصة أقسام الأشعة السينية والمعجلات الخطية وغرفة الأشعة المقطعية.

الاستنتاجات:

أن البيانات التي حصلنا عليها كانت ضمن مستويات التعرض المسموح بها من قبل منظمة WHO. تم تحديد أكثر المناطق نشاطًا إشعاعيًا في منطقة الدراسة حيث كانت أعلى قيمة (0.90 mSv) في جهاز الأشعة في مستشفى الحلة الجراحي وأقل قيمة كانت (0.015 mSv) في جهاز الأشعة السينية في مستشفى الإمام الصادق.

الكلمات المفتاحية: إشعاع ، خطر ، مستشفى الإمام الصادق ، مستشفى الحلة الجراحي.