بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Post Graduate Studies

Designing a Tele-Health Communication System for Patients & Medical Staff in Radioiodine Isolation rooms Using Java in TTCRC-Shendi

تصميم نظام الاتصالات الصحية عن بعد للمرضى والطاقم الطبي في غرف العزل لليود المشع باستخدام الجافا بمركز علاج الاورام وأبحاث السرطان -شندي

A Thesis submitted in partial fulfillment of the requirement for the M.Sc. degree in biomedical engineering

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September 2022

الآيـــــــــة

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
"اللّهُ لاَ إِلَـهَ إِلاَّ هُوَ الْحَيُّ الْقَيُّومُ لاَ تَأْخُذُهُ سِنَةٌ وَلاَ نَوْمٌ لَّهُ مَا فِي السَّمَاوَاتِ وَمَا فِي الأَرْضِ مَن ذَا الَّذِي يَشْفَعُ عِنْدَهُ إِلاَّ بِإِذْنِهِ يَعْلَمُ مَا بَيْنَ أَيْدِيهِمْ وَمَا خَلْفَهُمْ وَلاَ يُحِيطُونَ بِشَيْءٍ مِّنْ عِلْمِهِ إِلاَّ بِمَا شَاء وَسِعَ كُرْسِيُّهُ السَّمَاوَاتِ وَالأَرْضَ وَلاَ يَؤُودُهُ حِفْظُهُمَا وَهُوَ الْعَلِيُّ الْعَظِيم "﴿255﴾

صدق الله العظيم
سورة البقرة

DIDICATION

I dedicate my dissertation work to my dear father, who is credited with what I am today, and to my mother who supports me in every step of my life.

A special feeling of gratitude to my loving brothers and sisters, they have never left my side.

I also dedicate this dissertation work to my many friends who have supported me throughout the process. I will always appreciate all they have done, especially Eng. Abdalfatah for helping me develop the system.

I dedicated this to everyone that help me and without him it was impossible for me to complete this thesis work.

ACKNOWLEDGMENTS

This project would not have been possible without the support of many people. I would like to express my gratitude to my supervisor, Dr. Zinab Adam Mustafa , who guided me throughout this project , and Furthermore I would like to thank our doctors in Biomedical Engineering Department .and I also wish to acknowledge the help provided by the technical and support staff in the tumor therapy and cancer research Centre. I would also like to thank my friends and family who supported me and offered deep insight into the study. I am also grateful to my classmates and cohort members, for their editing help, feedback sessions, and moral support. Lastly, I would be remiss in not mentioning my family, especially my parents, brothers, and sisters. Their belief in me has kept my spirits and motivation high during this process.

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ABBREVIATION:

TTCRC	Tumor Therapy and Cancer Research Centre
I 131	Iodine 131
RAI	Radio Active Iodine
WHO	World Health Organization
IR	Ionizing Radiation
UI	User Interface
WBSN	Web-Based Social Networks
IOT	Internet Of Things
5G	Fifth-Generation
COVID-19	Coronavirus Disease
ICU	Intensive Care Unit
CCTV	Closed-Circuit Television
mHealth	Mobile Health
iSOCOMS	The Isolation Communication Management System.
SQL	Structured Query Language
IDE	Integrated Development Environment
JDK	Java Development Kits
JVM	Java Virtual Machine
Xampp	Cross-Platform, Apache, MySQL, PHP and Perl,
NMD	Nuclear Medicine Department

ABSTRACT:

The importance of using technology to solve problems in general and the problems of the health field in particular has emerged, and this importance is increasing with the increase in complications and risks in the medical field. In this research, a system was designed to avoid the dangers of radiation for workers in the field of nuclear medicine at tumor therapy and cancer research Centre, in addition to providing good treatment services to patients. The main factors in radiation protection methods, which were the basis and building block of the research, are to reduce the time and reduce the distance for the exposed. An electronic system was designed using the Java language as a means of communication between the different departments working in the radioactive iodine department and especially between the patient and the nurse, to increase the follow-up of the patient in order to preserve his safety and health inside the isolation rooms. The system found a great acceptance after it was presented to the employees of the nuclear medicine department, and it will be applied to take advantage of its properties in the future.

المستخلص

ظهرت اهمية استخدام التكنولوجيا في حل المشكلات عموما ومشاكل الحقل الصحي بالخصوص وتتزايد تلك الاهمية بزيادة التعقيدات والمخاطر في المجال الطبي. في هذا البحث تم تصميم نظام لتفادي خطورة الاشعاع بالنسبة للعاملين في مجال الطب النووي بالاضافة لتقديم خدمات علاجية جيدة للمرضى . العوامل الرئيسة في اساليب الوقاية من الاشعاع والتي كانت اساس ولبنة للبحث هي تقليل الزمن وتقليل المسافة بالنسبة للمتعرض . تم تصميم نظام الكتروني باستخدام لغة الجافا كوسيلة تواصل بين الاقسام المختلفة العاملة بقسم الايودين المشع وبين المريض والممرض خصوصا لزيادة المتابعة للمريض حفاظا علي سلامته وصحته داخل غرف العزل . وجد النظام قبول كبير بعد عرضه على العاملين بقسم الطب النووي وسيتم تطبيقه للاستفادة من خصائصه مستقبلا

CHAPTER ONE

INTRODUCTION

1.1 General Review:

With the rapid development of smart systems and web technology, it becomes very recommended that people more prefer to access the information through this flexible way especially in radiation areas to minimizing direct contact with patients. One of the precautions when it comes to deal with radiation is minimizing the contact period and length between people and patients, this project comes over this idea. So the requirement of proper communication according to different departments working in nuclear medicine section become a real need especially under the current circumstances in TTCRC which is an oncology governmental center located in River Nile state Shendi .

Basic radiation safety associated with radioactive I-131 involves using the principles of minimizing time and distance to reduce exposure to others as the basis for precautions [1]. That's why continuous monitoring of the patient is a dangerous process for involved health workers, especially the nurse, and also sudden deaths of patients may occur. Therefore, it is a must to assure the providence of proper and safe means of communication between patients and nurses outside the room.

Also, for the purposes of improving work and arrangement, there must be an electronic system that preserves workflow and organizes information for the purposes of scientific research in the future.

This project is about tele health, web application framework and responsive web design which base on the java language. This idea comes from observation that patients on isolation rooms suffer from lake of direct observation and few patients face sudden death in their isolated room. Though there are some existing researches in above fields but here we try to find a simple reliable method to save lives and improve healthcare providing process.

1.2 Problem Statement:

Difficulty of direct and continuously observation for patients in iodine isolation rooms due to radiation exposure risk beside the slowness of communication process between staff working in nuclear medicine department.

1.3 Main objective:

The main objective is to design cheap and reliable system for facilitate the process of communication between patients and nurses, and between the rests of the staff. It offers a basic model which can be used by application developer in the future. And is designed to be applied in TTCRC to develop a specific communication way to the patients in isolated radioactive iodine's rooms.

1.3.1 Specific objectives:

1. Design the system using java.
2. Practical simulation for the system will be done in TTCRC.

1.4 Methodology:

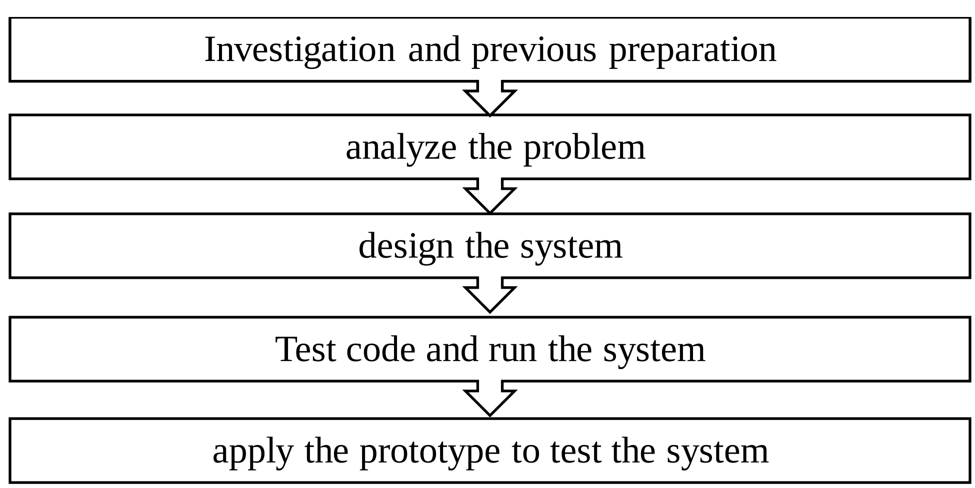


Figure (1.1): flow chart of the research methodology

1.4 Thesis Layout:

The project is divided into 6 chapters. The first chapter introduces the background and main objective of the research. And next Chapter introduces a study on thyroid cancer While Chapter three include the Literature review about this research Then the core part of the project will be introduced in Chapter four which it the methodology This part introduce the whole project development process in detail , in chapter five the results and discussion would be found particularly the application's system test and it's evaluation, and finally conclusion and recommendation are exist in chapter six and then the references will be attached at the end of the thesis.

CHAPTER TWO

THEORTICAL BACKGROUND

2.1 Thyroid cancer:

Thyroid cancer begins in the thyroid gland. This gland is located in the front of the neck just below the larynx, which is called the voice box. The thyroid gland is part of the endocrine system, which regulates hormones in the body. The thyroid gland absorbs iodine from the bloodstream to produce thyroid hormones, which regulate a person's metabolism .Thyroid cancer starts when healthy cells in the thyroid change and grow out of Control, forming a mass called a tumor. The thyroid gland contains 2 types of cells:

- **Follicular cells**. These cells are responsible for the production of thyroid hormone.
- **C cells**. These special cells of the thyroid make calcitonin, a hormone that participates in calcium metabolism.

A tumor can be cancerous or benign. A cancerous tumor is malignant, meaning it can grow and spread to other parts of the body. A benign tumor means the tumor can grow but will not spread. Thyroid tumors can also be called nodules, and about 90% of all thyroid nodules are benign [2].

2.1.1 Types of thyroid cancer:

Thyroid cancer is classified based on the type of cells from which the cancer grows. Thyroid cancer types include:

Papillary: Up to 80% of all thyroid cancers are papillary. This cancer type grows slowly. Although papillary thyroid cancer often spreads to lymph nodes in the neck, the disease responds very well to treatment. Papillary thyroid cancer is highly curable and rarely fatal.

Follicular: Follicular thyroid cancer accounts for up to 15% of thyroid cancer diagnoses. This cancer is more likely to spread to bones and organs, like the lungs. Metastatic cancer (cancer that spreads) can be more challenging to treat.

Medullary: About 2% of thyroid cancers are medullary. A quarter of people with medullary thyroid cancer have a family history of the disease. A faulty gene (genetic mutation) may be to blame.

Anaplastic: This aggressive thyroid cancer is the hardest type to treat. It can grow quickly and often spreads into surrounding tissue and other parts of the body. This rare cancer type accounts for about 2% of thyroid cancer diagnoses [3].

2.1.2 Statistics about thyroid cancer:

Sudan, the most diverse country in the African continent, is experiencing growing cancers problems. However, little is known about thyroid cancer epidemiology and patterns. In total, 1,062 cases were reported during 1st January 2005 and 31stDecember 2015. Of these, (360; 33.9%) were male and (702; 66.1%) were female. The highest number of cases was in the 25-54-year-old age group (451; 42.5%), and more than 65-year-old age (331; 31.2%). The most predominant type of thyroid cancer among the Sudanese population was Papillary carcinoma (734; 69.1%) followed by Follicular carcinoma 178(16.8%) and Medullary carcinoma (150; 14.1%).There were significant differences in gender, age groups and types of thyroid cancer (P=0.001).Based on geographical distribution thyroid cancer showed high prevalence in Khartoum, North Kurdufan, River Nile, Kassala, North Darfur, Northern, and south Kurdufan. Whereas, low distribution is seen in Red sea, West Darfur, West Kurdufan, East Darfur, Al Gadarif, and the Blue Nile. Our results suggest that thyroid cancer continuous presenting alarming challenge with an increasing the prevalence in females. Papillary carcinoma is the most common type among Sudanese populations. Further epidemiological studies are required in policy strategies for control and prevention strategies of thyroid cancer in Sudan [4].

2.1.3 Types of Treatment:

In many cases, a team of doctor’s works together to create a patient’s overall treatment plan that combines different types of treatments. This is called a multidisciplinary team. For thyroid cancer, this team may include a surgeon, medical oncologist, radiation oncologist, radiologist, nuclear medicine physician, and endocrinologist. Thyroid cancer is commonly treated by 1 or a combination of treatments. Treatment options and recommendations depend on several factors, including the type and stage of thyroid cancer, possible side effects, and the patient's preferences. The common types of treatments used for thyroid cancer are listed below:

- Surgery.
- Hormone treatment.
- Radioactive iodine (radioiodine) therapy.
- External-beam radiation therapy.
- Therapies using medication.
- Ionizing radiation [5].

2.1.3.1 Radioactive iodine (radioiodine) therapy:

Thyroid gland absorbs nearly all of the iodine in our body. Because of this, radioactive iodine (RAI, also called I-131) can be used to treat thyroid cancer. The RAI collects mainly in thyroid cells, where the radiation can destroy the thyroid gland and any other thyroid cells (including cancer cells) that take up iodine, with little effect on the rest of your body. The radiation dose used here is much stronger than the one used in radioiodine scans.

This treatment can be used to ablate (destroy) any thyroid tissue not removed by surgery or to treat some types of thyroid cancer that have spread to lymph nodes and other parts of the body [6].

CHAPTER THREE

LITRETURE REVIEW

3.1 Telehealth systems:

Exposure of humans to ionizing radiation (IR) during medical procedures is the greatest contributor to annual radiation exposure dose from all artificial IR sources. Diagnostic and therapeutic use of IR has substantially increased in the last decades, exemplified by a range of new imaging techniques [7, 8] and new targeted irradiation therapeutic modalities [9]. Accordingly, medical workers comprise the largest professional human group that are exposed to occupational IR at low doses and low dose-rates (7.35 million worldwide, representing 75% of workers exposed to artificial sources of radiation) [10]. Exposure to moderate-to-high doses of IR induces genotoxic effects that can lead to carcinogenesis [11].A significant factor in minimizing the risk of exposure to radiation in radioiodine isolation rooms is the reduction of person-to-person contact, this is where the importance of using telemedicine technology comes in that is both patient-centered and protects patients, physicians, as well as others.

3.1.1 Tele health systems in Healthcare:

In this paper Fang, J et all proposed a cost-effective plan for rapid implementation with minimal equipment and setup to minimizing entry-exit cycles by necessary staff to isolated patients rooms and provide a way for patients to connect with their families. Ultimately, based on ease of setup, patient privacy, settings UI simplicity, and maintenance, they implemented their protocol using Face Time app but that limited them to using iPads rather than android devices, which can cost less compared to other options, Face Time was the easiest to set up [12]

It is well known that an effective monitoring healthcare system can detect abnormalities of health conditions in time and make diagnoses according to sensing (WBSN) data.

Farah Nasri, Abdellatif Mtibaa proposed a general architecture of a smart mobile IoT healthcare system for monitoring patients risk using a smart phone and 5G. The design of multi-protocol unit for universal connectivity. Web and mobile applications developed to meet the needs of patients, doctors, laboratories' analysis and hospitals services, and that for this study provided measures of physiological parameters such as body temperature, pulse rate and oxygen saturation level. The physiological data are processed using 5G, body sensors coupled to an Arduino and RasberryPi boards [13].

It aimed to help patients to consult anywhere doctors, and doctors to follow up patient's requests and data. It used Wireless Body Sensor and information technologies to provide remotely clinical healthcare. It helped to reduce distance barriers and improve access to medical services. It was also used to save lives in critical care and emergency situations inside cities and rural communities [13].

The system advises and alerts in real time the doctors/medical assistants about the changing of vital parameters of the patients, such as body temperature, pulse and Oxygen in Blood etc… and also about important changes on environmental parameters, in order to take preventive measures, save lives in critical care and emergency situations [13].

The first case of COVID-19 in Saudi Arabia was confirmed on March 3, 2020. Saudi Arabia, like many other countries worldwide, implemented lockdown of most public and private services in response to the pandemic and established population movement restrictions nationwide. With the implementation of these strict mitigation regulations, technology and digital solutions have enabled the provision of essential services. The aim of this paper is to highlight how Saudi Arabia has used digital technology during the COVID-19 pandemic in the domains of public health, health care services, education, telecommunication, commerce, and risk communication. In this paper they documented the use of digital technology in Saudi Arabia during the pandemic using publicly available official announcements, press briefings and releases, news clips, published data, peer-reviewed literature, and professional discussions [14].

Saudi Arabia's government and private sectors combined developed and launched approximately 19 apps and platforms that serve public health functions and provide health care services. Education processes continued using an established electronic learning infrastructure with a promising direction toward wider adoption in the future. Telecommunication companies exhibited smooth collaboration as well as innovative initiatives to support ongoing efforts. Risk communication activities using social media, websites, and SMS text messaging followed best practice guides. The Saudi Vision 2030 framework, released in 2017, has paved the path for digital transformation. COVID-19 enabled the promotion and testing of this transition. In Saudi Arabia, the use of artificial intelligence in integrating different data sources during future outbreaks could be further explored. Also, decreasing the number of mobile apps and merging their functions could increase and facilitate their use .It is currently estimated that 30,260,000 people in Saudi Arabia (89% of the population) use the internet, 96% of the population uses smartphones ,and the majority of the population now has access to smartphones, laptop computers, desktop computers, and tablets; therefore, digital service provision is much easier than in the past and has aided the mitigation efforts established by the government [14].

Figure (3.1): Examples of digital apps available for various health care domains during the COVID-19 pandemic in Saudi Arabia.

Also B Naveen Naik et al; they implemented a technology for re-mote monitoring of ICU, utilizing closed-circuit television (CCTV) cameras and smartphones. High definition CCTV cameras were installed over each ICU bed for visualizing patient mechanical ventilation and monitoring system round the clock [15].

Another study Susan G. Rodder et all, evaluated the effectiveness of a curriculum expansion which addressed mHealth technology provided to physician assistant (PA) and clinical nutrition (CN) students enrolled in an academic health center. In addition, to determine the validity of MyNetDiary as compared to the gold standard nutritional estimation tool, SuperTracker, was determined in, they used a smartphone application appraisal tool, based on scientific recommendations, was developed [16].

Students were taught how to use this tool to evaluate mobile apps. They received instruction on providing patient education on mobile apps used to track calories and nutrients and mobile medical apps to measure blood pressure. Pre-/post-surveys and objectively structured clinical examinations measured students' confidence and abilities in teaching patients to use MyNetDiary and Withings Health Mate apps. Wilcoxon rank sum tests evaluated statistical significance. Validity of nutrient estimates was determined using Spearman correlations. [16].

Confidence levels improved significantly on all items measured for both PA and CN students ($P < 0.001$). During the objectively structured clinical examination, all students demonstrated effective communication skills with 98.4% successfully demonstrating of how to enter foods into the MyNetDiary app and 94.3% connecting the blood pressure cuff with the withings app, significant correlations were found when comparing MyNetDiary to Super Tracker (all $P < 0.001$). This study investigated and demonstrated the effectiveness of an expanded curriculum designed to enhance students' confidence and skills in providing lifestyle counseling incorporating the use of mHealth technology. This study demonstrated that an expanded curriculum focused on mHealth can improve skills and students' confidence in their use of MMAs and mobile apps to provide lifestyle counseling [16].

Early diagnosis of chronic diseases and monitoring of risk factors slow down the progression of diseases and may avoid adverse events in the everyday life of patients. An undetected chronic disease results in several complications that put patients in injury-risk situation. The chronic kidney disease (CKD) is a worldwide critical problem, especially in developing countries. CKD patients usually begin their treatment in advanced stages, which requires dialysis and kidney transplantation, and consequently, affects mortality rates. This issue may face by a mobile health (mHealth) application (app) . in this paper Alvaro Sobrinho et all, aimed to assist the early diagnosis and self-monitoring of the disease progression for people with chronic kidney disease considering quality attributes such as safety, effectiveness, and usability [17].

T. V. P. Sundararajan et all , proposed A remote mobile health monitoring system with mobile phone and web service capabilities in this paper. It provides an end-to-end solution; specifically, [18] physiologic parameters, including respiration rate and heart rate, are measured by wearable sensors and recorded by a mobile phone which presents the graphical interface for the user to observe his/her health status more easily; [19] it provides doctors and family members with necessary data through a web interface and enables authorized personnel to monitor the patient's condition and to facilitate remote diagnosis; and [20] it supports real-time alarming and positioning services during an urgent situation, such as a tumble or a heart attack, so that unexpected events can be handled in a timely manner. Experimental results show that the proposed system can reliably monitor the physiologic parameters and conveniently report the user's position [21].

3.1.2 Tele health system in radiation and contaminant areas:

Taking Precautions when we deal with radioactive materials and contaminated areas minimize the risk and may avoid adverse events in the everyday life of patients and medical staff. Telemedicine technology is a means of deploying medical resources with low cost and high efficiency. A set of remote radiotherapy system based on Citrix was designed proposed in this paper by Yu, L and his collogues, so that the senior radiation therapists from the developed areas can provide medical services effectively for the patients in the rural areas [22].This paper focused on the design ideas and the detail of the technical implementation of how to design a remote radiotherapy system based on the existing equipment in the primary hospital. And the technical reliability and security of the remote radiotherapy system were verified by the scientific test method with pairwise comparison. The early practical experience shows that through the remote radiotherapy system the primary radiotherapy personnel and the radiotherapy experts from third grade class-A hospital can form effective alliance in radiotherapy techniques to allow patients in rural areas to receive more professional radiation therapy[22].

Telemedicine is considered to be an important approach for medical education in rural areas. Due to a significant shortage of radiation oncologists in rural areas of Sichuan Province in China, a tele-radiotherapy system has been designed and developed for training radiation oncologists in the Sichuan Cancer Hospital and Research Institute. The whole process of the radiotherapy teaching platform was designed and established in the tele-radiotherapy system. A detailed radiation therapy process could be obtained in rural areas through the tele-radiotherapy system. Through the tele-radiotherapy system, oncologists in rural hospitals are trained at anytime and anywhere. And the experience of experts in the Sichuan Cancer Hospital and Research Institute is effectively and quickly conveyed to rural areas. A tele-radiotherapy system is considered to be an important means to promote the level of radio therapy and to solve the shortage of radiation oncologists in rural areas [23].

Allison Gossen1, Beth Mehring2, Brian S. Gunnell3, et al; developed a Novel application of technology such as telemedicine (in this application, defined as real-time video-enabled interactive services) has the potential to reduce exposure risks for HCPs caring for patients with EVD while conserving PPE., they developed an internal network of telemedicine technologies, designated the University of Virginia Health System Isolation Communication Management System (iSOCOMS) [24].

The Johns Hopkins Hospital created a high-level isolation unit to manage the comprehensive and complex needs of patients with high-consequence infectious diseases, including Ebola virus disease. The unique challenges of and opportunities for providing care in this high-level isolation unit led the authors to modify the hospital incident command system model for use during activation. This system has been tested and refined during full-scale functional and tabletop exercises. Lessons learned from the after-action reviews of these exercises led to optimization of the structure and implementation of ICS on the biocontainment unit, including improved job action sheets, designation of physical location of roles, and communication approaches. Overall, the adaptation of ICS for use in the high-level isolation unit setting may be an effective approach to emergency management during an activation [25].

3.1.3 Tele-Healthcare Monitoring System Using java:

In This paper Ogunniyi, J. et all, presents a design, implementation and evaluation of Tele-healthcare monitoring system with the aids of GPS, smartphone and cellular network infrastructure to monitor patients with diabetes especially during diabetic emergencies. This system depends on remote monitoring of patient when away from the place of domicile or their treating doctor or family members using patient’s data. Patient can also be linked to nearby hospitals using GPS and the attending doctors would have access to patient’s data. Alarm is also issued by the system to the next-of-kin/family members or care giver by sending emergency SMS including the location, time and patient’s clinical condition. The developed system consists of mobile application and web based application. The Mobile application was developed with JAVA programming language and SQLite database [26].

From all that mentioned and achieved from previous studies it’s strongly recommended to use telehealth system to minimizing radiation hazards for medical staff working in nuclear medial department.

CHAPTER FOUR

METHODOLOGY

In this part, we will explain how to use the Tele health system to develop a communication method for patients in radioactive iodine isolation rooms.

We created various forms for different departments like medial statics, doctors, medical physicist, nurses, biomedical engineer and patient itself using Java language. Through the upcoming steps:

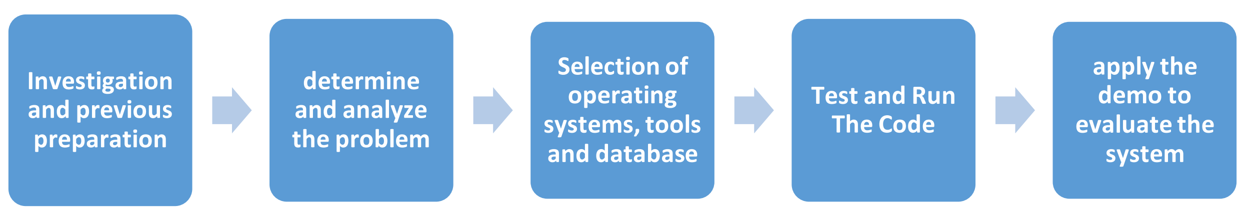


Figure (4.1). Methodology steps block diagram

4.1 Investigation and preparation:

Aiming at this telehealth system, a systematic survey has been done through Different methods including meeting with related medical expert, and internet search.an initial understanding of radioactive iodine treatment has obtained. The nuclear medicine specialist interviews the patient to determine the type of the disease and the suggested dose, and then transfers him to the Medical Statistics Department to record his data and determine the time of the dose. When the patient enters the isolation room in order to take the dose, a complete follow-up process begins by the nurse and medical physicist directly and by the doctors and medical engineer when any problems occur .The patient takes an average of four to five days in the room and then is transferred to the gamma-camera department to do a bone scan to evaluate the treatment.

4.2. Determine and analyze the problem:

Firstly we studied the work system in the nuclear medicine department, especially in the radioactive iodine rooms. We analyzed the system and identified problems related to patient and staff safety, we face lake of observation problem for patients in iodine isolation rooms and nurses that lead to series problems .so I try to develop a way for communication through audible messages and chatting methods with maintaining the quality of the treatment process.

4.3 Selection of operating systems, tools and database:

We choose proper programming language and here we used java with eclipse code environment which is *free* and *open-source* Java Integrated Development Environment (IDE), surly we need The Java Development Kit (JDK) to create Java programs that can be executed and run by the JVM .To store all this data in an organized manner we have used SQL from xampp development environment. And we used Apache Tomcat which is popular open source web server and Servlet container for Java code.

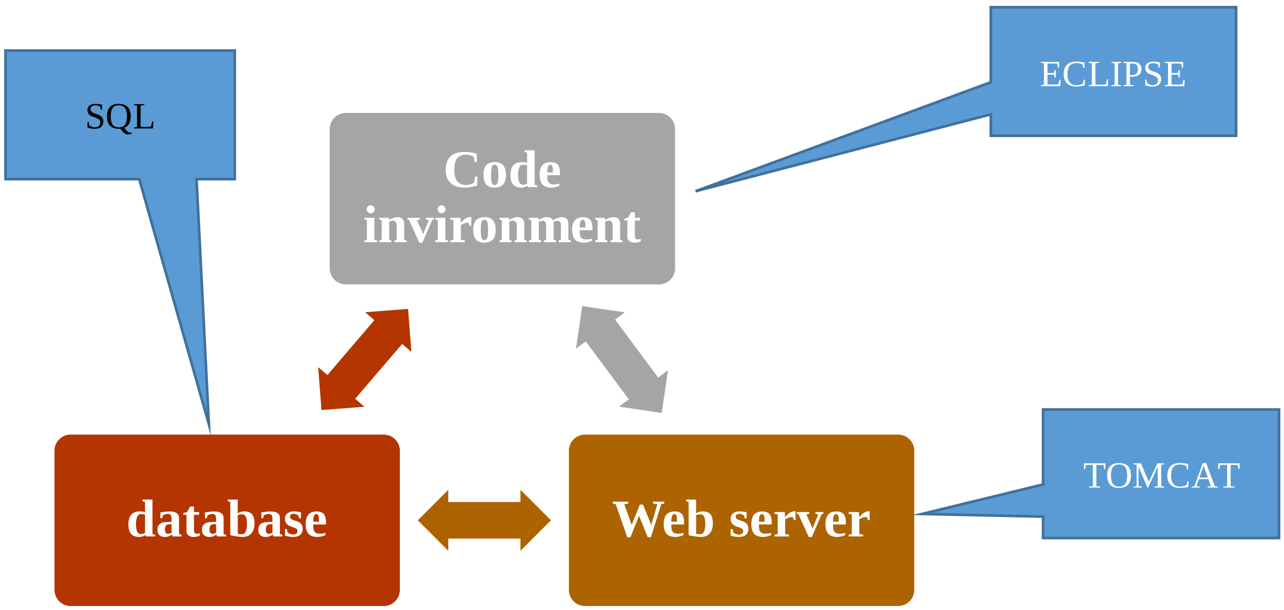


Figure (4.2): System Architecture Design

4.4 Test and Run The Code:

First, it is necessary to ensure that the code works by simulating the system and initially testing it to ensure its work and efficiency before circulating it to the concerned departments.

4.5 Apply the demo to evaluate the system:

After designed the system, built and installed, assessment will be needed in order to measure its efficiency and usefulness, a demo will be used by different technical and medical department those work in nuclear medicine which they are:

- **Doctor :**

The doctor performs clinical examinations and sees the results of the tests to determine the appropriate dose for the patient, follow up the patient's condition during isolation and evaluate his condition after preview the bone scan image.

- **Medical statistician:**

The employee in the Medical Statistics Department takes the patient’s data and records it to determine the available time for taking the dose then he will inform the patient.

- **Medical Physicist:**

Nuclear medical physicists work with nuclear imaging instrumentation and radiation dosimetry. They are considered experts in dealing with the interactions between ionizing radiation and matter. He can perform tests on new equipment, develop and maintain a quality control program for equipment, make dosimetric calculations or create computer programs for clinical use.

To guarantee proper safety of patients, co-workers, staff and the public, many nuclear medicine physicists are involved with radiation protection work. Patients are only allowed to return home, or be transferred to another Ward, once the activity of Iodine-131 within the patient has fallen to a sufficiently low amount. The activity of Iodine-131 will be monitored by Medical Physics staff to determine when the patient may be released

- **Nurse:**

Patients may receive radioactive iodine therapy as both in-patients and out-patients and nurses roles is to deliver safe care to patients undergoing therapy.

- **Medical engineer.**

They responsible of assuring that all medical equipment in the isolation rooms are working before entering patients, and they must be ready in the event of any malfunction while the patient is inside the room.

- **Nuclear Medicine Technologist**

A nuclear medicine technologist works closely with the nuclear medicine radiologist. The technologist perform imaging procedures

During an imaging procedure, the nuclear medicine technologist works with the patient. The technologist obtains important patient history, describes imaging procedures and answers questions, monitors the physical condition of the patient during procedures and takes note of patient comments that may be useful to the physician in interpreting procedure results.

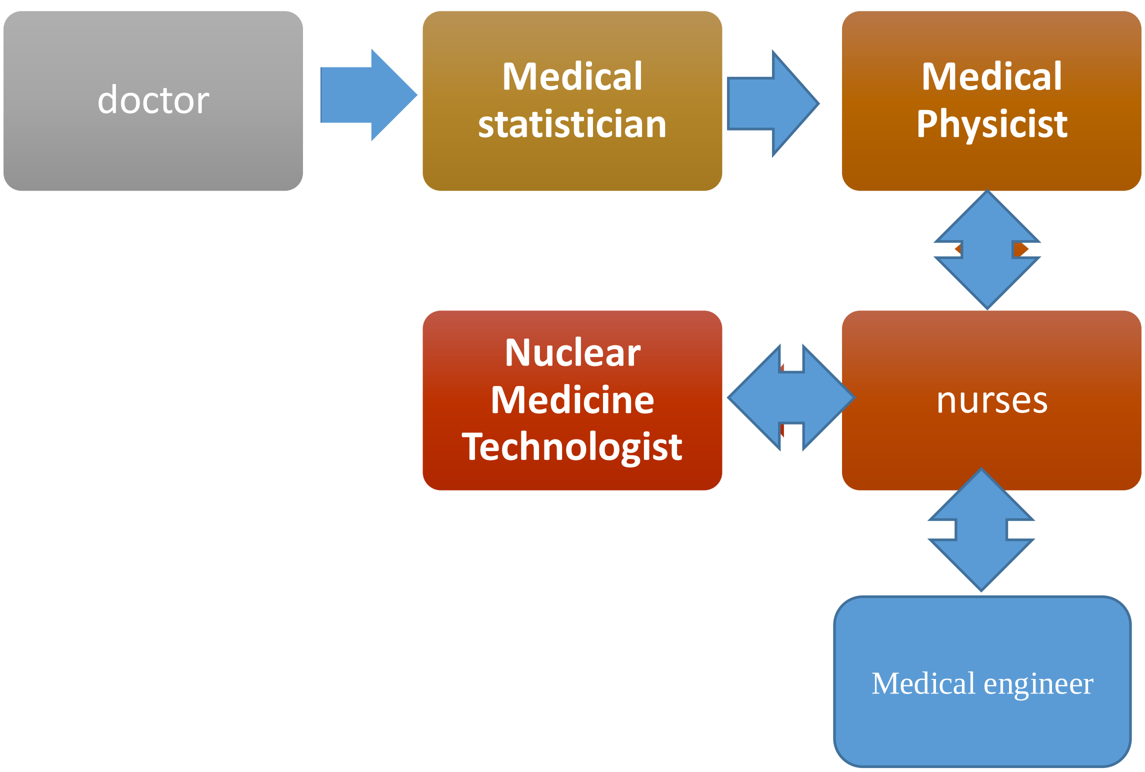


Figure (4.3): Team work in NMD

The mechanism of the system is based on the need of rapid communication between the different departments and establish a method for rapid communication between the patient and the nurse, especially in emergency cases.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1 Satisfaction questionnaire for the system:

Table 1 Questionnaire for nurse satisfaction of the system				
Was it easy to deal with the system	Yes	76.2	No	23.8
Is the system beneficial for your practice?	Yes	90.5	No	9.5
Did you find the system service Feasible and convenient?	Yes	90.8	No	9.2
In term of radiation exposure will the activity be less than when applying traditional way of treatment?	Yes	98	No	2
Would like to promote your colleagues toward tele-health service?	Yes	90.5	No	9.5
Is the time factor for the treatment process better than the traditional method?	Yes	90	No	10
is the system provides desirable results in Your patient's diagnosis/treatment process?	Yes	92	No	8

Table (5.1). Questionnaire for nurse satisfaction of the system

When the demo launched in the center we make a Questionnaire for The Nursing Department, because they are directly responsible for the health of the patient and the most medical staff enters the isolation rooms during the presence of patients, meaning they are the most exposed to radiation and as we saw in the table (5.1) we face technical problem with using the system which mean we need more training period for the staff to be familiar with system. But the good things in term of minimizing radiation hazard 98 % of the nurses said the system will solve that critical problem and will be good method in protection process That mean we fulfil one of the main objective of the thesis with high rate.

5.2 System launching :

The result from the previous chapter will be shown in the next figures when run the system to find the specific information. The first page shows the system interface in which the user name appears TTCRC Information system

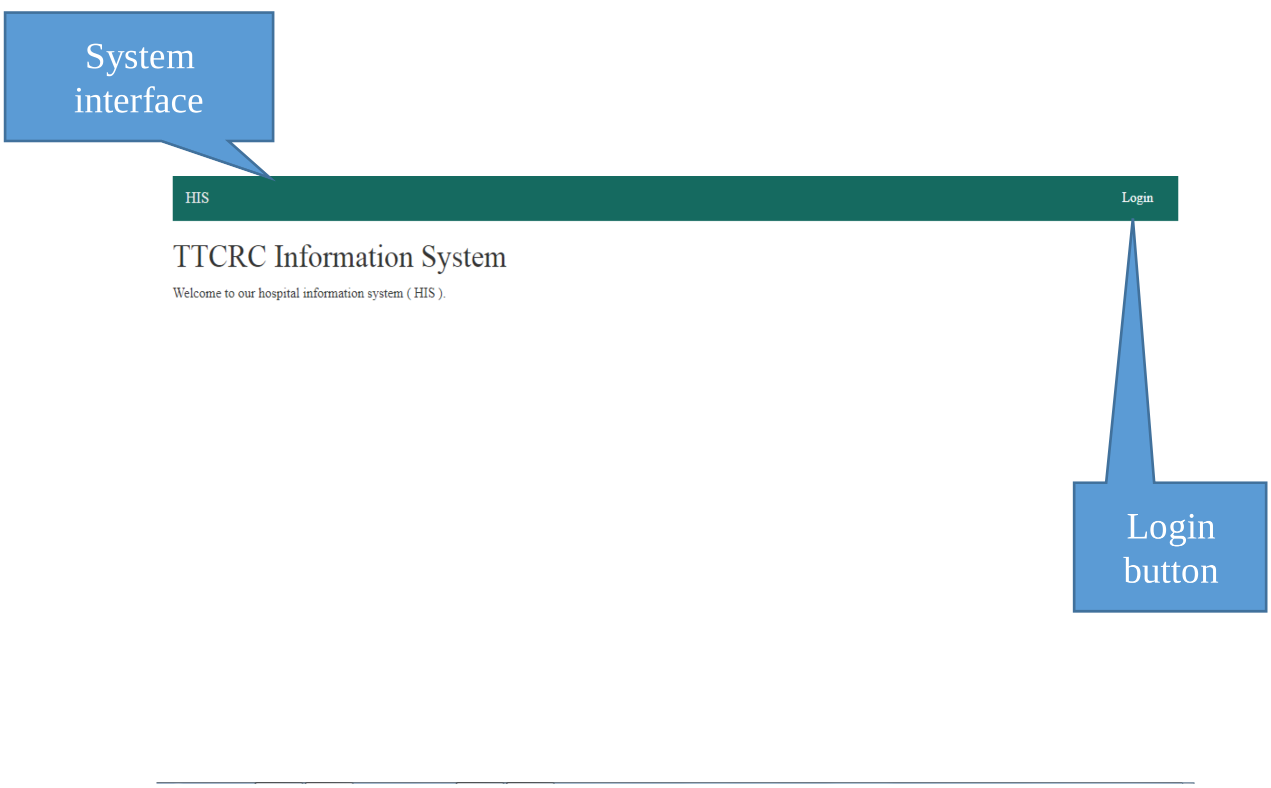


Figure (5.1): The system interface

The next page appears after pressing login from the main page, the person could enter the system according to the user name and password of the department to which he belong.

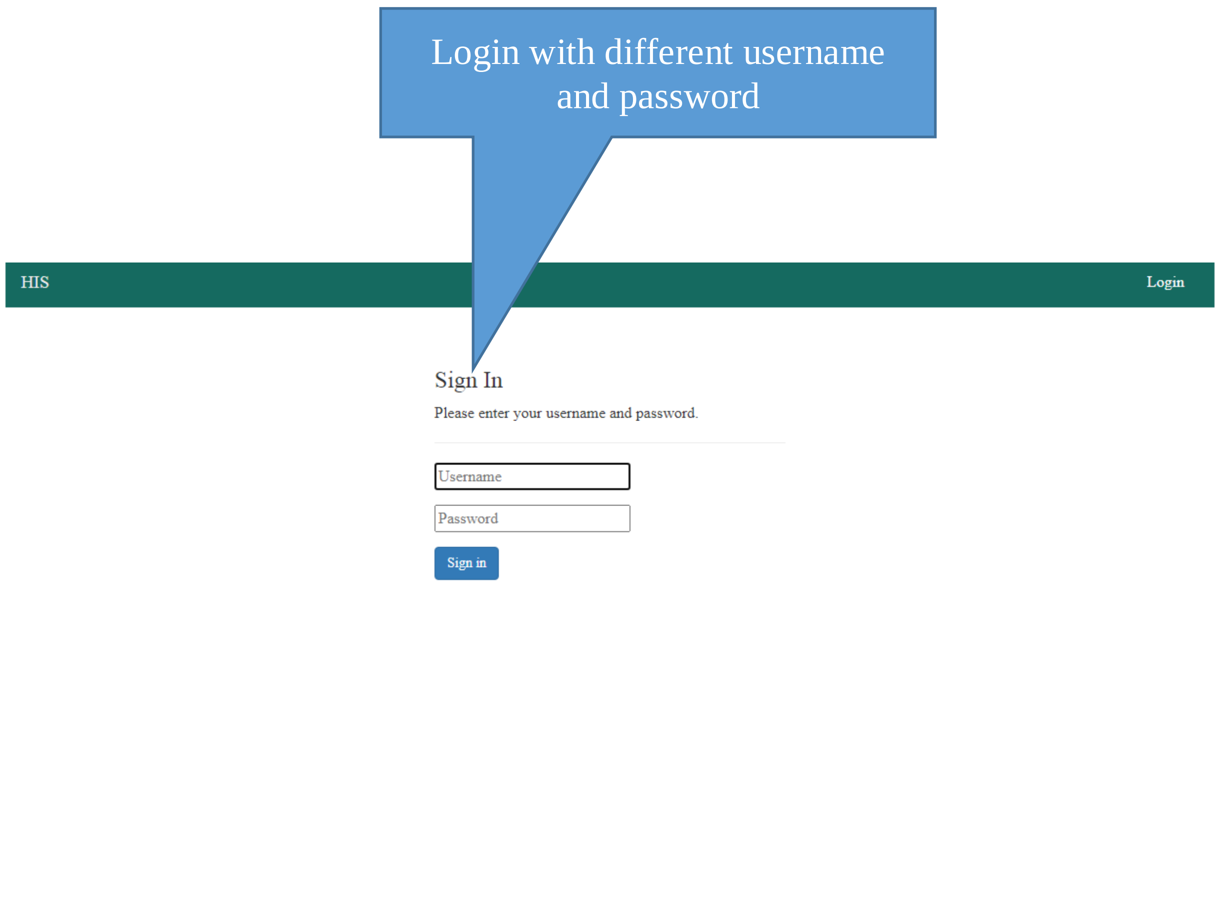


Figure (5.2): login page

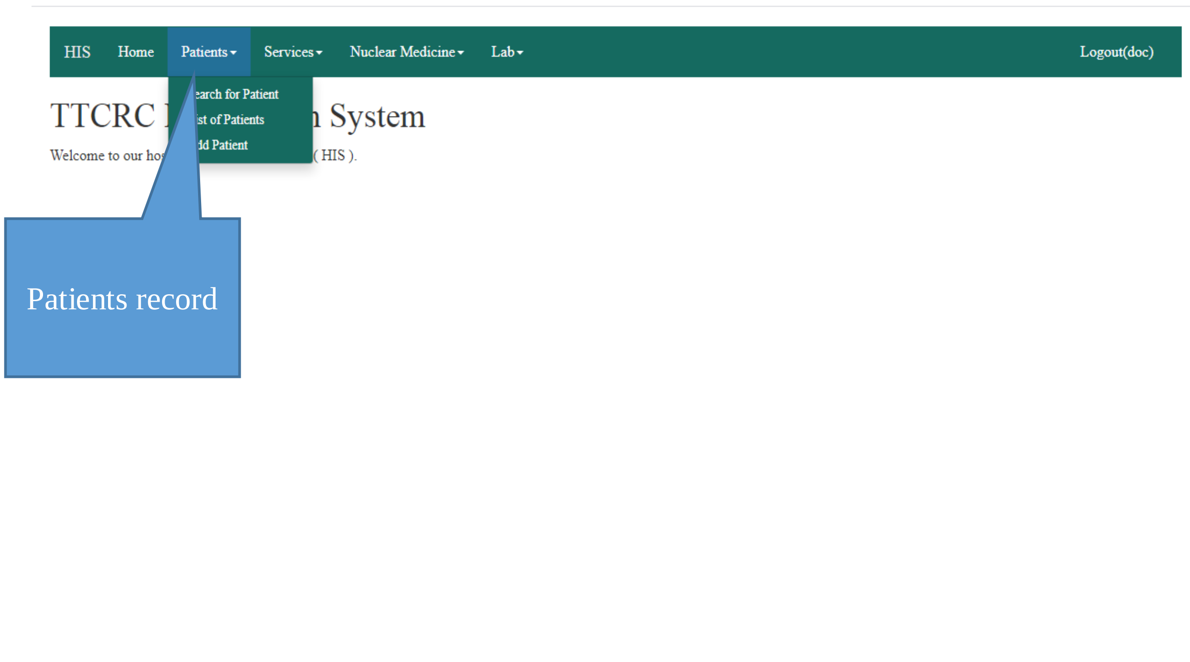


Figure (5.3): The patients' record

From patients bottom we can make the upcoming tasks:

1-search for patient data by entering his/her name.

2- Find the list of patients.

3- Add a new patent

The figures(5.3),(5.4) and (5.5) illustrate the patient Registration section where are records of all patients are stored and then assigned a unique registration id, which can be used later, view or update the details of that particular patient and they can add new one.

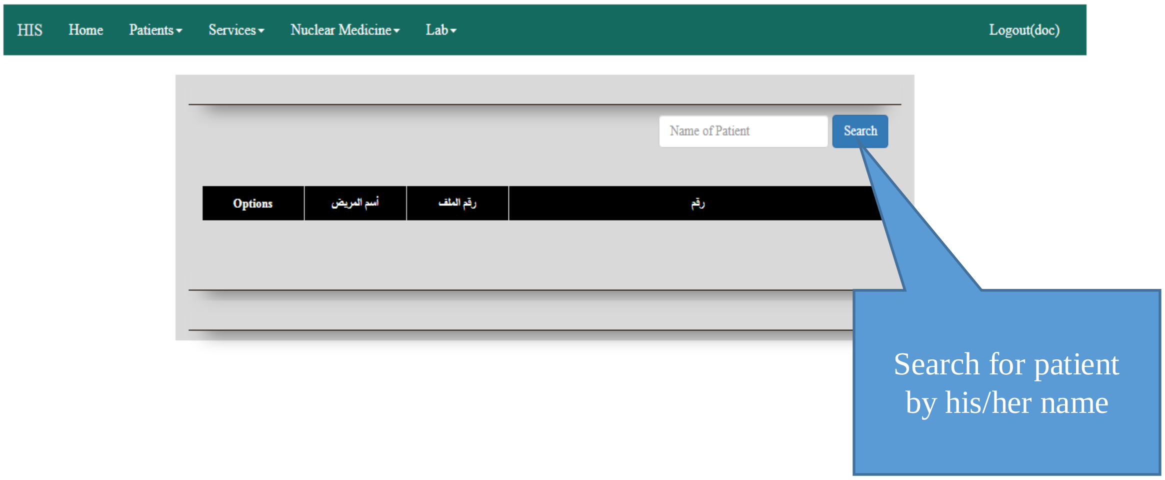


Figure (5.4): search of patient page

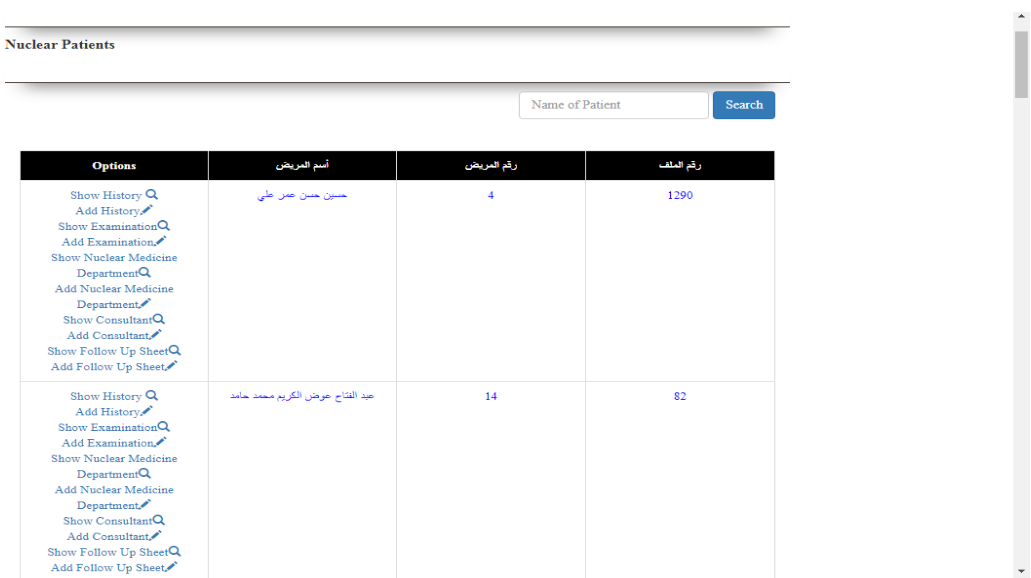


Figure (5.5): radioiodine patients' record

The upcoming figures for medical physicists who are responsible for monitoring patient activity and record it. Patients are only allowed to return home once the activity of Iodine-131 within the patient has fallen to a sufficiently low amount.in figure (5.6) illustrate dosage measurement for the patient activity. Figures (5.7) and (5.8) explain decontamination process, to guarantee proper safety of patients, co-workers, staff and the public, many nuclear medicine physicists are involved with radiation protection work. And one of their roles is to perform decontamination process which is a process that renders whole area mean isolation rooms safe to enter. Sterilization, disinfection, and antisepsis are all forms of decontamination.

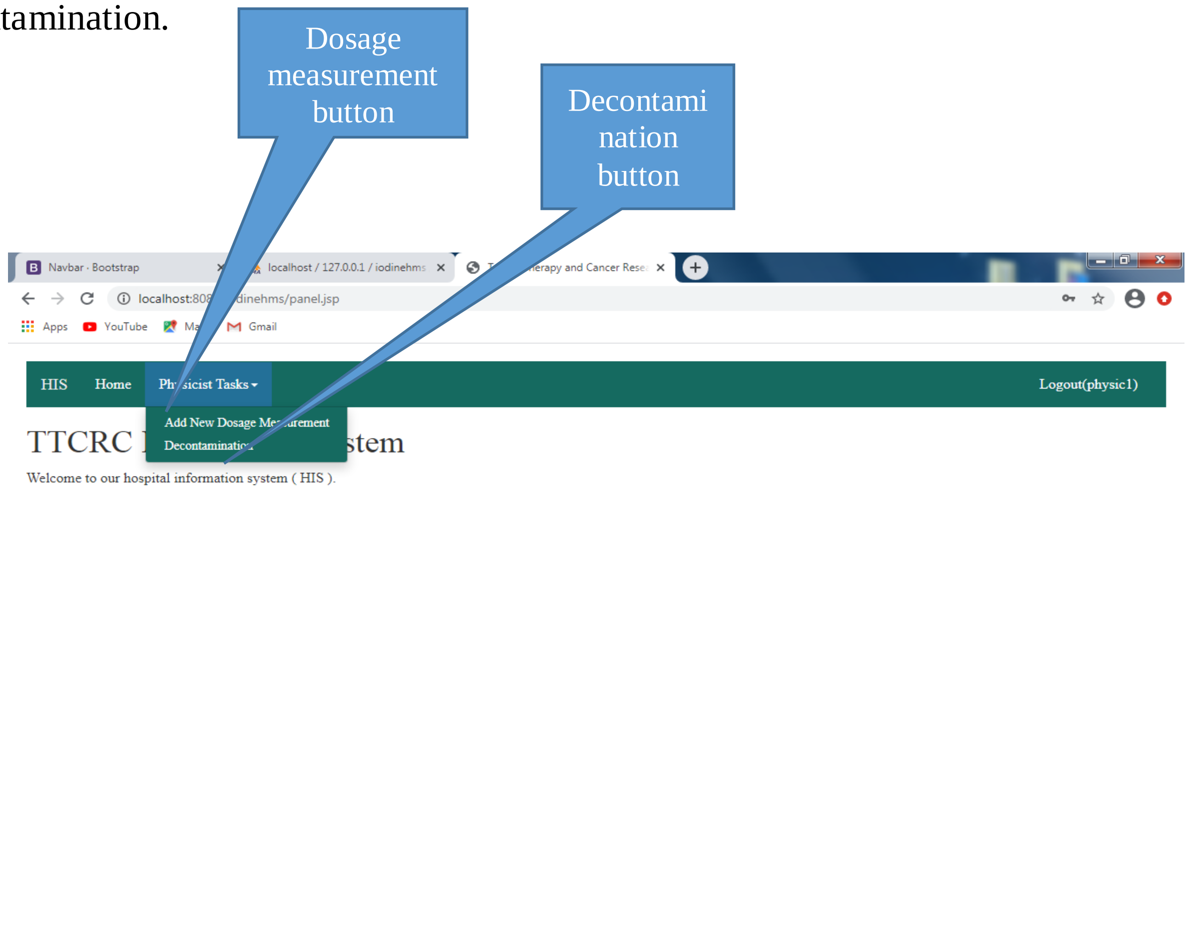


Figure (5.6): medical physicist tasks

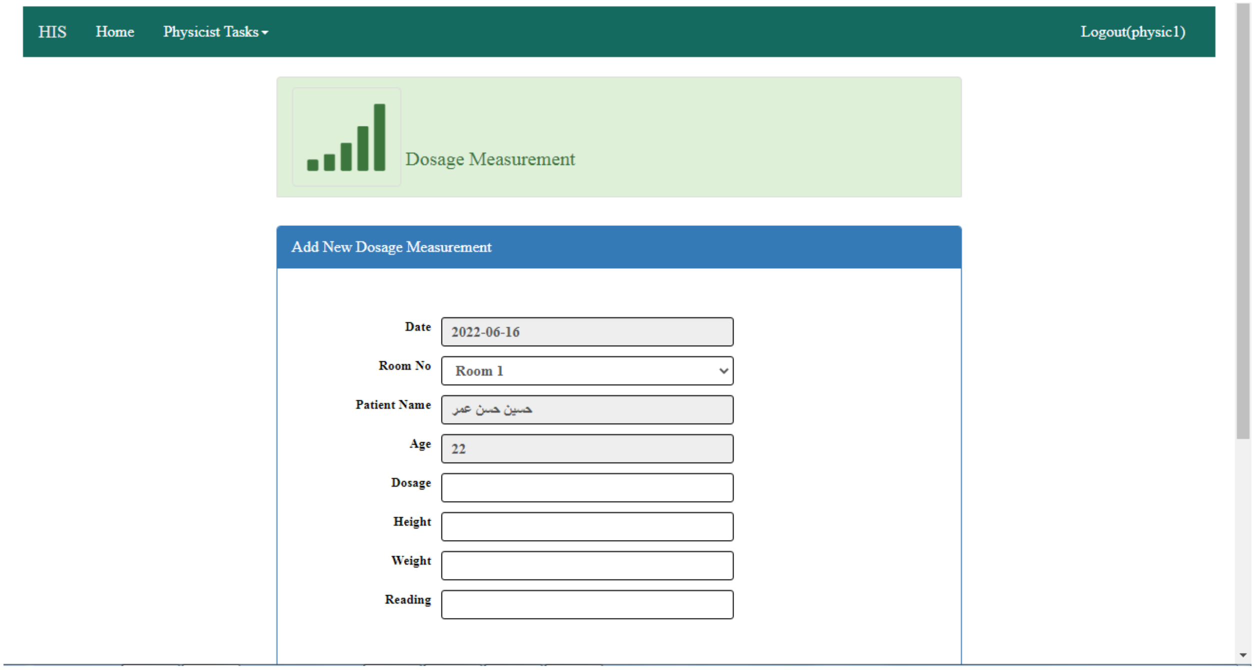


Figure (5.7): dosage measurement form

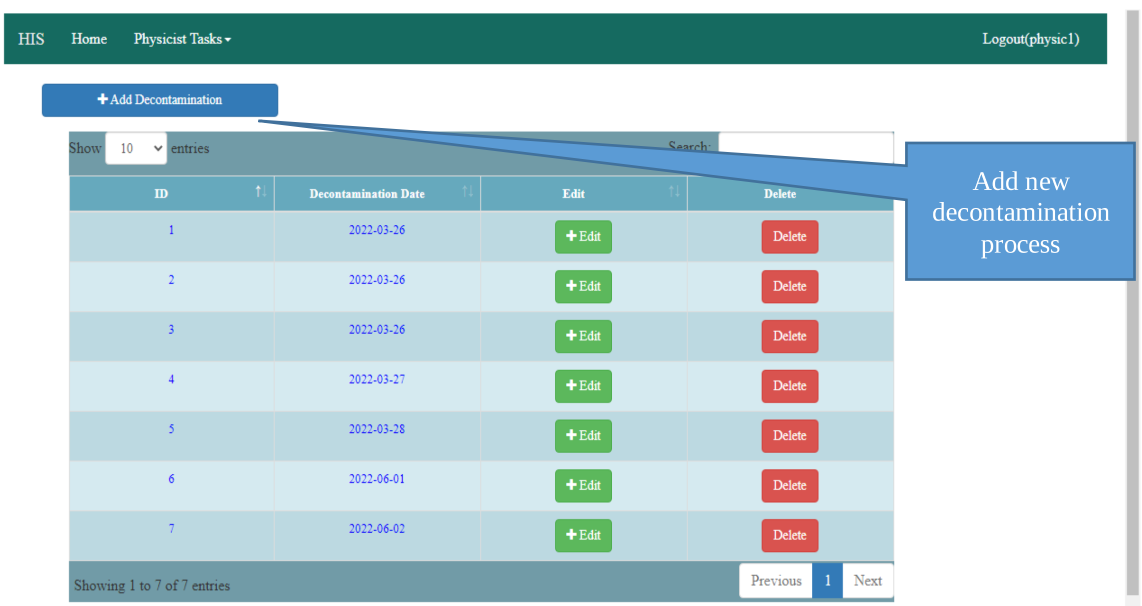


Figure (5.8): decontamination page

The next figures illustrate the biomedical engineer role in isolation rooms which is insuring the efficiency of equipment before the patient enter the room and then be ready if there any malfunction in any device .

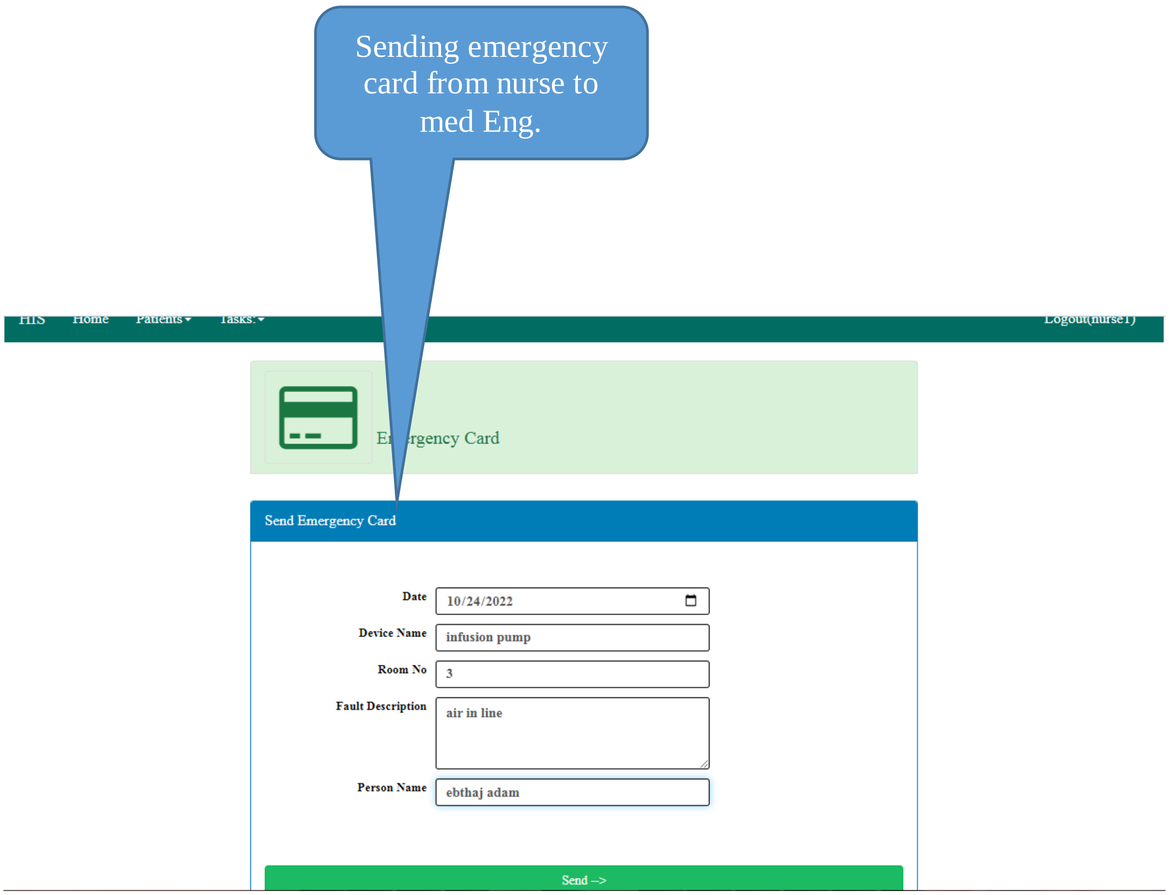
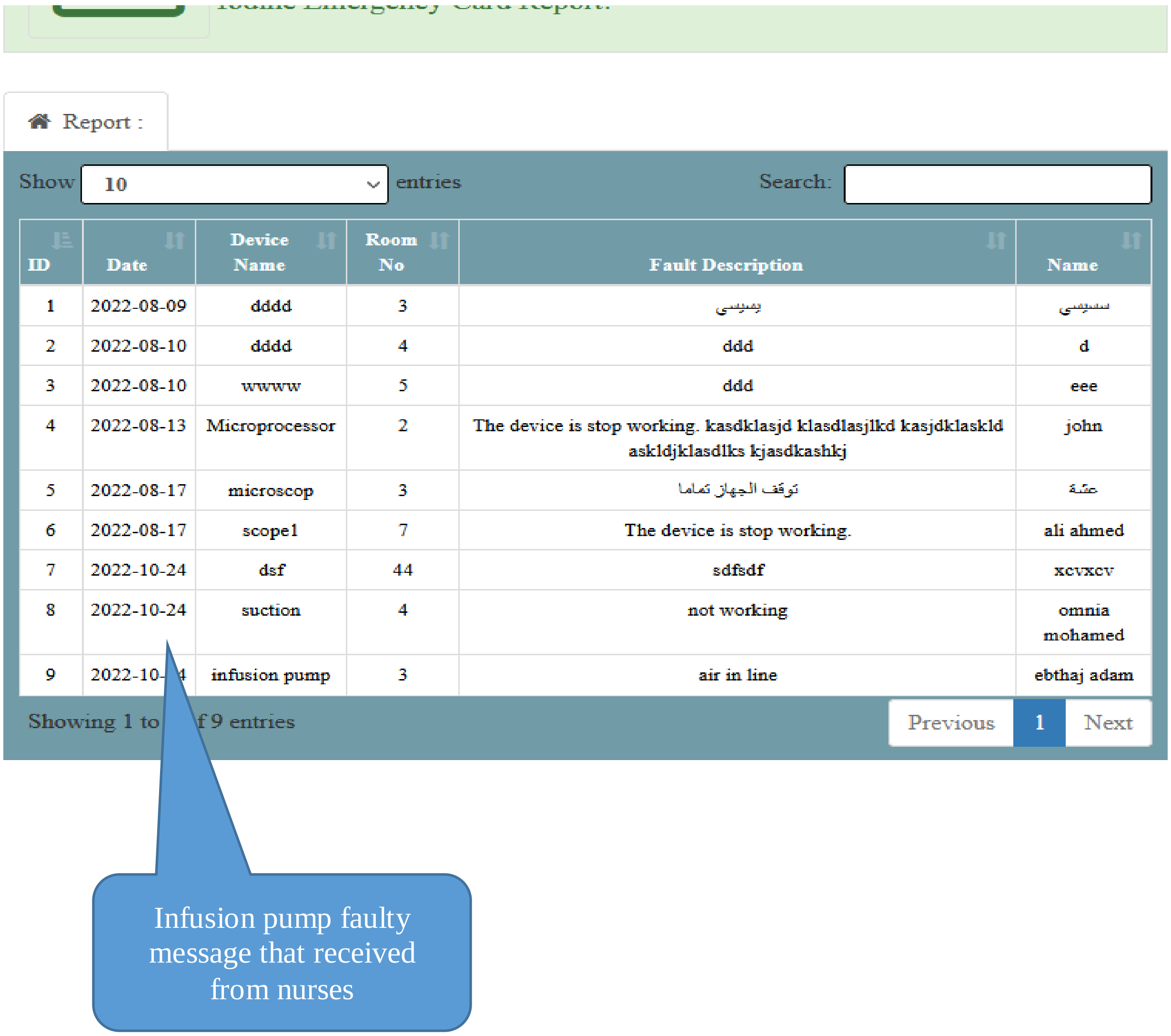


Figure (5.9): emergency card



ID	Date	Device Name	Room No	Fault Description	Name
1	2022-08-09	dddd	3	يسيسي	سسيسي
2	2022-08-10	dddd	4	ddd	d
3	2022-08-10	wwww	5	ddd	eee
4	2022-08-13	Microprocessor	2	The device is stop working. kasdklasjd klasdlasjlkd kasjdklaskld askldjklasdlks kjasdkashkj	john
5	2022-08-17	microscop	3	توقف الجهاز تماما	عشة
6	2022-08-17	scope1	7	The device is stop working.	ali ahmed
7	2022-10-24	dsf	44	sdfsdf	xcvxcv
8	2022-10-24	suction	4	not working	omnia mohamed
9	2022-10-24	infusion pump	3	air in line	ebthaj adam

Figure (5.10): emergency cards list

- As we saw in figures (5.9) and (5.10) there is a problem in the infusion pump at on of the rooms so a nurse send an emergency card for medical engineers to solve the problem .

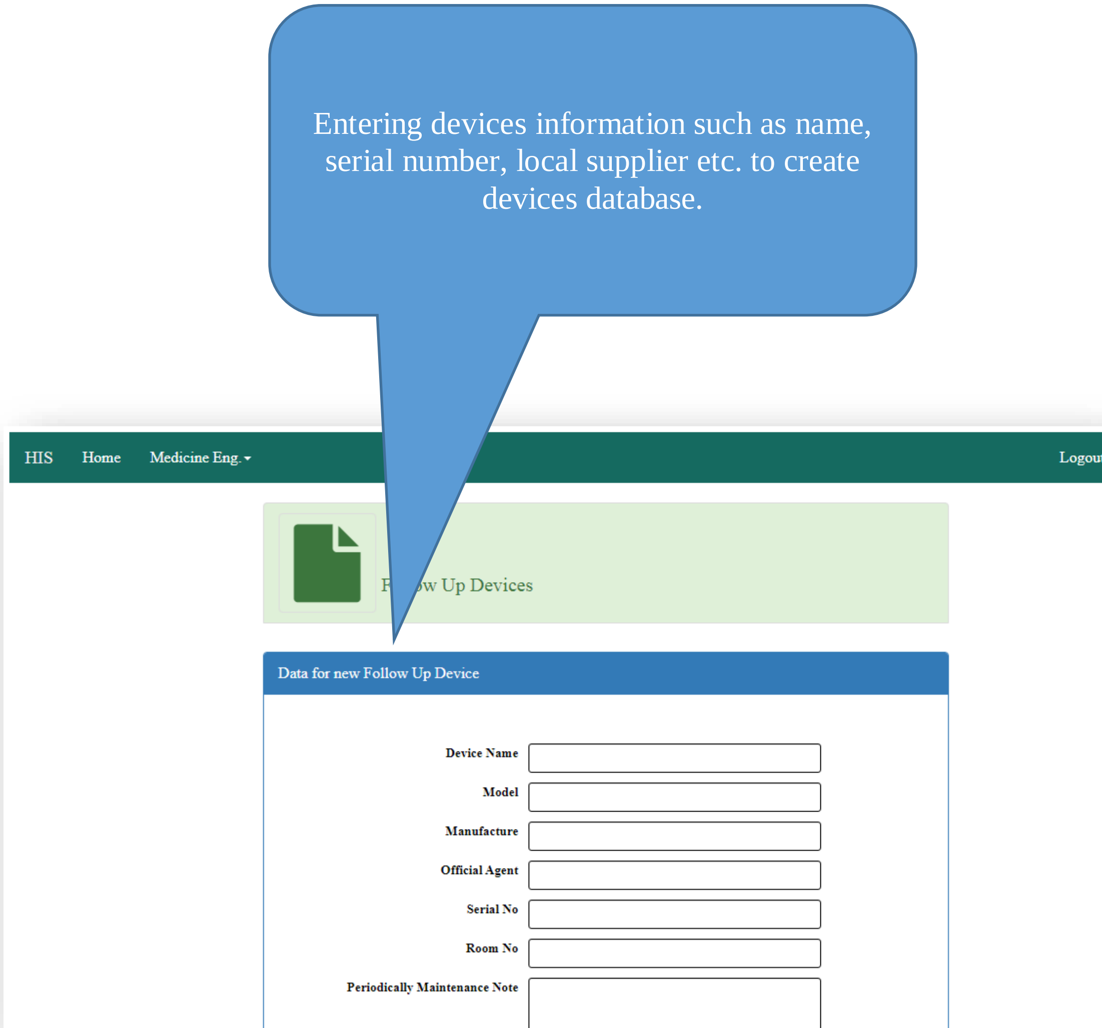


Figure (5.11): follow up devices

As shown in figure (5.11) a biomedical engineer can save a record for any device in NMD contented important information such as S/N, agent and manufacture.

The next figures will illustrate the core of this project which is direct communication between nurses and patients in the isolation rooms. There is direct chatting page to ensure continuous follow-up of the patient while minimizing exposure for nurses. In emergency cases and when it is difficult for the patient to send a message, he can press the alarm button, and an alert message will be sent to the nurse attached with the room number.

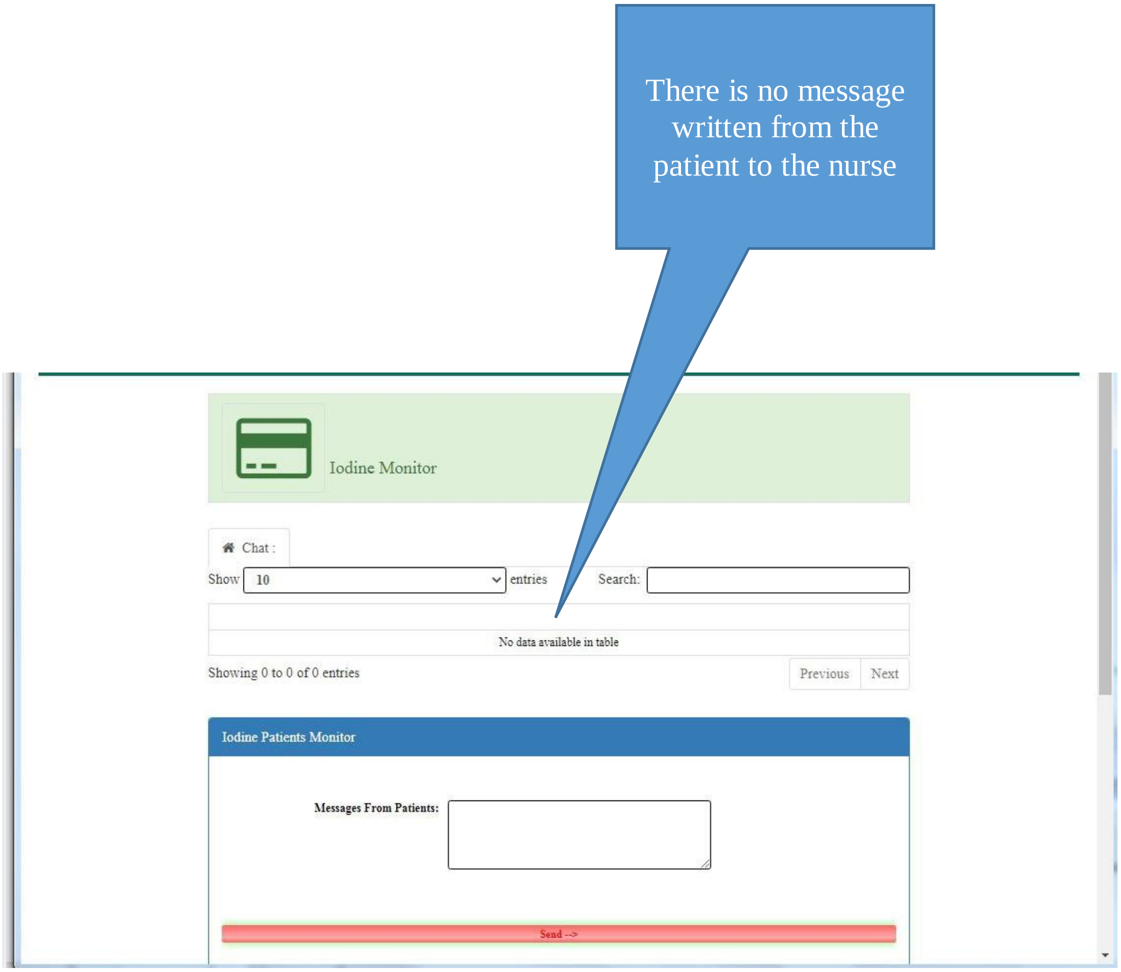


Figure (5.12): patient /nurse chatting and alarm page

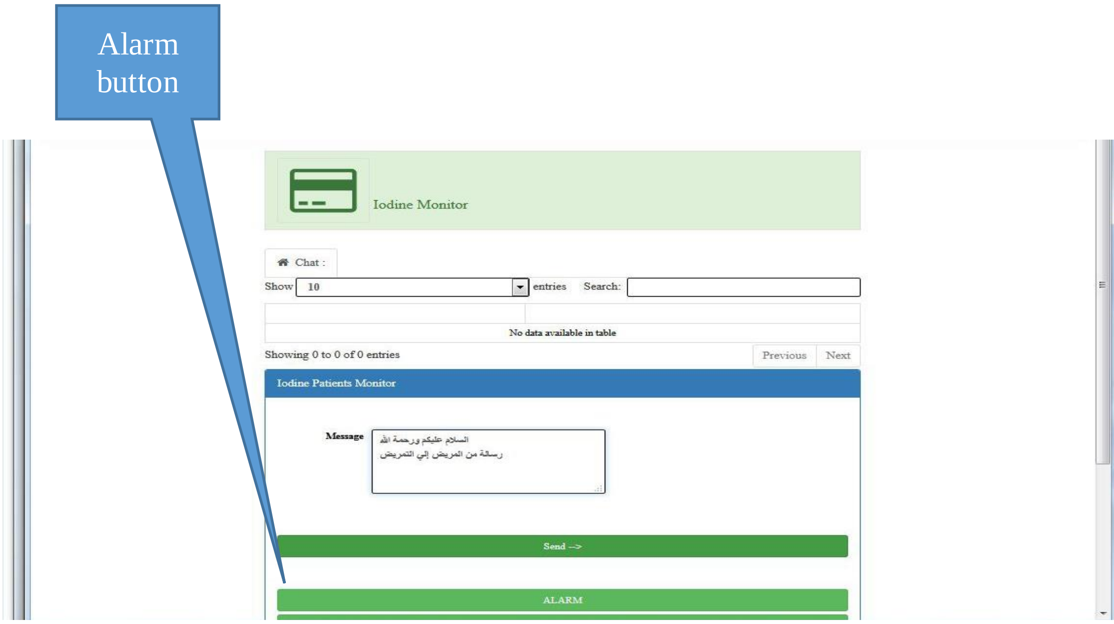


Figure (5.13): patient /nurse chatting and alarm page

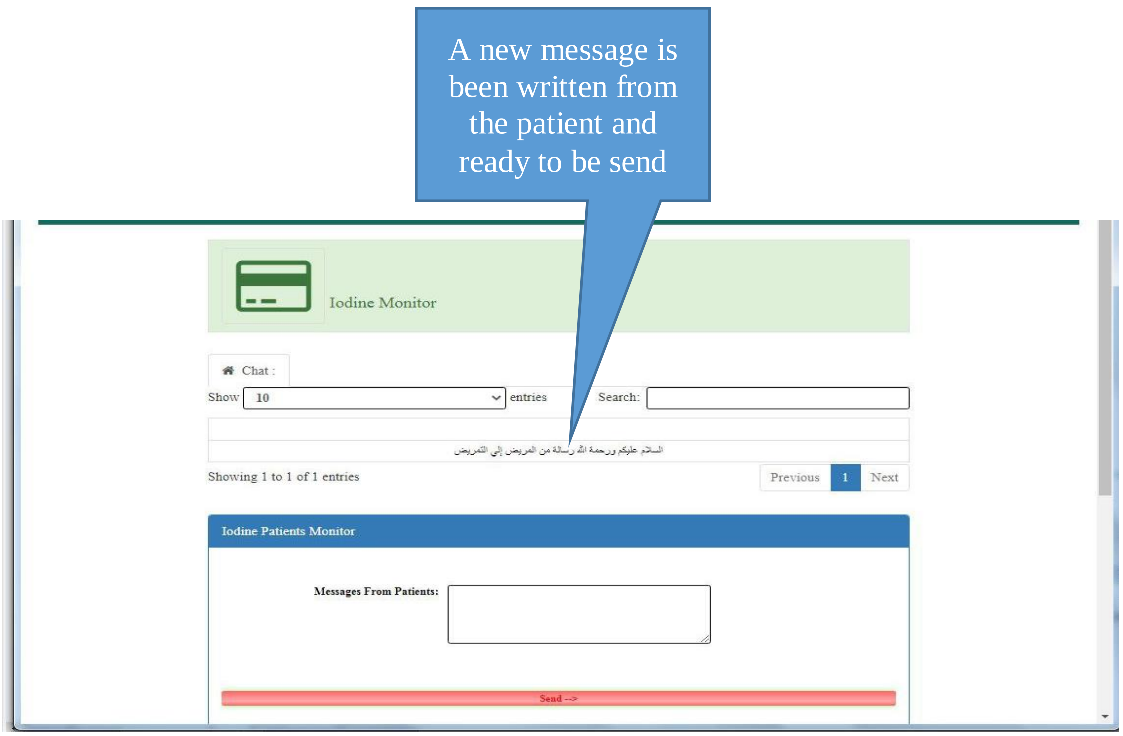


Figure (5.14): patient /nurse chatting and alarm page

Figure (5.14) illustrate that patient send a new message to the nurses and can get a quick response.

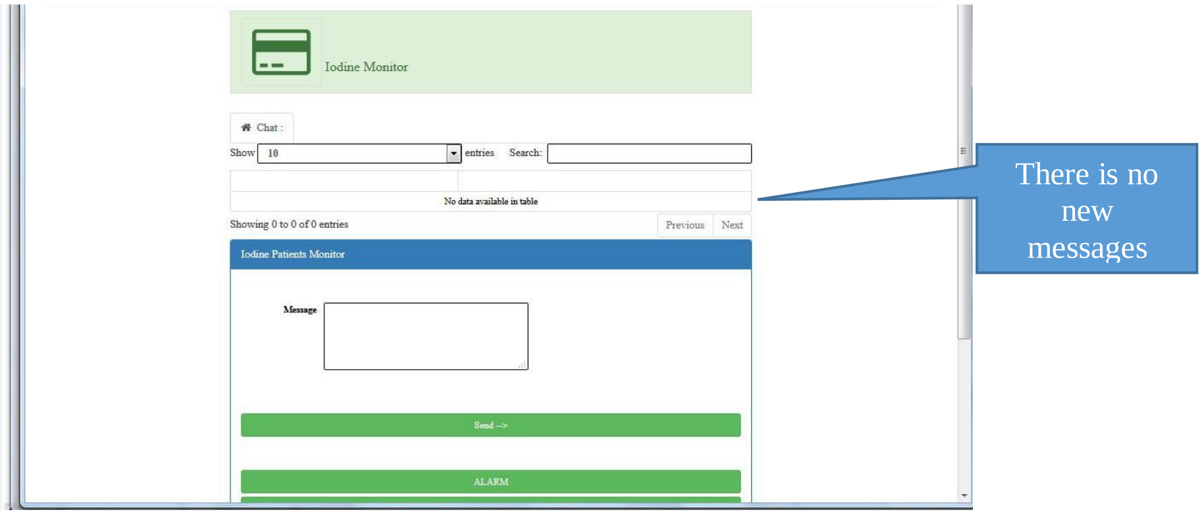


Figure (5.15): nurse/patient chatting and alarm page

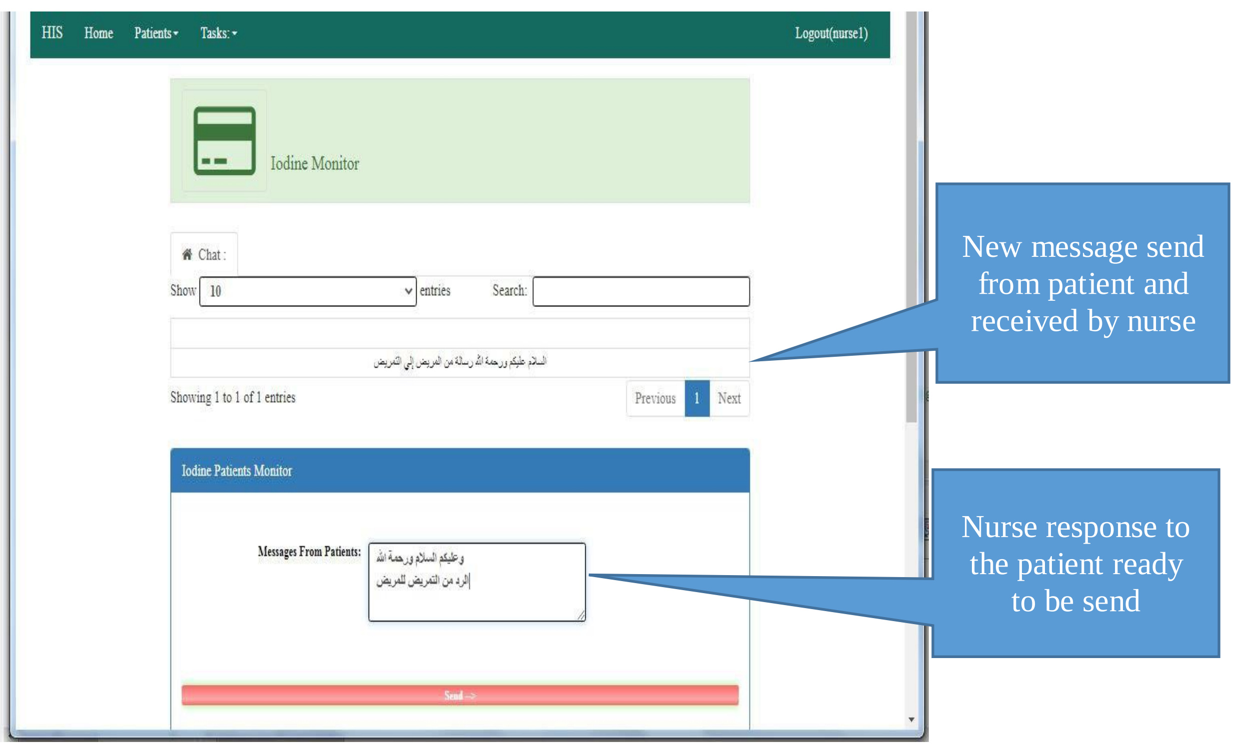


Figure (5.16): nurse/patient chatting and alarm page

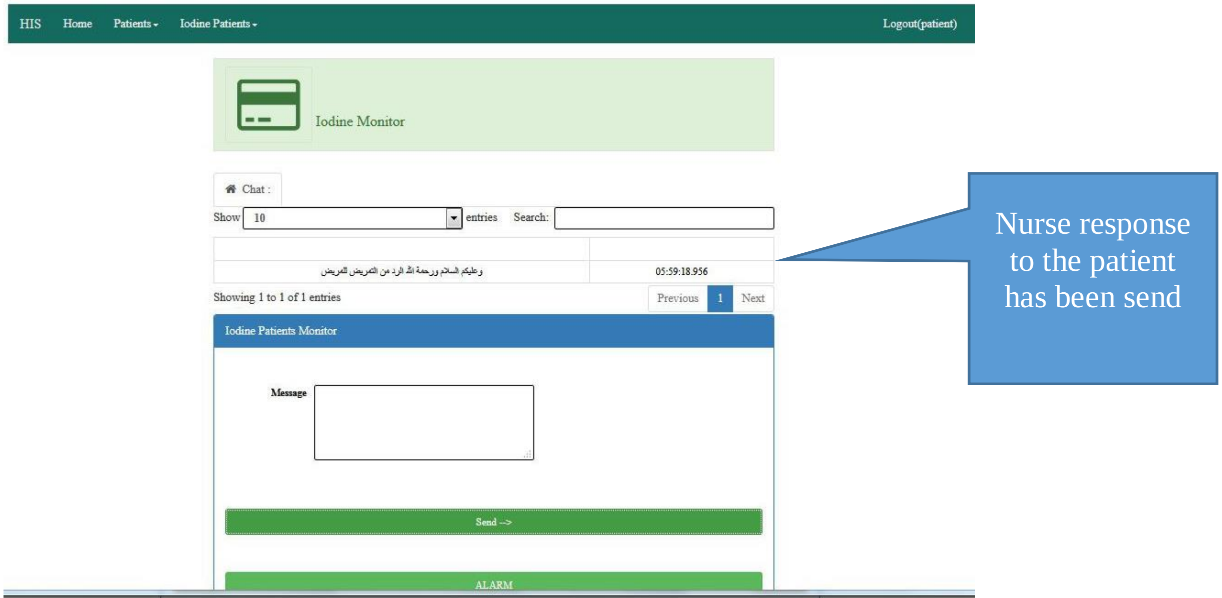


Figure (5.17): nurse/patient chatting and alarm page.

- Patient / nurse chatting window will minimize exposing dosage by controlling nurses entering to the patient room and in the other hand help patient that has a fear problem of being alone in the isolation room for the 5 days by making a direct and continuous communication line between him and nurses.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion:

The main purpose of the project is to establish reliable electronic system using java language in order to organize work in radioiodine department

a proper programming language was chosen which is java with eclipse code environment and it is free and open-source Java Integrated Development Environment .And also we used Apache Tomcat which is popular open source web server and Servlet container for Java code. The problem with the paper system is that it is exposed to damage most of the time. The electronic system is considered a solution to this dilemma. In the case of our center and areas with radioactive risk or infectious diseases, telemedicine is one of the methods of prevention and protection from a particular danger.

Finally, a prototype system has been designed and implemented. Through testing, it was found that that the electronic system is more efficient than the traditional system previously applied at the center

6.2 Recommendations:

- Develop a mobile application to make the communication process easier.
- Improve the data security level.
- Use barcode system that lead to quick dealing with patient data.
- Apply the system in TTCRC, making assessment and develop the communication system.
- Use a voice message tool instead of writing.

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APPENDEX:

Questionnaire for nurse satisfaction of the system:

1/ was it easy to deal with system?

- Yes
- No

2/ is the system beneficial for your practice?

- Yes
- No

3/ did you find the system service Feasible and convenient?

- Yes
- No

4/ in term of radiation exposure will the activity be less than when applying traditional way of treatment?

- Yes
- No

5/would you like to promote your colleagues toward tele-health service?

- Yes
- No

6/ is the time factor for the treatment process better than the traditional method?

- Yes
- No

7/ is the system provides desirable results in your patient's diagnosis/treatment process?

- Yes
- No