Special Issue for 3rd International Conference on Information Literacy
Issue 73, December 2024
DOI: 10.70000/cj.2024.73.620

Cybrarians Journal
E-ISSN 1687-2215

Architectural design for remote patient monitoring system implementation in haematology units: a proposed model

Research – Literature review

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Abstract

Information and communication technology (ICT) has been pivotal in healthcare. In particular, wireless communication and wearable sensors technology have garnered more attention in healthcare. They allow for real-time healthcare monitoring systems, early diagnosis, and timely treatment, which can significantly reduce unnecessary loss of lives primarily due to delays of response healthcare providers, Furthermore, low healthcare professionals-to-patient ratios.

This study proposes a framework of remote patient monitoring (RPM) for managing haemophilic children in Egypt. This program is designed for health data management inside the Regional Blood Transfusion Center (RBTC) at the Therapeutic Unit in Alexandria. Meanwhile, it employs a descriptive-analytical method to investigate the impact of Wireless Body Sensor Networks (WBSN) on the timely collection of physical health data. Moreover, this study outlines a planning strategy for integrating Wireless Body Area Network (WBAN) technology into telemonitoring systems, emphasizing its applications within healthcare, particularly in haematology.

The results of this study indicate the effectiveness of RPM in improving patient experience, and medication compliance, and reducing hospital readmissions. RPM monitors wirelessly patients' physiological parameters in real-time transmitting data to the Electronic Medical Record (EMR) in real-time, and alerting healthcare providers when abnormal readings are detected. The study concludes that home therapy can

lead to prompt and optimal treatment, thereby reducing pain, dysfunction, and long-term disability for patients.

Keywords

Wireless Body Area Network (WBSN); Remote Patient Monitoring (RPM); Medical information

2. Literature review

One of the most important studies of RPM is (Demir et al.2017) which presented an integrated system design that allows collection, recording, and transmission through a cloud application of the data from different sensors placed in the house of a person having dementia. This system is based on the Internet of Things (IoT) where information from smart things around us can be evaluated and transmitted over the internet. The system used seven kinds of sensors placed in four different locations in the house. The system was developed to identify activities and their logical consequences in such a way that actions done halfway or forgotten (situations such as the forgetting tap open, the oven door open, the doors and the windows open, etc.) are reminded to the patient as well as to his caregiver/doctor. These situations are also sent as photo notifications through the Pushbullet application, which runs on an Android operating system. it also Situations such as fire hazards that are of vital importance for the patient can be detected in real time.

Whereas (Malasinghe et al.2017) discussed contact and noncontact monitoring - based on images in the RPM system., that all methodologies focus on human vital signs extraction, they addressed heart and blood-related systems, fall detection systems, brain and nervous system-related systems, diabetics, and mental health as the deterioration of these vital signs affects the human health system. Furthermore, this study analyzed the developments in the remote health monitoring field from 2012 to 2016, with high scope on the activity detection of patients like fall detection and mobility-related diseases. The authors reviewed ambiance device-based and vision-based fall detection systems but addressed significant problems like higher accuracy, precision, dependability, and usability that remain pending for contactless monitoring. While (Boccalandro et al.2019) emphasized the importance of telemedicine which has been increasingly

proposed as a way to provide persons with hemophilia PWH with a range of services designed to improve their health, saving the time and cost involved in going to the treatment center, and increasing therapeutic adherence. The authors expressed available tools for managing hemophilia such as videoconferencing, mobile phones, wearable sensors, and serious games (exergames) for telerehabilitation. In general, the study pointed to the need of extensive data in the near future through participation of different centers specialized in hemophilia, with respect to privacy protection that must be tackled. Patients should be adequately informed and signing an informed consent form should be mandatory.

Thoughtfully, (J. Gordon et al. 2020) deployed a Remote Patient Monitoring (RPM) program to monitor patients with coronavirus disease (COVID-19) upon hospital discharge. They designed an electronic questionnaire embedded in patient portal software called (MyChart Care Companion) which has both mobile and desktop versions and was available in English and Spanish. The mobile version reminds a patient each morning to complete a survey, at which point the patient is able to self-enter their device data (oxygen saturation and temperature) and answer five symptom questions related to shortness of breath, cough, appetite, weakness, and vomiting. This program conducts five hospitals in Massachusetts. At the end of the program, A majority of enrolled patients (66%) completed the monitoring period without triggering an abnormal alert. Enrollment was associated with a decreased odds of ED or hospital readmission. therefore. RPM for COVID-19 provides a mechanism to monitor patients in their home environment and reduce hospital utilization.

In another study (Sharma et al .2021) proposed a framework based on the Internet of Things and an alarm-enabled bio-wearable sensor for early detection of COVID-19 in rural areas. Also, the same information can be used to warn the people in the vicinity to get cautious and adopt preventive measures with utmost care. The proposed system tracks the individuals and records their behavior. It may also receive online diagnoses to manage its health. Thus, the proposed system can manage health from a mobile phone's without leaving home. the authors relied on techniques. RFID, microcontrollers, and sensors for patient monitoring applications. It also designed an analytical system for recorded COVID-19 parameters to predict COVID-19 infection. whereas, the model was

trained on the collected dataset to classify the patients into an infected and non-infected category. the results obtained from the efficiency of the proposed model are validated in terms of accuracy and power consumption during the simulation of the model, it was evidenced that the model gives an accuracy of 96.33 %. Additionally, it is also observed that the proposed model is also efficient in terms of power consumption.

The comprehensive study of (El-Rashidy et al. 2021) stated trends and challenges of adopting a wireless body area network (WBAN), a subdomain of IoT that connects wireless sensors with the patient's body to the network. The authors reviewed 56 papers in the period of (2015–2019) that cover several features related to RPMs, including IoT, WBAN, cloud computing, fog computing, and Clinical decision support systems CDSS. This survey was conducted in five main databases (IEEE, Springer, PubMed, Scince.Gov, and Science Direct). thereafter, it provided a case study of remote patient monitoring for chronic disease patients that tries to cover several limitations of the state-of-the-art architectures. In the reviewed study of (Shaik et al .2022) advanced technologies such as video-based monitoring, IoT-enabled devices, cloud, edge, fog, and blockchain and AI algorithms such as reinforcement learning, and Traditional machine learning adopted by RPM systems. moreover, they described technologies adopted in current RPM systems for noninvasive techniques to monitor vital signs, physical activities, emergency events, and chronic diseases. it also presented the impact of AI in enhancing RPMs with its ability to learn, predict, and classify patients' behavior and vital signs. Finally, they discussed current challenges in adopting AI algorithms to remote monitoring systems for vital signs precision and activity recognition such as AI or ML explainability, Privacy, Uncertainty, Signal processing, Imbalanced dataset, Dataset volume, and Feature extraction.

In another study (Gualtierotti et al .2022) designed a computer-aided diagnosis (CAD) system for the automatic detection of joint recess distension in patients with hemophilia could support physicians in prioritizing interventions for managing hemophilia therapy. they developed a deep-learning algorithm to automatically recognize joint capsule distension as a proxy of hemarthrosis in MSK-US images. The algorithm is based on an object detection framework that is trained to detect the normal and distended joint recesses. Meanwhile, the authors collect (2,267 knee scans). Of these, 483 were considered valid and used for the learning model. 330 images were used for training and 120 images for testing the

classifier, leading to the detection of joint recess distensions with a 78% accuracy (69% sensitivity; 87% specificity).

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