p-ISSN 1607-3274 Радіоелектроніка, інформатика, управління. 2026. № 1
e-ISSN 2313-688X Radio Electronics, Computer Science, Control. 2026. № 1

UDC 004.93

A FRAMEWORK FOR THE REMOTE MONITORING OF PATIENTS IN THE HEALTHCARE SYSTEM

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ABSTRACT

Context. Remote patient monitoring (RPM) technology plays a vital role in developing healthcare services. The medical team can continuously monitor a patient's health status, even outside of hospitals. It is considered one of the most important digital health services, as it facilitates patient care and reduces the spread of disease.

Objective. This paper aims to review current remote patient monitoring (RPM) systems for various diseases. Then proposes a new platform architecture to increase the effectiveness and quality of remote patient care.

Method. The paper analyzes systems for remote monitoring, focusing on the most common systems of several diseases such as diabetes, epilepsy, headache, cardiovascular and heart failure diseases, COVID-19, chronic kidney failure, fainting and unconsciousness, and cancer. Additionally, it provides an overview of the systems with contact and contact-less features, addressing them according to the system type, architectures, technology used, and services they provide.

Results. After analyzing remote patient monitoring (RPM) applications for a variety of diseases, the results highlighted the strengths and weaknesses of existing systems. We then demonstrated how the proposed architecture addresses these shortcomings and develops a scalable and effective solution.

Conclusions. This paper validates the effectiveness of RPM for healthcare development, offering an innovative ontology-based platform that improves service delivery and patient outcomes. This work offers valuable insights for healthcare providers, developers, and policymakers who are advancing remote care solutions.

KEYWORDS: biomedical telemetry, diseases, framework, medical information systems, Telemedicine.

ABBREVIATIONS

DSS is a decision support system;
RNS is a responsive neurostimulation;
EEG is an electroencephalogram;
RELAXaHEAD is an app for Migraine;
WHO is a world health organization;
CKD is a chronic Kidney Disease;
CDSS is a clinical decision support system;
DS is a Diabeo System;
RPM is a remote patient monitoring;
ECG is an electrocardiogram;
ICU is an Intensive Care Unit;
COVID19 is a Corona Virus Disease of 2019;
SWRL is a semantic web rule language;
HTTP is a hypertext transfer protocol;
ICT is an Information & communication technology;
UTAUT2 is a unified theory of acceptance and use of technology;
TMIS is a telemedicine information system.

NOMENCLATURE

H_t is a Health Status at time *t*;
S_t is a Vector of patient vital signs at time *t*;
C_t is a Vector of patient context parameters at time *t*;
O is a Ontology-based Context;
A_t is a New assertions incorporated into the ontology at time *t*;
R is a Set of SWRL rules applied for reasoning;
r_t is an Aggregated risk score derived from patient data;
z_t is a Notification zone classification;
τ_Y, τ_R is a Thresholds for Yellow and Red alert zones;
H^* is a Nearest hospital to the patient;
Ho is a platform's hospitals;
S is a specific hospital within the platform's hospitals;
φ_P, λ_P is a Patient's latitude and longitude;
φ_S, λ_S is a Hospital's latitude and longitude;
$d(\cdot,\cdot)$ is Geographic distance function ;
$f(.)$ is a Processing Function.

INTRODUCTION

Remote patient monitoring is a set of technologies and techniques that empower healthcare representatives, making them integral to the process of tracking patients' health data in real time, monitoring their health condition remotely, and utilizing related information in their treatment plan. The rapid growth of technology has brought many changes in the 21st century and modern society, and healthcare professionals are at the forefront of this transformation [1]. Their role is becoming more essential and

DOI 10.15588/1607-3274-2026-1-15

influential in people's daily lives. In addition, technology affects many aspects of human life, such as the education field, commerce, politics, the work environment, health, and so on. Therefore, healthcare institutions have turned to using new information and communication technologies to improve the quality of their services and their productivity. Furthermore, emerging technologies have enabled healthcare providers to share patient information and monitor them remotely [2].

The emergence of modern technologies and the internet has also contributed to the advancement of telemedicine. These advancements are evident in several areas, including consultations, medical record management, radiology, surgical procedures, remote patient monitoring, patient education, and medication reminders [3]. Remote patient monitoring is considered one of the most important telemedicine services, enhancing immediate access to healthcare [4]. Lin [5] defines telemedicine as the use of communication technologies to address medical concerns. These services promote high-quality healthcare and contribute to cost savings for governments and patients.

Furthermore, modern technologies and telemedicine have enabled patients to access healthcare services anytime, anywhere, eliminating the need for extensive travel to find the best specialists, especially for individuals residing in remote areas [6]. This focus on technology benefits not only patients but also healthcare professionals and policymakers. Studies have proven the effectiveness of patient monitoring in many areas, such as mental health, immunodeficiency, patients with chronic diseases, such as heart patients, and monitoring patients' compliance to medicines [7]. In addition to primary data, the system can collect additional information such as sleep patterns, activity levels, and patient weight. Some systems extend their capabilities to include postoperative management and monitoring of patient wounds [1] as shown in Fig. 1.

Figure 1 – Features of Remote Patient Monitoring System

The object of study is examined remote patient monitoring systems and highlights their shortcomings and limitations. In addition, it examines the technologies, methods used, and system architectures discussed in recent literature. It categorizes remote patient monitoring systems into contact-based and contact-free types. Additionally, it investigates communication channels between doctors, patients, caregivers, and families. Communication is a critical area that needs immediate attention and enhancement. Improving communication between these parties will ensure that families are promptly informed of any progress in the patient's health condition and needs, especially in critical conditions that require immediate attention.

The subject of study focuses on remote patient monitoring systems managing different diseases, like diabetes, epilepsy, headache, cardiovascular and heart failure diseases, COVID-19, chronic kidney failure, fainting and unconsciousness, and finally, cancer. This paper aims to pave the way for future improvements in remote patient monitoring systems, offering a hopeful outlook for the potential advancements in healthcare technology.

The purpose of the work is to offer a comprehensive outline of the proposed platform and a detailed plan. This detailed plan is designed to avoid the most significant limitations and incorporate the most compelling features of previous systems, thereby reinforcing confidence in the study's recommendations.

1 PROBLEM STATEMENT

The problem of remote patient monitoring can be formally defined as:

– A time series of heterogeneous patient vital signs, St.

– A set of patient context parameters at time *t*, Ct, includes medical history, location, and activity.

– Knowledge Base: Represented as an ontology, O, with medical concepts and relationships.

– A set of inference rules, **R**, defined in Semantic Web Rule Language (SWRL).

– Predefined thresholds for risk zones τY (Yellow) and τR (Red).

– A set of hospitals, Ho, with their geographic coordinates $\phi S, \lambda S$.

Now, the problem to find as presented as follows:

– The patient's inferred health status at time *t*, Ht.

– A quantitative risk score, rt.

A notification zone classification, zt $\in$ {Green,Yellow,Red}, based on comparison of rt with τY and τR.

In the case of a critical alert (zt=Red), get the nearest hospital H^* to the patient's location (ϕP, λP).

The Objective is to minimize the time between the onset of a critical health event and the delivery of an appropriate intervention, through timely and accurate determination of Ht, rt, zt and H^*, subject to constraints of data privacy, system interoperability, and real-time processing requirements. Therefore, a deficiency in current systems is the weak use of semantic compatibility. Ontologies

DOI 10.15588/1607-3274-2026-1-15

provide a structured and interoperable framework across different fields. They unify knowledge, promote its reuse, and simplify problem-solving. This article, therefore, explores the concept of remote patient monitoring and its potential for improvement by identifying limitations in existing systems. The article's main contribution can be summarized as follows:

– To develop a patient-contextual ontology to support the semantic consistency of patient information. This ontology mitigates the impact of technology adoption resistance, enabling patients to benefit from its potential advantages.

– This paper describes an improved platform with an adaptable architecture for different diseases. This means the possibility of creating a universal framework for remote patient monitoring.

– This paper discusses the security and privacy of sensors, and their accuracy in sensing the patient's body. Furthermore, it explains the extent of its ability to protect sensitive patient information.

– The analysis of the communication system within the patient and healthcare institutions is of utmost importance. It plays a critical role in ensuring immediate response and prompt information about any health condition, thereby underlining its urgency and importance.

– The system's engineering for compatibility with multiple operating systems is a testament to its scalability. This, in turn, demonstrates the system's adaptability and reassures users of its acceptance in the technology landscape.

Generally, the problem can be summarized as determining a patient's health status H_t as a function of heterogeneous vital signs S_t and ontology-based contextual information O:

$$f(S_t, O) = H_t.$$

2 REVIEWS OF THE LITERATURE

This research focuses on some remote monitoring systems for specific diseases. It focuses on the most common systems of these diseases: diabetes, epilepsy, headaches, cardiovascular diseases, heart failure, COVID-19, chronic kidney failure, instances of fainting and loss of consciousness, and cancer disease. This section conducts a comprehensive analysis of existing research on remote monitoring for patients with specific diseases. Within each category, two additional classifications distinguish between contact-based and contact-free patient monitoring systems. The investigation aims to determine whether these systems incorporate functionalities for sending alerts to patients and their kin or medical personnel. Additionally, the systems will be assessed based on several elements: the type of application, the architecture utilized, the technology, and the services offered.

Remote monitoring systems for diabetes: Despite the availability of advanced treatment options for diabetes, many patients still struggle to achieve optimal control. The main obstacles to control are non-adherence to medications and dosage adjustments prescribed by the doctor, and difficulties in determining the appropriate insulin dose [8]. These patient concerns can be effectively addressed through remote monitoring and communication [9]. Many technological solutions have been successfully employed in diabetes management. We highlight some illustrative examples of these solutions, including the Diabeo (DS) system, which provides an alert message within the application interface, and the RPM system for pregnant patients, a specialized system designed by Kantorowska et al. [10] for pregnant patients with diabetes.

Monitoring systems for epilepsy patients: Epilepsy, a widespread neurological disorder, affects an estimated 65 million people worldwide. Moreover, seizures can manifest in various ways [11]. The development of systems for recording the number and characteristics of seizures represents a significant advancement for individuals with epilepsy [12]. Remote monitoring systems are capable of accelerating the diagnosis of the type of epilepsy and ensuring immediate medical intervention for patients [13]. Illustrative examples of these systems include monitoring system for epileptic patients using IoT [14], Nelli hybrid system enhancements from [15], EEG at home was designed by Biondi et al., [16], and the RNS designed by Skarpaas et al., [17]. The first system stands out for its unique feature of sending patient notifications.

Monitoring systems for headache patients: Headaches affect more than one billion people worldwide. They primarily affect individuals under 50 years of age, necessitating attention and the development of medical and technological solutions to alleviate their effects [18]. Studies indicate similar satisfaction rates and outcomes between telemedicine visits for headache patients and traditional in-person consultations, confirming the effectiveness of telemedicine [19].Here we review some examples of remote monitoring systems used to manage headache patients. The Leiden Headache Center has devised a web-based electronic diary on a time-bound schedule [20]. Conversely, Minen et al., [21] developed a program called RELAXaHEAD, a smartphone-based electronic diary (e-diary). H- diary application aims to monitor chronic headache patients from a distance [22].

Monitoring systems for cardiovascular disease and heart failure: Emerging technologies have opened up significant possibilities for improving healthcare support for older adults living in their own homes or in nursing homes. These technological advancements can be particularly beneficial in providing electrocardiogram (ECG) monitoring services to a wide range of individuals, including the elderly, athletes, and the general public. Providing these technologies in patients' homes reduces the cost of medical equipment and minimizes reliance on additional resources for caregivers [23].

Remote electronic monitoring of cardiac patients is becoming increasingly prevalent. This method, which involves taking the patient home, alerts, and routine interrogations at fixed intervals, offers a level of convenience that can be reassuring. It allows for increased comfort, faster identification of serious arrhythmias or organ dysfunction, and timely responses from doctors. Moreover,

DOI 10.15588/1607-3274-2026-1-15

remote monitoring screening may reduce the need for stressful in-person visits, particularly for patients with long travel periods or difficulty accessing personal care [24]. This section presents some examples of remote cardiac patient monitoring systems. For instance, remote clinical monitoring of heart patients is described by [15]. Amrita Spandanam was designed to monitor heart patients remotely. A model in Gontarska et al. [2] study estimates the degree of risk based on the vital parameters of a remote patient. The 'ECG Android App' is a mobile application that allows users to visualize their Electrocardiogram (ECG) waves [25].

Monitoring systems for COVID-19 patients: COVID-19, abbreviated from "coronavirus disease 2019". It is an infectious respiratory disease. It swiftly spread worldwide, prompting the World Health Organization (WHO) to declare a pandemic in 2020 [26]. The global COVID-19 pandemic, with its immediate and widespread impact, has prompted healthcare systems to enhance their utilization of remote patient monitoring (RPM) tools for patient assessment and prioritization from a distance. The surge in COVID-19 cases worldwide has strained healthcare systems, exposing vulnerabilities and jeopardizing patient well-being [27]. This section provides examples of remote monitoring systems employed for managing COVID-19 patients.

Additionally, this section reviews two types of remote monitoring systems: contact-based and non-contact-based. As the name suggests, contact-based systems require physical contact with the patient, such as through wearable devices or sensors. On the other hand, non-contact-based systems can monitor patients from a distance, often using technologies like cameras or remote sensors. Paganelli et al. [28] established an Internet of Things-based framework for monitoring and examining COVID-19 patients in the hospital or home and issuing early warnings. An electronic platform in Sharma et al. study [29] was designed to monitor COVID-19 patients remotely using IoT devices, aiming to contain the spread of the disease.

Monitoring systems for chronic kidney disease patients: chronic kidney disease is a progressive decline in kidney function [30]. Dialysis patients are individuals with significant frailty. Home dialysis is a good solution for enabling these patients to effectively reduce their exposure to the hospital setting [31]. Remote monitoring and online tools provide enhanced convenience and access to care for these patients. These tools facilitate remote consultations between patients and healthcare professionals from the comfort of the patient's home and bring relief and comfort, knowing that their health is being monitored closely. Remote monitoring systems for kidney failure patients have provided numerous benefits, including reduced hospital visits and improved access to healthcare providers. By utilizing these technologies, patients can receive timely care and support while minimizing disruptions to their daily lives. This section examines contact-based and non-contact-based systems. Markossian et al. [32] designed an app that primarily aims to facilitate self-management for individuals with CKD who do not require dialysis. Scarpioni et al. [31] developed a system to monitor and assist dialysis patients in reducing hospitalization risks during the COVID-19 pandemic.

Remote monitoring for fainting and loss of consciousness: Most of the unconscious patients are in the intensive care unit (ICU). These patients often require multiple life-sustaining devices [33]. However, with technological advancements, healthcare providers can remotely monitor pain, identify potential issues, and take preventive measures. This proactive approach enhances patients' ability to detect problems early on and also plays a crucial role in reducing complications that may result in hospitalization. Moreover, technology and remote pain monitoring have significantly mitigated barriers to continuous care. This section provides examples of patients in intensive care units who are being monitored. Unlike the other systems in this category, the first two systems possess the communication feature. The system designed by Lee et al. [33] aims to introduce an innovative solution: a remote monitoring system specifically tailored for agitated patients. Emuoyibofarhe et al. [34] designed a remote monitoring system for preterm infants in neonatal ICU incubators. The system utilizes fuzzy rules for modeling and simulation. Garelli et al. [35] have pioneered the development of a groundbreaking platform for remote glucose monitoring, specifically designed for COVID patients in the ICU. A wearable system equipped with a mask contains sensors that capture vital signs has been proposed by Yang [15].

Remote Monitoring for Cancer Patients: Cancer treatment protocols encompass a wide range of procedures, including cancer diagnosis and various interventions. These treatments, such as chemotherapy, radiation therapy, and others, often lead to the development of pain. Digital health tools and technologies help support families, monitor disease symptoms, and remotely determine patients' pain levels. This side overs some examples of these technologies to monitor cancer patients remotely. Bernier Carney et al. [36] developed a game-based innovative mobile application specifically designed for children aged 6–12 with cancer. Pavic et al. [37] created an application capable of early detection and prevention of health deterioration among cancer patients. ASyMS is a mobile application that enables remote monitoring of cancer patients [38]. Mayo Clinic has introduced a remote monitoring system for cancer patients involving a diverse team of healthcare professionals [39]. To overcome the limitations of these systems, as detailed in the work contributions section, the proposed platform aims to build on the semantic web rules and build an ontology that enables semantic interoperability of patient information. This ontology will play a crucial role in addressing the issue of interoperability between different devices. Furthermore, it provides an architecture that is adapted to various diseases. In addition, the proposed platform is designed to significantly enhance communication between the doctor, patient, patient's family, and the healthcare giver, fostering a sense of connection and engagement. The commu-

DOI 10.15588/1607-3274-2026-1-15

nication provides notifications that contain developments of the patient's health condition and needs or an alert if there is a critical condition that requires dealing with it. Table 1 provides an overview of the studies we reviewed. It shows the systems that were classified based on diseases, the technology used, their architecture, the method used, limitations, and contact-based systems.

3 MATERIALS AND METHODS

This paper proposes a novel ontology-based framework for remote patient monitoring. The core methodological contribution is the integration of a dynamic patient-contextual ontology with a rule-based inference engine to enable semantic interoperability and real-time, context-aware clinical decision support. The complete architecture of the proposed platform, named Reayah, is illustrated in Figure 2 and consists of three primary components: the actor side, the Reayah management unit, and the database. The actor side encompasses all users of the platform, including patients, doctors, and family members. In addition, it is responsible for collecting data from the Actors. The information that should be entered contains all information about all users of the platform. For instance, the patient possesses the following data: vital signs, location, medical record, medical history, etc. On the other hand, the doctor can view all the information about his patients. Finally, the health provider manages all the system's users, hospitals, appointments, etc. So, this side works as an acquisition operator that captures inputs for the actors without regard to the data processing. The core processing is handled by the Reayah management unit, which is responsible for semantic inference processing. It maps input data to ontology-consistent individuals. It uses ontology rules alongside an inference reasoner to deduce the correct notification. Based on the patient's information and context, the action manager decides on the most appropriate alert (e.g., critical, medium, low). Following this decision, the designated notification will be forwarded to the notification center.

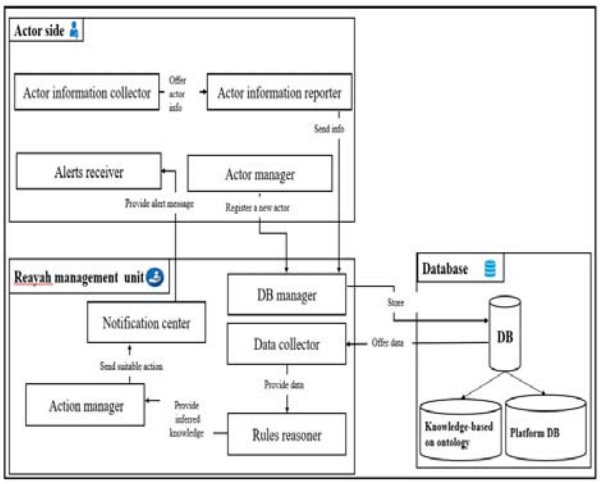

Figure 2 – Proposed Framework

Data persistence is managed by a dual-part database, which includes the Reayah database and the knowledge-based database. The database contains all data of actors, which in this context refers to patients and healthcare providers. For instance, the actor's data includes name, age, date of birth, identity, file number, height, weight, medical record, etc. The healthcare institution database contains all the data of the institution, such as hospitals, doctors, etc. In contrast, the knowledge-based ontology contains predefined rules. SWRL is used to deduce insights that are used within the platform.

This process can be formulated as a generalizable computational method rather than a theoretical description of the platform. In general, after a patient enters their medical information C_t such as [age, medical history, health record, location, activity, and vital signs S_t through the Reayah app, the underlying function F transforms the information into new assertions A_t that are integrated into the ontology in real time. The rule-based inference engine in the ontology determines the estimated health status H_t, risk score r_t, and notification zone z_t

$$f:(S_t,C_t)\to A_t,\quad O=O\_\{t-1\}\cup A_t,$$
$$(H_t,r_t,z_t)=f(O,R),\qquad z_t\in\{Green, Yellow, \mathrm{Re}d\},$$

Zone mapping: $z_t=\mathrm{Re}d$ if $r_t\ge\tau R$; Yellow if $\tau Y\le r_t<\tau R$; Green if $r_t<\tau Y$.

The proposed ontology is implemented in Web Ontology Language (OWL 2), and the patient's condition is compared and inferred through the Pellet/Jena interpreter, which uses the Semantic Web Rule Language (SWRL) to infer the abnormal states and the current state of the patient.

Fig. 3 illustrates the workings of the Reayah platform. After a patient submits their vital signs S_t, the patient's context C_t via the mobile app then the A_t is determined. The SWRL-enabled model evaluates the rules to infer abnormal status and calculate a risk score (r_t). The notification zone then assigned to one of three zones

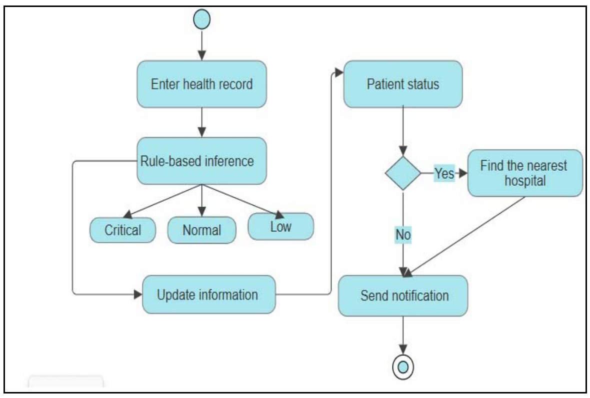

Figure 3 – Activity diagram of Reayah platform

DOI 10.15588/1607-3274-2026-1-15

(green/yellow/red) based on thresholds $(\tau Y, \tau R)$. The knowledge base is continuously updated, and notifications are sent to doctor and family members. In red cases, the nearest hospital (H^*) is determined

$$H^* = \arg\_\min_{S \in Ho} d((\varphi\_P, \lambda\_P), (\varphi\_S, \lambda\_S)).$$

Therefore, the methodology adopted in this study is a formal approach to remote patient monitoring, relying on semantic web rules to give accurate conclusions. It contributes to improving the efficiency, consistency, and accuracy of medical decisions within the proposed platform. Furthermore, it utilizes context-aware messaging to enhance and minimize errors in alerts. Alert messages vary and depend on the patient's condition. They may be considered normal or emergency. All information about patients, doctors, and the correct medical decisions is stored in the proposed platform database. The proposed platform supports many services. It supports messaging services that generate alerts for the patient, the doctor, and the patient's kin automatically at the time of an emergency by the server. Fig. 4 illustrates the data that has been exchanged between the proposed platform units during the platform's operation. First of all, the patient and doctor have to register on the server using his/her own information, such as email, name, and location. The following scenarios explain messaging between patients and doctors in normal situations. For example, the patient enters his daily vital signs as a medical report and sends a consultation to a doctor. The server sends a notification to the concerned doctor. The doctor checks the medical report of the patient and the patient's medical history. After that, he sends medical advice and the appropriate drug dosage to the patient.

On the other hand, we assume that the second patient has an emergency. The patient's blood pressure is high. He enters his vital signs using the Reayah application. Then the data will be analyzed and processed, and a warning alert will be sent to a certain doctor and the family of the patient. The doctor will decide the appropriate medical procedure and send it to the patient. The platform automatically sends medical advice and alerts to the patient's relatives.

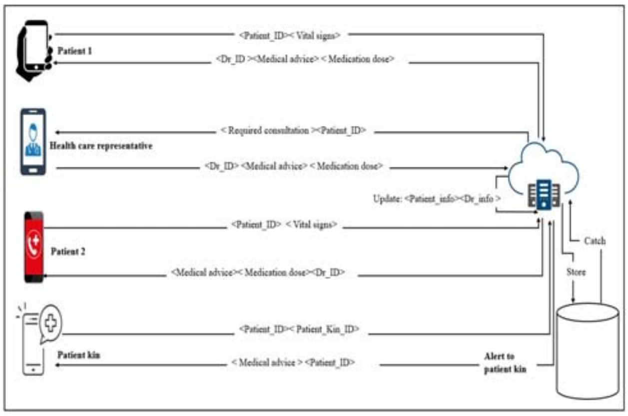

Figure 4 – Data flow of the proposed platform

4 EXPERIMENTS

Remote patient monitoring improves treatment adherence, a crucial aspect of patient care. These approaches have mainly been applied to chronic health conditions. Studies have shown that hospital treatment costs can be significant. However, by delivering health services at home, remote patient monitoring can help reduce time and cost, as patients no longer need to travel to seek medical attention, providing them with more comfort and less inconvenience. This article focuses on exploring the concept of remote patient monitoring, analyzing the associated systems, and highlighting the restrictions in the current systems.

Fig. 5 offers a comprehensive overview of the classification of systems based on specific diseases and the feature of communication between members of the clinical team, patients, and their kin. In this representation, the contact-based patient monitoring systems are represented by blue-filled shapes. Consequently, Remote Patient Monitoring (RPM) for pregnant patients, the Diabeo System, and a prototype for monitoring diabetes patients represent remote monitoring systems for diabetes. The Diablo System involves contact-based monitoring, distinguishing it from the other systems in this category. On the other hand, a Nelli hybrid system, a monitoring system for epileptic patients using IoT, EEG@HOME, and the RNS System, are examples of epilepsy disease remote monitoring. The system for epileptic patients using IoT sends notifications to the patients, providing a unique level of reassurance. Conversely, Leiden Headache Clinic

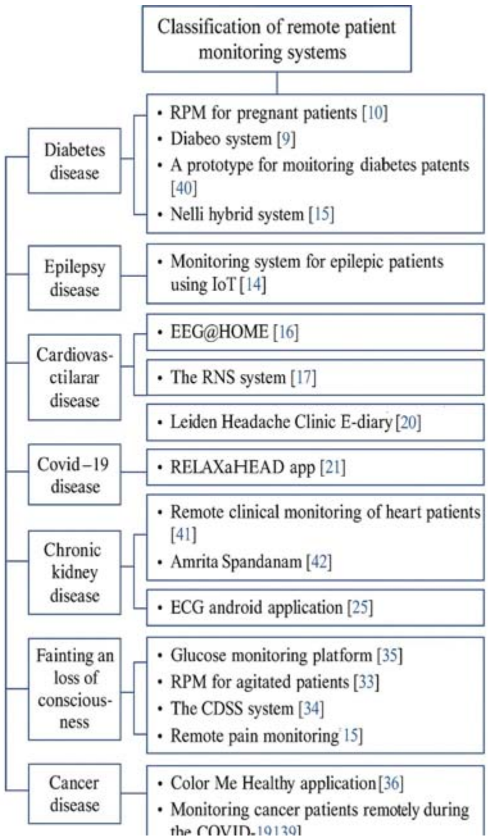

Figure 5 – Classification of remote patient monitoring systems

DOI 10.15588/1607-3274-2026-1-15

E-diary, RELAXaHEAD app, and H-Diary are standard systems for remote patient monitoring with Headache disease. Notably, the H-Diary offers contact-free functionalities compared to the other systems, which may intrigue and interest the audience.

Furthermore, remote clinical monitoring of heart patients, DSS, Amrita Spandanam, and ECG android applications represent remote patient monitoring for heart failure disease. Remote clinical monitoring of heart patients and Amrita Spandanam are contact-based systems, distinguishing them from the other systems in this category. Moreover, an early-warning system for remote monitoring of COVID-19 patients and an electronic platform to monitor COVID-19 patients are examples of remote patient monitoring of COVID-19 disease. The former operates as a contact-based system, while the latter functions as a non-contact-based system. In addition, a self-management mobile app for chronic kidney disease and an emote dialysis monitoring system are examples of RPM for chronic kidney disease. The former operates as a contact-based system, while the latter functions as a non-contact-based system. However, the glucose monitoring platform, RPM for agitated patients, the CDSS system, and remote pain monitoring are examples of RPM for fainting and loss of consciousness. The RPM for agitated patients and the CDSS system are contact-based systems, distinguishing them from the other systems in this category. Finally, the Color Me Healthy application monitors cancer patients remotely during COVID-19, and the Activity Monitoring application and the ASyMS application are examples of RPM for cancer disease. Monitoring cancer patients remotely during COVID-19 is a contact-free feature in contrast with other systems in this category. Context-aware technologies in healthcare offer tangible benefits that can be measured through the results of the studies and systems discussed. Previous systems have shown a reduction in hospital admissions for chronic patients by enabling alerts, adjusting treatment plans, and adhering to medications remotely. Additionally, the systems discussed have shown a decrease in emergency room visits due to timely interventions. This proves that systems can improve patient care by predicting and preventing health crises before they escalate.

5 RESULTS

Although technology has advanced over the years, the systems mentioned have some significant areas for improvement. As a result, we seek to provide a platform for remote patient monitoring, which includes context-aware technologies. Context-aware applications are increasingly being used in healthcare due to their potential to increase efficiency by providing real-time information on patient's health conditions. Context-aware refers to systems that can understand and interact with their physical and digital context [15].

Additionally, our context-aware platform can alert medical staff and patients of critical conditions (see Fig. 6), providing a sense of reassurance and confidence.

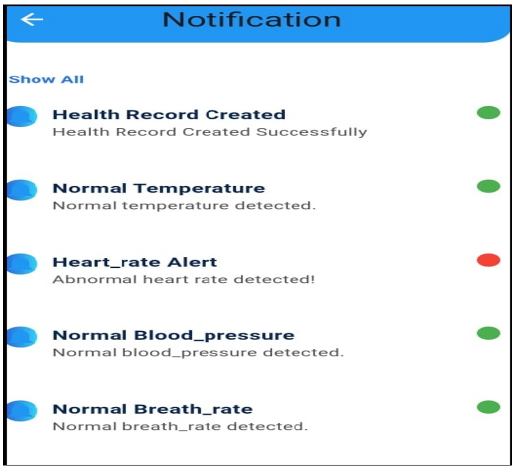

Figure 6 – Reayah platform notifications

Our platform is designed to be context-aware of the patient, focusing on determining the patient's location, health condition, physical activity, and more (see Fig. 7).

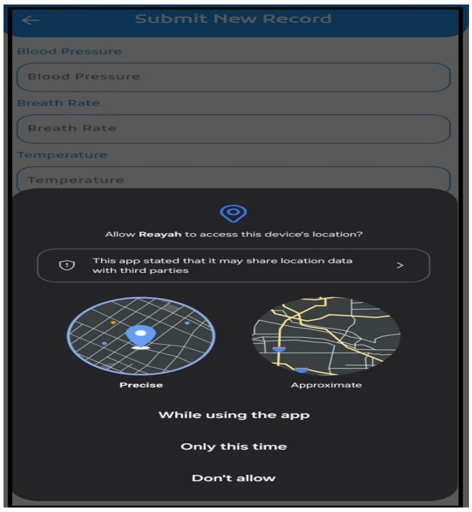

Figure 7 – Determine the location of the patient and their health status

It will use context-aware technology to deliver personalized notifications, analyze individual health data, and send customized messages to patients, their families, or healthcare providers based on specific parameters (see Fig. 8). It is important to recognize that the platform can modify care plans to meet the changing needs of patients, which enhances confidence in our platform's ability to adapt.

Furthermore, the platform can identify the nearest hospital to the patient by utilizing the patient's location. This feature helps ensure faster patient arrival, especially in emergencies. It thus allows healthcare providers to intervene proactively to save the patient's life. Finally, the contextual features of our platform significantly improve remote consultations by providing doctors with real-time data, enabling them to make more informed decisions.

DOI 10.15588/1607-3274-2026-1-15

Figure 8 – Communication between patient and doctor

In addition, deficiencies in communication between patients and doctor were observed in some analyzed systems [17, 29, 31, 39], emphasizing the need to enhance communication between these two parties. This ensures that patients are informed about any developments in their health condition and needs and are alerted in critical conditions that require immediate attention. To enhance alerts' reliability, efficiency, and effectiveness and expand them to include sending the patient's family, we intend to use context-aware messaging in alerts on our proposed platform. The involvement of the patient's family in the messaging system is crucial for providing additional support and care, and it can be instrumental in mitigating false notifications and increasing communication efficiency between the medical staff and the patient's family.

6 DISCUSSIONS

This paper has conducted a comprehensive analysis of remote patient monitoring systems documented in current literature, presenting a wide range of disease categories covered by the existing systems. It specifically focuses on the most common systems of these diseases: diabetes, epilepsy, headache, cardiovascular and heart failure diseases, COVID-19, chronic kidney failure, fainting and unconsciousness, and cancer. After that, the researchers proposed an ontology-based framework consisting of both with-contact and contact-free features by developing a remote monitoring system. In addition, the paper demonstrated the data flow model and comprehensively analyzed the different systems presented by different researchers in the literature. This analysis highlights the significant potential of the evolving healthcare technology field to greatly enhance patient care. The presented generic platform architecture is a pathway for the developers to build a patient monitoring ontology-based system based on context-aware category. Table 1 summarizes a comparison between previous studies and the current study. It illustrates the systems classified based on diseases, the technology used, their structure, the method used, limitations, and the communication-based system. It demonstrates that the current study differs from previous studies in that it relies on an ontology and semantic web rules and is distinguished by its classification of alerts into three zones. Furthermore, the researchers are excited to design a platform for remote patient monitoring that offers enhanced electronic healthcare services through the use of telemedicine information systems (TMIS) and cloud computing platforms. The plan, an ontology-based system, will not only facilitate the semantic interoperability of patient data but also leverage patient context to provide more efficient and effective patient care services.

Table 1 – Comparison between previous studies and the current study

System	Disease Type	Technology Used	Architecture of the system	Method used	Limitations	Contact-based system
RPM for pregnant patients [10]	Diabetics disease.	Bluetooth, MyChart app, and Electronic Health Record.	3-tiered	Replaced the conventional paper-based method of monitoring blood glucose with an Electronic Health Record	The scope of the study was limited to pregnant women.	No.
Diabeo System [9]	Diabetics disease.	Mobile application on Android and iOS platforms and a web portal.	3-tiered.	Machine learning algorithms.	The accuracy rate is not available.	Yes.
A prototype for monitoring diabetes patients [40]	Diabetics disease.	Clinical Decision Support System, knowledge base, and HER.	4-tiered.	Clinical Decision Support Systems (CDSS) and Electronic Health Records (EHR).	The architecture in this study does not encompass a real system of remote patient monitoring.	No.

DOI 10.15588/1607-3274-2026-1-15

Continuation of Table 1

Nelli hybrid system [15]	Epilepsy disease.	Video camera and microphones.	1-tiered.	Machine learning techniques.	Data were collected only from one recording, and the study targeted a group less prone to seizures. Finally, patients with non-motor seizures were not evaluated.	No.
Monitoring system for epileptic patients using IoT [14]	Epilepsy disease.	MATLAB and IoT devices.	1-tiered.	Fuzzy logic.	Insufficient accuracy of the sensors employed for identifying epileptic seizures.	Yes.
EEG@HOME [16]	Epilepsy disease.	Wearable sensor device, EEG recording, and mobile app (Seer app; Seer Medical).	2-tiered.	ANT Neurowas is used to record EEG, self-report self-reporting sensors, and the app collects data related to seizing occurrence app.	Fewer number of participants.	No.
The RNS System [17]	Epilepsy disease.	Tablet, Patient Data Management System (PDMS).	3-tiered.	The physician utilizes a tablet to configure detection and stimulation settings, as well as access and review data from the neurostimulator. The data monitor for the patient's home.	Lack of security.	No.
Leiden Headache Clinic E-diary[20]	Headache disease.	Electronic diary and tablet.	1-tiered.	A web-based survey was sent to the patient through email.	There is an absence of a reliable method to assess patient acceptance.	Yes.
RELAXaHEAD app [21]	Headache disease.	RELAXaHEAD app, electronic diary, and smartphone.	1-tiered.	Self-reported specific details about patients' headaches, sleep-related questions, and medications	The limited sample size and absence of a reliable method to assess patient acceptance.	Yes.
H-Diary [22]	Headache disease.	Web server, Oracle, JAVA, PHP5, JavaScript, HTML, and CSS.	3-tiered.	The patient enters data through daily diaries that contain a questionnaire consisting of yes and no questions.	The absence of a mechanism to assess patient acceptance.	No.
Remote clinical monitoring of heart patients [41]	Cardiova scular disease.	De novo pacemakers, implantable cardiac defibrillators, and follow-up device care.	1-tiered.	Scheduled and unscheduled in-person interrogation before discharge and remote interrogation post-discharge	The limited sample size and the absence of a mechanism to assess the utility of interrogations.	Yes.
DSS for remote patient monitoring of heart disease [2]	Cardiova scular disease.	Deep neural network models and the rule-based model.	1-tiered.	The database was split into three sets: train, validation, and test, with a distribution ratio of 4:1:1.	The capacity for the model was reduced.	No
Amrita Spandanam [42]	Cardiova scular disease.	IoT devices, Wi-Fi and cellular data, mobile phones, and the Cloud.	5-tiered.	Sensors collect data and then analyze it. The severity is measured using Consensus Abnormality Motif technology and other algorithms, and the results are sent to the medical team to take the correct action.	The limited sample size.	Yes.
ECG android application [25]	Cardiova scular disease.	SQL,Bluetooth, IOIO Microcontroller, MATLAB.	3- tiered.	The app leverages microcontroller technology, signal processing algorithms for ECG wave analysis, and communication protocols to ensure secure and private data transfer.	The app was run on Android only.	No.

DOI 10.15588/1607-3274-2026-1-15

Continuation of Table 1

An early-warning system for remote monitoring of COVID-19 patients [28]	COVID-19 disease.	SQL and NoSQL, data mining. Machine learning models and blockchain.	3- tiered.	Data acquired from sensors are analyzed on cloud servers.	The accuracy of the sensor data was not examined.	Yes.
An electronic platform to monitor Covid-19 patients [29]	COVID-19 disease.	Cooza simulator, IoT, artificial intelligence techniques, and Wi-Fi.	3- tiered.	The collected data was analyzed using CAF and KMCCA methods. It was then classified using SVM and KNN.	The model needs more energy.	No.
Self-management mobile app for chronic kidney disease [32]	Chronic kidney disease.	NVivo software and smartphones.	1-tiered.	Patient self-management, recommendations for adherence to medication regimens, avoidance of further nephrotoxic insults, and maintenance of diet.	The limited sample size.	Yes.
Remote dialysis monitoring system [31]	Chronic kidney disease.	Video camera, monitor, microphone, and technology communication.	1-tiered.	Home dialysis network.	The limited sample size.	No.
Glucose Monitoring Platform [35]	Fainting and loss of conscious ness	Different continuous glucose monitor devices and Bluetooth.	1-tiered.	Observed a detailed view of each patient's glucose evolution and other metrics, automatically uploaded daily to the platform.	The limited sample size.	No.
RPM for agitated patients [33]	Fainting and loss of conscious ness	Microsoft Kinect, computer game graphics, and IBM SPSS.	1-tiered.	Designed a detection system to identify the position of the patient in three-dimensional space.	The accuracy of the sensor data was not examined.	Yes.
The CDSS system [34]	Fainting and loss of conscious ness.	LabVIEW and MATLAB.	3- tiered.	The system utilizes fuzzy rules for modeling and simulation.	There is an absence of a mechanism to test and assess the system's accuracy.	Yes.
Remote pain monitoring [15]	Fainting and loss of conscious ness.	Sensing devices, Wi-Fi, cloud server, computer, or a smart device	4- tiered.	This device utilizes a facial surface electromyogram (sEMG) to monitor a patient's pain intensity.	The accuracy of the sensor data was not examined.	No.
Color Me Healthy application [36]	Cancer disease.	Game-based application, JavaScript, and tablet.	1-tiered.	Self-report, a checklist of general symptoms, and children express their pain experiences.	The accuracy of the sensor data was not examined.	Yes.
Monitoring cancer patients remotely during the COVID-19 [39]	Cancer disease.	Cellular-enabled tablet, Resideo Life Care Solutions software, Bluetooth-enabled devices	1-tiered.	Patients measure their vital signs regularly; this data is integrated with electronic health records.	The system is implemented for a small number of patients in one healthcare system.	No
Activity Monitoring application [37]	Cancer disease.	Smartphone Galaxy S5 mini, SIM card, the bracelet Everion,	1-tiered.	The patient is at home filling out a daily symptom questionnaire.	The limited sample size and the absence of a mechanism to test and assess the acceptance of wearable devices.	Yes.
The ASyMS application [38]	Cancer disease.	Android mobile phone	1-tiered.	Electronic symptom questionnaires to assess the presence, severity, and distress levels associated with various symptoms.	There is an absence of a mechanism to test and assess the acceptance of the application.	Yes.
Current study	General	Flutter, Laravel and Protégé	1-tiered.	The patient enters his vital data daily, compared with the semantic web rules, and medical advice is sent.	The limited sample size.	Yes

DOI 10.15588/1607-3274-2026-1-15

CONCLUSIONS

This study provides a detailed review of several remote patient monitoring (RPM) systems, focusing on common diseases such as diabetes, epilepsy, cardiovascular disease, chronic kidney disease, and cancer. The analysis highlights significant differences in technological approaches and identifies critical limitations, including issues of semantic consistency and contextual awareness.

The scientific novelty of the study is that researchers propose an innovative ontology-based framework for remote patient monitoring systems, integrating contact-based monitoring methods. This framework utilizes ontology, semantic web rules, and cloud computing to enable the delivery of scalable and efficient healthcare services.

The practical significance of the findings demonstrates the potential of a context-aware and semantically enriching platform to revolutionize telehealth services. By facilitating alignment and intelligent decision-making, the proposed system lays the foundation for remote patient monitoring. A data flow model is included to illustrate how patient context is integrated into context-aware messaging processes for monitoring patient health status. The practical significance of this research lies in its real-world applicability, providing developers and systems engineers with a clear blueprint for designing intelligent and adaptive remote patient monitoring platforms. This framework paves the way for improved patient care and reduced hospital visits.

Prospects for further research are focuses on implementing the proposed system in diverse healthcare settings and larger areas to assess its user acceptance. The study also calls for continued research in the fields of ontology engineering and remote monitoring.

ACKNOWLEDGEMENTS

The authors would like to thank the editorial board, especially Prof. Sergey Subbotin, for his valuable comments that helped enhance the quality of this study.

DECLARATIONS

Conflict of interest: The authors declare that they have no conflict of interest in relation to this study, whether financial, personal, authorship, or otherwise, that could affect the research and its results presented in this paper.

Authors' contributions: Alaa Almagrabi: methodology of the study; Halimah Mafraq: collect data and interpret the results; Hana Almagrabi: technical side of the study.

Data availability: the data of the study are available to the corresponding author.

Software availability: The paper has no associated software.

Use of artificial intelligence tools: The authors confirm that they did not use artificial intelligence technologies in creating this work.

REFERENCES

1. Malasinghe L. P., Ramzan N., Dahal K. Remote patient monitoring: a comprehensive study, *J Ambient Intell Human Comput*, 2019, No. 1, pp. 57–76. DOI: 10.1007/s12652-017-0598-x.
2. Gontarska K. et al. edited by Tucker A. et al. Predicting Medical Interventions from Vital Parameters: Towards a Decision Support System for Remote Patient Monitoring, *Artificial Intelligence in Medicine*. Cham, Springer International Publishing, 2021, pp. 293–297. DOI: 10.1007/978-3-030-77211-6_33.
3. Alomi Y. A., Aljudaibi S. M. National Survey of Total Parenteral Nutrition Practice in Saudi Arabia: Drug Monitoring and Patient Education at MOH Hospitals, *EC Nutr*, 2016, pp. 784–792. Available at: https://www.researchgate.net/publication/314231507
4. Qureshi B., Tounsi M. A Bluetooth enabled mobile intelligent remote healthcare monitoring system in Saudi Arabia: Analysis and design issues, *18th national computer conference. Citeseer*, 2006. Available at: https://www.researchgate.net/publication/244924911
5. Lin J. C. Applying telecommunication technology to health-care delivery, *IEEE Engineering in Medicine and Biology Magazine*. IEEE, 1999, No. 4, pp. 28–31. DOI: 10.1109/51.775486.
6. Mainanwal V., Gupta M., Upadhayay S. K. A survey on wireless body area network: Security technology and its design methodology issue, *2015 international conference on innovations in information, embedded and communication systems (ICIIECS).* IEEE, 2015, pp. 1–5. DOI: 10.1109/ICIIECS.2015.7193088.
7. Leal Filho W., Wall T., Azul A. M., Brandli L., Özuyar P. G. (eds) Remote patient monitoring (RPM), in: Good Health and Well-Being, *Encyclopedia of the UN Sustainable Development Goals*. Cham, Springer, 2020, pp. 583–583. DOI: 10.1007/978-3-319-95681-7_300115.
8. Miller K. M. et al. Current state of type 1 diabetes treatment in the US: updated data from the T1D Exchange clinic registry, *Diabetes care. Am Diabetes Assoc,* 2015, No. 6, pp. 971–978. DOI: 10.2337/dc15-0078.
9. Joubert M. et al. Remote monitoring of diabetes: a cloud-connected digital system for individuals with diabetes and their health care providers, *Journal of diabetes science and technology. SAGE Publications Sage CA*. Los Angeles, CA, 2019, No. 6, pp. 1161–1168. DOI: 10.1177/1932296819834054.
10. Kantorowska A. et al. Remote patient monitoring for management of diabetes mellitus in pregnancy is associated with improved maternal and neonatal outcomes, *American Journal of Obstetrics and Gynecology*, 2023. DOI: 10.1016/j.ajog.2023.02.015.
11. Moshé S. L. et al. Epilepsy: new advances, *The Lancet. Elsevier,* 2015, No. 9971, pp. 884–898. DOI: 10.1016/S0140-6736(14)60456-6.
12. Ricci L. et al. Clinical utility of home videos for diagnosing epileptic seizures: a systematic review and practical recommendations for optimal and safe recording, *Neurological Sciences.* Springer, 2021, pp. 1301–1309. DOI: 10.1007/s10072-021-05040-5.
13. Amin U. et al. Value of smartphone videos for diagnosis of seizures: everyone owns half an epilepsy monitoring unit, *Epilepsia. Wiley Online Library*, 2021, No. 9, pp. e135–e139. DOI: 10.1111/epi.17001.
14. Hassan S., Mwangi E., Kihato P. K. IoT based monitoring system for epileptic patients, *Heliyon,* 2022, No. 6, P. e09618. DOI: 10.1016/j.heliyon.2022.e09618.
15. Yang G. et al. IoT-Based Remote Pain Monitoring System: From Device to Cloud Platform, *IEEE J. Biomed. Health In-*

DOI 10.15588/1607-3274-2026-1-15

form, 2018, No. 6, pp. 1711–1719. DOI: 10.1109/JBHI.2017.2776351.
16. Biondi A. et al. Remote and Long-Term Self-Monitoring of Electroencephalographic and Noninvasive Measurable Variables at Home in Patients With Epilepsy (EEG@HOME): Protocol for an Observational Study, *JMIR Research Protocols,* 2021, No. 3, P. e25309. DOI: 10.2196/25309.
17. Skarpaas T. L., Jarosiewicz B., Morrell M. J. Brain-responsive neurostimulation for epilepsy (RNS® System), *Epilepsy Research*, 2019, pp. 68–70. DOI: 10.1016/j.eplepsyres.2019.02.003.
18. Burch R. C., Buse D. C., Lipton R. B. Migraine: epidemiology, burden, and comorbidity, *Neurologic clinics. Elsevier,* 2019, No. 4, pp. 631–649. DOI: 10.1016/j.ncl.2019.06.001.
19. Bonavita S. et al. Digital triage for people with multiple sclerosis in the age of COVID-19 pandemic, *Neurological sciences.* Springer, 2020, pp. 1007–1009. DOI: 10.1007/s10072-020-04391-9.
20. Ede van E. S. et al. Continuous remote monitoring in post-bariatric surgery patients: development of an early warning protocol, *Surgery for Obesity and Related Diseases.* Elsevier, 2022, No. 11, pp. 1298–1303. DOI: 10.1016/j.soard.2022.06.018.
21. Minen M.T. et al. User Design and Experience Preferences in a Novel Smartphone Application for Migraine Management: A Think Aloud Study of the RELAXaHEAD Application, *Pain Medicine,* 2019, No. 2, pp. 369–377. DOI: 10.1093/pm/pny080.
22. Aljaaf A.J. et al. H-Diary: Mobile Application for Headache Diary and Remote Patient Monitoring, *2018 11th International Conference on Developments in eSystems Engineering (DeSE)*. Cambridge, United Kingdom, IEEE, 2018, pp. 18–22. DOI: 10.1109/DeSE.2018.00010.
23. Berrouiguet S. et al. Fundamentals for future mobile-health (mHealth): a systematic review of mobile phone and web-based text messaging in mental health, *Journal of medical Internet research. JMIR Publications Toronto*. Canada, 2016, No. 6, P. e135. DOI: 10.2196/jmir.5066.
24. Cronin E. M. et al. Remote monitoring of cardiovascular devices: a time and activity analysis, *Heart Rhythm. Elsevier*, 2012, No. 12, pp. 1947–1951.
25. Mohammed J. et al. Internet of Things: Remote Patient Monitoring Using Web Services and Cloud Computing, *2014 IEEE International Conference on Internet of Things(iThings), and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom)*. Taipei, Taiwan, IEEE, 2014, pp. 256–263. DOI: 10.1109/iThings.2014.45.
26. Gunderson M., Melton G. B. Ambulatory Remote Patient Monitoring Beyond COVID-19: Engagement and Sustainment Considerations, *Mayo Clinic Proceedings*. Elsevier, 2022, No. 12, pp. 2184–2185. DOI: 10.1016/j.mayocp.2022.10.016.
27. Alboksmaty A. et al. Effectiveness and safety of pulse oximetry in remote patient monitoring of patients with COVID-19: a systematic review, *The Lancet Digital Health,* 2022, No. 4, pp. e279–e289. DOI: 10.1016/S2589-7500(21)00276-4.
28. Paganelli A. I. et al. A conceptual IoT-based early-warning architecture for remote monitoring of COVID-19 patients in wards and at home, *Internet of Things,* 2022, P. 100399. DOI: 10.1016/j.iot.2021.100399.
29. Sharma N. et al. A smart ontology-based IoT framework for remote patient monitoring, *Biomedical Signal Processing and Control,* 2021, P. 102717. DOI: 10.1016/j.bspc.2021.102717.
30. Webster A.C. et al. Chronic kidney disease, *The lancet*. Elsevier, 2017, Vol. 389, № 10075, pp. 1238–1252. DOI: 10.1016/S0140-6736(16)32064-5.
31. Scarpioni R., Manini A., Chiappini P. Remote patient monitoring in peritoneal dialysis helps reduce risk of hospitalization during Covid-19 pandemic, *J Nephrol,* 2020, No. 6, pp. 1123–1124. DOI: 10.1007/s40620-020-00822-0.
32. Markossian T. W. et al. A Mobile App to Support Self-management of Chronic Kidney Disease: Development Study, *JMIR Human Factors*, 2021, No. 4, P. e29197. DOI: 10.2196/29197.
33. Lee Y.-L. et al. Validation of Agitated Patient Remote Monitoring Alarm System in the Intensive Care Unit, *Studies in Health Technology and Informatics*, 2021, pp. 365–366. DOI: 10.3233/SHTI210747.
34. Emuoyibofarhe J. O. et al. A fuzzy rule-based model for remote monitoring of preterm in the intensive Care Unit of Hospitals, *International Journal of Medical Research & Health Sciences. International Journal of Medical Research & Health Sciences,* 2019, No. 5, pp. 33–3. Available at: https://www.researchgate.net/publication/333508315.
35. Garelli F. et al. Remote Glucose Monitoring Platform for Multiple Simultaneous Patients at Coronavirus Disease 2019 Intensive Care Units: Case Report Including Adults and Children, *Diabetes Technology & Therapeutics*, 2021, pp. 1–3. DOI: 10.1089/dia.2020.0556.
36. Bernier Carney K. M. et al. Communication of pain by school-age children with cancer using a game-based symptom assessment app: A secondary analysis, *European Journal of Oncology Nursing,* 2021, P. 101949. DOI: 10.1016/j.ejon.2021.101949.
37. Pavic M. et al. Feasibility and Usability Aspects of Continuous Remote Monitoring of Health Status in Palliative Cancer Patients Using Wearables, *Oncology*, 2020, No. 6, pp. 386–395. DOI: 10.1159/000501433.
38. Moradian S. et al. Usability Evaluation of a Mobile Phone–Based System for Remote Monitoring and Management of Chemotherapy-Related Side Effects in Cancer Patients: Mixed-Methods Study, *JMIR Cancer*, 2018, No. 2, P. e10932. DOI: 10.2196/10932.
39. Pritchett J. C. et al. Association of a remote patient monitoring (RPM) program with reduced hospitalizations in cancer patients with COVID-19, *JCO Oncology Practice. Wolters Kluwer Health,* 2021, No. 9, pp. e1293–e1302. DOI: 10.1200/OP.21.00307.
40. Ahmad B.I. et al. Remote patient monitoring system architecture for diabetes management, *2017 International Conference on Computing, Engineering, and Design (ICCED)*. Kuala Lumpur, IEEE, 2017, pp. 1–6. DOI: 10.1109/CED.2017.8308120.
41. Yang S. et al. Clinical utility of remote monitoring for patients with cardiac implantable electrical devices, *J Interv Card Electrophysiol*, 2023, No. 4, pp. 961–969. DOI: 10.1007/s10840-022-01406-7.
42. Pathinarupothi R. K., Ramesh M. V., Rangan E. Multi-layer architectures for remote health monitoring, *2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom)*. IEEE, 2016, pp. 1–6. DOI: 10.1109/HealthCom.2016.7749443

Received 08.10.2025.
Accepted 14.01.2026.
Published 27.03.2026.

DOI 10.15588/1607-3274-2026-1-15

УДК 004.93

СТРУКТУРА ДЛЯ ДИСТАНЦІЙНОГО МОНІТОРИНГУ ПАЦІЄНТІВ У СИСТЕМІ ОХОРОНИ ЗДОРОВ'Я

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АНОТАЦІЯ

Актуальність. Дистанційний моніторинг пацієнтів (RPM) відіграє ключову роль у трансформації охорони здоров'я, забезпечуючи безперервне відстеження здоров'я в режимі реального часу поза межами традиційних клінічних середовищ. Як наріжний камінь цифрових медичних послуг, RPM сприяє проактивним та профілактичним підходам до догляду.

Мета роботи. Ця стаття має на меті дослідити концепцію RPM, переглянути існуючі системи та запропонувати нову архітектуру платформи для підвищення ефективності, доступності та якості надання медичної допомоги.

Метод. Використовуючи якісний аналітичний метод, дослідження розглядає системи RPM, адаптовані до конкретних умов. Воно класифікує ці системи за режимом роботи, контактним чи безконтактним, та оцінює їхні технології, архітектури та пропоновані послуги. Крім того, воно представляє запропоновану онтологічну платформу RPM, що включає міркування на основі правил для посилення прийняття клінічних рішень.

Результати. Аналіз охоплює застосування RPM для таких станів, як діабет, епілепсія, головний біль, серцево-судинні захворювання, серцева недостатність, COVID-19, хронічна хвороба нирок, рак та непритомність. Він визначає сильні та недоліки існуючих систем та ілюструє, як запропонована архітектура вирішує ці проблеми, надаючи персоналізовані, масштабовані та ефективні рішення для моніторингу.

Висновки. Дослідження підкреслює зростаючу важливість RPM в охороні здоров'я та представляє інноваційну, онтологічно орієнтовану платформу для покращення надання послуг та результатів лікування пацієнтів. Подальші зусилля будуть зосереджені на клінічній валідації та оцінці ефективності в реальних умовах. Ця робота надає цінну інформацію для медичних працівників, розробників та політиків, які вдосконалюють рішення для дистанційної допомоги.

КЛЮЧОВІ СЛОВА: біомедична телеметрія, хвороби, фреймворк, медичні інформаційні системи, телемедицина.

ЛІТЕРАТУРА

1. Malasinghe L. P. Remote patient monitoring: a comprehensive study / L. P. Malasinghe, N. Ramzan, K. Dahal // J Ambient Intell Human Comput. – 2019. – No. 1. – P. 57–76. DOI: 10.1007/s12652-017-0598-x.
2. Predicting Medical Interventions from Vital Parameters: Towards a Decision Support System for Remote Patient Monitoring / K. Gontarska et al. edited by. A. Tucker et al. // Artificial Intelligence in Medicine. – Cham : Springer International Publishing. – 2021. – P. 293–297. DOI: 10.1007/978-3-030-77211-6_33.
3. Alomi Y. A. National Survey of Total Parenteral Nutrition Practice in Saudi Arabia: Drug Monitoring and Patient Education at MOH Hospitals / Y. A. Alomi, S. M. Aljudaibi // EC Nutr. – 2016. – P. 784–792. Available at: https://www.researchgate.net/publication/314231507
4. Qureshi B. A Bluetooth enabled mobile intelligent remote healthcare monitoring system in Saudi Arabia: Analysis and design issues / B. Qureshi, M. Tounsi // 18th national computer conference. Citeseer. – 2006. Available at: https://www.researchgate.net/publication/244924911
5. Lin J. C. Applying telecommunication technology to healthcare delivery / J. C. Lin // IEEE Engineering in Medicine and Biology Magazine. IEEE. – 1999. – No. 4. – P. 28–31. DOI: 10.1109/51.775486.
6. Mainanwal V. A survey on wireless body area network: Security technology and its design methodology issue / V. Mainanwal, M. Gupta, S. K. Upadhayay // 2015 international conference on innovations in information, embedded and communication systems (ICIIECS). IEEE. – 2015. – P. 1–5. DOI: 10.1109/ICIIECS.2015.7193088.
7. Remote patient monitoring (RPM), in: Good Health and Well-Being / [W. Leal Filho, T. Wall, A. M. Azul, L. Brandli, P. G. Özuyar (eds)] // Encyclopedia of the UN Sustainable Development Goals, Cham: Springer. – 2020. – P. 583–583. DOI: 10.1007/978-3-319-95681-7_300115.
8. Current state of type 1 diabetes treatment in the US: updated data from the T1D Exchange clinic registry / K. M. Miller et al. // Diabetes care. Am Diabetes Assoc. – 2015. – No. 6. – P. 971–978. DOI: 10.2337/dc15-0078.
9. Remote monitoring of diabetes: a cloud-connected digital system for individuals with diabetes and their health care providers / M. Joubert et al. // Journal of diabetes science and technology. SAGE Publications Sage CA: Los Angeles, CA. – 2019. – No. 6. – P. 1161–1168. DOI: 10.1177/1932296819834054.
10. Remote patient monitoring for management of diabetes mellitus in pregnancy is associated with improved maternal and neonatal outcomes / A. Kantorowska et al. // American Journal of Obstetrics and Gynecology. – 2023. DOI: 10.1016/j.ajog.2023.02.015.
11. Epilepsy: new advances / S. L. Moshé et al. // The Lancet. Elsevier. – 2015. – No. 9971. – P. 884–898. DOI: 10.1016/S0140-6736(14)60456-6.
12. Clinical utility of home videos for diagnosing epileptic seizures: a systematic review and practical recommendations for optimal and safe recording / L. Ricci et al. // Neurological Sciences. Springer. – 2021. – P. 1301–1309. DOI: 10.1007/s10072-021-05040-5.
13. Value of smartphone videos for diagnosis of seizures: everyone owns half an epilepsy monitoring unit / U. Amin et al. // Epilepsia. Wiley Online Library. – 2021. – No. 9. – P. e135–e139. DOI: 10.1111/epi.17001.
14. Hassan S. IoT based monitoring system for epileptic patients / S. Hassan, E. Mwangi, P. K. Kihato // Heliyon. – 2022. – No. 6. – P. e09618. DOI: 10.1016/j.heliyon.2022.e09618.
15. IoT-Based Remote Pain Monitoring System: From Device to Cloud Platform / G. Yang et al. // IEEE J. Biomed. Health

DOI 10.15588/1607-3274-2026-1-15

Inform. – 2018. – No. 6. – P. 1711–1719. DOI: 10.1109/JBHI.2017.2776351.
16. Remote and Long-Term Self-Monitoring of Electroencephalographic and Noninvasive Measurable Variables at Home in Patients With Epilepsy (EEG@HOME): Protocol for an Observational Study / A. Biondi et al. // JMIR Research Protocols. – 2021. – No. 3. – P. e25309. DOI: 10.2196/25309.
17. Skarpaas T. L. Brain-responsive neurostimulation for epilepsy (RNS® System) / T. L. Skarpaas, B. Jarosiewicz, M. J. Morrell // Epilepsy Research. – 2019. – P. 68–70. DOI: 10.1016/j.eplepsyres.2019.02.003.
18. Burch R. C. Migraine: epidemiology, burden, and comorbidity / R. C. Burch, D. C. Buse, R. B. Lipton // Neurologic clinics. Elsevier. – 2019. – No. 4. – P. 631–649. DOI: 10.1016/j.ncl.2019.06.001.
19. Digital triage for people with multiple sclerosis in the age of COVID-19 pandemic / S. Bonavita et al. // Neurological sciences. – Springer, 2020. – P. 1007–1009. DOI: 10.1007/s10072-020-04391-9.
20. Continuous remote monitoring in post-bariatric surgery patients: development of an early warning protocol / Ede van E. S. et al. // Surgery for Obesity and Related Diseases. – Elsevier. – 2022. – No. 11. – P. 1298–1303. DOI: 10.1016/j.soard.2022.06.018.
21. User Design and Experience Preferences in a Novel Smartphone Application for Migraine Management: A Think Aloud Study of the RELAXaHEAD Application / M. T. Minen et al. // Pain Medicine. – 2019. – No. 2. – P. 369–377. DOI: 10.1093/pm/pny080.
22. H-Diary: Mobile Application for Headache Diary and Remote Patient Monitoring / A. J. Aljaaf et al. // 2018 11th International Conference on Developments in eSystems Engineering (DeSE). Cambridge, United Kingdom: IEEE. – 2018. – P. 18–22. DOI: 10.1109/DeSE.2018.00010.
23. Fundamentals for future mobile-health (mHealth): a systematic review of mobile phone and web-based text messaging in mental health / S. Berrouiguet et al. // Journal of medical Internet research. – JMIR Publications Toronto, Canada. – 2016. – No. 6. – P. e135. DOI: 10.2196/jmir.5066.
24. Remote monitoring of cardiovascular devices: a time and activity analysis / E. M. Cronin et al. // Heart Rhythm. – Elsevier. – 2012. – No. 12. – P. 1947–1951.
25. Internet of Things: Remote Patient Monitoring Using Web Services and Cloud Computing / J. Mohammed et al. // 2014 IEEE International Conference on Internet of Things(iThings), and IEEE Green Computing and Communications (GreenCom) and IEEE Cyber, Physical and Social Computing (CPSCom). – Taipei, Taiwan : IEEE. – 2014. – P. 256–263. DOI: 10.1109/iThings.2014.45.
26. Gunderson M. Ambulatory Remote Patient Monitoring Beyond COVID-19: Engagement and Sustainment Considerations / M. Gunderson, G. B. Melton // Mayo Clinic Proceedings. Elsevier. – 2022. – No. 12. – P. 2184–2185. DOI: 10.1016/j.mayocp.2022.10.016.
27. Effectiveness and safety of pulse oximetry in remote patient monitoring of patients with COVID-19: a systematic review / A. Alboksmaty et al. // The Lancet Digital Health. – 2022. – No. 4. – P. e279–e289. DOI: 10.1016/S2589-7500(21)00276-4.
28. A conceptual IoT-based early-warning architecture for remote monitoring of COVID-19 patients in wards and at home / A. I. Paganelli et al. // Internet of Things. – 2022. – P. 100399. DOI: 10.1016/j.iot.2021.100399.
29. A smart ontology-based IoT framework for remote patient monitoring / N. Sharma et al. // Biomedical Signal Processing and Control. – 2021. – P. 102717. DOI: 10.1016/j.bspc.2021.102717.
30. Chronic kidney disease / A. C. Webster et al. // The lancet. Elsevier. – 2017. – Vol. 389, № 10075. – P. 1238–1252. DOI: 10.1016/S0140-6736(16)32064-5.
31. Scarpioni R. Remote patient monitoring in peritoneal dialysis helps reduce risk of hospitalization during Covid-19 pandemic / R. Scarpioni, A. Manini, P. Chiappini // J Nephrol. – 2020. – No. 6. – P. 1123–1124. DOI: 10.1007/s40620-020-00822-0.
32. A Mobile App to Support Self-management of Chronic Kidney Disease: Development Study / T. W. Markossian et al. // JMIR Human Factors. – 2021. – No. 4. – P. e29197. DOI: 10.2196/29197.
33. Validation of Agitated Patient Remote Monitoring Alarm System in the Intensive Care Unit / Y.-L. Lee et al. // Studies in Health Technology and Informatics. – 2021. – P. 365–366. DOI: 10.3233/SHTI210747.
34. A fuzzy rule-based model for remote monitoring of preterm in the intensive Care Unit of Hospitals / J. O. Emuoyibofarhe et al. // International Journal of Medical Research & Health Sciences. International Journal of Medical Research & Health Sciences. – 2019. – No. 5. – P. 33–3. Available at: https://www.researchgate.net/publication/333508315.
35. Remote Glucose Monitoring Platform for Multiple Simultaneous Patients at Coronavirus Disease 2019 Intensive Care Units: Case Report Including Adults and Children / F. Garelli et al. // Diabetes Technology & Therapeutics. – 2021. – P. 1–3. DOI: 10.1089/dia.2020.0556.
36. Communication of pain by school-age children with cancer using a game-based symptom assessment app: A secondary analysis / K. M. Bernier Carney et al. // European Journal of Oncology Nursing. – 2021. – P. 101949. DOI: 10.1016/j.ejon.2021.101949.
37. Feasibility and Usability Aspects of Continuous Remote Monitoring of Health Status in Palliative Cancer Patients Using Wearables / M. Pavic et al. // Oncology. – 2020. – No. 6. – P. 386–395. DOI: 10.1159/000501433.
38. Usability Evaluation of a Mobile Phone-Based System for Remote Monitoring and Management of Chemotherapy-Related Side Effects in Cancer Patients: Mixed-Methods Study / S. Moradian et al. // JMIR Cancer. – 2018. – No. 2. – P. e10932. DOI: 10.2196/10932.
39. Association of a remote patient monitoring (RPM) program with reduced hospitalizations in cancer patients with COVID-19 / J. C. Pritchett et al. // JCO Oncology Practice. Wolters Kluwer Health. – 2021. – No. 9. – P. e1293–e1302. DOI: 10.1200/OP.21.00307.
40. Remote patient monitoring system architecture for diabetes management / Ahmad B. I. et al. // 2017 International Conference on Computing, Engineering, and Design (ICCED). Kuala Lumpur : IEEE. – 2017. – P. 1–6. DOI: 10.1109/CED.2017.8308120.
41. Clinical utility of remote monitoring for patients with cardiac implantable electrical devices / S. Yang et al. // J Interv Card Electrophysiol. – 2023. – No. 4. – P. 961–969. DOI: 10.1007/s10840-022-01406-7.
42. Pathinarupothi R. K. Multi-layer architectures for remote health monitoring / R. K. Pathinarupothi, M. V. Ramesh, E. Rangan // 2016 IEEE 18th International Conference on e-Health Networking, Applications and Services (Healthcom). IEEE. – 2016. – P. 1–6. DOI: 10.1109/HealthCom.2016.7749443.

DOI 10.15588/1607-3274-2026-1-15