Innovative Concept of Application of Electronic Modeling in Building e-Health Systems

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Abstract **– The paper presents a concept of application of electronic modeling in the development of e-Health systems for prevention in the diagnosis of problematic skin wounds, which include prevention and treatment, allowing uniformity in the assessment and increase the reliability of treatment tools to achieve a full life without pain, risk, and stress. Health and disease are two phases, changing smoothly or dramatically. It is to this uniqueness of the influences for their direct or indirect management that the research is directed - providing the practicing medical specialists with an opportunity for alternative and adequate diagnostics to ensure the subsequent normal life of the patient. The developed e-Health systems have been applied in the training of specialists in the specialties "Midwife" and "Nurse" and in the specialty "Electronics" at the University of Ruse. They are used in practical training of future doctors in UMHAT KANEV Ruse**

Keywords **– e-Health, software system, algorithms, problematic skin wounds, platelet rich plasma PrP.**

DOI: 10.18421/TEM113-20
https://doi.org/10.18421/TEM113-20

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Received: 28 Jun 2022.
Revised: 29 July 2022.
Accepted: 04 August 2022.
Published: 29 August 2022.

1. Introduction

Modern electronic information systems used in healthcare facilities create convenient access for users to various information according to their status of users – medical professionals or patients. The provision of health e-services is carried out by conducting various activities in health care – personal health record, telemedicine, telehealth or based on sources of medical information [1], [2], [3]. The introduction of electronic information systems in the healthcare industry is defined as a significant asset of patients, especially in the provision of outpatient structure [4].

The use of electronic health systems can lead to the establishment of a new structure – through standardization, medical systems and their impact on the quality of health care, reducing health care costs and more [5], [6]. There are many initiatives related to e-Health systems, including practice planning, information source and sharing, service delivery (for chronic diseases), remote care management, support for clinical solutions in interdisciplinary diagnosis, treatment and care processes, electronic health card and public health research and prevention [3].

Back in 1998, Jacques Attali (Dictionnaire du XXIE Siècle, Jacques Attali, 1998, 349 pp, ISBN-10: 2702819591) defined medicine as "Modified by electronics, and later completely transformed by genetics, medicine will deal at least as much with the healthy as with the sick. First, a definition of a normal life profile will be sought - height, weight, biochemical criteria for normality - and norms of behavior will be established that everyone will try to follow [12]. Telediagnostics and teletherapy will be generalized. A surgeon selected from a world catalog will be able to assist a colleague remotely and even much later to be present as a branch image of the operation, performing virtual manipulations on the patient. Then we will move on to self-diagnosis. Self-monitoring tools that will be worn on the wrist

(biowatches) will allow everyone to monitor whether they meet certain simple standards (blood pressure, cholesterol levels, thermography, heart and brain rhythm, endorphin levels.). Today, this definition brings the full development of medical technology through electronic, telemedicine and digitalization [12].

e-Health is a unique socio-technical system, a dynamic collaboration of different numbers of participants, united by expert goals and with achieved new functional capabilities. Automated systems involve a person (expert) in the processes of regulation and management, unlike automatic ones, in which there is no human participation. This has led to the creation of control algorithms and their adaptation to the system [9], [13], [14].

Directing the influences from the inside out for the system is the tendency to manage it in a planned way, as well as to manage the environment in which it is placed. In this characteristic, systems analysis is the only scientific methodology for describing and managing ultra-complex systems, such as human health – individual and social [16], [17]. Each object (process, phenomenon) is considered not as a single, indivisible whole, but as a complex of interconnected constituent elements and they are described first separately, and then the causal relationships and influences between them [9], [10], [11]. By default, this type of research requires modeling on a modular basis of the system with subsequent information and computer experimentation and management [9], [13], [14].

The paper presents a concept of application of electronic modeling in the development of e-Health systems for prevention in the diagnosis of problematic skin wounds for prevention and treatment, allowing uniformity in the assessment and increase the reliability of treatment tools to achieve a full life without pain, risk and stress. Health and disease are two phases, changing smoothly or dramatically. It is to this uniqueness of the influences for their direct or indirect management that the research is directed – providing the practicing medical specialists with an opportunity for alternative and adequate diagnostics to ensure the subsequent normal life of the patient.

The developed e-Health systems have been applied in the training of specialists in the specialties "Midwife" and "Nurse" and in the specialty "Electronics" at the University of Ruse. They are used in practical training of future doctors in UMHAT KANEV Ruse.

Developed modules proposed in the paper for e-Health are evidence-based medicine based on scientific developments and evaluations of the authors for a period of more than 10 years [9], [15].

2. Methodology and Algorithms

The electronic readiness of the system is identified as the electronic readiness of the practitioner, the organization and the public to adopt e-Health systems [6], [7]. Certain indicators are used to measure this readiness, including needs identification, dissatisfaction, awareness, technology compliance, trust, planning, integration and overall satisfaction [6], [8].

The term e-Health includes specialized activities in electronic format related to health and recovery – Prevention and promotion of health; Medical and health care; Healthcare management and administration; Health economization; Ideology and practice of health policy; Training for the qualification of the expert staff; compare cultural, semiotic and moral-ethical practices.

E-health is characterized as dialogic health – communication is carried out through information products that are derived from the dynamic state of "health". e-Health is a relatively new term that sets out options for practicing healthcare supported by information and communication technologies [9].

The systematic analysis of e-Health covers:

- Technical means – (i) Information technologies, telecommunication infrastructures and mobile devices for communication between suppliers, authors, and users; (ii) Medical equipment; (iii) Software.
- Live participants – (i) Users (medical and health professionals); (ii) Users (patients and persons authorized by them); (iii) Technology, maintenance, and development providers; (iv) Financing institutions; (v) Regulatory, licensing, supervisory authorities and organizations.
- Methods and methodology for working with information products and regulation – (i) Language for communication; (ii) Specific modes of operation of the equipment and formats for the exchange of health data and information; (iii) Medical qualification; (iv) Standards and recommendations for service quality.

e-Health is a collective term for the delivery of healthcare, administration, and specialized training, as well as their technological dissemination through ICT technologies. Using this wording, the authors of the paper build an e-Health system based on scientific and research experience and information technology. The electronic information system for diagnosing skin wound problems and treatment with enriched platelet plasma combines healthcare and specialized training. The processing of patients' medical data in diagnosis and therapy is related to the individual registration of the attending physician. The assessment of the condition of the patients and

the visualization of the tendency for change of the qualitative indicators by quantitative method provides an additional clear direction for the treatment and a training environment for training of doctors practicing treatment by the method of enriched platelet plasma.

Figure 1 presents the Use-Case Diagram of the developed e-Health system. The features available to users depend on whether the user is logged in, has active subscription, or just a guest. User with active subscription has access to the entire website. User without subscription can view their own profile, make a subscription, and use the calculator. Guest user can only register.

The Use-Case Diagram describes the level of access and the role of each user of the system.

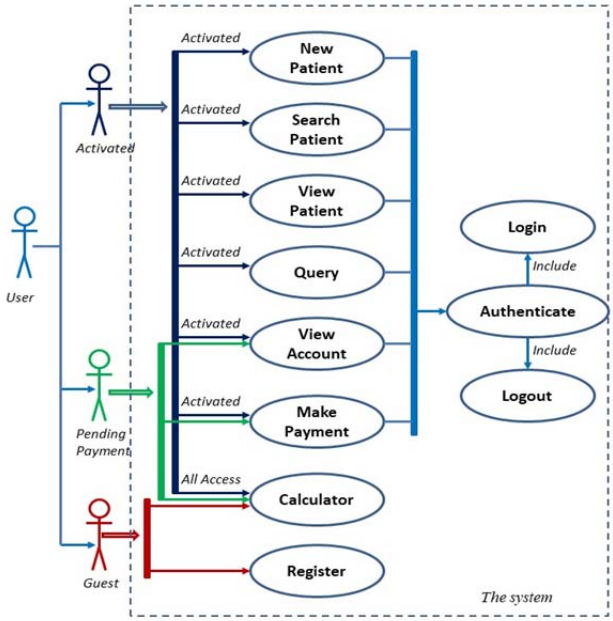

Figure 1. The Use-Case Diagram

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3. Database

The backend environment used is Node.JS, which runs on a single thread using an event loop and is therefore an event-driven application. This allows the system to process thousands of simultaneous connections, continuing code execution while waiting for the result of an event such as a database request or I/O to complete.

The database used for the e-Health system is MongoDB – a document-oriented non-relational database that requires a fixed document structure, Figure 2. Using MongoDB, the developed system is scaled horizontally, which improves performance by using database splitting and the use of different machines, which is shown in Table 1 and Table 2.

Firebase's Firestore was used for image processing and storage. The user interface is created with the help of the ReactJS library, and code fragments reflect a certain part of the user interface through repetitive multiple web pages.

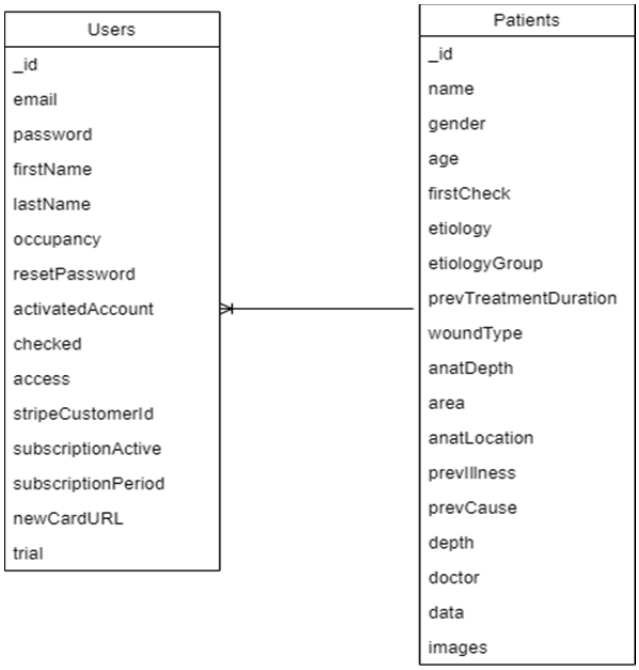

Figure 2. Database Design

Table 1. Data Base Design User

Attribute	Data type	Length	Constraint	Required
_id	Object ID	24	Not NULL	YES
email	String	50	Not NULL	YES
firstName	String	50	Not NULL	YES
lastName	String	50	Not NULL	YES
resetPassword	String	100	Not NULL	YES
activatedAccount	Boolean	N/A	Not NULL	YES
checked	Boolean	N/A	Not NULL	YES
access	Number	N/A	Not NULL	YES
password	String	150	Not NULL	YES
occupancy	String	50	Not NULL	YES
stripeCustomerId	String	50	Not NULL	YES
subscriptionActive	Boolean	N/A	Not NULL	YES
subscriptionPeriod	Date	N/A	Not NULL	YES
trial	Boolean	N/A	Not NULL	YES
newCardUrl	String	150	Not NULL	YES

Table 2. Data Base Design Patients

Attribute	Data type	Length	Constraint	Required
Attribute	Data type	Length	Constraint	Required
_id	Object ID	24	Not NULL	YES
name	String	100	Not NULL	YES
gender	String	10	Not NULL	YES
age	Number	N/A	Not NULL	YES
firstCheck	Date	N/A	Not NULL	YES
etiology	String	50	Not NULL	YES
etiologyGroup	String	50	Not NULL	YES
prevTreatmentDuration	Number	N/A	Not NULL	YES
wouldType	String	50	Not NULL	YES
anatDepth	Number	N/A	Not NULL	YES
area	Number	N/A	Not NULL	YES
anatLocation	String	50	Not NULL	YES
prevIllness	String	50	Not NULL	YES
prevCause	String	50	Not NULL	YES
depth	Number	N/A	Not NULL	YES
doctor	Number	N/A	Not NULL	YES
data	Array of Objects	N/A	Not NULL	YES
images	Array of Objects	N/A	Not NULL	YES

4. Results and Discussion

The presented e-Health system for the prevention of problematic skin wounds is organized by an e-Calculator based on the diagnostic algorithm [15]. In the initial assessment of the wound in a hospital or pre-hospital structure, it is essential that medical professionals determine the need for treatment using the enriched platelet plasma method.

The e-Calculator provides the attending physician with six criteria for assessing the condition of the problem skin wound of a particular patient: (1) Age; (2) Evaluation by indications (etiological reasons that can turn a wound into a problematic skin wound); (3) Assessment of contraindications; (4) Anatomical localization; (5) Presence of an infectious indicator; (6) Concomitant diseases. By following these steps, e-Calculator determines the right direction for medical treatment of wounds - treatment by the method of PrP or alternative treatment.

The processed information is processed according to the proposed PrP Diagnostic Algorithm for problematic skin wounds [15] and the result of the calculations of the e-Calculator for the specific case is visualized in the form of recommendations to the attending physician from the hospital or prehospital structure regarding security of choice and treatment, which is shown in Figure 3.

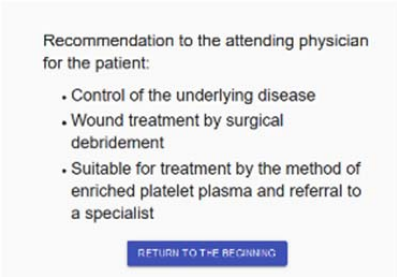

Figure 3. Analysis of the result from eHealth system e-Calculator

The developed modules for diagnosis and treatment of problematic skin wounds from the e-Health system are included as a web application and are available online. Through appropriate registration of practitioners or interns, the created database provides access to real cases of patients diagnosed or treated by the method of PrP, Figure 4.

In 2020 and 2022, the e-Health system is included in the practical training in medical technology of medical and electronic specialists at the University of Ruse. Online learning required teaching methods and tools to provide real-world knowledge to learners in an outpatient setting. The system provided students with the opportunity to assess the role of the method of treatment through enriched platelet plasma, to study the specifics of the quantitative assessment of qualitative indicators and also to see the trend of treatment.

The presented modules of the e-Health system are effective and applied in the pre-hospital and hospital system, and provide reliable analysis and assessment of the condition of patients. Tests of the e-Health system in the work environment show increased interest from doctors and medical professionals.

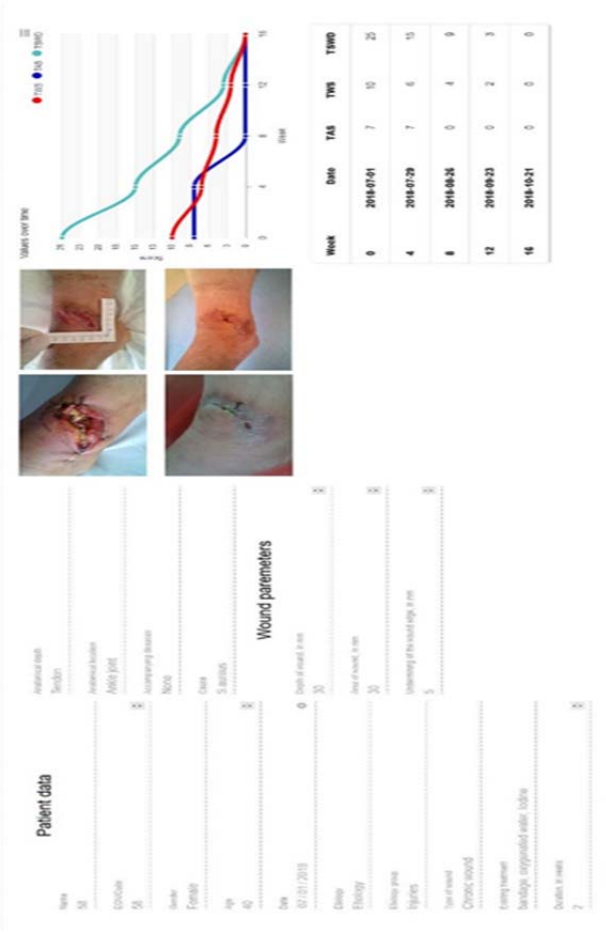

Figure 4. Analysis of the result from eHealth system

5. Conclusion

Developed e-Health system has the following advantages:

- Facilitates the creation and follow-up of patient-specific data by allowing a quick overview of its therapeutic history in platelet-enriched plasma therapy;
- It allows one to create a database of different locations of treatment and compare photos in different medical cases, as well as references to each indicator, at any time, through the mobility of the application;
- Opportunity for training and effective communication between doctors and medical professionals when discussing clinical cases.

The created innovative software system has been successfully implemented in the pre-hospital and

hospital care and allows complex treatment and training by the method of platelet rich plasma. It is used in the training for medical specialists at the University of Ruse.

The future work on the proposed system is related to expanding the implementation in practice and expanding the areas of application in the system itself.

Acknowledgements

The article reflects the results of the work on the project No 2022–FEEA–02, funded by the Research Fund of the University of Ruse.

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