

# Opportunities for Establishing a Knowledge System for Proactive Services in Primary Health Care in Republic of North Macedonia

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## Abstract:

In recent decades, the world has seen significant changes driven by advancements in Information and Communication Technologies (ICT) and data analysis. These technologies have transformed knowledge management and decision-making, particularly in e-health, where the focus is on improving medical practices and patient advisory, especially in preventive care. The healthcare system is knowledge-driven, necessitating the active use of new ICT tools to enhance patient care. This shift from a reactive to a proactive approach is exemplified through proactive electronic health services. The national system "Moj Termin" can integrate a knowledge management module for preventive care. This system generates insights into potential future illnesses based on factors like patient age, genetic predisposition, and current health status. By cross-referencing this data, alerts can be created for primary care physicians to initiate preventive examinations for patients. This approach aims to achieve two primary objectives: early detection and treatment of diseases, and reducing the healthcare system's burden by conserving resources. The module will function by creating proactive e-services within the e-health framework, allowing for more efficient and proactive management of citizens' health.

## Keywords:

Knowledge management, e-health, proactive e-services, preventive care, primary health care.

## 1. Introduction

The healthcare landscape is undergoing a transformative communication revolution fueled by advanced health information technologies. These innovations promise to enhance healthcare delivery and promote public health by facilitating access to relevant health information and improving the quality of care. A myriad of e-health applications—ranging from health information websites and social support networks to interactive electronic health records and tele-health applications—are emerging as critical tools in this revolution. These technologies not only aim to reduce healthcare delivery errors and foster collaboration among healthcare providers but also empower patients to adopt healthier behaviors.

In the Republic of North Macedonia, primary health care is vital as it serves as the primary entry point into the health system. Primary healthcare plays an essential role in the functionality of the healthcare system, addressing numerous challenges that demand improvement. Despite ongoing reforms aimed at modernizing healthcare services through the integration of Information and Communication Technologies (ICT), open issues remain.

One significant moment is the introduction of the "My Appointment" ("Moj Termin") platform, which has fundamentally altered the doctor-patient relationship. These shifts have led to notable improvements in communication between healthcare providers and patients, and overall efficiency in healthcare delivery. But, while scientific advancements in understanding diseases and treatments continue to grow exponentially, the underutilization of healthcare knowledge created during the process of medical practice. The storage, and timely and appropriate use of healthcare knowledge during the medical practice has the

potential to transform practices, leading to improved patient focus, safety, and care quality. Therefore, it is strategically important to address the factors contributing to the underutilization of knowledge; one of them is knowledge management. Knowledge management can play a crucial role in organizing and structuring healthcare knowledge, especially in direction of better preventive protection.

Despite the rapid generation of new healthcare knowledge, challenges remain in effectively preservation, storage, analysis and reuse of this knowledge. This paper identifies three key challenges in North Macedonia's primary healthcare that could benefit from enhanced ICT: (1) achieving optimal preventive care, which is hindered by a shortage of general practitioners and its excessive loads by the numerous patient; (2) maximizing physician knowledge utilization, as time constraints often lead to a reactive rather than proactive healthcare approach especially when it comes to the preventive care of patients; and (3) enhancing the ICT capabilities of the "My Appointment" system, which currently lacks a knowledge management component that is essential for preventive care.

The primary objective is to consider the possibilities for design e-services that inform patients about necessary check-ups based on their health histories, thereby improving preventive care and reducing healthcare costs. By leveraging ICT and enhancing knowledge management practices, the healthcare system can evolve towards a more proactive, efficient, and patient-centered model.

The structure of the paper is organized as follows: it begins with an overview of the achievements in e-health in the Republic of North Macedonia, along with a general introduction to e-health. Next, the research methodology used is outlined. The fourth section presents the research findings, and the paper concludes with key conclusions.

## 2. E-Health in Republic of North Macedonia: state of the art

With the rapid development of new technologies and the integration of informatics into nearly every facet of human life and activity, these innovations have found substantial applications in the healthcare sector, coining the term e-health. E-health according to the World Health Organization is broadly defined as "the use of information and communication technology to support health and health-related fields" [1]. It encapsulates a wide array of applications, including telemedicine, tele-care, and online health services. Scholars Wyatt and Liu [2] describe e-health as "the use of internet technology by the public, healthcare professionals, and others to access information, services, and support for health and lifestyle." Furthermore, according to Van der Klei et al. [3], it refers to "health services and information delivered or enhanced via the Internet and related technologies."

As highlighted by researchers Rooij and Marsh [4] e-health combines healthcare and technology to improve efficiency and reduce costs, ultimately aiming to streamline treatment options to enhance patient safety and outcomes. In this context, a group of authors led by Clegg et al. [5] cites Shaw and collaborators, who identify three distinct functions of e-health that contribute significantly to primary healthcare: informing and monitoring, interaction, and data utilization. The first function involves using e-health technologies to observe and study health parameters. The second function pertains to facilitating communication among all stakeholders in healthcare. Finally, the third function focuses on the collection, management, and utilization of health and medical data sources to inform medical decision-making and intervention development. This third function is the focal point of our interest, emphasizing the need for deeper and better use of health data to enhance patients' health and quality of life, processed it the work of Savoska et al. [6].

Generally, the integration of ICT in healthcare achieves two primary advantages [7]: (1) it establishes an electronic information system that simplifies the administration of processes and operations while connecting different levels of healthcare across the country and involving all actors in the healthcare process, including patients; and (2) it creates equipment and new opportunities for applying ICT in delivering healthcare services to patients.

In the Republic of North Macedonia, the primary document regulating the healthcare sector is the Law on Healthcare Protection [8]. Analyzing this law reveals the structure, organization, and functionality of the healthcare system, the roles of its participants, and how healthcare activities are performed, particularly

concerning primary care and preventive health services. This law also encompasses measures and activities aimed at health protection, including health promotion, disease prevention, early diagnosis, treatment, and rehabilitation. Healthcare services are provided by both public and private institutions, including clinics, polyclinics, and health centers. Patients have the autonomy to choose a primary care physician, who is responsible for managing their health, maintaining medical records, making referrals for specialized treatment, and implementing preventive health measures.

The implementation of e-health in North Macedonia occurs at several levels, leading to a structured presentation and analysis that can be segmented into three key areas: Module Level within Digital Health, Institutional Level (Agency for E-health) and Web Platform Level for E-health. Digital Health encompasses various modules that have been developed to constitute e-health in North Macedonia. The primary platform can be accessed at [www.e-zdravstvo.mk](http://www.e-zdravstvo.mk) [9] and consists of five main modules: My Appointment, My Health, Telemedicine, E-Prescriptions, and Hybrid Health, presented at Figure 1.

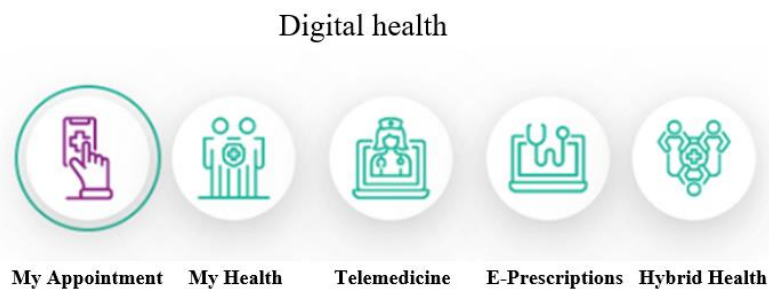


Figure 1. Structure of Digital Health in Republic of North Macedonia [9]

The "My Appointment" module is integral to the overall system and vision for digital health in the country. Launched more than ten years ago, this module marked the beginning of e-health in North Macedonia and represents an integrated national system for electronic health records and scheduling. Over time, it has expanded to include all segments of the healthcare system within the network of health institutions. Following its launch, additional modules such as e-Referral and e-Prescription were developed, transforming the system into a fully integrated information platform uniting data from institutions at all healthcare levels, including primary, secondary, and tertiary care.

Patients and healthcare workers can access the "My Appointment" system, allowing patients to check for available appointments, find referrals, or search for doctors or medical equipment [10]. Furthermore, healthcare professionals have a dedicated section to log in and access important updates, referrals, initiatives, preventive measures, and other relevant health system information. This system enables primary care physicians to manage their schedules effectively and connect with specialists, ensuring comprehensive patient care. The architecture of "My Appointment" is designed to support process-oriented development.

Currently, the e-health information system in North Macedonia boasts over 30 modules [8, 9, 10], each equipped with various functionalities, such as the E-Referral Module, E-Prescription, Electronic Medical Record, and more. The Electronic Health Record (EHR) represents every record created as a result of any event related to a patient's health (e.g., hospital admission, visit to a general practitioner, etc.) [11]; this indicates the complexity of the national health information system, serving as a central electronic system.



Figure 2. The Electronic Health Record (EHR) [11]

The services when delivered electronically, are referred to as e-services. In the context of improving the accessibility of healthcare services, a large number of e-services are provided within e-health, utilizing various delivery channels (through platforms, websites, different types of applications, or mobile phones via SMS). Thus, the creation of e-services marks a new era in health informatics, offering vast opportunities not only in treatment but also in preventive care and informing citizens, especially patients, about maintaining their health [12].

### 3. Research Methodology

To achieve the previously defined goal, a research methodology was applied, consisting of research methods used to gather information, analyze the results, and describe the conclusions drawn. The range of scientific research methods used in this research includes (1) an on-desk analysis of available documentation related to healthcare, e-government, e-health, and e-services. This method explored health protection laws, existing literature in the relevant fields, global research in these areas, case studies, and provided an analysis of the existing information system in the healthcare sector of North Macedonia; (2) the synthesis method was used to integrate the insights gained from the conducted research as well; and (3) the descriptive method was utilized to describe the findings obtained from the research, including a description of the healthcare information system and the proposed solutions for improving the information system in primary healthcare. This includes the upgrade of the knowledge management system and the description of the proactive e-service that was proposed. The research was conducted from December 2022 to October 2023.

### 4. Research findings

An examination of the national integrated information system indicates that, despite notable advancements in developing and upgrading the national e-health system, there are still significant opportunities for improvement in patient preventive care; its notable absence is a module dedicated to storing the practical knowledge gathered by doctors during their practice.

The evaluation of the previously mentioned systems, modules, and the national e-health framework illustrates that these are integrated systems designed to collect, disseminate, and store data. However, beyond these basic functions, there appears to be no existing tool or module capable of processing data based on specific criteria. For instance, the My Appointment system, utilized at the primary care level, essentially operates as an application that is supported by an information system connecting all stakeholders

in the network and storing data in databases to facilitate rapid and efficient data exchange. Moreover, an examination of the available options within primary healthcare reveals a lack of advanced data processing capabilities through information technology at this level.

The research identified three critical gaps: (1) the absence of a dedicated section or module for inputting the knowledge and experiences of primary care physicians that pertain to their patients, and (2) the system does not perform any analyses aimed at enhancing preventive care based on the progression of diseases linked to prior health conditions or genetic factors; and (3) although primary care physicians are legally tasked with providing preventive care, the reality of their workloads often limits their ability to do so effectively - the emphasis on preventive health is crucial for early disease detection, treatment, and health improvement, yet the current system struggles due to high patient loads per doctor.

The findings suggest that the current emphasis is largely on connecting institutions and integrating their information systems while ensuring data security, with comparatively less focus on the actual analysis of data. The establishment of registers and databases is mainly utilized for record-keeping rather than serving as a foundation for comprehensive analysis and the development of higher-level patient services that are informed by the knowledge and experiences of primary care physicians.

Furthermore, the analysis also delved into the aspect of proactivity within healthcare services. It was concluded that there is minimal representation of proactive services in the realm of digital health. At present, apart from the reminders for patients regarding their scheduled appointments for secondary care provided by My Appointment, there are no additional services adopting a proactive stance. This indicates that the potential of innovative IT solutions in this area remains largely untapped, presenting a significant opportunity for future applications.

The analysis of the doctor's work, patient needs, and the potential for prevention are three key aspects whose observation provided guidance for the further development of the My Appointment information system. This means that the doctor has a good understanding of all aspects of their patient's file, but that knowledge and data are only placed in separate folders—the patients' files. Such insights remain isolated, with no opportunity for at least combining them for retrieval in one place or for processing them.

One of the characteristics that characterize healthcare is that healthcare is generally a knowledge-driven process [13]. As we know that knowledge management solutions incorporate several computer science concepts, including data mining, rule-based reasoning, and multi-agent systems and ontological models play a crucial role in representing knowledge, enabling the use of powerful inference engines to extract insights from existing data and facilitate knowledge discovery, that it was more than clear that the right solution for this elaborate need is KM. Several KM frameworks leverage ontologies [14], allowing for advanced querying and manipulation of knowledge, as well as enhanced discovery and access. Furthermore, the multi-agent system paradigm is adapted to support knowledge distribution among autonomous entities, which fosters knowledge sharing among practitioners. On the software side, several free open-source tools, such as KAON or Protégé for managing ontologies and developing ontology-based applications, as well as Pellet for inference engines, are available.

Furthermore, it is well known that in various countries, particularly in the developed world, governments are making efforts to establish national electronic health record (EHR) systems that are digitized, it will become possible to access accurate patient information at the right time. This access can enhance diagnostic processes, support health-related decision-making, facilitate public health initiatives, and contribute to research endeavors. Although much of the current work on EHRs focuses primarily on data processing [15] knowledge management techniques can significantly enhance the functionality of EHRs. These techniques can help in navigating the extensive data collected, enabling practitioners to identify more effective treatment approaches by examining similar case histories.

A practical example of a knowledge system in primary healthcare, particularly from a preventive standpoint, could involve utilizing patients' health histories as a key resource [10]. Each health record provides a chronological account of a patient's health condition and disease progression. These records also include crucial information about the patients' ages and genetic predispositions. Such data form a robust database that, when applied in conjunction with physicians' expertise concerning three primary factors: (1) the patient's age, (2) genetic predispositions, and (3) previous disease history, can be effectively transformed

into a knowledge system through information and communication technology (ICT). This system can be used for various applications, one of which is enhancing preventive care for patients.

#### 4.1. Proposal for proactive e-health services: an example

The explanation provided above can be vividly illustrated through a specific example. In this example, the foundation for creating the knowledge system consists of widely known facts in medicine, such as:

- Women aged 45 and older enter menopause,
- Patients with thyroid gland dysfunction experience issues with other gland functions, particularly estrogen,
- Estrogen is responsible for reducing calcium in the bones,
- Reduced calcium in the bones leads to the disease osteoporosis.

These facts are knowledge that physicians possess, and if they connect the data of patients who visit the clinic complaining of back pain, the physician will often immediately offer a referral for a specialist examination—an orthopedic doctor—recommending that the orthopedic specialist conduct a DEXA scan of the patient's bone density. However, if the patient (a person with all the aforementioned predispositions) does not experience back pain or ignores it and does not consult their primary care physician, they may sustain a fracture after some time, at which point it may be discovered that they had osteoporosis. At that moment, the damage has been done, affecting both the patient's health and the healthcare system/state, which becomes financially burdened due to examinations, costs for materials to treat the injury, and rehabilitation expenses.

Personal Health Records (PHR) or Health Records (HR) contain patients' sensitive data such as personal information, health family history, and medical and healthcare data, protected properly according to national regulations regarding personal data protection laws in the country [17].

Collected data can be turned into valuable insights, turning operational health data into meaningful knowledge. With the added intelligent component in the current e-health information system in North Macedonia, the system will proactively indicate the potential possible diseases according to the patients with similar PHR and set diagnosis.

To upgrade the system we suggest patient-patient (user-user) collaborative filtering [18]. Based on previously set diagnoses of patients with similar PHRs, the system will send alerts and directions for detailed analyses using the already well-established SMS and e-mail sending component.

In ideal conditions of utilizing the opportunities provided by ICT, expanding the existing e-health system would involve upgrading the system, which would use data on gender, age, genetic predispositions, and disease history as triggers for activity. If 3 out of 4 preconditions are met, a notification would be sent to the primary care physician. Thus, the primary care physician, without needing to search through health records (as the system does this for them), will be informed about a potential patient with predispositions for osteoporosis. This information is sufficient for the primary care physician to contact the patient through one of the communication channels, provide them with information, and offer a referral to a specialist for further examinations. Some of these examinations may not occur because patients may decline the invitation to visit their primary care physician. Some, despite visiting their primary care physician, may not accept the offer to see a specialist. Others may agree to get a referral but fail to visit the specialist. Some, after visiting the specialist, may realize they do not have osteoporosis, while others who are found to have osteoporosis will undertake timely actions, and with appropriate therapy, further progression of the disease and its unwanted effects will be prevented.

## 5. Conclusion

Evidence-based medical practice seeks to merge individual clinical expertise with the most reliable and scientifically validated research findings, ensuring that medical knowledge is readily available to healthcare providers. However, while having access to knowledge is essential for evidence-based practice, it is not

enough on its own. As medical knowledge expands rapidly, there is an increasing need for tools that allow practitioners to quickly store relevant information.

So, the advancement of e-health in North Macedonia, especially within the primary healthcare information system, establishes a foundation for enhancement through the creation of a knowledge system dedicated to preventive care. Therefore, a place to store such important knowledge of doctors acquired throughout their working life and specific situations with patients, make this proposed system could act as a cornerstone for the development of proactive e-services designed to improve patient preventive care. The integration of e-health technologies along with the establishment of a knowledge management system can profoundly change healthcare practices in North Macedonia, with a strong focus on preventive care and effective use of existing health data. This approach can lead to better patient outcomes, increased operational efficiency and decreasing expenses, and ultimately contribute to a healthier population.

Therefore, we can conclude knowledge management in the context of ICT application is a mandatory component of the e-health information system. This system serves as a powerful tool offering great potential for improving the care provided to patients by primary healthcare, expanding the range of e-services offered by this sector, and transforming the healthcare concept from reactive to proactive by generating proactive electronic health services.

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