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# THE IMPACT OF eHEALTH AND BLOCKCHAIN TECHNOLOGY IN HEALTHCARE: A QUALITATIVE RESEARCH OF MEDICAL PROFESSIONALS OF ESTONIA[1]

# O IMPACTO DA TECNOLOGIA eHEALTH E BLOCKCHAIN NA SAÚDE: UM ESTUDO QUALITATIVO AOS PROFISSIONAIS DE SAÚDE DA ESTÓNIA

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***Abstract:***

*This study aimed to analyze the perception of healthcare workers of Estonia on the impact of eHealth and blockchain technology in healthcare, after over a decade of its nationwide adoption, and their perceived benefits and challenges of its implementation.*

*A qualitative research was conducted involving a semi-structured interview of eleven participants, selected amongst healthcare*

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*professionals such as doctors, nurses and managers of healthcare institutions.*

*The eleven participants referred to eHealth as a great tool which facilitates access to patient's medical data, saving time and improving communication with other healthcare providers and patients. Data overload, insufficient computer skills and the disparities on access by particular groups of the population are amongst the challenges on the implementation of eHealth.*

*This study highlights the perceptions of healthcare workers, on the impact of eHealth and blockchain technology, specifically detailing its benefits and challenges, after a decade of its adoption in Estonia. There is positive correlation between eHealth literacy and health-related behaviors for health promotion in the future and the majority of the participants are of the opinion that being able to access their own medical data, prescriptions, information about their condition, may increase patient's compliance to advice and treatment regimes proposed by healthcare providers.*

**Keywords**: eHealth, Blockchain, Healthcare, Estonia.

***Resumo**:*

*Este estudo teve como objetivo analisar a perceção dos profissionais de saúde da Estónia sobre o impacto da eHealth e da tecnologia blockchain nos cuidados de saúde, após mais de uma década da sua adoção neste país, e os benefícios e desafios percebidos da sua implementação.*

*Foi realizada uma pesquisa qualitativa envolvendo uma entrevista semiestruturada a onze participantes, selecionados entre profissionais de saúde como médicos, enfermeiros e gestores de instituições de saúde. Os onze participantes referiram a eHealth como uma excelente ferramenta que facilita o acesso aos dados médicos dos doentes, poupando tempo e melhorando a comunicação com outros prestadores de cuidados de saúde e doentes. A sobrecarga de dados, as competências informáticas insuficientes e as disparidades no*

*acesso por parte de grupos específicos da população estão entre os desafios na implementação da eHealth.*

*Este estudo destaca as perceções dos profissionais de saúde sobre o impacto da eHealth e da tecnologia blockchain, detalhando especificamente os seus benefícios e desafios, após uma década da sua adopção na Estónia.Existe uma correlação positiva entre a literacia em eSaúde e os comportamentos relacionados com a saúde, para a promoção da saúde no futuro, e a maioria dos participantes é da opinião que poder aceder aos seus próprios dados médicos, prescrições, informações sobre a sua condição, pode aumentar a adesão do doente ao aconselhamento e aos regimes de tratamento propostos pelos prestadores de cuidados de saúde.*

**Palavras-chave:** eHealth, Blockchain, Saúde, Estónia.

## 1. INTRODUCTION

eHealth is viewed by some as one of the most important revolutions in healthcare, comparable to modern medicines and vaccines (Silber, 2003) and has become an integral part of healthcare systems across Europe.

The broader objective of eHealth is to support healthcare professionals in their work and continuous, lifelong learning, as well as to assist all citizens in their own healthcare management, across organizational boundaries and health systems (Moen et al. 2012). In recent years Estonia has ranked highly in various international comparisons measuring e-readiness amongst EU countries. Its eHealth service has been established since 2008 becoming the first country in the world to fully implement such a system nationwide. The Estonian ehealth information system incorporates health data from all of Estonia's healthcare providers, which can then be safely exchanged between patients and medical staff.

The introduction of blockchain technology was the response of the Estonian government to a series of cyber attacks which plagued the

country in 2007. Initially developed for the crypto currency bitcoin, its properties of anonymity, transparency and auditability has sparked the interest of several market sectors. In healthcare the application of blockchain aims to improve the interoperability of patient health information between different healthcare organizations while maintaining the privacy and security of data. The technology ensures accountability and much needed transparency of processes through close monitoring of all actions. The principle of decentralization can provide the structural foundation for the paradigm shift towards a patient-centered, rather than institution-centered, healthcare delivery (Langerak et al., 2024).

As with many European countries, Estonia is facing a health workforce shortage caused by ageing healthcare workers, professional migration and inadequate training volumes of recent years but eHealth, and its many applications, is viewed as one of the responses to maximize the scarcity of human and material resources. By eliminating unnecessary face-to-face medical appointments, improve the cooperation between healthcare providers and involving patients in their own care by allowing them access to their data the implementation of eHealth is seen as a positive move towards time and resource efficiency. The digital transition is not without its challenges, however, as concerns have been raised that general implementation of eHealth may unintentionally aggravate healthcare disparities for vulnerable and under-resourced groups (Kelly et al., 2023).

After over a decade of implementation in Estonia, we are bound to ask, has eHealth lived up to its potential for those working with its many applications? What benefits and challenges have healthcare professionals encountered in their day-to-day experience with eHealth? The aim of this study is to attempt and answer these questions, with the following primary objectives:

a) Analyze the perception of medical professionals regarding eHealth and Blockchain

b) Recognize the benefits of the implementation of eHealth for medical professionals

c) Identify the biggest challenges of the implementation of eHealth for medical professionals

To respond to these objectives a qualitative study was carried out with a written interview of eleven participants working in healthcare, including doctors, nurses and managers of healthcare institutions.

This research begins with a brief analysis of the concept of eHealth, followed by a description of its several applications in Estonia and the justification behind the adoption of blockchain. In the second part of this paper the method is characterized as well as the presentation of the participants in the interview. Lastly, we reveal the questions of this interview and answers of the participants; the results are analyzed and discussed, assessing the perception and impact of eHealth and blockchain technology on the day-to-day life of medical professionals and in their interaction with other colleagues and their patients (Ji & Chi, 2024).

## 2. LITERATURE REVIEW

### 2.1. eHealth

There is no general agreement on a single definition of eHealth (Bruthans & Jiráková, 2023). The WHO (2006) defines eHealth simply as "the use of information and communication technologies for health". Despite the difficulty in defining eHealth, there is a common view that it is a rapidly expanding area, that has the potential to encourage the adoption of healthy behaviors, enable improvement of healthcare services and communication between healthcare professionals, at relatively low cost, time efficiency, and customized for individual patients (Ahern et al. 2006; WHO, 2006; Maramba et al. 2019; Schreiweis et al. 2019; Kim et al. 2023).

eHealth should not be viewed as just the use of information and communications technology but should be considered in relation to the multitude of needs within the health care system (Lagerak et al., 2024; Moen et al. 2012). eHealth is not the solution to all the current

healthcare problems, but it can significantly contribute to its improvement (Silber, 2018)

The quick and easy access to patient's medical history, laboratory tests and other medical data, at any time and at any location is perceived as one of the greatest advantages of eHealth for healthcare providers (Parv et al. 2014, van Kessel et al. 2022, Tuula et al. 2022). Booking appointments, as well as managing consultations, sharing data and referring to other specialists has been made easier and more efficiently by eHealth, saving time for both patients and medical professionals (Lluch et al. 2013; Lotman and Viigimaa, 2020).

There are several obstacles for eHealth, including limited investment and limited availability of skilled ICT personnel. Despite that, the use of electronic health records is well accepted and widely used by patients and healthcare professionals. (Bert et al. 2023). Evidence suggests that many people who already experience poor health outcomes are also more likely to face digital exclusion (Heinsch et al. 2022).

### 2.2. e-Health in Estonia

Estonia has developed several e-services since 2008, including the Estonian digital health platform (DHP), called the Estonian nationwide health information system (EHIS) which allows secure and trusted access to medical data, prescriptions and medical images. The Estonian e-Health system is unique because it is nationwide, integrating healthcare data of all healthcare providers (Metsallik et al. 2018)

The most widely used applications are the Electronic Health Record, the Patient Portal, the digital prescription, the drug interaction decision support, e-consultation and e-ambulance (Bertl et al. 2023).

#### Electronic Health Record

The electronic health record (e-Health Record) is a "nationwide system that integrates data from Estonia's different healthcare providers to create a common record that every patient can access online" (e-Health Record, n.d.).

The system functions as a national database that retrieves data from various providers, which may be using different programs, and presents

the data in a standardized format via the e-Patient Portal. In a single electronic file, doctors can access patient's records and read test results as they are entered (Tuula et al., 2022).

The electronic health record is a fundamental building block to all of the eHealth applications. It allows the sharing of medical records between healthcare providers, across many disciplines, institutions and, potentially, geographic boundaries (Silber, 2018).

**e-Patient Portal**

The e-Patient Portal allows patients to access their medical records, as well as the records of their underage children, or authorize others such as caregivers or family members. By logging in, using an electronic ID (eID), the patient can review doctor visits, check and renew prescriptions, assess which health providers have had access to their files, book appointments and ask for sick-leave notices, which are issued digitally and automatically sent to the patient's employer (Enter e-Estonia, 2020; Tuula et al., 2022). The e-Patient Portal includes a self-reported Health Declaration which is used towards specific requests such as driver licence's renewal; and includes reminders for vaccines and mandatory regular check ups (Nøhr et al. 2017).

**e-Prescription**

Estonian e-prescription system was first introduced in 2010, and currently over 99,9% of prescriptions are handled online (Tuula et al. 2022). e-Prescription is a centralized paperless system for issuing and handling medical prescriptions. Medicines are prescribed, by doctors, electronically, using an online form which can be accessed at the pharmacy with the information retrieved by the patient's ID-card. The centralized aspect of the system allows for any medical cost assisting benefits, that the patient might be entitled to, will also appear and the medicine is discounted automatically. The system allows automatic billing from pharmacies to the Estonian Health Insurance Fund. Doctors can issue repeated prescriptions without the need for an appointment. A patient can contact the doctor by e-mail, Skype or phone and with just a few clicks doctors can issue a refill, which can be collected from the

nearest pharmacy (e-Prescription, n.d.). This system saves time for both patients and health workers, but most importantly, it allows healthcare workers and authorities to keep track of prescribing patterns, patient's medicine use and monitor compliance (Tuula et al. 2022).

**e-Consultation**

The e-consultation service is an opportunity for family doctors to consult with medical specialists to clarify their patient's health problem. This service is carried out electronically and through a proper digital referral document the physician describes the patient's complaints and condition in detail, including any tests, analyses and studies carried out. The medical specialist prepares a proper response to the referral, which may be some advice regarding further treatment, further tests or analysis and/or if the patient requires specialist treatment.

The service improves the communication between family doctors and medical specialists; as well as it saves patient's time, avoiding unnecessary appointments (Tervisekassa, 2019).

**e-Ambulance**

e-Ambulance is a digital service that can detect and position an emergency phone call for the responding ambulance. It also allows for the attending emergency crew and the doctor at the hospital to read time-critical information, such as blood type, allergies, medication and recent treatment, through the patient's ID code (e-Ambulance, n.d.). Emergency crews can access patients medical history and condition en-route to the victim and, through live health monitoring devices, record and deliver status information to receiving hospitals, for preparation and increased readiness, thus saving time and effort (Matsumoto et al. 2015).

**Clinic Decision Support**

The clinic Decision Support system was first introduced in Estonia in 2020. It is an important tool used by doctors and nurses that brings patient-based recommendations to help make better decisions, faster. It collects and analyses human data, such as diagnoses, medications, tests from the last five years, blood pressure readings and lifestyle factors

(Enter e-Estonia, 2020). The amount of data that is available across the Estonian Health Information System helps healthcare professionals to support their decisions, take into consideration case-specific recommendations to improve clinical outcomes, avoid adverse effects and improve efficiency (Lotman and Viigimaa 2020). The intention is to focus on preventive health care, instead of reactive treatment to disease (Yeh and Saltman, 2019).

### 2.3. Blockchain Technology in Healthcare

Blockchain technology was introduced in 2008 by a person or group, under the pseudonym Satoshi Nakamoto, developed for the cryptocurrency, Bitcoin (Mettler, 2016). This technology is based on a distributed peer-to-peer system which applied to crypto currencies has made it possible to speed up international payments, eliminating intermediaries, normally banks; transactions happen practically immediately, with less costs and bureaucracy; and, without compromising security, continues to be verifiable and auditable (Nakamoto, 2008).

Since then, technology has been used in various other industries such as business, data management, education, finance, public services and more recently, healthcare. The underlying principle of immediate, transparent and decentralized access to information represents an essential starting point for many market sectors (Casino et al. 2019; Abu-Elezze et al. 2020). The healthcare sector, for which the storage and transfer of sensitive data is vital, could not remain indifferent to the evolution of this technology and the association of blockchain and healthcare has been the subject of particular interest (Ambrósio & Soares, 2022). “The quality management of information is indispensable to the quality of healthcare” (Silber, 2018).

Estonia became the first country to deploy blockchain technology on its digital services following several cyber attacks in 2007. Testing begun in 2008 with the objective to reduce the risk of possible threats (KSI Blockchain in Estonia, 2022). Blockchain technology is used to ensure the integrity of the electronic medical data as well as the system access logs (e-Health Record, n.d., Estonia Blockchain Technology,

n.d.). "Blocks" of information are connected to each other and make up a chain that reflect all the changes; so that every attempt to change the data leaves a trace in the pattern that can be instantly detected. The "chain of blocks" reaches a great number of computers all over the world, and can, therefore, be controlled and verified by a great number of parties. The information isn't stored in a single, specific, location and no centralized version exists for a hacker to corrupt, making it safe to use (Estonian Blockchain Technology, n.d.). Blockchain technology ensures "security, accountability and transparency of processes"; and the close monitoring of all actions allows for quick and definite identification of fraud and misuse (Metsallik *et al.* 2018).

The issue of trust is perceived as one of the main obstacles for the implementation of eHealth solutions (Ćwiklicki *et al.* 2020). Yet, Estonia's eHealth system ranks highly in trust reports due its long-term use of the system without incidents nor misuse of personal data (Lotman and Viigimaa, 2020).

## 3. METHOD

The research in this study is classed as qualitative, regarding the analysis and treatment of data. The method for collection of data was a written semi-structured interview with fourteen questions divided in four groups and submitted to the participants through google forms. The interview questions were constructed based on the study by Soares et al. (2023).

An interview is considered as the interaction between two or more people and is applied to the study of history, relationships, representations, beliefs, perceptions and opinions of individuals (Batista et al., 2017, Spencer et al., 2004). As a data collection instrument, written interviews help to provide personal depth to overall numbers and statistics.

The e-interview saves time and financial resources and, in this case, opened up the possibility for interviewing research subjects who lie beyond the geographical social reach of the researchers. This type of interview, however, provides a limited register for communication and is

dependent on competent access to reliable technology by researchers and subjects (Bampton & Cowton, 2002).

The selection of participants was intentional and was centered in healthcare professionals, mainly doctors and nurses, working actively, with eHealth applications, on patients or acting in management positions. The aim of the interview is to obtain a personal insight of those healthcare professionals that are in close contact with eHealth and therefore are able share their experience and opinions on the subject as well as their own perception of the impact of blockchain in their work.

The group of eleven (11) interviewed participants included oncologists, surgeons, physicians; nurse team leaders and advanced nurse practitioners; and a chief medical officer and government official.

The presentation of the results adopted the method proposed by Miles & Huberman (1994) cited by Batista et al. (2017) of data reduction (focusing, simplification and transformation of original data into organized summaries), followed by presentation and conclusion/verification. The analysis of the interviews follows the coding presente in table 1.

**Table 1**
Coding of Respondents by Role

| | |
|---|---|
| Doctor, Oncologist, Surgeon, Physician | DOC1, DOC2, DOC3, DOC4, |
| Nurse, Team Leader, Advanced Nurse Practitioner | NUR1, NUR2, NUR3, NUR4, NUR5 |
| Chief Medical Officer / Government Healthcare Official | MAN1, MAN2 |

## 4. RESULTS: Presentation and Analysis

The interview was divided into four parts to answer the objectives of this study. In table 2 the sociodemographic profile of the participants is presented. Most of the participants are between 34 and 49 years old

(64%). Regarding their role, 36% are medical doctors, which includes oncologists, surgeons and physicians; 46% are nurses, which includes team leaders and advanced nurse practitioners; and 18% refer to management positions in the medical field such as chief medical officer and government official. All the participants were working at their role for over five years.

**Table 2**

Sociodemographic profile of respondents

| **Age (Years)** | **Gender** | **Role** | **Professional Experience** (Years) |
|---|---|---|---|
| 21 to 33 (18%)<br>34 to 49 (64%)<br>50 to 65 (18%) | Female (73%)<br>Male (27%) | Medical Doctor (36%)<br>Nurse / Advanced Nurse Practicioner / Team Leader (46%)<br>Chief Medical Officer/Government Official (18%) | < 5 years (0%)<br>6 to 10 years (55%)<br>> 10 anos (45%) |

The second group of questions, presented in table 3, aims to assess the perception of the participants regarding eHealth and the relevance of eHealth for medical professionals, evaluating two of its main characteristics: access to patient's medical data; and the sharing of medical information and referral process between healthcare providers. The participants refer to eHealth as a "great tool", "simple and easy to use", that helps to access, manage and share relevant information. Also, believed to ensure better quality of service and improve health outcomes by involving the patient in the process.

The literature does support that patients are encouraged to take a more active role monitoring their own health, and through a better understanding of their medical conditions, adopt healthier behaviors which can potentially reduce overall rates of disease (Metsallik, 2018; Ye and Saltman, 2019).

When it comes to access, there is an overall agreement between the participants that eHealth is very useful and access is made simple and transparent, "with guaranteed privacy"; even when you change physicians. There is a concern expressed by one of the participants regarding the amount of available data which may make it difficult to access the relevant information. This has already been suggested by Parv et. al (2012) and Lotman and Viigimaa (2020) who have mentioned the risk of data overload which may require more time of medical professionals to check, review and provide feedback for their patients. The necessary security checks and electronic authentication of users require additional time and training (Metsalik et al. 2018).

In respect to sharing of medical information, once again the overwhelming opinion is that eHealth has made the referral process between healthcare providers, easy, with only one participant claiming it could still be made a lot easier.

Services such as e-Consultation and e-prescription have been shown to improve the cooperation between multiple professionals (such as family doctors and specialists) teams and institutions (Lluch, 2013, Tervisekassa, 2019).

The third group of questions, presented in table 4, aim to assess the opinion of professionals in the medical field about the relevance of eHealth in communication with patients; and the perceived impact of eHealth in patient's compliance to their treatment.

Most of the participants agree that it is "faster" and "easier" to communicate with their patients and issue prescriptions which they can, then, access electronically. This leads to saved time and reduces "unnecessary face-to-face" visits. From the point of view of the interviewed medical professionals, it is a great tool for patients to book their appointments and access their own medical data, mainly information discussed at previous appointments, referral letters and test results. A concern, however, is brought about by one of the participants regarding elderly patients. There is a need for mentoring on eHealth, and basic knowledge of computer skills to guarantee access to patients.

**Table 3**
eHealth for Medical Professionals

| Questions | Answer Threads |
|---|---|
| **What are your perceptions of eHealth?** | "Any electronic and digital process of healthcare data and access to it" "(…) helps to get and share relevant data" (NUR2, NUR4, DOC4) |
| | "It is a great tool, when used right" (DOC2, DOC3) |
| | "Its a good tool to exchange information between different specialists and to ensure better quality/service information for the patient" (NUR5) |
| | "Better management of data. Improved access. Bigger role of patients in the process, thus better health outcomes" (MAN1) |
| | "We need it" (NUR1) |
| | "Simple and easy to use" (NUR3) |
| **What are your perceptions of eHealth in the access to relevant medical data?** | "That makes communication, cataloguing, diagnostics and treatment to be done quicker and without unnecessary bureaucracy" (NUR2) |
| | "It is a good way to access data, but the problem is finding the relevant data fast" (DOC3) |
| | "It's good. You can change physicians and clinics when necessary and no data gets lost" (NUR4) |
| | "Better management of data in all aspects" (MAN1) |
| | "Everything that has been logged and not restricted by the patient becomes easily accessible; (…) access is simple, transparent and guaranteed privacy" (DOC4, NUR5, MAN2) |
| | "Absolutely positive"; "Useful"; "Great" (DOC1, DOC2 NUR1) |
| **Has the process of sharing relevant medical data between professionals and referrals process become easier, thanks to eHealth?** | "Yes" (DOC1, DOC2, DOC3, NUR1, NUR2, NUR5, MAN1, MAN2) |
| | "(Sharing data) has become a lot easier" (DOC4, NUR4) |
| | "It could be much better" (NUR3) |

The risk of digital exclusion of specific population groups has been identified and threatens the equitable access of healthcare. The most vulnerable group is indeed the group of older patients who use computers as a means of communication with some reluctance (Cwiklicki et al. 2020, van Kessel et al 2022).

The literature has suggested that eHealth can lead to higher compliance by patients regarding medical advice, treatments and prescriptions regimes. The interview shows some divide in this subject with a group of participants complementing the concerns raised in the previous question regarding the difficulty of older generations in accessing their own electronic records and therefore all the information regarding their treatment plans and prescriptions.

Finally, considering the possibilities for eHealth, and e-Consultations in particular, and the reduced need for face-to-face visits, a follow up question was asked regarding the reduction of waiting lists for hospital and emergency appointments. Two participants concurred but most of the participants did not agree with the assessment but pinpointed the lack of human resources as the main reason.

Table 5 presents the medical professionals' perspectives on the benefits and challenges of eHealth.

Fast and easy **access**, for medical professionals and patients, to medical information and eHealth services is the main advantage. This leads to another mentioned advantage: time efficiency and convenience. As stated before, eConsultations and ePrescriptions allow patients to get advice without leaving home and since everything is recorded in the patient's medical record, it avoids the risk of repeating investigations. Some participants state "better understanding" of patient status, quicker diagnosis and handling of emergencies which is also supported by the literature.

**Table 4**
eHealth for Patients

| Questions | Answer Threads |
|---|---|
| **What are your perceptions of eHealth regarding communication with patients?** | "Communication is easier, unnecessary face-to-face visits have been reduced" (DOC1) |
| | "Patients can access their health information and look up details they might have missed at previous appointments; (…) it is easy to forget what was told during the appointment" (DOC3, NUR4) |
| | "Communication is less time consuming and easier to commit. Patients can see all prescribed medications and get them from pharmacy without paper prescriptions. They can also see referral letters, test results, medical examinations and book appointments." (DOC4) |
| | "If patient is mentored, understands eHealth and is fine with basic PC skills; but with many elderly patients, it becomes a huge problem" (NUR2) |
| | "Good access to patient's health data enables a faster and more effective treatment plan" (NUR3) |
| | "Improved relationships, faster access, (…) useful" (DOC2, MAN1) |
| | "Information should be of high quality" (MAN2) |
| **In your opinion has eHealth led to higher compliance by your patients to medical advice and therapy prescriptions?** | "No, older generations show difficulties accessing their electronic records"(DOC1, MAN1, MAN2) |
| | "Yes" (DOC2, DOC3, DOC4, NUR1, NUR3, NUR4) |
| | "It's good. You can change physicians and clinics when necessary and no data gets lost" (NUR4) |
| | "Yes, but sometimes people get prescriptions too easily" (NUR5) |
| **In your opinion, has there been an improvement on the overall access to non-urgent care and consequent reduction of waiting lists?** | "Yes" (DOC1, NUR5) |
| | "No"; "No, but the problems lays elsewhere (…) lack of professionals, medical resources" (DOC2, DOC4, NUR1, NUR2, NUR4, MAN1, MAN2) |
| | "No significant reduction, but the treatment decision can be made faster using e-Consultation option with a specialist in the field" (DOC3, NUR3) |

The amount of aggregated information accessible online, record history of healthcare appointments, exams, test results and prescriptions improve the quality of diagnosis, and mitigates the risk of errors, increasing patient safety (van Kessel et al. 2022, Luca et al. 2021). The quality of care is improved, with a more personalized approach thanks to eHealth (Kwiatowska, 2016; Lotman and Viigimaa, 2020).

Finally, the possibility of sharing data with other medical professionals is also mentioned as one of the advantages of eHealth. According to Lluch et al. (2013) the cooperation between healthcare providers is crucial to ensure quality medical services and eHealth can support the development of cross-border integrated models of care, through sharing of information across multiple professionals and institutions.

Regarding the disadvantages, technical issues and the overwhelming amount of available data are amongst the most mentioned. The need for training and basic computer skills is also a concern for medical professionals.

Patients have the ultimate say on who accesses their medical information and that is viewed as a disadvantage by one participant.

The last group of questions relate specifically to the subject of blockchain technology. Analyzing the responses there is a general affirmation of unfamiliarity with the subject, with four of the participants clearly stating not knowing and the other participants suggesting a confusion between the blockchain technology and the broader subject of eHealth.

When the question of safety and security, attributed to as the major benefit of blockchain technology in healthcare, most of the participants feel their medical data is safe and secure; with only three expressing a concern regarding this matter.

**Table 5**
Benefits and Challenges of eHealth

| Questions | Answer Threads |
|---|---|
| **In your opinion, what were the observed benefits of eHealth for you and your patients?** | "Easy access to medical data by all interested parties. Easier doctor appointment system. Possibility of getting advice, without leaving home. Time saving, efficient" (DOC1, DOC3, NUR5) |
| | "Better understanding of the current status of my patients" (NUR2) |
| | "Faster access to patient's health data; medication, tests and episodes of crisis - better care" (NUR1, NUR3, NUR5, MAN1) |
| | "Booking appointments is faster and easier. Patients can look up information about previous procedures and recall what was told and advised" (NUR4) |
| | "Faster to reach the right diagnosis and treatment prescription. Administration and handling emergencies. No repetition of investigations. Transparency! (DOC2) |
| | "Sharing of data with other professionals" (MAN2) |
| **What have been the biggest challenges/difficulties working with eHealth?** | "Insufficient computer skills"; "Lack of training" (DOC1, NUR1) |
| | "Technical issues and having to go through a lot of data to find what you need (…) higher demand for secretaries/non medical personnel" (DOC3, NUR2, NUR4, NUR5, MAN1, MAN2) |
| | "Restricted access for medical professionals" (NUR4) |
| | "Data didn't use to be systemized" (DOC4) |
| | "None" (DOC2) |

**Table 6**
Blockchain technology in healthcare

| Questions | Answer Threads |
|---|---|
| **What is your perception of the use of Blockchain technology in Healthcare?** | "Don't know" (DOC1, DOC3, DOC4, MAN2) |
| | "Might be useful, easy to use, safe" (NUR2, NUR3, MAN1, MAN2) |
| | "Faster to reach the right diagnosis and treatment prescription. Administration and handling emergencies. No repetition of investigations. Transparency! (DOC2) |
| **Do you feel your medical data is safe and secure?** | "Yes" (DOC2, DOC4, NUR1, NUR3, NUR4, NUR5, MAN1) |
| | "No" (DOC3, MAN2) |
| | "Maybe" (DOC1, NUR2) |

## 5. CONCLUSION

As demand for more and better healthcare services increases, it is believed that a significant part of that demand can be satisfied with eHealth. The dissemination of eHealth and its many applications amongst the public is only possible with the clinical endorsement of healthcare providers. Therefore, medical professionals need to be an integral part of the plan for its implementation, development and constant evaluation.

With at least six years of experience working with eHealth the participants in this study were able to offer their perception of the subject as well as their personal insight into the advantages and challenges of the implementation of such digital solutions.

Easy access to medical data by medical professionals is the most highlighted trait of eHealth, with improved communication with patients

and other healthcare providers also being mentioned as a time saving solution.

More divisive is the subject of the amount of data available for consultation. For one side it can lead to faster diagnosis and treatment decisions, reducing also repeated investigations and prescription errors; but it can also lead to data overload and difficulty in reaching the necessary information, which is time consuming for frontline staff who need to use digital technologies efficiently.

In the opinion of the participants, although eHealth applications can help reduce waiting lists, through e-Consultation and e-Prescription, for example, it is not sufficient to solve the current problem, considering the lack of medical professionals.

The need for training is mentioned as one of the biggest challenges of eHealth, along with technical difficulties. This is corroborated by the literature and brings attention to the need to prepare students and health professionals to operate digital medical technology services and continuous development should not be underestimated (Metsallik et al. 2018).

There is a positive correlation between eHealth literacy and health-related behaviors for health promotion in the future (Bertl et al. 2023) and most of the participants are of the opinion that being able to access their own medical data, prescriptions, information about their condition, may increase patient's compliance to advice and treatment regimes proposed by healthcare providers. However, a common concern was also brought forward regarding elderly patients and their difficulty accessing that same medical information and using the full potential of eHealth applications. The risk of worsening existing inequalities in access to healthcare services should not be ignored.

Regarding the subject of blockchain, the technology behind the guaranteed security and transparency, it does not fall under the direct scope of action of the medical professionals and therefore its impact on their day-to-day work goes very much un-noticed. The issue of trust, when managing private, sensitive data, is however perceived as one of the main obstacles for the implementation of eHealth solutions and a general concern for patients and medical professionals (Ross et al. 2010;

Yeh and Saltman, 2019; Ćwiklicki *et al.* 2020). Time and the lack of events that raise suspicion over ill use of personal data have worked in favor of Estonia's eHealth system and the majority of the participants feel their private information is safe and secure, which is in itself a mark of blockchain's success.

### 5.1. Limitations:

The limitations of the study include the subjectivity of the interviews, which may reflect the interviewer's disposition; and the representativeness of the sample, which despite having a reasonable number of participants, does not identify the origin of the responses regarding the health service they represent and that may face different challenges.

### 5.2. Future investigations:

Future research should examine the impact of more specific eHealth applications for healthcare professionals. Finally assessing the perception of the impact of eHealth, and blockchain technology, by other stakeholders such as patients and healthcare institutions.

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