Digitalna preobrazba zdravstva skozi prizmo trendov, izzivov in načel

Digital transformation of healthcare through the prism of trends, challenges, and principles

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Izvleček

Z vidika teoretične raziskovalne metode predstavljamo kompleksno tematiko digitalizacije zdravstva. Članek začnemo z elaboracijo ključnih besed, povezanih z digitalizacijo, in nadaljujemo s pregledom načel, trendov in izzivov. Prispevek je omejen le na procese digitalne preobrazbe in tako izključuje vpogled v teme, povezane s tehnologijo, kot so nanomedicina, bioinženiring itd. Ob predstavitvi trendov poskušamo poudariti ključne nove tehnologije, ki se trenutno uporabljajo za podporo prizadevanjem za digitalizacijo zdravstva. Zaključimo s poudarkom na najpomembnejših pobudah (s poudarkom na EU), ki so in bodo v prihodnje zelo pomembne za področje zdravstva.

Abstract

Based on the theoretical research method perspective, we present the complex topic of digitalizing the healthcare domain. We start with the elaboration of the keywords related to digitalization and continue with a slight overview of principles, trends, and challenges. This study is limited only to the digital transformation processes and thus excludes insights into technology-related topics such as nanomedicine, bioengineering, and so forth. While presenting the trends, we try to emphasize the key novel technologies currently being used to support healthcare digitalization endeavors. We conclude by highlighting the most important actions and initiatives (focusing on the European Union market), which are and will be of high importance for the healthcare domain in the future.

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INTRODUCTION

If broken down into specific keywords, ***digital transformation*** (DT) encompasses a world of complexity, as *digital* represents the wide domain of Information and Communication Technology (ICT) and *transformation* is, by its nature, a process indicating complexity in almost all areas and domains, for example, Fourier transformation, cell transformation, and so forth. Hence, understanding or achieving DT can be highly challenging in any domain, specifically in complex and sometimes rigid domains such as healthcare. Neglecting the need for healthcare of DT is almost impossible, as the traditional (i.e., non-digital) *modus operandi* is not designed and fit for addressing the long-term challenges of the domain. If the coronavirus disease 2019 pandemic and its impact on DT is overlooked, the majority of the developed world faces a similar challenge of professional staff deficiency. This challenge can be effectively addressed by transforming processes in the healthcare domain through digitalization and process automation. The medical environment may be used to adopt new electronic equipment (e.g., new radiology equipment, optometric machines, etc.), but it lacks the overall strategy and approach to leverage these more efficiently at a broader level (e.g., a workflow triggering an automated appointment with various departments after a radiology scan result). Unfortunately, no specific recipe or blueprint for DT exists for any domain, including healthcare. The consequences of the current situation are seen in the different approaches adopted by healthcare institutions (i.e., clinical and/or health centers) and their departments. These approaches have resulted in the existence of several siloed and noncentralized digital health systems. Unfortunately, these systems are inefficient, noninteroperable, and miss the opportunity for a full DT. To put it into perspective, about 30% of the global data volume is generated by the healthcare industry, while no more than a small proportion of it is being leveraged (6). The solutions for the challenges are top-down approaches (i.e., legislation, policies, and governance), driven by governments, which, however, are faced with issues of diverse and complex healthcare ecosystems (i.e., private, public, and concessionaires). In this study, we continue to address the topic of DT in healthcare from a theoretical research method perspective, while focusing on the challenges, principles, measures, and trends. Although modern technology in healthcare also constitutes nanomedicine, bioengineering, immunotherapy, gene editing, and so forth, it is out of the scope of this study due to the definition of DT.

PRELIMINARIES

No single definition exists for DT, whereas a few suitable for this study are as follows:

1. *New digital technologies are used to enable major business improvements, such as enhancing customer experience, streamlining operations, or creating new business models.*
2. *DT encompasses both process digitization with a focus on efficiency and digital innovation with a focus on enhancing existing physical products with digital capabilities.*
3. *DT is not a software upgrade or a supply chain improvement project. It is a planned digital shock to what may be a reasonably functioning system (17).*

Digitalization is often misunderstood and often mixed up with **digitization**. The latter represents the first step in the process, referring to the process of converting physical and analog records into digital ones. While converting a patient's health record into a digital form, that is, electronic health record (EHR), the latter does not constitute digitalization if no other process related to the EHR is transformed and/or automated with the help of ICT. Hence, digitalization requires that usual processes and operations are adapted toward the integration of ICT, and thus optimized and, to some extent, automated. As an example, a referral document from your personal physician can be digitized for archiving purposes. Alternatively, it can be automatically sent to your email with a list of suitable specialists and health centers. In fact, you can even leverage digitization to automatically book an appointment with one of the recommended specialists. This automated appointment booking process exemplifies the transformation brought about by digitalization in healthcare. Therefore, digitalization introduces an increase in productivity and efficiency, enhances user experience, and creates new business models. However, DT refers to the cultural and management shifts in organizations where the digitalization of processes is actively pursued (9).

PRINCIPLES

Although DT is on the rise in the healthcare sector, a thoughtful approach is still required. The Pan American Health Organization has defined eight principles for DT of public health, which we should have in mind while pursuing our digitalization goals (13). **Inclusive digital health** requires us to think about a digitally illiterate person who may struggle with modern technologies. This is specifically true for the healthcare domain, where a majority of *service users* are older patients, who may experience challenges with the use of digital devices such as laptops or smartphones, be it due to digital illiteracy or due to physical challenges including the inability to read and write on small screens, and so forth. Digital inclusion thus implies appropriate accessibility options from the providers of digitalized services and general digital upskilling. The governments should provide a legal context for the former and a strategy, including several incentives, for the latter. Such a perspective shift is also dictated by the Society 5.0 paradigm, which seeks to put a cloak over Industry 4.0, thus emphasizing the personal and social aspects of the technology provisions. **Universal connectivity**, therefore, represents the principle that digital is nowadays ubiquitous and that healthcare and all other domains are interdependent. Thus, full consideration has to be taken from the individual and communities toward the service providers.

In relation to the governments and the legal frameworks concerning DT in healthcare, an emphasis should be placed on **human rights** to ensure that no biases (i.e., cultural, religious, political, or sex) are missed. If we argue that digital is by default, we cannot neglect the fact that some rural areas still have connectivity issues. This is related to the principle of **digital public health infrastructure**, which requires governments to build their digital strategies comprehensively because, as mentioned earlier, connectivity interchangeably influences all other digitalization endeavors, including those in healthcare.

Even bigger issues are so-called algorithmic biases, where artificial intelligence (AI) plays the main role. As AI's main advantages are faster decision- and conclusion-making, it can have hidden biases. This is primarily because AI algorithms learn from historical data, which may not adequately represent the diversity of populations. For example, 80% of collected data in genomics represents Caucasians, and as such, is more applicable for one group over another (8). Hence, **safe AI** is another principle, which seeks global cooperation and governance to achieve AI solutions that are nonbiased, secure, reliable, and explainable, and provide privacy. For example, drugs must comply with the rigorous regulations set by the U.S. Food and Drug Administration to ensure safety and effectiveness. It is crucial for ICT solutions using AI to adhere to these principles and be certified accordingly. The EU is already paving the way in this field with its AI Act (5).

The last three principles are more technically oriented and related to the challenges presented later on. **Interoperability** requires a comprehensive strategy to achieve synergies on all levels of digitalization, that is, semantic and syntactic data interoperability, (web) services accessibility, and so forth, irrespective of local, national, international, or any other business environments. Without true interoperability at all levels, the health centers may use high-quality digitalized solutions but these can only benefit their processes and not the whole healthcare domain and society. From the local perspective, patients can be given access to state-of-the-art digitalized solutions at one health center but they face challenges and rejections if they need to visit another health center. The latter may have similar capabilities, but no linked services exist and patient data cannot be transferred automatically because the systems are siloed. The same applies at a much more complex international level, where the patient travels to another country for treatment. Such challenges exist even in the EU, and are currently being tackled with initiatives such as the EU Data Space for Healthcare. In relation to this, the **digital public goods** principle not only requires global standards and regulations to tackle the aforementioned issues but also focuses on the idea of achieving accessibility for data, services, and solutions. This can be achieved through open-sourcing software and advocating for open science and knowledge. Finally, ensuring **information security** is paramount for DT. An important part of DT in the healthcare domain is the idea of having all healthcare-related data accessible, which, in turn, enables better data mining and, thus, insights and benefits for the whole society. Nevertheless, a fine line exists between general data accessibility and individual privacy, which requires a culture of proper understanding and acting, and related regulations for secure, private, and safe data and process management. Some pivotal regulations already exist, such as the Health Insurance Portability and Accountability Act (HIPAA) in the USA or the General Data Protection Regulation in the EU; the former is dedicated purely to the healthcare domain and covers some challenges in more detail, whereas the latter is a more general approach. Nevertheless, we are again faced with global interoperability issues.

TRENDS

Currently, several key trends of DT exist in healthcare (16); 15). A summarization is presented in Table 1, which also showcases the key and novel technologies and concepts by which the trends are driven. The most important and valuable trend is automation, which is driven by information platforms, various wearable devices, and AI. The trend constitutes the idea of eliminating peripheral devices such as keyboards and displays in medical encounters because the medical staff spends twice as many hours on paperwork than with patients. Therefore, the idea is to eliminate the work post of a *data entry clerk*, which, according to the World Economic Forum, is already among the top five jobs expected to decline swiftly. Another solution is the introduction of AI-driven speech-recognition devices, which enable physicians to seamlessly and automatically capture data and notes while focusing on the patient. Such devices can be stationary such as those already in private environments (e.g., Amazon Alexa) or part of wearable devices (e.g., smartwatch). Even if the speech recognition does not capture all the essential information, it can still be a valuable input for generative AI solutions such as Chat Generative Pre-trained Transformer (ChatGPT), which can complement the notes in various forms, that is, in professional slang for medical staff and layperson slang for patients. At the end of the work day, the notes generated can be automatically summarized and presented to physicians before being sent out to patients via email or uploaded to the patient portal. Besides efficiency, we also achieve accuracy because we usually have accuracy issues with the current approach. Furthermore, such an automated approach can, based on the data collected, suggest a diagnosis or suggest a correction on some already dictated and recorded diagnosis by the specialists during a procedure. The idea of such DT does not advocate for complete automation of AI-driven diagnosis but rather for repetitive and simple cases, enabling physicians to focus on more complex cases. Furthermore, in some cases, specialists/clinicians develop their own AI models, such as predicting sex from retinal scans using automated deep learning (3). Another trend is the introduction of augmented or virtual reality (AR/VR). The differentiation between these is based on the environment. That is, the former uses the real environment of the user (i.e., physician or patient) and enhances it with virtual augmented phenomena, whereas the latter immerses the user in a completely virtual world. AR is already being used in the form of hands-free service solutions, where physicians and caregivers get augmented point of care using smart glasses, such as the Microsoft HoloLens. This helps in, for example, automatically measuring and displaying the wound size and providing indications of the next steps and gestures (10).

Other trends are **digital biomarkers** and **digitally connected health centers and/or vehicles**. The physicians can be presented with a whole set of information due to the increase in affordable quality wearables devices, such as exercise trackers, sweat meters, and smartwatches, which enable the sensing of the heart rate, oxygen, and so forth. Such information (i.e., digital biomarkers) can indicate hidden diseases or the severity of diagnosed ones, thus bringing medical care from the reactive/curative to the preventive approach. Currently, such data are either not used at all or used sporadically and purely on request for a short time, making any serious long-range detection of anomalies difficult. The idea is to enable the automatic and continuous transfer of patient data to clinical centers. This can be of extreme importance if it is done through medical vehicles, which can deliver accurate and vital patient data during their transportation to the emergency rooms. Certain situations already exist where patients' biomarkers are automatically and continuously transferred to the cloud services of private tech giants through patients' wearables. However, such data are not accessible to clinics and patients' physicians, which should soon be solved through various regulations and technological paradigms such as those of the EU 's Data Space for Healthcare.

Telemedicine and **on-demand healthcare solutions** are related to digitally connected health centers. The approach is, to some extent, already in motion, where physicians are available for remote and online consultation, be it synchronously (i.e., audio–video session) or asynchronously (e.g., email). The American Academy of Family Physicians defines telemedicine as *the practice of medicine using technology to deliver care at a distance, over a telecommunications infrastructure, and between a patient at an originating site and a physician or other practitioner licensed to practice medicine at a distant site*. Although, to some extent, this is already in practice, the trend still is in its infancy because no generally defined approaches exist and health centers and/or physicians individually choose if and how they use technology for remote care. Furthermore, current approaches are primarily asynchronous administrative communications with the health supporting staff or, at maximum, a simple audio–video call with the physician. However, the next trend in telemedicine includes the aforementioned digitally connected health centers. These advanced centers not only facilitate remote communication between physicians and patients but also provide real-time access to the patient's current and previous digital biomarkers. This capability enables healthcare providers to gain a more effective insight into the patient's physical statistics. Another boost for telemedicine is AR/VR. Using a pre-appointed consultation link, both the patient and the physician can immerse into virtual reality from their home/office and thus experience a closer and more insightful information exchange. The list of using AR/VR in healthcare is exhaustive; thus, only one example for DT has been mentioned. Looking at the role of the family physician, it can be deduced that remote interaction can become the default way (i.e., not excluding live sessions when needed), which is already practiced a lot. In some countries, self-employed (family) physicians already provide their professional services to multiple health centers only through telemedicine, that is, the so-called physician-as-a-service (PhyaaS) business model.

Last but not least are **digital patient portals**. These represent one of the core elements of digitalized healthcare, thus providing patients with a user-centric digital platform for all their healthcare-related data and processes. Such portals should be centralized as much as possible at the national level to enable patients and physicians a single point of entry. The foundation of the portals is EHRs. The features already supported in many solutions are the review of patient's past and current specialist appointments (as well as book new ones), a review of past and current drug prescriptions, a review of past and current lab results, and other related healthcare data and processes. However, the next trend in this area includes digital twins, chatbots, and verifiable credentials. The former is based on AI, whereby a digital version of an individual patient can be built based on the EHR gathered in a central repository. Such digital twins of a patient can give the physicians a complete, accurate, and consistent overview of the patient's physical state, which can be sliced and diced for detailed insights. This can be performed before, after, or during a patient visit, and with each visit, the digital twins become more accurate and insightful. Thus, the AI models can give the physician suggestions for diagnosis or present predictions, which can be assessed and discussed with the patient. The digital portals are also equipped with AI-driven chatbots. These are based on generative AI such as ChatGPT, which enables the patient to ask preemptive questions and discuss some topic (e.g., lab results) with the chatbot. An example of such a conversation already supported by ChatGPT is presented in Figure 1. Such an approach

Table 1. *Trends and related technologies of DT in healthcare*

Trend	Short description	Involved technologies					
		Artificial intelligence (AI)	Big data	Internet of Things and wearable technologies	Virtual reality, augmented reality (AR/VR)	Information systems	Blockchain and SSI
Automation	Elimination of data clerks/officers; elimination of peripheral devices (e.g., keyboards); use of devices for automatic information capturing; enabling automatic data processing (e.g., diagnosis) including detection of discrepancies; etc.	x	x	x	x	x	
Digitally connected health centers/vehicles	Automatic collections of patient's vital data (i.e., digital biomarkers); transfer of data to medical centers on ad hoc and continuous basis; etc.	x	x	x		x	
On-demand healthcare solutions and telemedicine	Remote patient review; consultations and therapy; physician-as-a-service; etc.			x	x	x	
Digital patient portals	Review of EHR; E-appointment; controlling the usage of EHR; Chatbot support; digital identity wallet and verifiable credentials support, etc.	x				x	x

gives patients immediate attention 24/7 and gives the medical staff more time for other important tasks. Another step toward digital portals includes **digital identity wallets** (DIW), which aim to democratize technology. These wallets are usually mobile-first and user-centric and support multiple features, for example, the control of digital identity; also, they secure storage and management of personal attestations. The latter are formal and informal machine-readable documents, which have some sort of claim about the subject, for example, national ID card, driving license, health insurance card, and any other documents such as the EHR if provided in a specific digitized format, that is, verifiable credential (VC). An additional feature of DIW is the ability, provided to the user, to collect and share his attestations in a secure and digitalized manner with chosen counterparts, while also having the ability for selective disclosure. The latter encompasses the ability to disclose to the counterparts only a subset of all the attributes of information a specific VC holds. The receiver of such information (i.e., verifiable presentation) can verify the integrity of the (limited) data without having all the data. The idea of DIW in healthcare is for the patient to collect EHR in his wallet. When traveling to another country for a medical procedure, he can choose which personal EHR he may present to the foreign medical center, while also selectively disclosing only parts of his EHR, which are essential for the verifier. Such technology and related processes are currently in the early stages, but the European Commission has already defined it as one of the key strategies of digitalization of the EU, hence requesting the Member States to provide their citizens an EU DIW by the end of 2023 (4).

CHALLENGES

Although DT of healthcare is already a usual process, it still faces many challenges, which need to be addressed in the future to fully digitalize the domain. The biggest challenges can be grouped into the following categories:

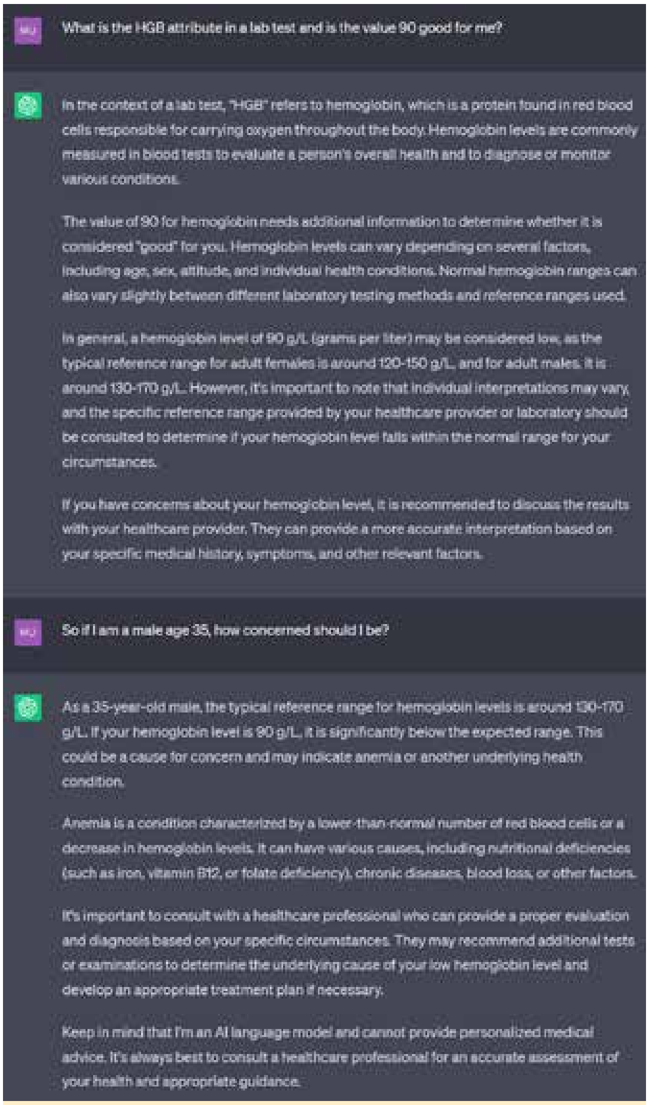

Figure 1. *ChatGPT communication on patient's lab results (12).*

(1) *management and organizing*, (2) *cost*, (3) *regulation and legislation*, (4) *interoperability*, and (5) *information security*. The first three are mutually linked and nontechnical, whereby the management and organizing addresses the challenge of managing the DT, which is an even more complex task in the healthcare domain. Theoretically, the Chief Information Officer (CIO) is the one who is in control of DT. However, such a role usually does not exist in companies, and even less in the healthcare domain. A subset of such a role comprises IT managers (i.e., heads of IT), which usually have time and resources for operational tasks and not strategic ones. The healthcare domain usually has a Chief Executive Officer and a Chief Technical Officer or Chief Operating Officer (COO), whereby one of the latter, in cooperation with the IT managers, is probably the best fit for implementing DT. They need to prepare a digital strategy for the organization based on national strategies, modern technologies, and specifics of the health center. However, the health centers usually cannot strategically focus on the DT due to the lack of resources (i.e., workforce, time, and money), thus resolving to sporadic and *ad hoc* steps of digitalization. Such an approach leads to several siloed solutions and interoperability challenges, even within a single health center between various departments. Furthermore, public health centers also have the problem of funding, which usually is only guaranteed for day-to-day healthcare operations and not for additional *experimenting* with improvements. Hence, the health centers individually develop their own DT actions, which again lead to interoperability issues at the wider level. Clear solutions for this challenge are a clear national-level digital strategy for the healthcare domain, which acts as a guideline for COOs of health centers to engage on, and dedicated funding for digitalization. The national strategies are provided by the governments, which should be followed by regulation and legislation. This ensures a common framework for the whole healthcare domain and actively tackles interoperability challenges (7). From the management perspective, the DT approach should focus not only on the technology but also on the organizational perspective, and support the staff with the necessary knowledge required to use this technology (11).

From a technical point of view, multiple challenges exist. Besides the most important ones, that is, interoperability and information security, other challenges are as follows (2):

1. contextualization,
2. virtualization,
3. datafication,
4. communication,
5. intelligence,
6. robotization,
7. convergence,

8. monetization, and
9. pervasiveness.

Contextualization deals with the challenges of user experience (UX), that is, how to enable natural and self-explanatory use of new devices and/or follow new digital processes, including the communication perspective. Patients expect to get from digital health services the same level of quality and experience as they get with common/popular ICT services, such as e-commerce, media entertainment, social media, online banking, and so forth. These service providers managed to get user's attention by providing services of high quality and experience, such that the customers preferred to use them over the physical ones (i.e., digital by default). As Benjamin and Potts stated, "*Amazon and Netflix did not need to train people to use their service - they created a superior service that actively responded to the needs of users in a dynamic way, with an intuitive layout*" (1).
Virtualization deals with the challenge of effectively converting physical objects/processes into digital ones. There are four digital maturity levels defined by Gopal et al. (2019): level I: patient data are captured in a paper-based fashion; level II: data are digitized; level III: digitalized processes, where organizations apply modern ICT for further improvements; and level IV: intelligent systems. Virtualization deals with the challenge of achieving higher levels of maturity. The fourth level of maturity is related to the challenge of intelligence and datafication, that is, how to make things efficiently intelligent by leveraging accessible data in a secure and privacy-consistent manner. The challenge of pervasiveness deals with how to democratize digitalization solutions, that is, the end-users should be in control of how and when to use the services. The challenge of convergence is related to the aforementioned management challenges while focusing on the interdisciplinary approach needed to achieve success in DT. Last but not least is the monetization challenge, which tries to figure out business models, enabling returns on investments, while still complying with all the trends such as noncentralization (e.g., democratization of technology, user-centrism, decentralization), interoperability, and so forth.
The interoperability challenge may be paramount because it has multiple levels such as interoperability on the level of data, technology, regulation, and so forth. As introduced at the beginning of the manuscript, as much as 30% of the global data are generated in the healthcare domain, while only as much as a few percentages are being effectively used. However, the volume is not the only problem, as it is a known fact from the Big Data field, where veracity, velocity, and variety are as much important. The latter focuses on the fact that a multitude of information types and data formats are available, such as patient demographics, encounters, diagnosis, pathology, laboratory test, treatments, financial statements, insurance claims, and so forth. Multiplying this with internationalization (i.e., different languages, metric systems, etc.) and variety becomes the biggest challenge in healthcare (6). An indication of this challenge is the 2020 report of the Organisation for Economic Co-operation and Development on linked health datasets, which shows that many countries have a high proportion of their health data digitized, while only a small percentage is linked with other sources of information. Even if we find common ground for all the diverse and unstructured or semi-structured data, the challenge of veracity still exists since data collected are usually inaccurate. The field of ICT has a ubiquitous statement, **garbage-in-garbage-out**, addressing the fact that building the decision-making (i.e., diagnosis) on unclean and inaccurate data can lead to bad and dangerous decisions.
Last but not least, cybersecurity is important and challenging to achieve. As with the CIO, bigger companies, specifically health centers, do not have a Chief Information Security Officer (CISO), who would, theoretically, be in charge of information security. Hence, the role of the CISO is placed on the IT manager, who, as mentioned earlier, usually does not have the resource to specifically focus on this matter. Nevertheless, cyber threats and attacks exist with or without a CISO. These range from phishing to ransomware attacks, leading to system intrusion, data loss, denial of service, critical and/or personal information disclosure, tampering with data and processes, and so forth. The attack space and attack vectors are usually extensive due to the complexity and size of the health centers, in terms of engaged people

and integrated tools, frameworks, and services. Besides security, another challenge is ensuring privacy, which is specifically important due to patients' personal health information. As mentioned in previous research, a vital part of digitalization in healthcare is the interconnected data, which can bring new insights and opportunities for the domain and society. However, to get these insights, all healthcare-related data must be accessible and readable, leading to privacy challenges. Therefore, the privacy challenge deals with the question of how to access all healthcare-related data and still ensure privacy and patient control over their personal data. The latter is vital considering that, based on a survey of Rock Health Rock Health (14), 70% of patients are willing to share their health-related data with their physicians, while only approximately 10% are willing to share with the government and technology companies.

ACTIONS AND INITIATIVES

For the challenges presented earlier, actions and measures are taken on various levels and forms. From the information security perspective, regulations are already in place such as the HIPAA (for the USA and similar national ones in the EU), which ICT service providers and health centers should comply with. A vital tool for strategically ensuring information security in any domain is ISO 27001, specifically for the healthcare domains ISO 81001 and ISO 27799.

The interoperability challenge is being tackled by the private and public sectors. Private, big tech companies such as Amazon, Apple, Google, and others want to take advantage of a market (i.e., digitalizing the healthcare domain) worth billions of euros, and hence have actively started with their initiatives. An interesting example is Google's sister company Verily, which aims to become the Google Maps of the healthcare domain, thus building on the baseline of good health, already working with thousands of volunteers and collecting and analyzing various biomarkers. Another example is the Fast Healthcare Interoperability Resources (FHIR), which is a standard proposed by HL7 (6). FHIR defines data formats and schemas on the data and application level, specifically for EHR. Several approaches are taken from the public and governmental sector domain. The World Health Organization (WHO) European Region presented the Regional Digital Health Action Plan 2023–2030, providing the public with guidelines to achieve efficient DT and overcome the challenges (7). The EU Common Data Spaces is another essential initiative because it defines a **dedicated Data Space for healthcare** (4). The Data Spaces are part of EU's Data Strategy and Data Act, and its objective is to define a common EU playground for data of a specific domain. For the healthcare domain, this means that it defines the data models, schemas, and glossaries for the healthcare domain, as well as provides tools and frameworks for an effective and high-quality data exchange between Member States and their organizations (i.e., private and public). Moreover, the Data Spaces also define new approaches for controlling the data by their owners (i.e., patients). Furthermore, all the aspects of the Data Spaces are governed by EU rules and values. Additionally, the EU is also funding the setup of so-called Testing and Experimentation Facilities (TEFs), which are domain-specific. The objective of Healthcare TEFs is to become beacons of best practices of DT in healthcare and also provide various stakeholders (i.e., health centers, health service providers, etc.) with the possibility to test their approaches on a larger scale while receiving the needed support and guidance. A similar approach will be provided by European Digital Innovation Hubs funded by the EU and national governments, which will provide SMEs and public institutions (e.g., health centers) support with the DT. The support will be provided through subsidized services such as digital skills training (i.e., on the topic of advanced digital technologies including AI, HPC, etc.) and test-before-invest activities (e.g., consulting, prototyping, proofs-of-concept, etc.).

CONCLUSIONS

It should be noted that each of the presented topics is much more convoluted and has its own research area. Thus, much more detailed reviews and surveys are needed. Nevertheless, as a concluding remark, we highlighted some of the points presented in the WHO's

Regional Digital Health Action Plan. While planning for DT, the healthcare domain should focus on the individual patient as much as on the desire to achieve higher efficiency, lower cost, and so forth. Moreover, without the support of the health workers, no DT is possible. Hence, the healthcare domains need to truly understand the value and importance of DT (i.e., if not for society, then at least for themselves) and become the pursuing force of DT. Finally, no true digitalized health systems based on dedicated digital strategies for the healthcare domain can be developed in the near future without governmental lead policies. Therefore, both the ICT and the healthcare domain should buckle up and recognize that this is a long-distance race.

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