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Exploring the Role of Medical Graduates in promoting Digital Health in Professional Settings in Germany: Insights from a Qualitative Interview Study

Christopher Koch, Jan P. Ehlers, Julia Nitsche, Theresa Sophie Busse

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Abstract

Background: To address care delivery gaps, the healthcare system must embrace innovative digital solutions. Additionally, the rising integration of digitalization as a topic into medical education is providing students with broader opportunities to engage with digitalization overall. As digital health becomes an increasingly integral component of medical education and healthcare practice, digital affine recent medical graduates constitute a vital resource for advancing digitalization within the healthcare sector.

Objective: This study examines how recent medical graduates acquire digital knowledge, apply it across diverse practical contexts – ranging from startups and corporate environments to traditional clinical settings – and how they contribute to the advancement of digitalization within the entire healthcare sector.

Methods: Using a qualitative approach, 19 interviews with medical graduates from the last 15 years, educated by a university in Germany with a strong focus on digitalization, were conducted. Subsequently, the interviews were transcribed and analyzed using a deductive-inductive approach, following the qualitative content analysis method by Kuckartz (2012).

Results: The findings reveal that medical graduates often acquire digital skills through an intensive self-study and learning on the job, integrating them in various ways into their professional life. Moreover, while graduates recognize their high potential to make on own contribution to the advancement of digitalization, they also face significant barriers such as knowledge gaps, limited resources, and complex regulations, which hinder their ability to contribute to push digitalization in a variety of professional settings. Medical graduates report that they face a pressing need for enhanced knowledge access, improved institutional frameworks, and supportive policy measures to maximize their potential in advancing digitalization initiatives.

Conclusions: Recent medical graduates represent an underutilized resource for healthcare digitalization. Unlocking this potential requires coordinated action across medical education, healthcare institutions, and policymaking to create appropriate conditions for graduates to actively drive digitalization.

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knowledge access, improved institutional frameworks, and supportive policy measures to maximize their potential in advancing digitalization initiatives.

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Keywords: Digital Skills, Digitalization, Healthcare, Medical education, Medical graduates

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1. Introduction

Challenges in Healthcare

The entire healthcare system in Germany is under a large pressure to solve existing care delivery gaps and to maintain an appropriate and patient-oriented health care infrastructure (Möller & Popa 2019, Schneider 2017). Already today, care providers and patients are confronted with many emergent changes and obstacles, preventing optimal medical care. Here, three promoting developments must be highlighted: First, there is a shortage of skilled physicians, especially in rural areas (Ruchholtz et al. 2024, Lukaschek et al. 2024, Futterer 2024). Thus, those available are increasingly overworked and have less time for comprehensive patient treatment (Staeck et al. 2023, Berberich 2023, Rieser 2022). Second, demographic change goes in line with an aging population, demanding more and specific health services (Werner 2024, Schneider 2017, Schmacke 2012). Thus, the prevalence of chronic diseases and the demand for services in geriatric care goes up very quickly (Fuchs et al. 2020, Prütz et al. 2014, Junius-Walker & Theile 2007). Third, patients' expectations of healthcare providers treatment increases, particularly regarding individual and flexible treatments (Miranowicz 2018, Thielscher & Schulte-Sutrum 2016 Fischer 2011). Consequently, new offers for more personalized medical care must be integrated by healthcare providers to meet patients' expectations (Kukalakunta et al. 2024, Illert et al. 2023). All these developments together show that the healthcare system faces considerable challenges, derived that there is a big and urgent need for improvement in the whole market. To meet these challenges, healthcare providers, policymakers and healthcare facilities must find innovative approaches to ensure high-quality care and relief offers for the medical staff. In this context, one possible approach is the increased integration of digital solutions into the whole healthcare industry (Weidenauer 2024, Kempe 2024, Becker 2021).

Digitalization in Healthcare

As in many sectors, digitalization, which refers to the use of digital technologies to optimize business processes and value creation (Iyamu et al. 2021), has also emerged as a pivotal strategy in healthcare (Weidenauer 2024, Dal Mas et al. 2023, Haggerty 2017), addressing care delivery gaps and offering innovative solutions to enhance efficiency, quality, and accessibility of healthcare services (Gommaa 2024, Horak 2023). Thereby, many stakeholders can benefit from digital opportunities (Dionisio 2023, Lux et al. 2017, Dörries et al. 2017). Patients can use digital services to develop a deeper understanding about their illnesses, to save travel and waiting time by moving medical consultations to the digital space or to integrate innovative treatment methods in the recovery process. Furthermore, digitalization enables patients to become an active and preventive part of their own care (Bamarni 2024, Burkart & Hanser 2018, Dörries et al. 2017, Lux et al. 2017). In contrast,

medical practitioners can use digital services to reduce administrative work, to improve diagnoses quality or to foster exchange with other healthcare institutions (Zhang et al. 2024, Patrinos et al. 2023, Dörries et al. 2017, Lux et al. 2017). But also, health insurance companies can benefit from an overall efficiency potential, i.e. through the reduction of double treatments or new emerging marketing opportunities (Dörries et al. 2017, Waldschmitt 2017). To improve the actual practical standards in Germany, healthcare organizations must find ways to integrate more digital technologies – as i.e. the meanwhile better-known electronic patient record (ePA), the electronic prescription (e-prescription), the TI messenger (TIM) or telemedicine (TM) – into daily practice (Stachwitz & Debatin 2023, Grösgen 2023). To realize this, healthcare institutions must solve different challenges, i.e. they need to overcome institutional resistance or integrate digital approaches that align on data security and legal constraints (Polacsek-Ernst et al. 2024, Garcia-Perez et al. 2023, Ilin et al. 2022). Overall, there is further potential for improvement of integration of technology and design of pathways – especially regarding emerging technologies such as artificial intelligence (Adeghe et al. 2024, Kleemann et al. 2024, Lee et al. 2023, Vatandoost & Litkouhi 2019). Therefore, the healthcare sector must seek for ways to integrate the full potential of digitalization into practice – one way of supporting could be the consideration of young medical graduates as intermediaries from theory to practice and creator of a new digital reality (Baumgartner et al. 2022, Cretu et al. 2020).

Recent medical graduates and Digitalization

Timely, most current medical students and recent graduates are belonging to Generations Y and Z (Talmon 2019). These generations will also occupy a large part of the labour market in the coming years and thus shaping the entire healthcare industry (Lourenco & Cronan 2017, Desy et al. 2017, Evans et al. 2016). Even though not everyone in this generation fits a single stereotype and even though there is a broad debate on the generalizability of generations (Schröder 2018), broad characteristics will be elaborated for the sake of simplification and clearer representation.

Thus, looking on their individual imprints, this generation has grown up in the digital age and has experienced the emergence of digitalization since their early childhood (Schenarts 2020, Eckleberry-Hunt et al. 2018, Klaffke 2014). In doing so, they have learned to constantly adapt to digital innovations and to use them in daily life (Jones 2008). In this context, they are particularly open to digital solutions and can handle computer-based technologies in an appropriate way (Schmidt et al. 2013, Jones 2008). Consequently, these people already have a pronounced digital affinity (Brinkmann 2020). Also, during their studies, those medical students want to understand the benefits of new digital applications, making them ready to shape their professional environment

(Baumgartner et al. 2022, Cretu et al. 2020). At the same time, overall, digital literacy is becoming one of the key skills on the job market (Law et al. 2018). Consequently, after graduation, these cohorts can become pioneers in transferring digital knowledge, i.e. from academia or their private learning to the health care practice (Machleid et al. 2020, Peterson et al. 2004).

However, extensive private use of digital media does not automatically ensure that students integrate these technologies into their studies effectively, highlighting the need of clear education training strategies (Jarva et al. 2022, Kuhn 2018 et al., Graham-Jones et al. 2012). Consequently, to make an appropriate practice transfer come true, universities must educate students based on their digital needs and set the right framework by promoting appropriate and supporting digital content (Hernandez-de-Menendez et al. 2020, Hege et al. 2020, Nuallaong 2010).

Digitalization in medical studies

At least since the corona pandemic, increased digitalization is also affecting the study experience of medical students (Holzmann-Littig et al. 2022, Egarter et al. 2021, Alfonso Beltran-Sanchez et al. 2020). In the last years, more and more medical content has been taught in or was transformed into digital formats (Gottschalk et al. 2023, Schick et al. 2020, Kuhn et al. 2018). Furthermore, the topic of digital medicine is also increasingly being integrated into the elective areas of various degree programs, showing the importance of digitalization in practice and consideration in medical education (Kuhn 2020, Tudor Car et al. 2021). Thus, medical curriculum is evolving, aiming to develop future oriented digital skills and competencies (Khafizova et al. 2023). In this context, medical lecturers as well as students classify the thematization of digitalization in study programs as an important part of modern medical education (Edirippulige 2022, Neumann et al. 2021). Nevertheless, as the National competence-based learning objectives catalogue for medicine (NKLM) in Germany has decided to allocate only a limited amount of time to digital content within the medical curriculum, many universities still consider few digital medical topics throughout their studies, deriving an existing improvement potential in the full medical education market (Sorg et al. 2022, Aulenkamp et al. 2021, Haag et al. 2018). Regardless the digitalisation of study programs, students are also looking for new ways to optimize their studies with digital offers, primarily focusing on innovative and digital resources to enhance learning improvement and performance evaluation (Lattouf 2022, Scott et al. 2018, Maloney et al. 2013). Here, digital learning opportunities give students an additional way to acquire and stabilize knowledge within their medical studies (Hyll et al. 2019). In addition to that, also the student’s environment becomes more digital, as universities are digitizing their processes and structures (Benavides et al. 2020, Safiullin & Akhmetshin 2019).

All these developments together show that medical students are confronted with an increased number of digital elements in their day-to-day life while becoming a professional physician, highlighting at the same time improvement potential by this cohort.

Digitalization in medical studies at Witten/Herdecke University in Germany

As a pioneer in the medical education landscape, Witten/Herdecke University (UW/H) offers a distinctive medical degree program that places particular emphasis on practical relevance, patient-centered training, and interdisciplinary learning (UW/H 2025a). As a private institution, UW/H employs a unique admission process that requires applicants to directly engage with digitalization — whether by composing essays or by participating in discussions on the subject (Zupanic et al. 2019). Moreover, digitalization is increasingly integrated into the medical curriculum. To this end, the university has introduced a digital health track in the electoral duty part of the medical study program, enabling medical students to deepen their digital knowledge through modules on digital health, artificial intelligence, and the digital healthcare in Germany in general. To demonstrate their gained digital expertise, students can also obtain a specific digital health certificate (UW/H 2025b). Additionally, UW/H actively supports student-led initiatives and fosters entrepreneurial thinking by providing a network for digital startups, coaching sessions and appropriate infrastructure designed to help the university-based startups to grow (Founderio 2025). Overall, education at UW/H has become increasingly digital, particularly since the outbreak of the coronavirus pandemic. Nitsche et al. (2021) are describing this development in more detail, focusing on the transition of the entire university to digital learning. A further study by Nitsche et al. (2023) indicates that the cross-faculty course “Digital Medicine” at UW/H has positively influenced students' digital skills and their perspectives on digitalization. This digital medicine course engaged students with key topics within the area of digitalization and healthcare, introduced through expert-led sessions. Here, external specialists provided thought-provoking impulses on current issues and innovations in digital medicine, which served as the basis for in-depth group discussions (Nitsche et al. 2023). The course was part of the studium fundamentale program at UW/H, designed to foster interdisciplinary collaboration. In this context, students from a wide range of academic backgrounds – including human medicine, dentistry, and other disciplines – came together to explore subjects beyond their core curricula, promoting broader academic and professional perspectives (UW/H 2025c, Nitsche et al. 2023).

Research Question

It becomes clear, that today's medical students are experiencing an increased digitalisation, which

will shape their professional future. Based on their personal experiences, they are probably open to digital innovations and new technologies. Exactly matching, increasing digitalization also offers an opportunity to improve the entire healthcare system and to solve existing care delivery gaps. Therefore, healthcare actors must find ways to better implement useful digital solutions into practice. As rarely few existing studies have investigated the potential of medical graduates in shaping digitalization in healthcare practice, this study tries to connect these two strands and focuses on how, when and why medical graduates can (not) transfer digital skills into their professions, improving the practical standard – focusing on the perspective of this target group. Therefore, this study investigates young medical pioneers to understand the potential practical transfer, deriving implications for medical education and practice. Consequently, the research question is:

- How can medical graduates contribute to advance digitalization in practice?

To answer this research question in full, three more sub-research questions were formulated:

- In which contexts do medical students acquire specific digital skills and knowledge, and what are their practical applications after graduation?
- What potential do recent medical graduates hold as architects of a new digital future?
- What challenges does this target group encounter in shaping a new digital reality, and how can these obstacles be overcome?

2. Methodology

Ethical votum

This study as well as its ethical and practical implication has been approved by the ethics committee of Witten/Herdecke University, Faculty of Medicine (application No. S-254/2024).

Reporting guideline

The reporting guideline by Tong et al. (2007) was applied.

Research purpose

This qualitative study serves to provide insights into the practice transfer of digital skills by medical graduates. Thus, the research team wants to understand how and in which context medical graduates learn relevant digital skills, how they apply and shape digitalization in practice, which challenges and potentials for further improvement by recent medical graduates they perceive, and how the elaborated challenges can be overcome. This research tries to contribute to this ambiguous problem

by preparing fundamental content, which needs to be tackled with explorative research (Sarstedt and Mooi 2014). To gain these specific insights, a qualitative approach was adopted. Therefore, primary data was collected for this specific research questions by conducting exploratory interviews (Aghamanoukjan et al. 2009). This research approach was deliberately chosen because qualitative interviews enable a deeper exploration of participants' experiences and further data interpretation. Furthermore, as the research team pursues a mixed-method approach, the results will serve as the basis for an upcoming quantitative study.

Researcher characteristics

The team consists of 4 researchers (CK, JE, JN, TSB) from diverse backgrounds with an overall extensive experience in qualitative research. CK is a doctoral researcher with a study background in economics. In his previous studies, he has already gained initial experience with qualitative research methods. JE holds a full-time professorship for didactics and educational research in healthcare, having a background in veterinary medicine and educational media. JE conducted and analyzed various qualitative interviews in the past years. JN works as a postdoctoral researcher for didactic and educational research, having a background in business psychology. JN has extensive experience in conducting as well as analyzing qualitative research. TSB holds a full-time professorship (junior) for digital health, having a background in nursing, health sciences and applied ethics. TSB has extensive experience in conducting and analyzing qualitative interviews in various forms. JE, JN and TSB bring extensive experience from diverse research projects with qualitative research. Overall, the research team consists of 2 women (JN, TSB) and 2 men (JE, CK).

Sample and Recruitment

The participating interview partners were selected based on four criteria.

1) First, only medical graduates of Witten/Herdecke University were considered, as this university places great importance on digital medicine and digitalization skills, even in the student selection process (Zupanic et al. 2019) and best practices should be identified.
2) Second, graduates from the two at UW/H offered medical specialties were included: human medicine and dentistry. Both degree programs have access to the same courses within the stadium fundamentale program. The study focuses primarily on human medicine graduates, as they are employed across a broader spectrum of healthcare settings, accounting also for a higher number of graduates in total.
3) Third, only medical graduates who have encountered digitalization in their stud-ies or

professional work in any form were considered (self-disclosure).

4) Fourth, as the study focused on the role of recent medical graduates, only individuals who had graduated within the past 15 years were included. This was done to capture the direct views of the target population on the specific research topic.

Within the research team, a list of potential interview partners from researcher's external network and throughout cooperation's with the alumni management and medical professors of Witten/Herdecke University was developed. Afterwards, the eligibility for this study was checked by evaluating their compliance with the elaborated criteria. Participants were invited to take part in the study via multiple channels, including face-to-face meetings, telephone interviews, email, and the social media platforms LinkedIn. 25 participants did not respond to the interview invitation, and 6 dropped out due to time constraints or personal reasons. The participants were recruited from September 23, followed by a smooth transition to the interview phase. In this context, participants were contacted and interviewed until theoretical saturation was reached, meaning that further interviews no longer provided relevant new insights.

Interview guide

To ensure comparability across the interviews, a semi-structured interview guide was developed. In this context, the SPSS method was employed for collecting, checking, sorting, and subsuming the questions within the research team (Helfferich 2011). Furthermore, the existing literature was considered while developing the guide. Therefore, the research team oriented at existing research designs as well as the main research context and the named research questions. This allowed to explore 3 key aspects in depth: learning digital skills, practical perspective (current status, potentials, challenges) and overcoming challenges. Each topic was accompanied by main and potential follow-up questions, enabling the researchers to address up to 4 questions per category. At the beginning of each section, rather open questions were asked, which became more closed as the interview section progressed. In addition to that, a deliberate question formulation was integrated to avoid social desirability and to foster creative thinking (Iacobucci & Churchill 2010, Aghamanoukjan et al. 2009). During the interviews, participants were encouraged to speak freely and share their experiences. Overall, the guide served as a framework to structure the interviews, enabling possible adaptation to changing interview situations.

Prior to conducting the interviews, the practical applicability was successfully tested with a smaller pilot group (n=4), which led to further refinement bevor finalizing the questions. The interview recordings from the pilot were not transcribed nor included into the final analysis.

Part	Main question	Possible detailed question
Introduction		
Introduction	Please briefly describe your professional career and your current position.	• Can you explain your intermediate steps in more detail? • What tasks do you have in your current role?
Learning digital skills		
Learning digital skills	What professionally relevant digital skills or knowledge regarding digital medicine or digitalization have you acquired – during your studies, privately, through self-study, on the job or in other contexts?	• In what contexts were you confronted with digital medicine / digitalization? • Which opportunities did you take advantage of? • Why did you decide for/against digital offers? • What did you learn and what did you take away in terms of digitalization?
Practical perspective (current status, potential, challenges)		
Application of digital skills	How do you use your digital skills in your professional environment?	• Which digital skills (e.g. from your studies) can you use in practice? • How can you drive digitalization in practice? What improvements have been made? • What motivates you and other recent graduates to apply digitalization skills in practice?
Potentials of digitalization and	What potential do recent graduates have to shape a new digital reality? Why can this target group make a	• What digital potential do you see in your professional context? • How does digitalization make your day-to-day work easier and

recent graduates	positive contribution?	what could be improved? • How can fresh graduates ensure that more digitalization potential is tapped in practice? What is necessary for this? • What advantages do you see in recent medical graduates as shapers of a new digital reality?
Challenges of digitalization and recent graduates	What prevents recent medical graduates from advancing digitalization within their practical settings?	• What digitalization hurdles or problems while integrating digitalization in practice do you generally perceive? • What do these challenges do to you? • What challenges and problems have you experienced in the context of digitalization in your practical setting?
Overcoming challenges		
Strategies for overcoming challenges	How can these challenges be overcome and what is needed to do so?	• What do students need to be taught during their studies so that they can help shaping digitalization in practice? • How can healthcare institutions or politicians help to encourage recent graduates to digitize? • Are there aspects of university education that could be improved?
End		
Conclusion	Are there any other topics relevant to you that we have not yet discussed?	• Do you have any other questions about our research progress? • Do you know any other interesting interview partners for our research project?

Table 1. Interview Guide

Data collection

From October 1st, 2024, to November 30th, 2024, 19 interviews were conducted by CK either in person or in a digital space by Zoom (version 6.4.10). Here, video recordings were conducted using Zoom software, while audio was also captured separately using a realme GT6 smartphone.

Before conducting the interviews, the participants were informed about the study's objective, design, and recording procedures. In this context, complete anonymity was assured throughout the evaluation and publication processes. All participants subsequently provided their consent to participate under the outlined conditions. For their participation, the interview partner received no remuneration. During the interviews, there was no presence of non-participants. After the interviews, CK transcribed the data according to Przyborski & Wohlrab-Sahr (2013), also by using the transcription software Sasaya_1.1.1 from RWTH Aachen University. Although none of the participants took advantage of this, the participants were given the initial opportunity to view the finished transcript and to make any comments on that if necessary. After the subsequent data analysis, the audio data were completely deleted.

Data analysis

In the next step, the interviews were analyzed and coded using MAXQDA by Verbi (Version 24), a software suitable for qualitative data analysis. This was done between December 1, 2024 to January 31, 2025. A qualitative content analysis based on Kuckartz (2018) was conducted, focusing on identifying patterns and connections within the data. Initially, the main categories were developed through a combination of a deductive and inductive approach. Deductively, the interview guide provided a framework for defining the primary categories. Inductively, these categories were refined and expanded through free-text analysis within both the main and following subcategories. Additionally, the entire text corpus was openly coded and assigned to the primary and emerging subcategories.

At the beginning, CK and TSB analyzed two interviews separately and discussed the results to develop an initial code system. The other interviews were analyzed by CK – following the initial code system. Finally, the evaluation was critically reviewed by JN, TSB and JE. The final category manual presents a detailed overview of the individual categories and subcategories. Here, the first three coding levels were reported, as these concisely summaries the most important findings. All published quotes have been translated into English language and have been adapted grammatically.

3. Results

In the following, the key findings are presented, structured by the final coding scheme. A total of 15 participants were interviewed until theoretical saturation was reached, ensuring that the mains aspects of the research questions were worked out. 19 interviews were conducted, lasting between 20 and 48 minutes, with a total duration of 10.4 hours, equally 624 minutes. On average, each interview lasted 31 minutes. The duration varied depending on the flow of conversation and the contributions of the participants.

11 men and 9 women aged between 26 and 40 years participated in the study. Primary, 17 people had a background in human medicine, 2 people in dentistry. To ensure a broad and diverse perspective on the application of digital skills, graduates from a variety of backgrounds were intentionally included. 13 people worked in a classical profession, i.e. as assistant physician or general practitioner, 7 in other and broader areas, i.e. as an entrepreneur or managing director.

Parameters	*n*
Participants	19
Gender	
Male	11
Female	8
Background	
Human Medicine	17
Dentistry	2
Position	
Doctor	13
Entrepreneur	6
Age	
Minimum age	26
Maximum age	40
Average	34
Interview duration	
Minimum	21 min
Maximum	48 min
Average	33 min

Table 2. Participants statistics

Overall, a total of 1640 coded segments and 1957 distinct codes were obtained through the entire analysis. Here, 5 codes belong to the first order, 17 codes to the second order and 58 codes to the third order. In the following, these first, second and third level codes are described in more detail. The participants did not provided feedback on the research findings.

First-order code	**Second-order code**	**Third-order code**
Occasion learning	*Job*	For concrete activities

digital skills		As a basic working method
	Private	Due to digital touchpoints
		Through self-study
	Study	Through teaching
		Through research projects as part of dissertations
		In self-study during exam preparation
	High School	
Application purpose digital skills	*Administrative*	Digital office software
		Clinical programs
	Strategic	Foundations
		Business model development
		Process optimization
	Communicative	Training and further education of others
		Leadership and negotiation
Potentials of recent graduates in advancing digitalization	*Organizational characteristics*	Recognition
		Error acceptance
	Personality traits	Impartiality
		Motivation
		Load capacity
		Willingness to change
		Learning ability
		Pragmatism
		Naivety
	Professional competences	Affinity & intuition
		Knowledge
		Digital ideas & interest
		Positive professional attitude
		Study proximity
	Social skills	Willingness to compromise
		Critical perspective
Challenges of recent graduates in advancing digitalization	*Organizational*	Role in the organization
		Diverging points of view
		Hierarchy
		Inadequate structures & processes
		Lack of incentives
		Lack of technical implementation options
		Established analog functionality
	Personal	No Motivation
		Lack of personality traits
		Lack of knowledge
	Subject-specific	Regulation
		Data protection
		Personal burden
		Lack of networking
		Lack of investment and infrastructure
		High cost pressure
Success factors	*Education*	School

and possible solutions		Study
		Further training
	Alignment of the organization	Positioning for digitalization
		Support from management & leadership
		Change management
		Thinking through system and culture
		Providing space and infrastructure
		Building digitalization expertise
	Politics and the state	Provide infrastructure
		Reviewing regulation
		Optimize data protection

Table 3. Code structure

3.1 Learning digital skills

Medical graduates report that they have enhanced their digitalization knowledge in various settings – particularly during their studies, in their professional roles, and in their personal lives.

Study. During their studies, graduates were introduced to digitalization through curriculum-based teaching, dissertation projects, and self-directed learning. According to the perceptions of the graduates, digitalization is still relatively underrepresented in the medical curriculum – even at Witten/Herdecke University. When addressed, it is typically limited to foundational courses within the selection area, offering just a broader overview of digitalization potential, digital applications or basic technical tools.

“I attended a series of lectures on digitalization in medicine, which focused on innovations and their potential applications in future medical practice” (Interviewee No. 16, Human Medicine, Assistant physician, Female)

Consequently, medical graduates receive limited formal preparation to increase their digital knowledge within their medical study programs. Furthermore, recent medical graduates report that they familiarize themselves with digital tools through intense self-studies, particularly during exam preparation. In addition to that, some respondents acquired their foundational digital skills through past high school activities.

In contrast, digitalization is more frequently explored in medical research, especially during dissertation projects, belonging to the third phase of the bologna study cycle, where students set their individual focus on investigating its impact and potential, allowing them to develop a deeper understanding of digital trends and developments.

Job. In their professional roles, graduates develop digital skills through an inherently digital work environment and related collaboration models. As a result, they frequently gained experience with

digital programs, including advanced AI-based tools, which they encounter as part of their daily practice. Throughout this process, recent medical graduates passively acquired new digital skills, shaped by the specific demands and technologies prevalent in their specific environments. Additionally, medical graduates also had to acquire deeper digital skills to perform specific job-related tasks and activities, especially to solve emergent entrepreneurial challenges. Therefore, the required skills were often developed through a hands-on learning-by-doing-approach.

"Learning digital skills often happens naturally when encountering them in daily work, especially when solving an immediate problem. It's not something I actively sought out, thinking, "What could I learn about digitalization today?" Rather, it's something that gradually becomes part of the workflow." (Interviewee No. 18, Human Medicine, Physician in further training, Female)

Private. In their private lives, graduates report that they have developed digital skills through a constant confrontation with digitalization over the years. Regular interaction with digital technologies in everyday activities – often since childhood – has fostered them an intuitive and ongoing engagement with a variety of digital elements. Thus, this passive yet consistent immersion has naturally shaped their digital competencies over time. Beyond this passive acquisition, many medical graduates have actively developed digital skills through various personal initiatives. Here, some graduated students learned coding or programming during their leisure time, which broadened their technical and digital understanding in depth, enabling them to take on special professional tasks in practice later. Driven by personal interest, some graduates also pursued self-study through courses and training programs, deepening their engagement with overlapping digital megatrends.

"I have also acquired some digital skills in my personal life out of genuine interest. For instance, I am currently learning to code. For me, this skill that is particularly relevant for understanding the growing prominence and impact of AI, which will change over full live fundamentally." (Interviewee No. 6, Dentistry, Co-Founder, Male).

3.2 Application purpose digital skills

Medical graduates report that they have applied their digital skills in different ways – especially in administrative, strategic, or communicative paths. Consequently, there are different approaches to bring their digital knowledge into practice and to other people.

Administrative. An administrative application occurs when graduates leverage their digital skills to manage simple and existing tasks or processes. In their workplaces, most graduates use digital software, tools or communication platforms, which have already been integrated before – both in everyday clinical practice and in office-related settings.

“In the hospital setting, a significant amount of time is spent on computers due to the need to document all information using digital systems.” (Interviewee No. 19, Human Medicine, Assistant Physician, Female)

Due to their strong digital affinity, medical graduates report that they can intuitively understand and incorporate these tools into their daily routines. The overarching goal of these efforts from medical graduates’ perspective is to save time and ultimately improve work quality by enhancing workflow and coordination within their professional settings. In addition to that, some graduates take on other roles regarding digitalization, i.e. acting as key users for a digital application.

Strategic. A strategic application occurs when graduates harness their digital skills to creatively and entrepreneurially advance digitalization initiatives. Thus, some digital affine medical graduates even enhance internal processes by introducing new software, communication tools or workflows, i.e. digital lean management. Furthermore, recent medical graduates have also engaged in various entrepreneurial ventures, either independently or in the respective organization they are working at. In this context, they pursue a variety of different initiatives, such as developing digital business models or founding digital health-tech startups to address emerging market opportunities. As an example, some graduates have developed digital knowledge tools, providing easy access to relevant medical knowledge. Ultimately, these creative endeavors have enabled recent medical graduates to generate entrepreneurial value while actively contributing to the overall advancement of digitalization.

“I would say that even before AI, we digitized quite a lot here in the company and simply looked into the processes, both on improvement potential on the patient side and in the processes towards employees.” (Interviewee No. 11, Dentistry, Managing Director, Male)

Communicative. A communicative application occurs when graduates share their digital skills with others through various means. In this context, especially graduates in a clinical practice pass on their digital expertise by organizing training sessions and engaging in dialogues with colleagues, where they inform them about emerging digital opportunities and recommend best practices. Consequently, some medical graduates also serve as a multiplicator, facilitating the adoption and integration of digital solutions. Furthermore, medical graduates also apply their digital skills in different management and negotiation contexts, utilizing their expertise to enhance final work results.

“It's also important to take other medical colleagues by the hand and say: Hey, watch out, do it like this. I would say that I'm very active in this respect, that I'm a bit of a multiplier” (Interviewee No. 8, Human Medicine, Family physician, Male)

3.3 Potential of graduates in driving digitalization forward

Medical graduates recognize numerous digitalization potentials within healthcare and possess personal attributes and professional conditions that enable them to advance digitalization. These encompass organizational characteristics, personality traits, professional skills, and social skills.

Organizational characteristics. Organizational characteristics encompass the advantages that graduates derive from their specific roles within their respective organizations. Therefore, graduates perceive that their needs are increasingly recognized as important by their employers, particularly considering demographic shifts that make these young professionals a valuable future resource. Aware of their value, some medical graduates report that they actively advocate for digital offers and, in some cases, even consider leaving employers who fail to meet their digital expectations. Additionally, early-career professionals perceive themselves to benefit from a form of entry-level protection, where mistakes are more readily accepted. Furthermore, their perceived risks of failure remain relatively low. As a result, young graduates possess considerable potential to advance digitalization through their unique starting position.

"You always enjoy a kind of "puppy protection" at the beginning. So, if you make mistakes, everyone tries to help you, and mistakes tend to be tolerated. That applies typically to the first six months."(Interviewee No. 4, Human Medicine, Assistant physician, Male).

Personality traits. Personality traits encompass the personal characteristics that many graduates possess, supporting their ability to drive digitalization forward. In this context, medical graduates report that they bring an unbiased perspective, allowing them to notice dusty aspects, challenge organizational blind spots, and approach longstanding problems in a different way of doing. In this context, graduates perceive to maintain an outsider's perspective that enables them to tackle problems with their fresh insights.

"A huge advantage that you should try to retain is that you usually look at old problems with a fresh eye and then you may notice certain problems, for example structures that are not running well." (Interviewee No. 1, Human Medicine, Assistant physician, Male)

Furthermore, their intrinsic motivation and genuine commitment to drive meaningful change in healthcare, combined with a strong enthusiasm for digitalization, positions them – from their perspective – as key agents of digitalization. Moreover, graduates perceive themselves as highly resilient. In this context, many graduates report that, having not yet assumed family responsibilities, they face fewer constraints than established leaders within their organizations. This relative flexibility allows them to devote more time and energy to explore additional topics, such as

advancing digitalization. Moreover, they demonstrate a high willingness to implement new digital solutions, as they point out to perceive the high potential of digitalization for real practical improvements. On top of that, they report their adaptability, pragmatism and a certain degree of naivety as further advantages helping them to contribute to the advancement of digitalization.

Professional competences. Professional competencies include the technical and subject-specific skills that many graduates possess, enabling them to advance digitalization. Therefore, graduates point out a strong affinity for and interest in digitalization, having mostly grown up in a digital environment where they learned to navigate through digital topics with ease. They possess foundational digital knowledge and, in some cases, also specialized expertise – especially in comparison to older generations. Their enthusiasm for digitalization extends beyond theory, as they describe themselves as actively identifying practical opportunities for digital improvements. Furthermore, medical graduates note that they approach data protection with a pragmatic mindset. Additionally, graduates indicate that their proximity to academic studies could allow them to be specifically trained in digitalization right before entering the workforce, enabling them to immediately apply what they have learned before.

"So, I would say that graduates today no longer must learn the digital language or being digital from scratch, but that for many it is internalized like a second mother language. And that they therefore feel much less of a barrier or fear of having to adapt or learn it." (Interviewee No. 15, Human Medicine, Co-Founder, Female)

Social skills. Professional competencies include the interpersonal skills that many graduates possess, enhancing their ability to drive digitalization forward. Here, recent medical graduates perceive themselves tending to question the status quo, seeking for ways to improve or optimize existing digital structures. Consequently, graduates report that they often adopt a critical perspective, questioning whether things are truly effective or necessary. Additionally, they describe themselves as open to compromise, which enables them to collaboratively find solutions when implementing digital solutions.

"In conclusion, I think it is simply important to remain critical. In other words, to always ask critical questions: What is the opportunity? What is the limit? Is it useful? And we can certainly contribute a lot to this because we have been brought up as critical minds in the broadest sense." (Interviewee No. 18, Human Medicine, Physician in further training, Female)

3.4 Challenges for graduates in advancing digitalization

But medical graduates also face general and target group specific challenges – especially,

organizational, personal and subject-specific hurdles.

Organizational. Organizational challenges encompass all obstacles that arise within the organization itself. As an example, some medical graduates state that they face challenges in gaining recognition within their organizations at all – especially in clinical settings. In this context, they report that they have limited influence, and that driving digitalization is not perceived as one of their core responsibilities – both by their employers and by themselves. Thus, their initial priority is to establish their role and to integrate into existing structures, a process further complicated by frequent transitions between different workplaces. Consequently, early in their careers, they often focus on fulfilling assigned tasks and hesitate to step into a shaping role, fearing mistakes or drawing too much attention. Diverging perspectives within the workforce present additional obstacles that medical graduates describe. While some professionals advocate for digitalization, others – particularly senior staff – remain committed to analog practices, exhibiting limited openness to change. Hierarchical dynamics further exacerbate this issue, as decision-making power over digital initiatives rests primarily with established professionals, who – from the perspective of recent medical graduates – often resist transformation to maintain existing structures.

“Of course, we are fresh, young and over-committed when it comes to some things. But that is simply not heard. (...) People don't take us that seriously. We young people come and say we want digital, and then the older ones say, yes, good for you.” (Interviewee No. 19, Human Medicine, Assistant Physician, Female)

Furthermore, medical graduates report that organizational constraints overall also impede digital progress. In this context, limited personnel resources, inflexible institutional frameworks, and the inability to disrupt ongoing healthcare operations create barriers to a successful digital improvement – especially in the clinical settings. Moreover, medical graduates report a lack of incentives to engage in digitalization efforts, as neither formal support nor tangible rewards are provided. Likewise, technical limitations prevent the seamless implementation of digital solutions. Additionally, the existing functionality of analog systems diminishes the perceived urgency for digital changes.

Personal. Personal challenges encompass all obstacles stemming from the individual characteristics and circumstances of medical graduates. Here, not all graduates are intrinsically motivated to drive digitalization. While some prioritize efficiently fulfilling their true core responsibilities, others find digitalization less engaging or are reluctant to invest additional effort, particularly when it requires extra work or overtime. Additionally, some medical graduates don’t feel as digitally inclined.

Furthermore, they identify certain personality traits they feel they lack, which hinder their ability to contribute to digitalization. In this context, some exhibit a strong aversion to risk, some a lack of confidence, and some a lack of entrepreneurial mindset. Furthermore, graduates highlighted several knowledge gaps that hinder the adoption of digital tools, such as limited technical expertise, limited digital knowledge and difficulties in navigating organizational processes.

"There are few who are really motivated, so the term work-life balance comes up very early on. And to be honest, I also did these projects in my free time in overtimes." (Interviewee No. 7, Human Medicine, Managing Director, Male)

Subject-specific. Professional challenges include all obstacles that are rooted in specific content-related issues. First, even at the beginning of their career, healthcare professionals report that they are still overburdened, leaving little time and energy to engage in shaping digitalization. This was reported only by employees in a clinical setting.

"What prevents young physicians from doing this is the time aspect. So you are overloaded with an extremely large number of medical and non-medical tasks." (Interviewee No. 1, Human Medicine, Assistant physician, Male)

Second, medical graduates argue that implementing digital solutions also requires significant financial investments, which are often hard to justify in the cost-sensitive healthcare sector. Furthermore, many medical graduates face bureaucratic processes and an outdated infrastructure. Third, medical graduates report that strict regulations prevent digital progress – especially due to straight data protection regulations. On top of that, medical graduates report that limited interconnectivity among healthcare institutions further impedes digital progress, as the lack of standardized digital collaboration systems prevents seamless data exchange.

3.5 Opportunities to drive digitalization forward

Medical graduates point out potential solutions to solve existing challenges, focusing on an enhanced education, improved practice conditions, and changed political regulations.

Education. The area of education encompasses potential education-oriented measures. In this context, medical graduates emphasized the need for more comprehensive digital education and continuous professional development – especially during their medical study programs, and, in some cases, also during high school. They suggested that universities should not only provide foundational digital courses, but also offer practical, hands-on experiences that reflect real-world challenges and best practices, preparing students to actively contribute to advance digitalization in healthcare

practice. This preparation should focus on the specific content of digitalization, but also on the organizational challenges they will face, such as resistance to change. Therefore, universities should provide medical students with strategies on how to navigate these as a recent alumnus effectively. Furthermore, medical graduates report that fostering a digital and entrepreneurial mindset is crucial for medical graduates to solve a variety of challenges.

“Digital skills, applications and the courage to integrate this innovation into must also be trained during the study program.” (Interviewee No. 4, Human Medicine, Assistant physician).

Thus, teaching students to think critically about how digitalization can be integrated into healthcare and different business models is a critical success factor from medical graduates’ perspective. Furthermore, medical graduates state that continuous workplace training is also essential to keep professionals up to date with a rapidly evolving digitalization.

“An employer should send a clear signal to the outside world that it is willing and has interest in digital innovations. They should clearly say: We want to actively promote this.” (Interviewee No. 17, Human Medicine, Assistant physician, Female)

Politics and the state. Additionally, from the participants' perspective, policy reforms are crucial to reduce bureaucratic hurdles, streamline processes, and provide more flexibility for digital initiatives. Therefore, reforms should aim to balance data security with the freedom to push digitalization, allowing for a safe but agile development of digital solutions. Furthermore, the state should establish a robust infrastructural framework to support the development and implementation of digital initiatives.

“This is very top-down. That's typical with the EU directives, they always come from the top and are not coordinated with the market. And I would like to see these hurdles taken to realize the entire digital functionality.” (Interviewee No. 11, Dentistry, Managing Director, Male)

4. Discussion

This qualitative interview study with 19 interviewees provides new insights into the role of recent medical graduates as potential drivers of digitalization within the healthcare sector. By exploring their digital competencies, application experiences, and perceptions of challenges, it highlights both the opportunities and limitations of this target group. The findings offer theoretical and practical implications for medical education, healthcare institutions, and policymaking.

Implications of the findings for research and practice

Learning and applying digital skills

Existing research emphasizes the lack of an appropriate digital training in medical curricula (Aulenkamp et al. 2021, Neumann et al. 2021). This study confirms these findings, showing that even at progressive institutions like UW/H, students acquire digital skills mostly informally – through extracurricular activities or on-the-job learning. In this context, participants reported a clear gap between the digital demands of healthcare practice and the content of their former education, regardless their year of graduation. Despite being digitally socialized and confident in the use of digital offers (Schenarts 2020, Eckleberry-Hunt 2018), students expressed frustration over the absence of a structured and practice-oriented digital education. These findings are supporting the calls of the recent medical graduates for integrating digital competencies more and more into national frameworks like the NKLM. At UW/H, the demands of Neumann et al. (2021) and Sorg et al. (2022) also become evident: medical graduates seek for a digital education, but this potential remains largely untapped. However, the actual conditions could also enable universities to go new ways, setting their own digital priorities. This perspective aligns with the arguments of Khafizova et al. (2023) and Monteiro & Leite (2021), who emphasize that universities could play a greater role in preparing students for the upcoming digital reality across various practical settings. This is particularly important because, to date, graduates appear to have developed their digital competencies primarily through informal means – such as extracurricular learning or on-the-job experiences, with an immediate application process. However, it is important to critically acknowledge that the majority of learning processes are occurring outside the traditional classroom, driven by experience and social interaction (Falk & Dierking 2010, Falk et al. 1998). Nevertheless, as further research pointed out, universities could play an even more important role and make their own contribution to ensure that medical graduates enter the workplace digitally prepared (Torbaghan et al. 2022, Jarva et al. 2022, Kuhn et al. 2018, Scuotto & Morellato 2013). In this context, digitalization has a transformative potential in education (Schmidt & Tangt 2020). Consequently, in medical education, it is essential for universities to rethink their approach about teaching digital competencies and to prepare graduates for a changing job market (Kopackova et al. 2024, Mohamed Hashim et al. 2022). In this context, universities should incorporate hands-on digital skills training that focuses not only on technical proficiency but also on how to apply these tools in real-world healthcare settings.

Potentials of graduates in driving digitalization forward

This study has made evident the diverse potentials of medical graduates, which are likewise addressed in the existing literature.

First, the perceived relevance of recent graduates for the future of healthcare organizations reflects broader demographic and workforce trends. As experienced professionals retire and the “war for talent” intensifies, early-career physicians are increasingly regarded as a strategic asset (Tirrel et al. 2025, Liebenow et al. 2014, Hullen 2013). The literature confirms this development, highlighting projected personnel shortages in the healthcare sector and the growing importance of attracting and retaining qualified talent – including also recent medical graduates (Reuß et al. 2025, Johna 2024, Schwendemann et al. 2024). In light of these trends, healthcare organizations must adapt more deliberately to the expectations of this target group – for example, by providing the desired digital infrastructure (Burfien et al. 2025, Winkelhake 2024, Vordenbäumen & Pfannstiel 2024). Taken together, these arguments suggest that the digital expectations of recent graduates alone can serve as a catalyst for change, particularly as organizations have to respond to these demands having the skilled labor shortages in mind. This finding aligns with Burnes (2017) perspective, which conceptualizes external stakeholder expectations as key drivers of organizational change. In this context, both external pressures – such as the demographic shift – and internal resources – such as graduates digital readiness and intrinsic motivation – interact to position recent medical graduates as important agents of digitalization. Building on Burnes view, this implies that healthcare organizations must not only acknowledge these expectations but also actively respond by implementing targeted solutions for recent medical graduates. These may include investing in talent development programs, establishing supportive digital infrastructures, or fostering a work culture that empowers early-career professionals to contribute meaningfully to digital initiatives.

Second, participants in this study emphasized that recent medical graduates possess a diverse set of professional competencies and personal attributes that position them well to contribute to the advancement of digitalization. However, these characteristics are not fixed. As Asselmann and Specht (2021) and Pataki-Bittó (2025) note, early-career professionals continue to develop essential traits – such as conscientiousness, assertiveness, or team orientation – during their initial years in practice. While these studies support the notion of a developmental trajectory, they also highlight its variability: not all graduates display the same levels of confidence, initiative, or digital affinity. It is therefore critical to avoid reductive assumptions based on generational stereotypes (Hurrelmann 2009, Jahn et al. 2024). Instead, intra-group differences and individual circumstances must be acknowledged, particularly when designing support systems intended to empower recent graduates to lead digital initiatives. Here, recent medical graduates’ individual strengths must be understood in relation to both their specific work environments and regarding the individual characteristics.

Challenges for graduates in advancing digitalization and Opportunities to solve

This study also surfaces substantial structural, personal, and regulatory barriers that restrict the actualization of recent medical graduates in making an own contribution to the advancement of digitalization. As in previous studies by Kakale (2024) or Nawroth et al. (2024), this study also points out a lack of formal authority, hierarchical resistance, time constraints, or a fragmented regulatory environment. These findings resonate with broader critiques of the German healthcare system, particularly concerning overly strict data protection frameworks and their chilling effect on digitalization and innovation (Kriegel et al. 2024, Hessel & Jung 2024, Čas 2008). Furthermore, participants' references to bureaucratic overload, outdated infrastructure, and the difficulty of implementing digital solutions in analog-dominated settings align with the observations made by Matusiewicz et al. (2018) and Wendling (2024), who also emphasize the systemic nature of these obstacles. It is therefore evident that medical graduates face still-documented and persistent challenges within the entire healthcare system, damping their intrinsic motivation to act as a key driver of digitalization.

To address these limitations, this study also highlights potential enablers of digitalization and emerging solutions. In particular, structured mentorship, leadership support, and a receptive organizational culture are frequently identified as critical success factors (Beer et al. 2014, Heo 2015, Karcsics 2007), aligning with participants' calls for greater top-down encouragement. Such indirectly acting measures may contribute to create an environment that increasingly supports the digital initiatives of recent medical graduates. Moreover, consistent with the change management frameworks proposed by Glasl and Lievegoed (2024) and Mizrak (2024), the findings emphasize the necessity of coordinating diverse stakeholder interests. Medical graduates alone cannot be expected to navigate the often conflicting expectations of all different stakeholders alone. Here, an effective professional leadership seems to be essential. As Burnes (2017) notes, change is not a linear process, but rather a dynamic and ongoing interaction between internal capabilities and external pressures. This perspective is also reflected in the views of the study participants, who call on their organizations to manage emerging change processes systematically in order to respond professionally to evolving and changing conditions In this context, it may be beneficial for organizations to implement structured change management approaches, as suggested by Mento et al. (2002), and to adopt targeted interventions at the individual, team, and organizational levels (Cameron & Green 2019). Utilizing such established reference models may help to meet the growing demand for structured and sustainable change processes, impacting at the end also the opportunities for recent medical graduates in advancing digitalization in practical settings. Finally, the political dimension of digitalization cannot be overlooked. The literature highlights a central dilemma:

fostering innovation while ensuring robust data protection (Weichert 2024, Pförringer et al. 2020). This tension is also frequently emphasized by participants in this study, underscoring the need for appropriate and balanced solutions by policymakers.

Overall, it becomes evident that a diverse range of stakeholders are playing a crucial role in enabling medical graduates to contribute meaningfully to the advancement of digitalization in practice. Considering this, the main recommendations for action are summarized below:

At the *educational level*, medical curricula should systematically integrate comprehensive knowledge about digitalization, digital medicine or concrete digital tools. In addition, practical training should equip students with essential digital skills to prepare them for the demands of the modern healthcare.

At the *organizational level*, it is crucial to create an environment that actively supports and promotes digital initiatives of recent medical graduates. This includes establishing mentorship programs, appropriate leadership structures, and incentive systems that genuinely value and reward digital innovation. Furthermore, young professionals should be given the necessary resources, time, and autonomy to develop and implement their own digital solutions.

At the *political level*, regulatory and legal barriers that hinder digital progress must be addressed and adapted. Overly restrictive data protection laws should be revised to enable emerging innovations, while simultaneously ensuring the responsible use of existing data.

Here, without coordinated reform across policy, education, and healthcare governance, the transformative potential of digitally competent graduates is likely to remain underutilized. In sum, a multi-level approach is therefore imperative: graduates alone cannot bear the burden of driving digital initiatives without supportive structures and an appropriate ecosystem.

Limitations

For sure, the results must also be viewed with the following limitations in mind. First, the sample consists exclusively of medical graduates from Witten/Herdecke University, known for its focus on digitalization. As a result, the findings may reflect a more favorable perception of digitalization, potentially overstating the readiness and ability of new graduates to adopt digital solutions into practice. Second, the reliance on recent graduates limits the generalizability of the results. In this context, older healthcare professionals, stakeholders within the medical environment or lecturers could also add valuable insights and perspectives to fully explore the research topic. Third, as the study is based on self-reported data, there is a risk of bias due to social desirability or selective

memory. Participants may have portrayed themselves as more willing to adopt digital technologies in practice, thus overestimating their possible impact. Fourthly, the results of this qualitative study are context-specific, i.e. they just pertain to the healthcare and education system at a specific university in Germany. Consequently, an international transferability of these findings is not possible. Overall, the findings must be tested with a higher number of participants to generalize and test the elaborated findings, consequently following a subsequent quantitative approach. Furthermore, there is also the option of investigating other geographical areas. Here, as the research team pursues a mixed-method approach, a quantitative study is still in elaboration.

5. Conclusion

To sum it up, this study revealed the potential and challenges that recent medical graduates experience as they seek to advance digitalization in the healthcare sector. Graduates see themselves as well-positioned to drive digitalization, outlining their organizational, personal, professional and social potential. However, they also face different organizational, personal and professional barriers, hindering them to make an appropriate contribution to push digitalization. Consequently, recent medical graduates request for support options, especially through an improved digital education, organizational support and changed regulations by the state. In conclusion, from this qualitative perspective, medical graduates are an underutilized resource in the digitalization of healthcare, which is caught between high motivation and structural obstacles in the entire healthcare system. They are holding a great potential to contribute systematically to the advancement of digitalization, which could be awakened even more through different stakeholders within the entire healthcare sector.

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Abbreviations

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