

Innovating Healthcare for Emerging Economies



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2. Abstract

Digital health is a rapidly growing field that utilizes information and communications technologies to manage illnesses and promote wellness. This cultural transformation has been shaping the basics of healthcare since the beginning of the 21st century, resulting in a change in the doctor-patient hierarchy towards an equal-level partnership. Patients are becoming empowered, leading to the emergence of the empowered physician movement. The role of physicians is shifting from being the key holder in the ivory tower of medicine to becoming a guide for patients in the jungle of health and digital information.

Advanced technologies such as sensors, portable diagnostic devices, and artificial narrow intelligence-based algorithms will enable patients to receive diagnosis and treatment wherever they are, making them the point-of-care. This transformation will redefine well-being as patients enter healthcare before experiencing symptoms, and medical professionals will design preventive plans using vast amounts of data from patients and studies. However, this change will bring unprecedented challenges regarding privacy, freedom of choice, and patient safety.

To investigate the viability of developing an information and guidance system for patients, we propose a study that emphasizes the development of low-cost, partially generative audio feedbacks combined with streamlined visual illustrations in both local and official languages. Accucenture reported that only 2% of patients in the 100 largest hospitals in the country use mobile apps offered by the institutions, despite at least 2/3 of these institutions providing patients with applications. Providers are losing potential revenue streams and a significant part of the patient experience to digital health disruptors who offer rival goods and services. Thus, it is essential for providers to build a better user experience that is more suited to patients' functionality needs to improve their mobile strategies.

Cost and payment are major factors that influence patient satisfaction, and even if costs cannot be reduced, payment accessibility can be increased to improve satisfaction. Customers expect constant access to goods and services, and those who are unsatisfied with a provider's mobile services or lack thereof may search for other providers. Ultimately, serving patients should be the driving force behind every aspect of a healthcare business, and failing to meet their expectations will adversely affect revenue performance.

3. Overview

3.1. Digital Health

Digital Health, though still a growing term, refers to the use of various digital technologies for healthcare purposes; such as various services that support healthcare providers and help consumers improve their health and wellness. They include wearable medical devices, personalized medicine, mobile health (mHealth), health informatics, health information technology (IT), and telemedicine and telehealth (Coursera 2022).

3.2. Global Market Analysis on Digital Health

Statista in 2022 published their study on the global market for digital health. They found that the global digital health market in 2019 was worth almost 175 billion U.S. dollars and should reach 660 billion dollars (about \$2,000 per person in the US) by 2025(Statista 2022). The Grand View Research, in their report confirmed the global digital health market size to be worth around 211 billion USD in 2022 and continue to grow at a compound annual growth rate (CAGR) of 18.6% from 2023 to 2030 (GVR 2022).

A major factor driving the current rise in digital healthcare is the continuous shortage of trained medical professionals in emerging economies, as well as advanced economies; coupled with an increasing demand for healthcare professionals due to an aging population and chronic disease prevalence. Digital health has proven very effective in helping medical professionals reach more people in need in cases like telehealth/telemedicine, among others (GVR 2022).

3.3. Global Consensus on Digital Health

The World Health Organization (WHO) recognized that digital health could not only make health systems more affordable and equitable, but also help improve the quality of care. Therefore, in 2020 we adopted a global strategy on digital health to improve health outcomes. This strategy gave a blueprint that combines the latest development in digital health and innovation. This, however, is not without its challenges, especially for emerging economies. Therefore, the design was done in a way to support even those member states with limited access to digital technologies so they would be able to benefit significantly, in

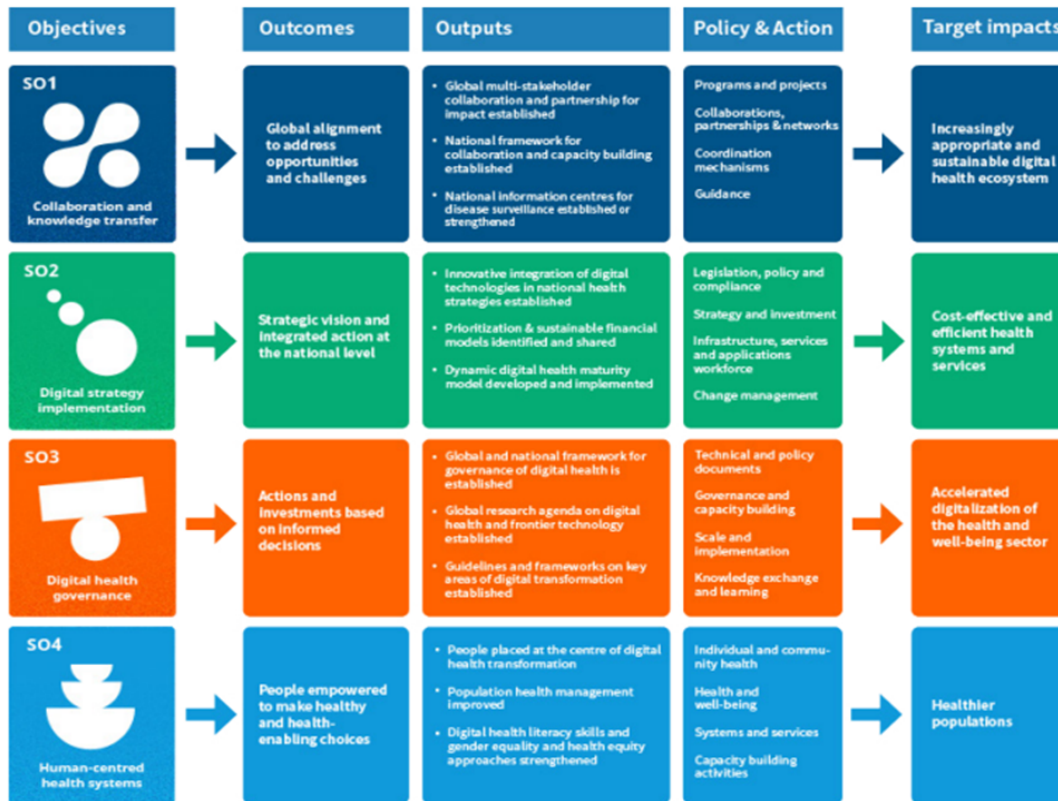
order to strengthen their health systems and achieve the vision of health for all (WHO 2020).

Although a few emerging economies are catching on with the current trend in digital healthcare, there still exists a huge divide between the advanced economies and the emerging ones. This study aims to explore the current trend in digital healthcare in both emerging and advanced economies, cite challenges faced by emerging economies, and propose solutions to these challenges. We will also present a few case studies and explore the feasibility of our proposed solutions.

3.4. Implementation of the strategy and action plan

The global strategy on digital health aims to support and respond to the growing needs of countries to implement appropriate digital technologies in accordance with their health priorities and to make progress towards universal health coverage and the health-related Sustainable Development Goals. It also responds to the objectives of WHO's Thirteenth General Programme of Work, 2019–2023. Figure 1 below summarizes the action plan.

Fig. 1. Summary implementation of the action plan



-Unsurprisingly, in many Low-Middle Income Countries (LMICs), there are basic digital skills shortages across both the health workforce and patients, especially in rural and remote areas. According to the 2019 Global Digital Health Index, the skills base among health-care professionals is generally low. Only 2 of the 22 countries surveyed by the Index include digital health in training for health-care professionals, with less-significant gaps among physicians, and more-significant gaps in training for nurses and community health workers. Skills gaps are particularly pronounced in WHO’s Eastern Mediterranean region, with Southeast Asia having the strongest base of skills to enable digital health.

-The need to improve digital skills is recognized as a key objective of WHO’s “Global Strategy on Digital Health 2020–2024.” The ideal long-term solution would be introducing or bolstering digital skills at primary, secondary, and tertiary education levels. However, given resource constraints and the need for quicker results, upskilling health workforces to make them digitally competent could be a more pragmatic strategy. Best practice involves introducing digital skills into the health education curricula for health-care workers both

pre- and post-deployment, ideally for both clinical staff and community workers. This can be done as part of general capacity building efforts as well as those related to specific digital health projects and could happen at workforce training institutions (such as for vocational training) and private-sector-led programs (such as for re-skilling). These private-sector-led training and certification schemes could bridge the digital skills gap, without people needing to go back for formal, secondary, or tertiary-type education and training.

3.5. What Is an Emerging Market Economy?

An emerging market economy is the economy of a developing nation that is becoming more engaged with global markets as it grows. Countries classified as emerging market economies are those with some, but not all, of the characteristics of a developed market. Characteristics of developed markets may include strong economic growth, high per capita income, liquid equity and debt markets, accessibility by foreign investors, and a dependable regulatory system.

As an emerging market economy develops, it typically becomes more integrated with the global economy. That means it can have increased liquidity in local debt and equity markets, increased trade volume and foreign direct investment. It can develop modern financial and regulatory institutions. Currently, some notable emerging market economies include India, Mexico, Russia, Pakistan, Saudi Arabia, China, and Brazil.

Critically, an emerging market economy is transitioning from a low income, less developed, often pre-industrial economy towards a modern, industrial economy with a higher standard of living.

Some important characteristics include;

*An emerging market economy is an economy that's transitioning into a developed economy.

*Emerging market economies typically feature a unified currency, stock market, and banking system; they're in the process of industrializing.

*Emerging market economies can offer greater returns to investors due to their rapid growth.

*They also offer greater exposure to some inherent risks due to their status.

*Over time, emerging markets typically adopt reforms seen in developed markets.

Table 1. Functionalities of the digital health tools used across the large-scale vaccination process in low- and middle-income countries.

Tool name	Functionality	Newly developed for COVID-19
AfriDoctor	● ● ●	No
Carné de Vacunación (Ministerio de Salud del Peru)	●	Yes
CommCare (Dimagi)	● ● ● ● ●	No
Conecte SUS	●	Yes
District Health Information Software 2 (DHIS2) COVID-19	● ● ● ● ●	Yes
Co-WIN	● ● ● ● ●	Yes
Digital Infrastructure for Verifiable Open Credentialing (DIVOC)	●	Yes
Mi Argentina/ Mi Salud	● ●	No
M-Vaccin (Gavi and Orange)	● ●	No
mVacciNation	● ● ● ● ● ●	Yes
Open-source smart register platform (OpenSRP) FHIR Core	● ●	Yes
Oracle Health Management System	● ● ● ● ● ● ●	No
South Africa's Electronic Vaccination Data System (EVDS)	● ●	Yes
Simprints	●	No
Trusted Vaccines	● ● ●	Yes
Vaxiglobal	● ● ●	No
Vxnaid	● ● ● ● ● ● ●	No
WeTel Health Platform	● ●	No

● Vaccination appointment scheduling	● Vaccination verification	● Vaccine reporting
● Personal identification appointment	● Vaccine certification	● Follow-up communication and reminders

Some examples of digital health tools utilized in the large-scale vaccination process in emerging economies. (Mc Kenna et al. 2023).

4. Current Status of Healthcare in Emerging Economies vs Advanced Economies



Figure 2. Low- and middle-income countries using the capabilities of digital health tools along the vaccination process.

Colored countries indicated countries in which we could identify the use of digital tools along the large-scale vaccination process. Due to an insufficient level of granularity in the available data, a distinction between tool functionalities in each country could not be made. This is not an exhaustive list. The sources to build this map are listed in [Table 1](#) and in [\[25\]](#) for DHIS2 COVID-19 (Vaccine Delivery toolkit).

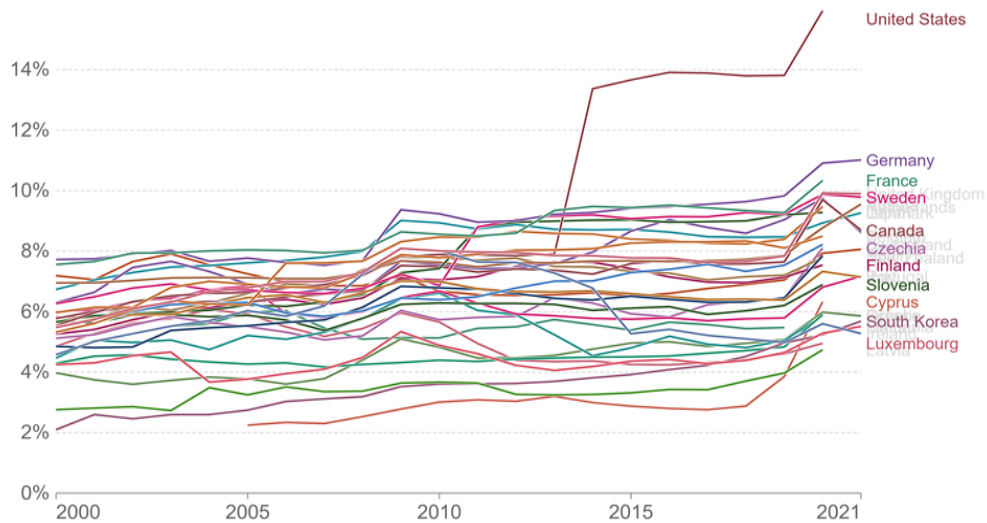
► Health financing by governments (Funding healthcare)

To show this development we have produced a long-run dataset with estimates of government expenditure on healthcare as a percent of gross domestic product (GDP) for a selection of emerging economies and advanced economies, going back to 2000.

*Health financing by governments in advanced economies

Government health expenditure as a share of GDP, 2000 to 2021

This metric captures spending on government funded health care systems and social health insurance, as well as compulsory health insurance.



Source: Our World In Data based on Lindert (1994), OECD (1993), OECD Stat

OurWorldInData.org/financing-healthcare • CC BY

Note: Health spending includes final consumption of health care goods and services (i.e. current health expenditure). This excludes spending on capital investments.

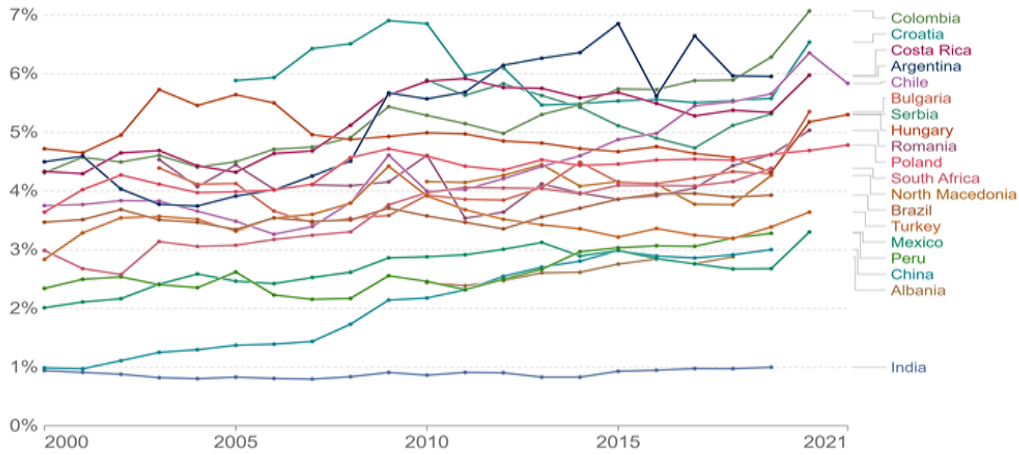
Government spending on healthcare was above 2% of GDP in all these countries. And an average of about 5% to 9%. and always at a slight increase year over year except for some significant increases in countries. Stable increase and decrease.

*Health financing by governments in emerging economies

Government health expenditure as a share of GDP, 2000 to 2021



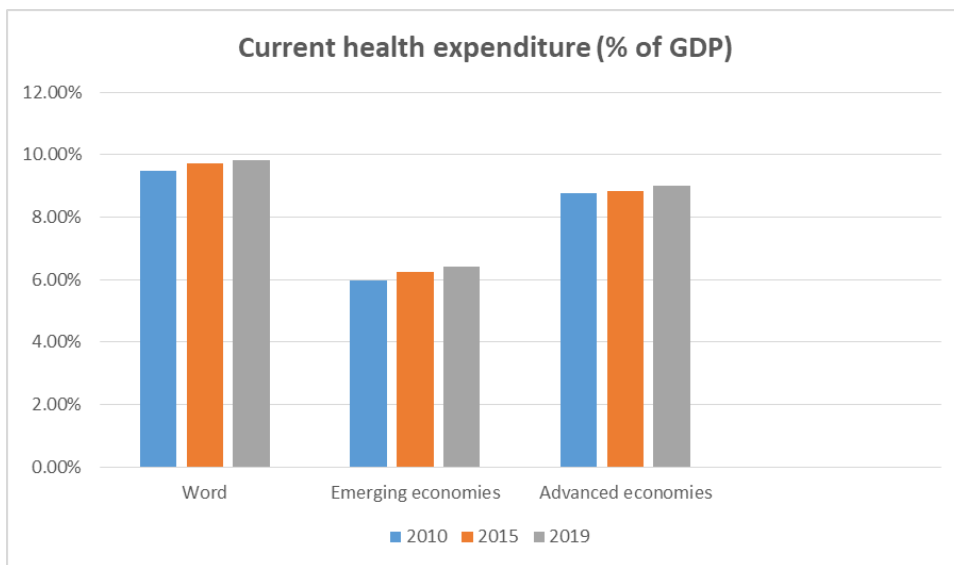
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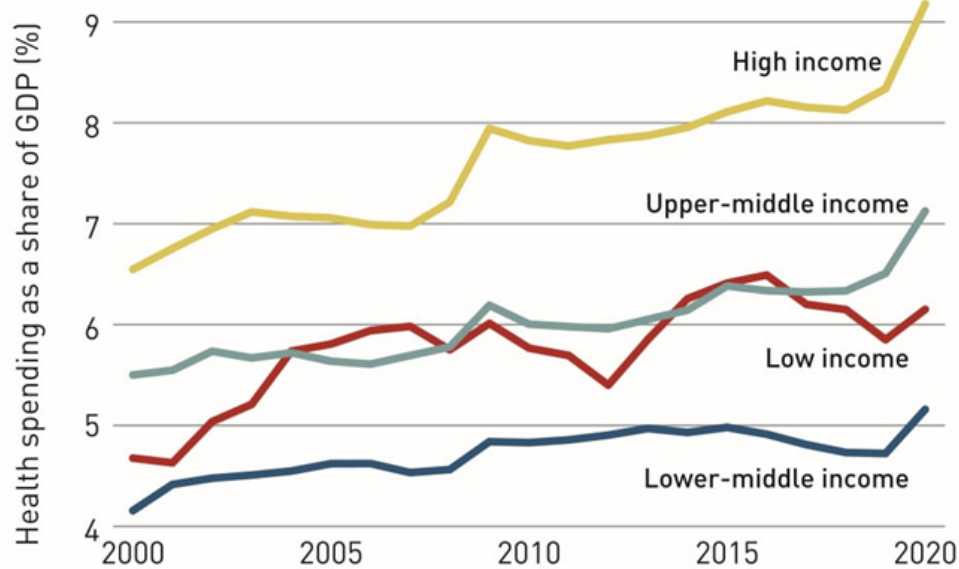


Source: Our World In Data based on Lindert (1994), OECD (1993), OECD Stat
 Note: Health spending includes final consumption of health care goods and services (i.e. current health expenditure). This excludes spending on capital investments.
 OurWorldInData.org/financing-healthcare • CC BY

For countries with emerging economies, some have rates as low as 2%. and increased and decreased markedly year by year.

► Healthcare expenditure as a percentage of GDP (2010, 2015, 2019)





In addition to examining the level and composition of health spending in 2020, that health systems responded during the first year of the pandemic. Sharp increases in government spending on health at all income levels underpinned the rise in health spending to a new high of US \$9 trillion (approximately 11% of global GDP). Government health spending generally increased in line with the various prevention, detection, and treatment needs of the pandemic and offset declines in out-of-pocket spending. Importantly, the rise in public health spending was part of a much broader fiscal response to the pandemic. In high income and upper-middle income countries social protection spending also increased sharply as governments attempted to protect populations from the economic impacts of COVID-19.

While governments effectively rose to the challenge of the first year of the pandemic, they face the further challenge of sustaining increased public spending on health and other social sectors in the face of deteriorating macroeconomic conditions and rising debt servicing. A further challenge is sustaining external support for low-income countries, which is essential for reducing poverty, ensuring access to health services and strengthening pandemic preparedness.

Table 1. Summary of national COVID-19 mHealth applications released by India and Vietnam

Country	Application name	Release date	Adoption	Functions
India	Aarogya Setu	April 2, 2020	50 million downloads within first 2 weeks of launch 100 million downloads 1 month after launch	Risk assessment of contracting COVID-19 Likelihood of having COVID-19 based on self-reported symptoms Exposure tracking and notification Information dissemination Electronic passes for movement through checkpoints ^a Telemedicine (virtual doctor visits, home laboratory testing, and home medication delivery) ^a Electronic vaccination verification ^a
Vietnam	Vietnam Health Declaration application	March 9, 2020	>1 million downloads before being retired ^b	Medical declaration upon entry of country at airport or border Electronic passes corresponding to medical declaration
	NCOVI	March 9, 2020	7.2 million 4 months after launch	Voluntary symptom logging Telemedicine (triaging services provided by healthcare professionals) Information dissemination Mapping of suspected positive cases based on symptom logs Electronic passes for checkpoints ^a Exposure tracking and notification
	Bluezone	April 18, 2020	200 000 downloads 3 months after launch 20 million downloads 4 months after launch	Information dissemination
	PC-Covid	September 30, 2021	Over 3.6 million downloads in the first month after launch	Medical declaration upon entry of country at airport or border Voluntary symptom logging Exposure tracking and notification Telemedicine (scheduling tests and vaccinations) Information dissemination Electronic domestic travel passes and vaccination cards Mapping of suspected hot spots based on symptom logs and reported test results

^aFunctions added in updates after initial application release.

^bDownloads by month after release not disclosed.

A study by Winkie (Winkie and Nambudiri 2022), taking the situation in Vietnam and India as examples during the covid pandemic reported that these nations' governments independently launched the apps listed above. The report highlighted the functions and strategies utilized in mitigating COVID-19. They also reported that a lot of the mHealth applications released in Low middle income countries took different approaches, they ultimately share common core features ranging from contact tracing to quarantine tracking, testing coordination, screening, clinical management recommendations, and information dissemination.

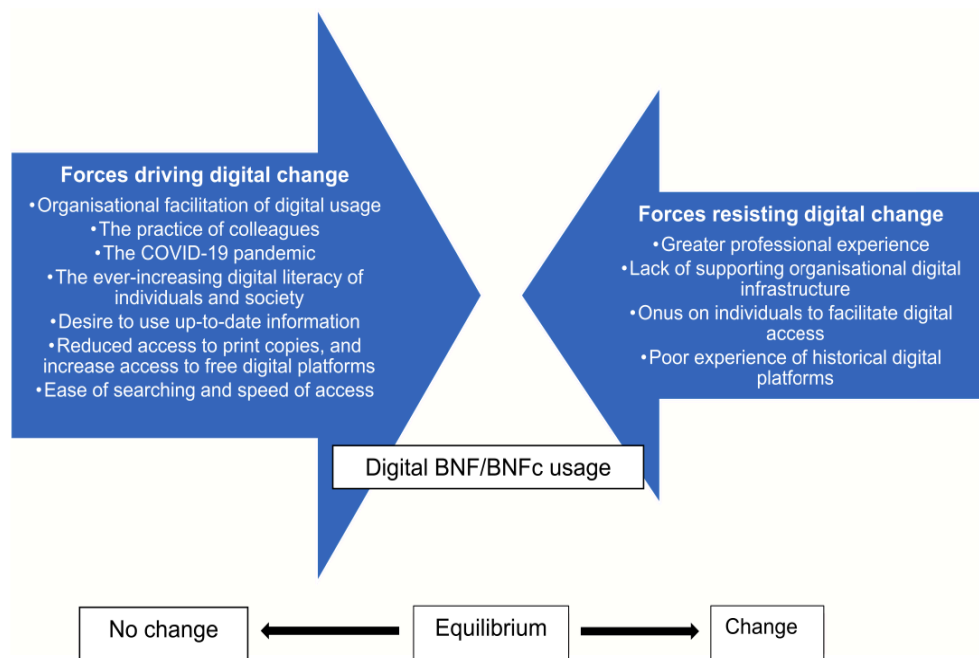


Fig. 1. Forcefield analysis of forces driving and resisting change in relation to digital BNF/BNFc usage.

The diagram above is from an article depicting the status of digital health information usage in the context of the British National Formulary (BNF) and the British National Formulary for Children (BNFc) (Blagden et al. 2022).

Sun et al. (2022), in their study of mobile Health(mHealth) in China, concluded that even though mHealth contributes significantly to accessibility, efficiency and health promotion, to achieve sustainability of mHealth in the health system, four policy improvement aspects were listed; an integrated approach, a robust governance mechanism, a new legislative response, and private sector engagement. (Sun and Buijsen 2022)

Digital tools have helped lower- and middle-income countries address major healthcare system challenges.

Primary healthcare use cases in eight lower- and middle-income countries

1 Burkina Faso: Rapidly and widely deployed COVID-19 modules enabled by digital-healthcare tools and scaled over a decade (Company: CommCare)

2 Nigeria:

- Quickly scaled existing disease-surveillance platform (Company: SORMAS)
- Implemented data system to manage public-health-goods supply chain (Company: LMIS)
- Provides self-managed care platform for users with chronic health issues (Company: mDoc)

3 South Africa: Chatbot app enabled around 11 million symptom checks across various industrial sectors during COVID-19 pandemic (Company: Turn.io)

4 Uganda: Mobile app supported healthcare workers in pandemic response and primary care (Company: SmartHealth)



5 Kenya:

- Text messaging enables healthcare payments; connects patients, providers, and payers (Company: CarePay)
- Telemonitoring model supports case-based learning on broad health topics (Company: Project ECHO)

6 Rwanda:

- Wide uptake of telemedicine tool with users/providers (Company: Baby!)
- Remote monitoring via text messaging improves workflows and adherence (Company: WelTel)

7 Sri Lanka: Digital tool helped launch nationwide response to COVID-19 before first case was detected (Company: DHIS2)

8 Vietnam: Suite of digital tools tracks and traces COVID-19 (Companies: NCOVI, Bluezone, and others)

Note: The boundaries and names shown on this map do not imply official endorsement or acceptance by McKinsey & Company.
Source: McKinsey analysis based on 12 large-scale digital-tool implementations in 8 lower- and middle-income countries in Africa and Asia

**McKinsey
& Company**

A brief summary of digital health status in some emerging economies. Source: [Unlocking digital healthcare in lower- and middle-income countries | McKinsey](#)

5. Challenges to Digital Health Monitor and Measurement systems (DHMMs)

Digital Health Monitor and Measurement Systems have been met with several challenges all over the world, more so in emerging economies where they have rather limited access to digital technologies. We will summarize a few challenges in this chapter.

5.1 Age factor

Verma et al. (Verma, Saldanha et al. 2022), in their scoping review identified some barriers to electronic health (eHealth) literacy among older adults with cancer and their caregivers. They came up with two categories to these findings; intrinsic and extrinsic barriers (Fig.2). Intrinsic being those barriers that relate to older adults and their caregivers' abilities and knowledge. While extrinsic barriers were those from an individual's environment that plays a significant role in impacting their literacy.

Figure 2 Intrinsic and Extrinsic Barriers to eHealth literacy among older adults living with cancer and their caregivers.

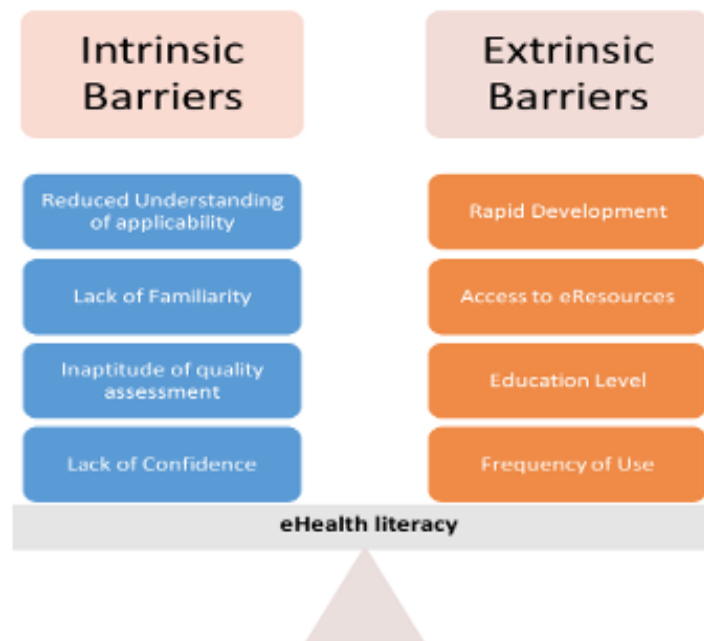
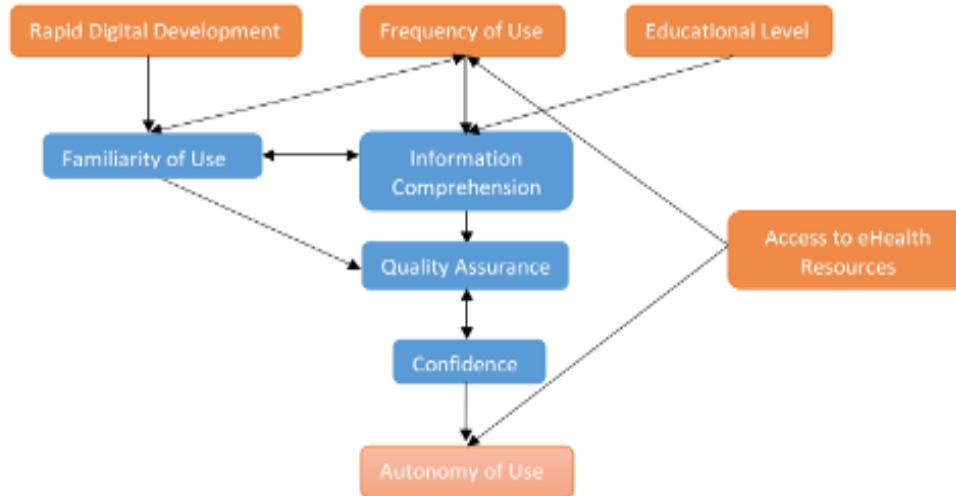


Figure 3 Correlation between the intrinsic and extrinsic barriers to eHealth literacy.



A positive correlation was found by Verma and colleagues in their study (Fig.3). They found that those cancer caregivers that were eHealth literate were more likely to seek a second opinion, had more treatment options, and had more support in their treatment decision making with a broader social network for additional information. The eHealth literacy level also correlated with older adults having more trust in the healthcare system (Verma, Saldanha et al. 2022).

However, Mace et al., in a commentary raised the issue of ageism when it comes to digital health and buttressed the importance of promoting equity in digital health practices involving older adults (Mace, Mattos, and Vranceanu 2022). This might be the case in high income countries, but the emerging economies have a totally different experience. Despite this, some of the methods he proposed for combating ageism are still very valid and relatable even in emerging economies. Some of these will be briefly introduced in the “Solutions” section of this article.

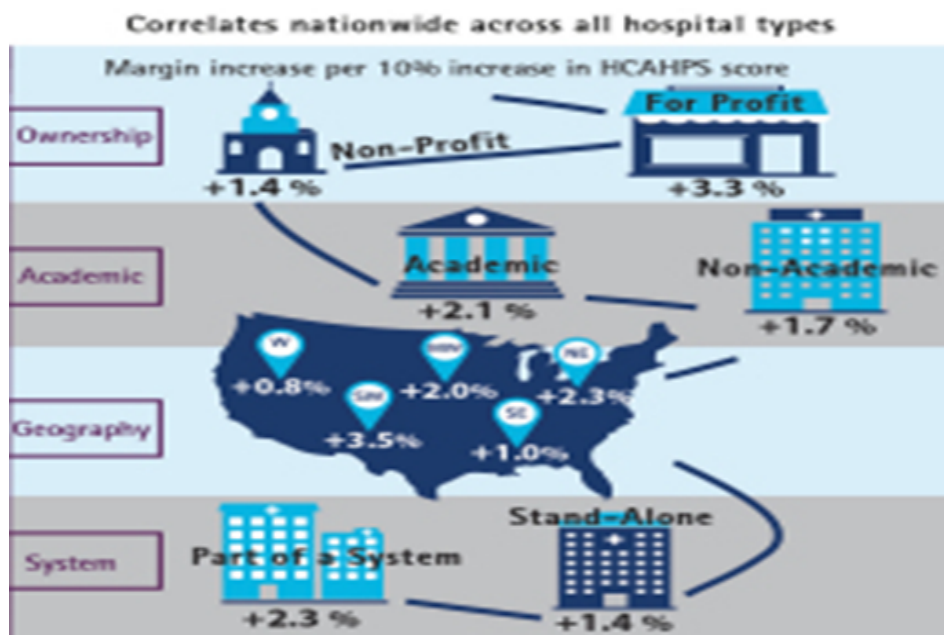
5.2 Patient Satisfaction.

1. The impact of patient satisfaction on the revenue cycle

A lack of technological alignment may cause hospital revenue cycle to dip substantially, according to research from Accenture. Stronger patient engagement efforts and revision of digital health strategies may help hospitals protect their revenue cycle. When healthcare providers fail to meet consumers' increasing desire for mobile patient engagement, they will potentially lose revenue, Accenture adds. This kind of 'do it your self' approach to healthcare means without a digital touch, untapped revenue and value-based outcomes potentially falter. When a hospital is wired, its revenue reportedly flourishes.

The value we offer patients has a direct effect on the revenue you collect. This applies to all healthcare organizations, but unfortunately, not all providers understand the impact patient satisfaction can have. The more satisfied your patients are, the better your revenue cycle management performance will be, which affects many other aspects of your business.

2. How patient satisfaction contributes to financial growth (and losses).



2.1. The high costs of low patient satisfaction

Patients want clear pricing and payment expectations. They also want:

- A deep understanding of their condition
- Actionable steps they can take to improve their health
- Simple, stress-free payment processes
- The option to manage high treatment costs with a payment plan

All these things show patients that they're genuinely cared for. When providers offer such resources and payment options, patient satisfaction increases. When these aren't included in treatment, patients are likely to be dissatisfied.

And when satisfaction is low, many aspects of your organization are hindered including financial performance, market share, and care quality. Dissatisfied patients are less likely to pay their medical bills in full, if at all. There's very little chance these people return for more services, which is how market share can suffer. Even patients who continue treatment may not be fully engaged, resulting in a decrease in quality care levels as patients stop adhering to their treatment plans.

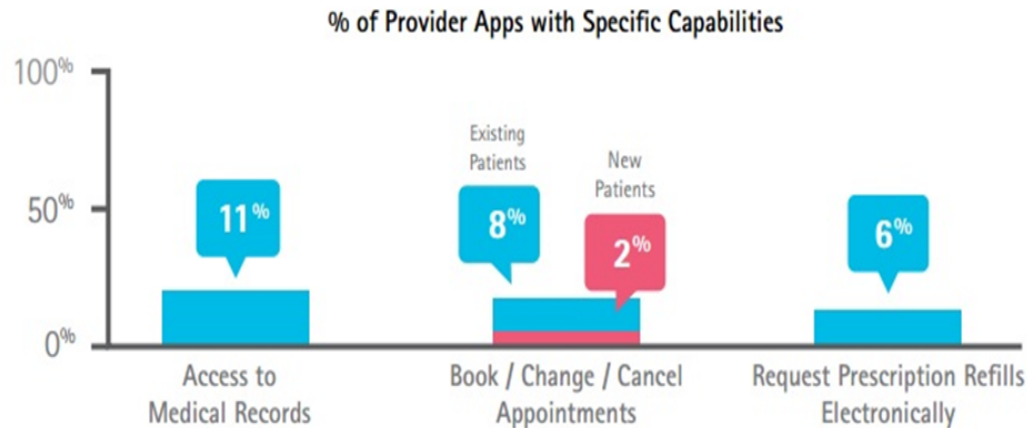
Luckily, these issues can be avoided by investing more in your patients. There are plenty of ways to increase patient satisfaction while also improving revenue cycle management performance, care quality and much more.

2.2 The revenue cycle management benefits of investing more in patients

Providing a more satisfactory patient experience can be as simple as taking the time to explain payment responsibilities or as significant as implementing new tools and processes. Convenient payment technology or an advanced claims management system can help you better serve your patients, your staff and your bottom line.

3. Mind the mobile gap

Less than 11% of providers offer proprietary apps that have at least one of the three functions that consumers want the most.



Sources: Accenture analysis, 2013 Accenture Consumer Survey on Patient Engagement, Google Play, iTunes

The primary problem, however, is that hospital revenue cycle is not keeping up with patient engagement demand. Only 2 percent of patients across the nation's 100 largest hospitals utilize hospital-provided mobile apps, says Accucenture. Such data perhaps seems contradictory to another finding that at least 2 in 3 of these hospitals offer apps to their patients. By not having solid mobile engagement strategies, providers are ceding a portion of the patient experience – and potential revenue streams – to digital health disruptors that increasingly offer competing products and services. To improve their mobile strategies, providers should look to create a better user experience that is more tailored to the functionality demanded by patients.

4. Why are hospital apps failing to engage patients?

The professionals with diverse backgrounds (which include individuals from IT, engineering, public health, and digital health) face many barriers in implementing the technology due to the following:

- (1) patentability;
- (2) little deployment of mHealth apps and new digital tools in current clinical practices;

- (3) a communication gap between multiple stakeholders (which include technology entrepreneurs, investors, developers, researchers, and practicing physicians) because of the complexity and involvement of experts from diverse domains in digital health projects (the data shows that clinical experts were only involved in the implementation phase and were not represented or asked for input at the planning and initiation phases of the interventions);
- (4) lack of evidence on the validations of digital health devices and smartphone apps;
- (5) unavailability of regulatory frameworks.

On the other hand, the existing technologies currently used do not support large data sets, the replacement of gadgets is costly, and the tools for natural language processing for local languages are unavailable.

5. Catalyzing Culture

There is a communication gap when it comes to exchanging ideas and initiatives, primarily between physicians, technology experts, and researchers. Hence, there is a need for better communication to scale up and integrate digital health into the health care system.

5.3 Language and Cultural barriers.

Low and middle-income countries have seen a rapid growth in the domain of digital healthcare projects in recent years. Easing the access to basic healthcare services, in low- and middle-income areas around the globe has always been extremely challenging in terms of affordability, lack of qualified professionals who can meet the needs of local populations and the lack of up to standards infrastructures.

. Local populations in such areas benefit from various private and public digital healthcare initiatives that usually implement via online and offline communication campaigns devoted to their education in enjoying better healthcare and health-monitoring services.

. But these Patients' Education Campaigns are only effective in sensitizing local populations about general-purpose healthcare services and information in both official and local languages. Such campaigns do not really tackle the technical and scientific vulgarization that these patients need in order to get personalized and specialized diagnoses

in their daily use of digital healthcare services. This persists due to a very low literacy rate (both literary and digitally) of beneficiaries irrespective of the language of communication.

. As far as languages of communication are concerned, there is a great lack of scientific knowledge and scientific use of official languages. A major issue that hinders the appropriate understanding, interpretation and use of healthcare information in their digital forms. In addition, the same issue is also at stake when it comes to local languages, especially in conducting and deploying large scale, personalized and specially tailored scientific vulgarizations via the production of tailored audio-visual contents.

. We've already witnessed various examples of production of audio-visual contents as a major form of contents to implement effective Patients' Education Campaign. But most of the platforms and interfaces via which they are displayed are not interactive enough to help patients get the best out of the services provided. Such service providers are always struggling with the issue of producing cost-effective contents that will be affordable for low-income and middle-income end-users.

Other challenges in conducting digital interventions in LMICs include:

- High costs and shortage of national and international funding for such projects
- Problems related to internet access in remote areas
- Barriers in communicating with semiliterate populations
- Lack of cultural acceptability with regard to the use of technology, especially for women
- Hospital apps are failing to engage patients by not aligning their functionality and user experience with what consumers expect and need
- Consumers want ubiquitous access to products and services as part of their customer experience, and those who become disillusioned with a provider's mobile services – or a lack thereof – could look elsewhere for services.
- Security concerns regarding patient data
- High capital expenditure and maintenance requirements.

6. Proposed Solutions

6.1 A Generative and Interactive audio feedback system.

. In this study, we are going to explore the possibilities of setting up a Patients' Education Information and Guidance Providing System, that is going to focus on the possibility of building low-cost and partially generative audio feedbacks coupled with some simplified visual illustrations in both local and official languages.

1. *-Reasons for the partially generative and partly interactive features of our patients' education system*

1.1. - Interactive features as a complement to generative features

The patient's education system we seek to set up here has to put human interactions at the heart of the knowledge production and transmission between healthcare professionals and end-users. Thus, the generative features of this platform are going to provide general purpose instructions and directions for all types of users. But when it comes to tackling personalized healthcare services, the system is to be shifted into an interactive mode enabling users to submit specific health issues to the expertise of health professionals who are expected to provide automatic or delayed feedbacks and guidance.

1.2. -Level of familiarity of end-users (local populations) with generative education platforms

Here we plan to launch a large-scale survey investigating how comfortable and familiar end-users would feel with a generative health-service platform versus an interactive one. We will also design a separate survey investigating a platform or a system that is both generative and interactive. Data collected from that information gathering are to be coupled and compared to the ones of another separate survey investigating users' engagement on the platforms to get real-time assessments about their actual familiarity with such platforms.

2. *-Related works:*

As aforementioned, one of the major challenges in providing healthcare services and educating patients in LMICs via digital platforms is the tedious task of converting complex scientific and technical contents into low-cost, interpreted, vulgarized and simplified forms.

Another challenge is to design all contents or courses in the form of an interactive curriculum that can achieve a better level of acceptability and compatibility with traditional medical and medicinal practices within local communities, a curriculum that can gradually foster both online and offline engagement in patients' behaviors.

Generative technologies have been extensively applied to various theoretical and practical knowledge assessment purposes within almost all domains ranging from arts to sciences with a strong emphasis on the medical field. Although the adoption and the deployment of AI language models in healthcare and medicine comes with a plethora of ethical implications that need addressing with effective regulatory measures (Stefan Harrer 2023), this domain of application is bound to permanent growth as demands on the digital service markets has skyrocketed especially for AI-assisted medical education (Kung TH, Cheatham M, Medenilla A, Sillos

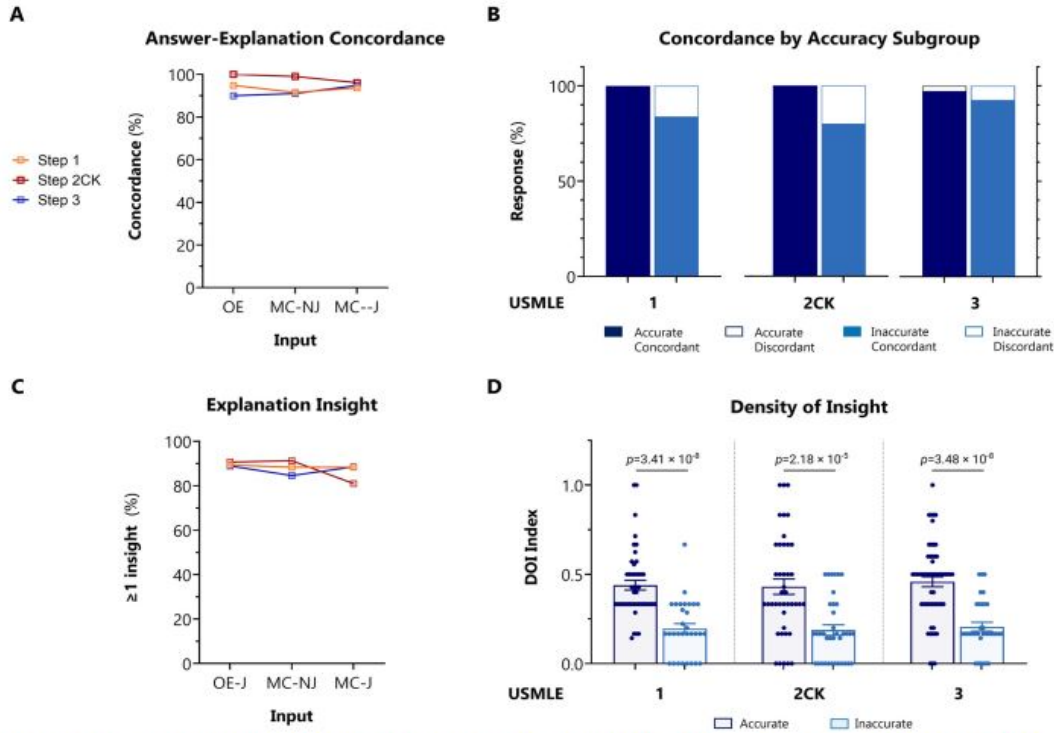


Fig 3. Concordance and insight of ChatGPT on USMLE. For USMLE Steps 1, 2CK, and 3, AI outputs were adjudicated on concordance and density of insight (DOI) based on the ACI scoring system provided in [S2 Data](#). **A:** Overall concordance across all exam types and question encoding formats. **B:** Concordance rates stratified between accurate vs inaccurate outputs, across all exam types and question encoding formats. $p < 0.001$ for accurate vs inaccurate outputs by Fisher exact test. **C:** Overall insight prevalence, defined as proportion of outputs with ≥ 1 insight, across all exams for questions encoded in MC-J format. **D:** DOI stratified between accurate vs inaccurate outputs, across all exam types for questions encoded in MC-J format. Horizontal line indicates the mean. p -value determined by parametric 2-way ANOVA testing with Benjamini-Krieger-Yekutieli (BKY) *post hoc* to control for false discovery rate.

activier
Accédez à C,

De Leon L, Elepaño C, et al. 2023).

Sticking to one of the main objectives of this study (a Patients' Education Information and Guidance Providing System designed in the form of a partially generative audio feedbacks coupled with some simplified visual illustrations in both local and official languages) which seeks to explore and design an interactive and generative audio feedback system, we can borrow a lot from the gaming industry. We have seen an overall betterment of gaming experiences these last decades and specially these last years with the design of generative and interactive dialog models that are specifically set up for educating gamers in understanding and mastering related instructions, jargons, plots, characters and a bunch of gaming strategies. From the human-machine interaction perspective, the tedious task involved has been alleviated thanks to the development of tailored AI-powered toolkit designed for generating written dialogs (Daniel C. Howe 2020). The challenge in this study is to replicate such a model in the form of low-connectivity and low-cost generative audio systems to educate patients at improving their accessibility to digital healthcare in LMICs.

As the system we sort to design is going to be partly generative but coupled with simplified visual illustrations in both local and official languages, there is going to be a crucial need of making use of AI-generated characters (animated avatars in the special case of our design) that maybe more cost-effective and less-computing power consuming. Apart from the cited paper here with examples of the use of identities of famous scientists as main characters (see figure below extracted from the cited paper).

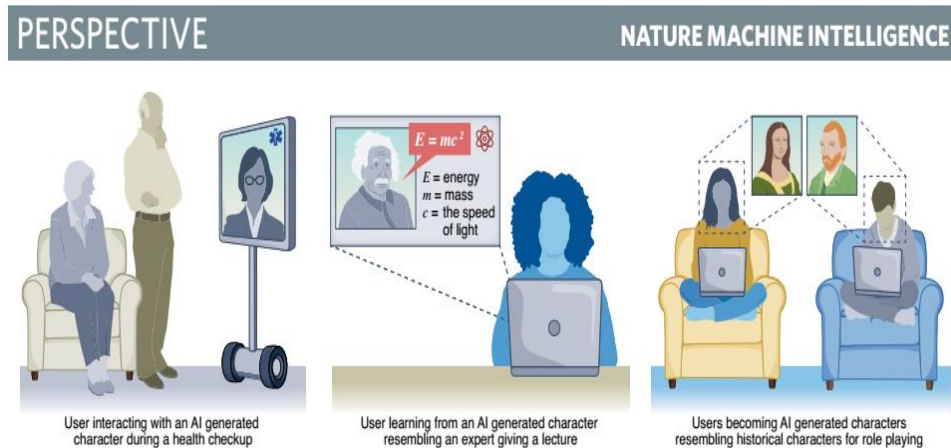


Fig. 1 | Example applications of AI-generated characters that resemble contemporary and historical figures. Users are shown interacting with an AI-generated character during a health check (left), learning from an AI-generated character resembling an expert in a lecture (middle) and becoming AI-generated characters that resemble historical characters for role playing (right).

This approach is going to be quite useful in reaching the goal of providing personalized and specially tailored scientific vulgarizations. This inclination of research and development to the AI branch of generated characters for the purpose of educational activities, is the best indication that there are more to come up with, it in terms of innovations (Pat Pataranutaporn, Valdemar Danry, Jeonne Leong, et al. 2021). The cited study presents in the figure below, the schematic diagram of how AI-generated characters can be designed in a way that resembles humanoid robots, CGI/VFX characters in films and 3D characters in games.

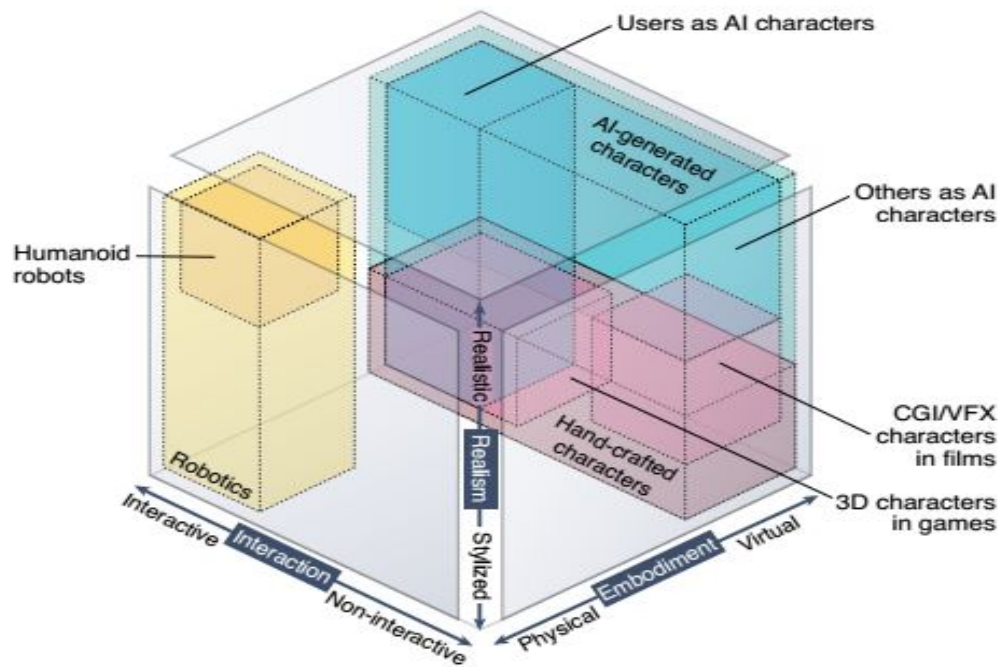


Fig. 2 | AI-generated characters as a domain can be characterized along three axes: realism, embodiment and interactivity. Within these axes, AI-generated characters can be compared with other domains, such as humanoid robots, CGI/VFX characters in films, and 3D-characters in games.

6.2 Multimedia Animations.

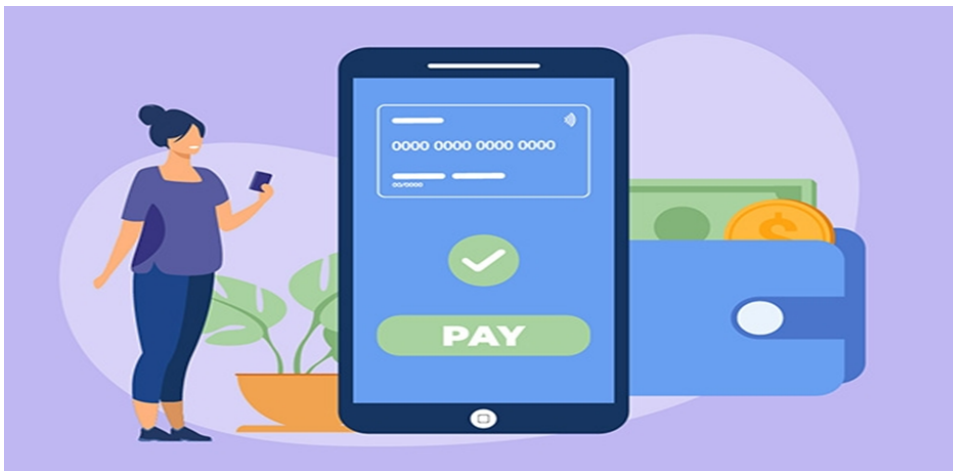
Culture and language barrier among people living in low-middle income emerging economies has been identified as a significant challenge in patients' comprehending their various health issues, inevitably influencing treatment outcomes and follow-up (Dallimore, Asinas-Tan et al. 2017). Various tools have been implemented recently to help healthcare providers educate patients, but limitations have been met, especially as it relates to those patients with low levels of literacy (Jlala, French et al. 2010). A way to tackle this is by implementing multimedia animations which can very easily describe various diseases, to adequately improve patients' knowledge and awareness. This is in part similar to the audio-visual system suggested above.

To implement this solution,

- i. Animations would be created to explain specific procedures, maybe starting out with one disease pathology at a time. E.g., Appendectomy.
- ii. Create universally available short videos i.e., web access guaranteed.
- iii. A designated website to serve as the platform.
- iv. Contents should be generally appropriate for all ages.
- v. Ensuring use of latest content with little to no medical jargons.
- vi. Use of local languages and closed captions.
- vii. Absolute adherence to local protocols and evidence-based content.

6.3 Help patients pay faster and in full.

Price and payments are some of the biggest factors that affect patient satisfaction. While you may not be able to lower your costs, you can make patient payments more accessible. This allows patients to conveniently pay their fees anyw. here, anytimePatients with ongoing treatment can set up automatic payments and those who see you for one-time services have the choice to pay with a credit or debit card in addition to cash and checks. These payment practices are very familiar to your patients; they're tools patients use every day in other aspects of their lives. When patients have the option to pay for medical bills in the same manner, they're more likely to pay quickly and in full, increasing patient satisfaction and practice revenue.



6.3.1 Decrease billing mistakes



Billing mistakes don't benefit anyone involved in treatment, yet for most organizations, they're a common occurrence. These issues slow down your revenue cycle and can lead to lost profits. They're also a stressor for patients.

If it's become the norm to see your staff discussing billing mistakes with patients, it's time to try a new approach. Implement an eligibility and claims management process that creates a satisfactory experience for all. Make it easy for billers to input patient information and track claims. Eliminate the need for your staff to sift through paperwork and the risk that patients' bills go unpaid by their payers.

This will result in higher patient satisfaction and engagement, a more motivated staff and a healthier revenue cycle.

6.3.2 Prepare for price shopping

One-third of healthcare consumers used the internet or mobile apps during the past year to compare the quality and cost of medical services. They price shopped before seeking treatment, a trend that will continue to rise in the coming years.

Providers need to prepare for this now by improving pricing transparency, strengthening their organization's brand and increasing patient satisfaction. They need to put a bigger emphasis on value-based care and comprehensive treatment.

These are the details potential patients look for when comparing provider reviews. They keep current patients coming back and new patients coming in to begin treatment. Thinking long-term, an early adjustment to price shopping can mean significant rewards for your organization.

6.4 Start improving patient satisfaction today.



At the end of the day, all the functions of your organization should be rooted in one purpose: serving your patients. If you fail to meet their expectations, revenue performance will be one of the first things to feel the consequences. However, put the above tips to work to make sure your organization is performing well across the board and watch how patient satisfaction skyrockets and how your entire organization benefits.

6.5 Combating Ageism

Gerontechnology, an inter-disciplinary field that helps in matching digital health to various older adults, based on their individual needs, can help fill the knowledge gaps in the appropriate, ethical and effective implementation of digital healthcare services among older adults (Hua 2018). Although the feasibility of this method needs to be assessed in emerging economies, but if properly adapted, in combination with the other solutions proposed above, such as availability in local languages, then it might indeed help get the older adults in emerging economies more conversant with technology.

Another way of combating ageism is appropriate inclusion of older adults in research studies, especially in emerging economies, to get adequate representation. Eligibility criteria can be broadened to include older adults.

6.6 On-the-Job Training for Healthcare Providers

A curriculum was developed recently in Germany termed “Digitalization in medicine”. It is a structured blended-learning on-the-job training defined specifically for practicing physicians to expose them to digital transformation. As already established, digital transformation as it relates to medicine is a process of change that besides reshaping the technologies that are used to work and interact with patients, also reshapes the way healthcare professionals achieve this.

In emerging economies, implementing such a curriculum will significantly improve healthcare, not only will the healthcare providers feel more competent and confident, but the patients will have more treatment options, and more trust in the healthcare system.

The curriculum proposed will look a lot like the one used originally in the study by (Bosch et al. 2022) displayed below. It is quite simple and straightforward with six modules including:

- Important principles and definitions
- Telematics infrastructure,

- Digital tools,
- Artificial Intelligence and big data,
- Ethics in digitalization,
- Physicians and patients.

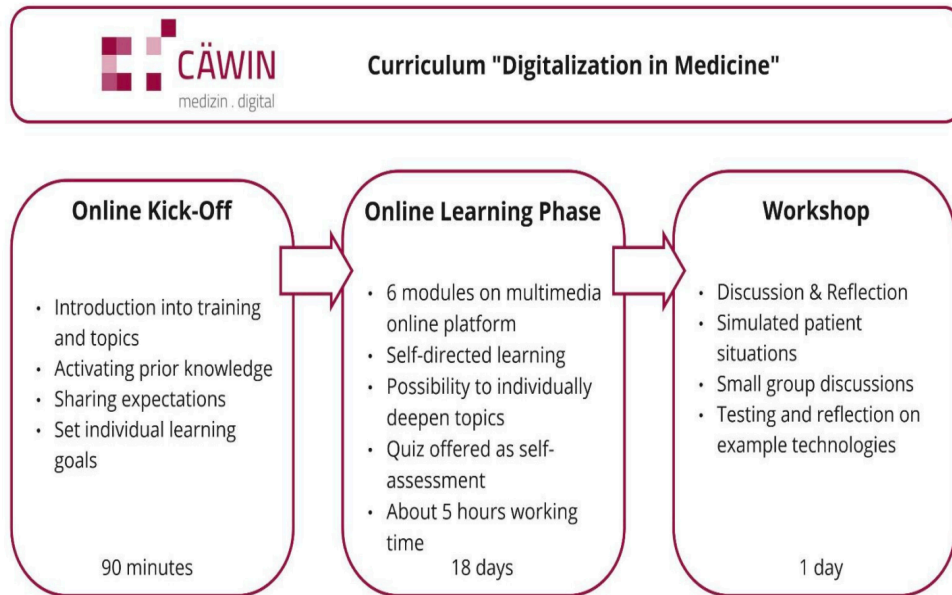


Figure 1. The three parts of the training "Digitalization in Medicine".

We propose not only building a curriculum like this, but presenting it totally free of charge, on a well-established platform as a Continuing Medical Education (CME) course and presenting a certificate of completion upon completing this course. This would make it even more attractive to practitioners in emerging economies.

7. Case Studies and feasibility assessment

7.1 Digital Health care scientific communications: Educating patients and the caregivers the importance of health literacy through different forms of communication

Public health professionals, healthcare providers, and their administrative staff need to communicate clearly with the public, with patients, and with each other. Using your intended audience's preferred communication channels to share public health information is a health literacy best practice. However, preferred communication channels may be disrupted and inaccessible during and after natural disasters, including but not limited to earthquakes, floods, and hurricanes.

A study by Gandhi et al. (2022) found that most participants had limited knowledge about mold-related illnesses and mold cleanup recommendations after Hurricane Harvey—potentially due to message dissemination channels. Most study participants were 60 years and older and preferred to receive information about mold through in-person outreach, radio and TV announcements, printed flyers distributed at local venues and by mail, and phone calls. The authors noted that these preferred communication channels contrast with reports that social media was widely used to share information after Hurricane Harvey. Participants also faced technical difficulties accessing health information because many participants lacked reliable internet and phone service. The authors:

- Noted that communication preferences may also vary by population factors such as income, race/ethnicity, and education.
- Recommended that messaging should use plain language and be tailored towards specific groups, especially during a disaster.
- Suggested using traditional (e.g., radio, in-person, written materials) and contemporary channels (e.g., social media and internet) to reach a greater range of people after natural disasters.

To help more people understand and wade through the huge volume of information coming from different sources, including information about risk and how to cope the health professionals need to effectively communicate with the public through well-known social media platforms and make sure that a vast number of people get to know about the

information. In the case of language barriers translators need to be on the frontline to help with the translation and make sure that people have a better understanding of the information. Other cases like people from the remote areas where they have less privileges to everything volunteers are always called upon to communicate the information with efficiency.

For instance, at the beginning of COVID –19 pandemic the researchers came together, recruited other subject matter experts, and launched a pandemic-related website with social media presence, they were educating people about the risks of the virus and how to cope during that time.



The picture above clearly communicates the preventive ways of COVID-19. By looking at the pictogram you can easily tell what each picture represents, this was one of the ways that the health professionals communicated. Also, this way of communication doesn't need much translation, it's the easiest way of communication.

Recent shifts in the delivery of care—including specialization and fragmentation of care, an emphasis on self-management, and complex financing and coverage requirements—have placed additional demands on patients to be informed and proactive about their health. Many factors in the current health care system contribute to limited health literacy, including:

- Lack of coordination among health care providers
- Confusing forms and instructions
- Limited use of multimedia to convey information

- Insufficient time and incentives for patient education
- Differences in language and cultural preferences and expectations between doctors and patients
- Overuse of medical and technical terms to explain vital information

In recent years, the National Board of Medical Examiners has added a 1-day clinical skills exam for all medical students that includes an assessment of communication and interpersonal skills. Currently, the clinical skills test does not address how limited health literacy affects interactions with patients. Because health literacy is a relatively new clinical concept, most health care professionals already in practice have not had formal training in improving communication skills; although a growing number of continuing medical education courses in health literacy are available. The American Medical Association, the HHS Health Resources and Services Administration, the Centers for Disease Control and Prevention (CDC), and the Medical Library Association, for example, have low or no-cost training available for professionals who provide health services. (Office of the Surgeon General (US) 2006).

In addition, more must be done to meet the needs of people whose primary language is not English or who have a disability that affects their communication skills. Forty-seven million people in the United States over age 5 speak a language other than English at home, and 21 million adults have LEP. (Office of the Surgeon General (US) 2006)

- **Why is communication important in health care?**

Healthcare leaders understand that effective communication in healthcare organizations starts with recognizing the importance of listening to one another. Skillful communication is essential to health care. Clear, honest communication between patient and provider paves the way for accurate diagnoses and treatment decisions. Similarly, clear, confidential communication between members of a care team (which often includes patients and multiple providers) results in swiftly and ethically delivered care without breaching confidentiality. Providers can help patients feel heard, ease their fears, and encourage them to disclose relevant information. For example, a patient who feels embarrassed about a

pubic rash will likely feel safer mentioning this to a provider who they know will treat them with compassion and a professional demeanor.

In addition, every person deserves to understand the medical care they receive. That means that healthcare organizations may need to do better to train and hire interpreters so that patients can give their informed consent to treatment.

- **Strategies for effective communication in health care**

Effective communication in health care can make a life-or-death difference. Health administrators and other healthcare professionals can benefit from learning more about types of communication in health care, barriers to communication in health care, and evidence-based strategies for effective communication in health care today.

- i. Patients need to feel safe enough to communicate honestly and openly with their care providers to receive effective treatments.
- ii. Providers need to convey treatment plans and health education clearly, accessibly, and empathetically so that patients can receive optimal care.
- iii. Administrators and providers need to share information ethically and responsibly to protect patient confidentiality.
- iv. Healthcare organizations need to apply culturally responsive measures to bridge communication gaps between stakeholders.



7.2 Multimedia animation use in presurgical patients

Schnitman and colleagues (Schnitman, Gomes et al. 2022) conducted a pilot study to assess the feasibility of guiding surgical patients with preoperative digital animations presented in the local language of the study population. They utilized a 3-item questionnaire to reflect the acceptability of this tool by the patients. The survey was conducted online via the same website built for this preoperative digital animation. The study population included patients preparing for two urgent surgical procedures: appendicectomy and cholecystectomy. The survey was presented as a prompt following the animation visualization, and the answers directly stored on a secure online database only visible to the main researcher as an anonymous dataset.

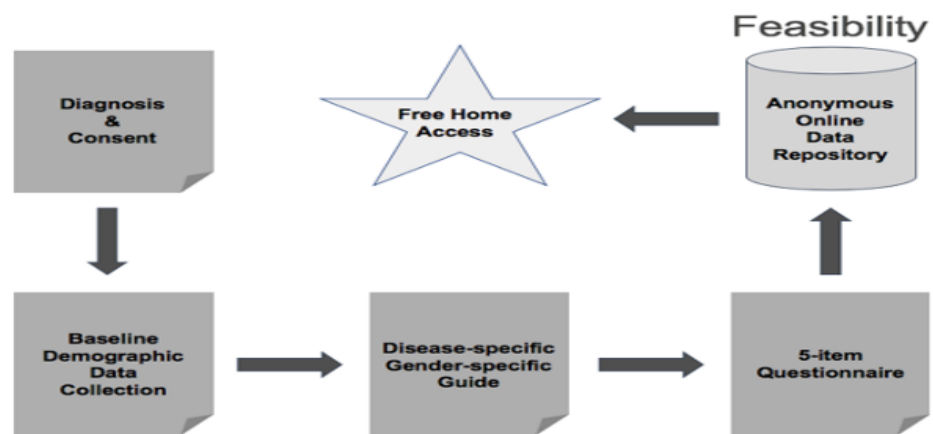
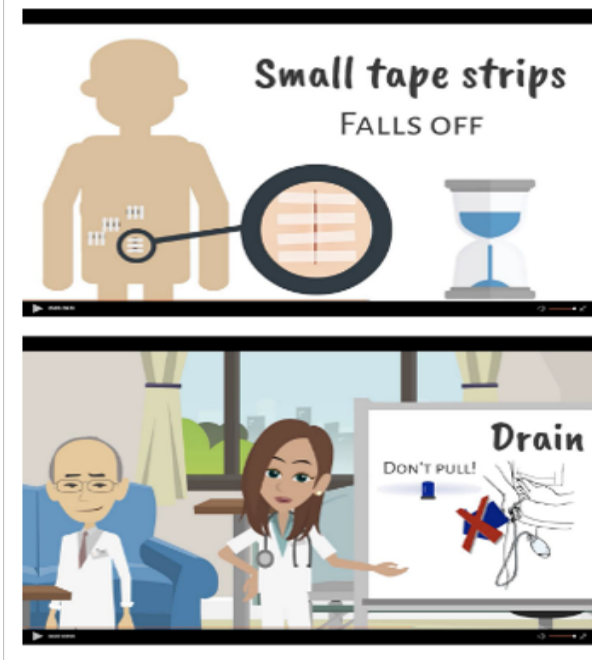


Fig. 1. Study steps.

They reported an acceptability rate of 76.5%, indicating a strong feasibility and acceptance of this tool.

Appendix A2. Still images of animations





G. Schnitman *et al.*



However, a significant limitation to this tool's feasibility noted by the health practitioners and the participants was internet connectivity, which remains a significant barrier in emerging economies.

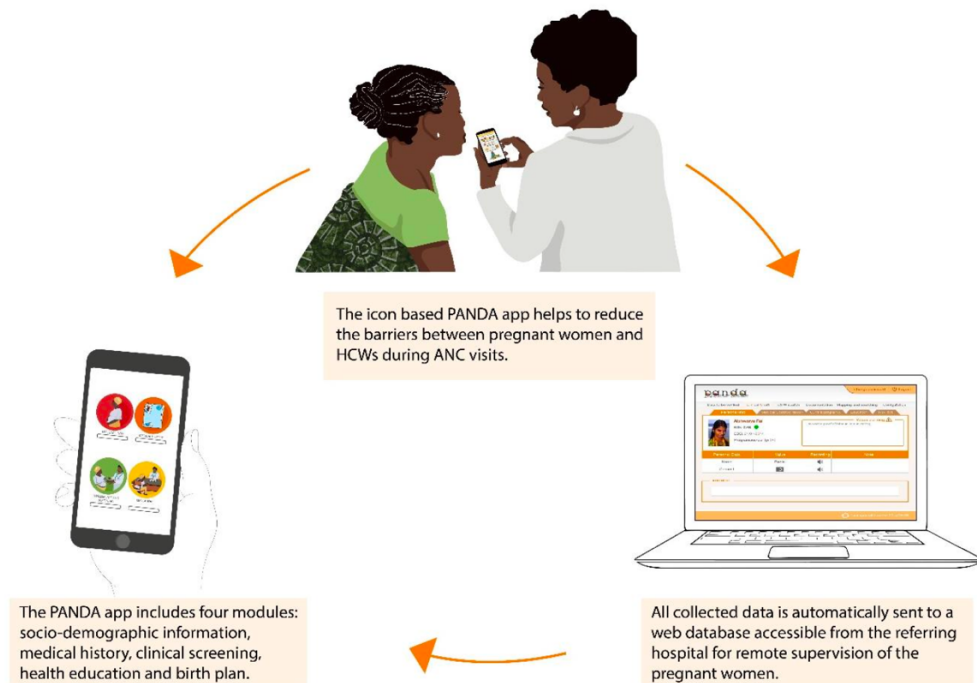


Figure 1. The PANDA system structure.

A study testing the use of mHealth in improving antenatal care, reported the rate of healthcare workers acceptability in Tanzania. The system works as depicted above and in cases of bad internet connectivity, also works offline to provide continuous access. It automatically syncs up to the internet once connectivity is restored. (PANDA- Pregnancy and Newborn Diagnostic Assessment, HCWs- Healthcare Workers, ANC- Antenatal care, mHealth- Mobile Health) (Paduano et al. 2022).

The report concluded that all participants, including patients and healthcare workers declared that the PANDA icons helped them in understanding and remembering the provided information, that the PANDA app significantly improved access of pregnant women to healthcare, and generally improved antenatal care (ANC). Healthcare workers themselves also reported that the app was “easy-to-use” and “able to improve the adherence to ANC WHO recommendations”.

7.3 Empowerment for Digital Transformation.

Bosch (Bosch et al. 2022) and colleagues reported in their cross-sectional analysis that followed the digitalization of medicine curriculum, that beside the attitudes of participants becoming a bit more encouraging, they had more empowered mindsets, and lesser insecurity when it comes to technological, legal and ethical consideration of the digital transformation, preparedness for this transformation is still quite low.

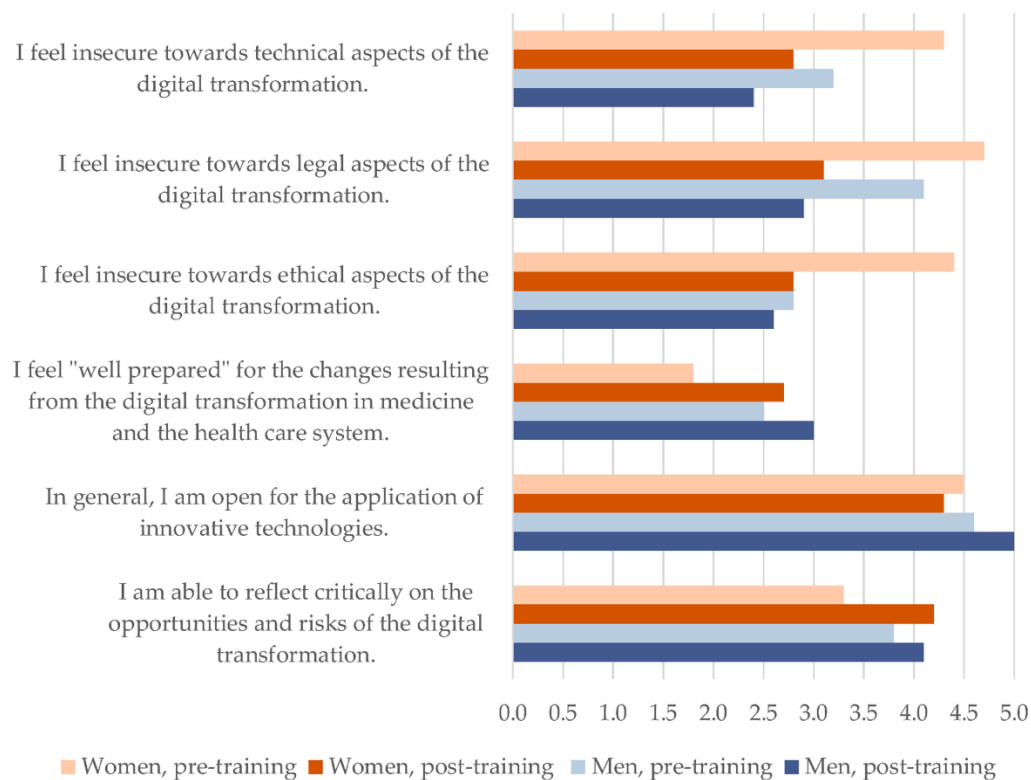


Figure 3. Self-evaluated attitudes regarding physicians' empowerment for the digital transformation pre-training vs. post-training for $n = 32$ participants compared for gender.

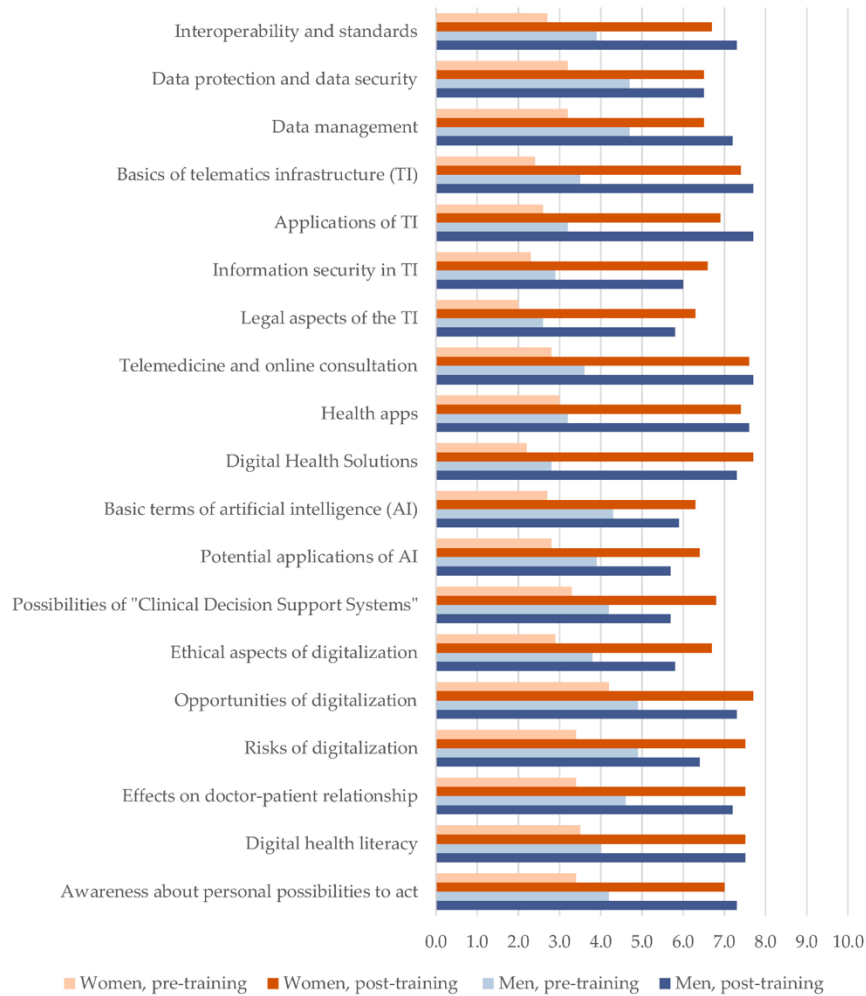


Figure 2. Physicians’ self-evaluated knowledge about central content domains of the digital transformation, pre-training vs. post-training for $n = 32$ participants compared for gender.

They, however, concluded that the curriculum indeed had significant effects on the knowledge and attitudes of the participants, although more needs to be done to further empower and support the system.

Table 5 Barriers and facilitators to implement synchronous and asynchronous E-learning activities

Domain	Themes	Related E-learning format	Description	Predefined themes
Barriers	Matching the supply and demand	Asynchronous and synchronous	Some TB health workers complained that the training materials in synchronous sessions were too difficult to learn, while some sessions were not related to their daily practices	No
	Organizational coordination	Asynchronous and synchronous	Leaders paid relatively little attention to the capacity-building subprojects, so they could not mobilize adequate resources they needed	Yes
		Synchronous	No coordinating mechanism for TB training; the CDCs and TB designated hospitals worked separately	No
	Internet technology	Synchronous	1. Professional remote equipment with a special remote centre was only available in a few provincial hospitals. Most institutions only have limited space for synchronous training. 2. The synchronous learning sessions still required all participants to join the virtual classroom at the same time, which often conflicted with their schedule	Yes
		Asynchronous and synchronous	1. Technical issues: slow processing speed of E-learning platform, network jams, system errors, fuzzy sound and blurry videos. 2. Barriers in teacher-student communications	Yes
	Motivations	Asynchronous and synchronous	(1) The lack of motivation among TB health workers due to the incentive mechanism, both extrinsic (low income) and intrinsic (lack of work motivation). (2) The incentive mechanism caused a vicious circle: low salary could only attract people with limited learning capacities and digital literacy, which further hinder them learning. (3) Still rely on external incentives such as continuing medical education credits or rules, but neither of them works very well	Yes
	Sustainability	Asynchronous and synchronous	The capacity to mobilize resources of the training organizers was very limited, which make it difficult to continue the training after the program. In addition, the platform could not charge to sustain itself due to the existing rules	Yes
Facilitators	Training format	Asynchronous and synchronous	E-learning have expanded access to high-quality continuing medical educational resources, timesaving, and reduced its costs	Yes
	Training content	Synchronous	Provincial and city-level TB health workers preferred the knowledge about disciplinary frontiers in synchronous E-learning activities	Yes
		Asynchronous	County-level TB health workers favoured sections about routine clinical practice in asynchronous E-learning activities	Yes

Note: Data source: Key informant interviews and FGDs

Wang et al (Wang et al. 2021) conducted a study to measure E-learning CME program implementations, analyse the facilitators and barriers during utilization and provide policy recommendations. The study population here were tuberculosis health workers in three provinces in China.

The main barriers identified in this study are described above in Table 5.

Table 6 Supply and demand of training among tuberculosis (TB) health workers. Data source: TB health worker survey (first quarter in 2017 and third quarter in 2019)

Type of TB health workers	Training demand		Training supply		Matching
	Sample size	Top three most mentioned (%)	Sample size	Top three most mentioned (%)	
Doctors	97	Treatment for MDR-TB (83.5)	136	Treatment for common TB (90.4)	Yes
		TB radiology (78.4)		TB radiology (85.3)	Yes
		Treatment for common TB (70.1)		Treatment for common TB (85.3)	Yes
Public health physicians	65	TB planning (73.4%)	49	TB planning (91.8)	Yes
		TB infection control (76.2)		TB management (89.8)	No
		TB surveillance (63.1%)		Treatment of common TB (75.5%)	No
Primary care workers	267	Treatment for common TB (79.8)	164	Treatment for common TB (90.2)	Yes
		Treatment for MDR-TB (70.4)		TB case detection (72.6)	No
		TB management (66.7%)		TB management (83.5)	Yes

MDR-TB Multidrug resistant tuberculosis

The study found that the key facilitators to E-learning CME activities were training content and format.

They concluded that it is indeed feasible to conduct such large-scale E-learning CME activities in the three provinces.(Wang et al. 2021)

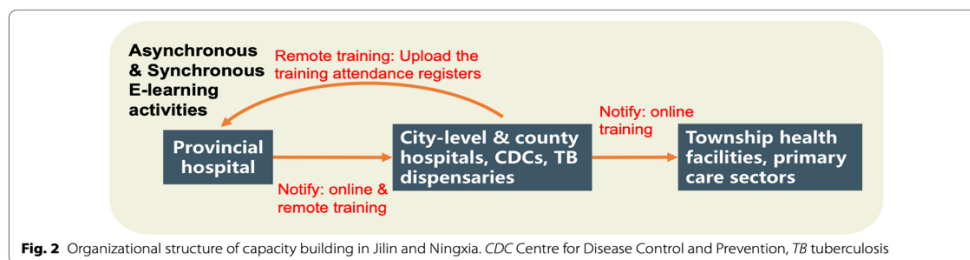
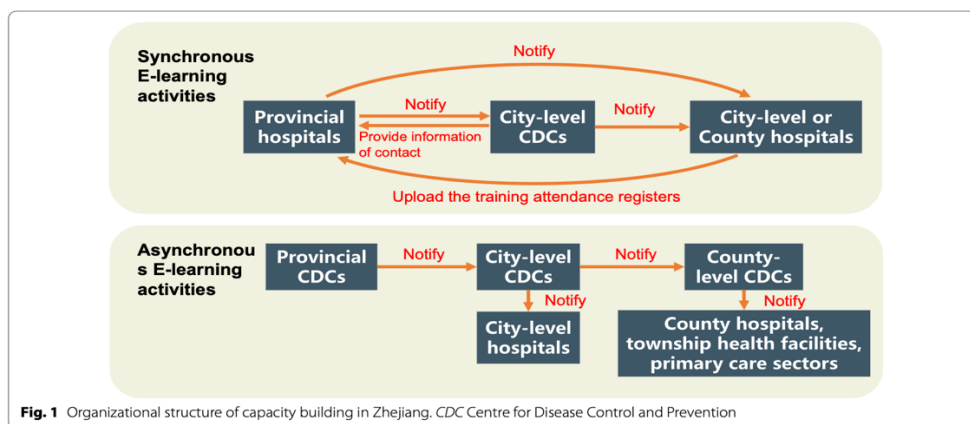


Fig. 1 and Fig. 2 above refers to the E-learning format that was employed in the implementation process. Source (Wang et al. 2021).

8. Conclusion

We have covered the condition, development, and landscape of the field of research on digital transformation in healthcare in this article. We've discovered that less research than one might anticipate is being done on the digital revolution of the healthcare industry. High costs and a lack of finance for such projects on a national and worldwide level. Internet access issues in rural locations and communication barriers with illiterate populations. a lack of cultural acceptance of technology use, particularly among women by failing to match their functionality and user experience with what customers want and need, hospital apps are failing to engage patients. Customers desire constant access to goods and services as part of their overall shopping experience, and those who are dissatisfied with a provider's mobile services - or lack thereof - may search for other providers. Concerns about patient data security high maintenance and capital cost requirements.

Healthcare executives are aware that listening to one another is the first step in effective communication in healthcare businesses. Health care requires effective communication. Accurate diagnosis and treatment choices are made possible through open, honest communication between the patient and the practitioner. Similar to this, effective, confidential communication within a care team—which frequently consists of patients and various providers—enables prompt, ethical care delivery without jeopardizing confidentiality. Patients can be made to feel heard by providers, who can also allay their worries and persuade them to divulge pertinent information. It has been observed that demographic factors including income, race/ethnicity, and education may also affect communication preferences.

It is advised that communication uses straightforward language and is adapted to particular populations, particularly after a disaster.

We suggested using both conventional (such as radio, in-person, written materials) and modern (such as social media and the internet) methods to reach a wider spectrum of people in the wake of natural catastrophes.

Health professionals must effectively communicate with the public through well-known social media platforms and ensure that a sizable number of people are made aware of the information in order to help more people understand and navigate the enormous volume of information coming from various sources, including information about risk and how to cope. Translation services must be available when there are linguistic barriers.

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