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EDITORIAL

Near-Term Digital Health Future Predictions: A Glimpse Into Tomorrow's AI-Driven Healthcare

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Abstract

Healthcare is rapidly evolving, particularly in the realm of digital health. When we consider the future of digital healthcare, it is impossible to ignore the vast potential of artificial intelligence (AI) and the profound impact it will have on the healthcare industry. This momentum of change has accelerated, particularly since the onset of the COVID-19 pandemic, and is largely attributable to workforce shortages and an increased demand for healthcare services. These circumstances have given rise to a unique scenario, compelling healthcare to harness AI for various applications.

The integration of AI in healthcare necessitates a comprehensive and rigorous approach to ensure accuracy and safety, acknowledging the inherent risks to patient care and safety when used improperly. When implementing care models that rely on AI for decision-making, it is imperative to establish meticulous workflows that emphasize human guidance in model development and allow models to adapt and learn from input data. In addition to prioritizing accuracy and safety, equal emphasis should be placed on the implementation of robust measures to protect patients from potential cybersecurity threats posed by data breaches.

AI's advantages extend beyond healthcare institutions, as patients will also experience a transformation in the way they receive care. Harnessing AI will empower patients to establish stronger connections with their health data and gain access to unique insights that are not readily available in traditional care models. These enhanced connections will enable patients to collaborate more effectively with their healthcare teams and receive care that is tailored to their specific needs.

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Calvin D. Lawrence, MSc

Digital health is rapidly evolving, and recent advancements indicate that it will continue transforming the healthcare landscape. Integrating artificial intelligence (AI) and machine learning in healthcare systems has improved patient care and made healthcare more accessible and efficient. When leveraged responsibly and transparently, AI holds the near-term promise to provide

innovative solutions once thought to be permanent disabilities and incurable diseases.

Here are five trends and developments shaping the near-term future of digital health.

Wearable AI-infused Tech

Wearable tech will become more sophisticated and capable of continuously monitoring vital signs, blood glucose levels, and more. Currently, scanning devices such as heart monitors capture data for a brief time. Then, the device owner retrieves the data and passes it along to a cardiologist for review. But in the short term, these devices will provide patients and healthcare providers with real-time data, enabling proactive interventions and better disease management.

AI-powered Diagnostics

AI-powered tools will analyze medical images, such as X-rays and magnetic resonance imaging (MRI), with incredible accuracy, aiding the early detection of diseases. In addition, these technologies will assist healthcare professionals in making more personalized treatment recommendations based on the patient's medical history and real-time analysis of bodily functions.

Digital Therapeutics

As regulations catch up with technology, we expect an increase in prescription-based digital therapeutics, providing patients with accessible and effective treatment options.

Blockchain and AI for Health Data Security

When using powerful technologies such as generative AI in healthcare, large amounts of personal data are paramount in training the models. Protecting these health data is critically important, and blockchain technology is emerging as a powerful solution. Blockchain ensures the security and integrity of medical records, giving patients greater control over their data. This technology will safeguard sensitive health information while facilitating secure data sharing among healthcare providers.

Personalize Digital Healthcare Journey

Advances in genomics and data analytics will drive the growth of personalized medicine. By analyzing an individual's genetic makeup and medical history, doctors can tailor specific treatments and medications to each patient's unique genetic profile. This approach promises more effective treatments, fewer side effects, and improved patient outcomes.

I might add that genetic profiling does not equate to making healthcare decisions based on one's race or ethnicity. The social concept of race often shapes human experiences. However, race has no genetic basis.[1]

The impact of AI on the near-term future of digital health is exciting and promising. Among the key trends shaping the healthcare landscape are wearable technology, diagnostics, digital therapeutics, blockchain security, and personalized medicine. As these technologies mature and integrate into mainstream healthcare systems, patients can look forward to more accessible, efficient, and customized healthcare services. Digital health leveraging AI is set to enhance the quality of care, improve patient outcomes, and revolutionize how we approach healthcare.

Seth Dobrin, PhD

Generative AI offers significant opportunities to advance telehealth in various domains, including conversational AI, content discovery, content creation, and simulation.

Let us explore each area with telehealth-focused examples.

Conversational AI

Generative AI can revolutionize telehealth interactions by creating lifelike virtual healthcare assistants. For example, a generative AI-powered chatbot can engage in natural language conversations with patients, collecting symptoms and medical history while providing initial triage advice. This enables scalable and personalized telehealth support, ensuring timely remote access to healthcare expertise.

Content Discovery

Generative AI can enhance content discovery in telehealth by analyzing patient preferences and generating tailored recommendations. For instance, a generative AI algorithm can examine a patient's health profile, search patterns, and medical history to offer personalized suggestions for relevant articles, research papers, or educational resources. This assists healthcare providers in staying informed and making evidence-based decisions.

Content Creation

Generative AI can assist in generating telehealth-specific content, such as patient education materials. For instance, it can create visually appealing infographics or instructional videos that explain medical conditions, treatment options, or self-care practices. This streamlines the development of engaging and informative content, empowering patients to understand their health better and make informed decisions.

Simulation

Generative AI-driven simulation can facilitate immersive training and scenario modeling for telehealth practitioners. For example, it can simulate virtual patient

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consultations that mimic real-world scenarios, allowing healthcare professionals to practice telemedicine skills, improve communication, and refine diagnostic abilities. This helps build confidence and expertise in delivering high-quality care remotely.

These telehealth-focused applications of generative AI in conversational AI, content discovery, content creation, and simulation highlight the potential for transformative advancements in the field. By harnessing the power of generative AI, telehealth can become more efficient, personalized, and accessible, ultimately improving patient outcomes and expanding the reach of quality healthcare services.

However, implementing generative AI in telehealth content creation has limitations and challenges. Ensuring the accuracy and reliability of generated content is crucial, requiring rigorous validation and quality assurance processes to align with medical guidelines. Ethical and legal considerations must be addressed, focusing on protecting patient privacy and data security. Building and maintaining a robust knowledge base that covers various medical conditions and keeping it up-to-date requires ongoing effort. Generative AI algorithms must also understand contextual nuances and patient variability to tailor content effectively. Additionally, user experience and engagement should be prioritized to deliver engaging, user-friendly, and easily understandable content. Overcoming these challenges requires technical expertise, domain knowledge, and continuous evaluation to optimize the use of generative AI in telehealth content creation while ensuring accuracy, reliability, and patient-centricity.

William Cherniak, MD, MPH, CCFP(EM), DABFM

In the last year, AI and large language modules (LLMs) exploded across healthcare as quickly as the rapid adoption of telehealth at the beginning of the COVID-19 pandemic. The challenge with these tools is to ensure that their byproducts are safe, compliant with the Health Insurance Portability and Accountability Act of 1996 (HIPAA), and unbiased and factual.

Rapid iterations of healthcare-specific AI tools will plug into digital technology in the next two to three years. Rather than replacing an MD with an AI that can pass the United States Medical Licensing Examination (USMLE), these tools will aggregate and present data with the most up-to-date literature and guidelines for clinicians to choose from. These will likely be mapped to already validated healthcare decision trees and/or algorithmic guidelines, with eventual articles published to support utilization and FDA approval required in the way that a pharmaceutical is today. The tools will adapt and evolve so quickly that they make it possible to engage with patients visually and verbally without clinician oversight. However, this requires much further evidence and testing before roll-out.

Fernando De La Peña Llaca, PhD, MSc

Seconds matter when a physician tries to save a life, which can go from an emergency to an early diagnostic. One of the main challenges is getting the physician on-site during an emergency—or at least the essence of the physician, if not a physical body. Technologies in development, such as holographic teleportation, can make this possible. This novel advance is a type of capture technology that allows users to see, hear, and interact with remote participants in 3D as if they are in the same physical space.[2]

The doctor may appear as a three-dimensional live hologram rather than be in the patient's physical presence. This holo-doc will gather important data about the patient, the most crucial part of a diagnostic being the medical history, which reportedly determines 83% of the diagnoses in medical outpatients.[3]

In addition, new devices such as U-scan—a scanner attached to the toilet bowl—will provide a metabolic tracker to monitor pH, ketone, and vitamin levels, as well as hormone and ovulation cycles,[4] valuable information the physician will use to make the correct diagnosis remotely. Holo-docs will gather information in their medical office and interact with the patient using their volumetric representation—saving precious time. This technology also provides haptics, which allows the surgeon to touch the patient instead of only interacting with a holographic representation.

Holographic teleportation has been used in the International Space Station since 2021. A priority for using this technology is to provide medical treatment.[5] However, a trip to Mars offers significant challenges because the communication delay ranges from 8 to 16 minutes for one-way communication and 16 to 32 minutes for two-way communication. In other words, an astronaut on Mars can call, "Houston, I'm bleeding." Once the information reaches Houston, the surgeon and the doctor will ask the patient, "From where?" By then, it might be too late to save the patient! This is why combining AI with holographic teleportation can create a physician's assistant driven by AI.

Generative Pre-trained Transformer is an AI language model in the form of a generative pre-trained transformer that can interact with users conversationally.[6] Certainly, the physician's role, experience, and intuition may never be substituted; however, this holographic assistant doctor can gather vital information to complete the medical history and provide the first steps to treat the astronaut. Meanwhile, the "real" doctor on Earth provides the next steps to heal the crew member with the information previously collected by the AI. From the astronaut's perspective, the crew members will always interact with a

holographic doctor. However, astronauts will never notice the difference between the human and the AI providing instructions to act as fast as possible, as the transition from the AI to the human doctor will be smooth. The same technology applied here on Earth will benefit everyone as the AI and the Holo-Doc act as first responders and trigger an alert to the physician to continue the treatment in person or as a hologram.

Jefferson Fernandes, MD, MSc, PhD, MBA

In the near future, doctors and nurses will be able to reduce their stress levels while spending more time with their patients or attending to more patients. This will be accomplished by expanding the automation of repetitive administrative and clinical processes with the aid of AI. With Natural Language Processing, a machine learning technology that allows computers to interpret, manipulate, and comprehend human language, there will be a significant reduction in the number of clicks these professionals must make during their workdays.

The continuity of healthcare for people will be more effective as it will be more often performed in their homes, with devices for detecting biological signals and with remote monitoring of patients. The hybrid modality will prevail, especially for patients who need management of their chronic diseases.

The market will embrace digital innovations in healthcare as long as the proposed solutions provide clear evidence that they deliver what they promise.

Aditi U. Joshi, MD

Over time, telehealth has expanded and then contracted, leading to incorrect assumptions about the momentum of virtual care and digital health. Today, telehealth is positioned to grow in the near term as virtual care continues to be used in direct-to-consumer models. The new utility for obesity medicine, such as GLP-1 agonist prescriptions, is proof of that.

Any consideration of telehealth in the near future (next six months) must include four considerations. These are my predictions.

First, virtual care offerings will become so common that they will not be recognized as a telehealth option. For example, some obesity medicine and chronic care management use chat telehealth. However, it is only sometimes recognized as telehealth. This is a good sign of telehealth's integration into healthcare, although it makes us forget that telehealth is still a form of growing virtual care options.

Second, RPM (remote patient monitoring) and RTM (remote therapeutic monitoring) are and will continue to be used as adjuncts to aid in improving virtual care visits. To this end, there are now more data, research guides, and information on practical utility to support this growth. Part of my work has been evaluating digital health products in relation to clinical evidence, and we are seeing some of the most significant gains in this space. I predict we will continue to do so.

Next, a note on AI. This buzziest of buzzwords will slow down with the clinical rigor required to be used in clinical spaces. This is a natural progression, one we have seen with telehealth and RPM, and I suspect the same with AI. It will, however, take less time to understand and create guidelines. The practice with the above two has set a pathway.

Finally, there will be more mergers or direct-to-consumer virtual care offerings by big tech companies, larger entities, health systems, and pharmaceuticals. Reimbursement today does not always support young companies. But, there is still plenty of innovation that a larger company can benefit from and use.

I am looking forward to seeing the next big thing in healthcare.

Bilal Naved, MD, PhD (Candidate)

AI systems will reduce gaps in access and improve the efficacy of care in resource-scarce areas. Specifically, automating triage, care navigation, and diagnostics prediction using patient-facing AI will make it easier to access the proper care, streamline care, and make self-care more straightforward.

To understand the potential, let us take a real example that Clearstep is currently implementing internationally. Imagine a patient in a small town in Nigeria is experiencing new symptoms. With no doctor nearby, the patient heads to their local pharmacy, where they use an AI chat healthcare assistant at a kiosk. The patient inputs the issues they are dealing with, and the online chat uses sophisticated expert systems and computational models to enquire about their symptoms, history, demographics, etc. The system then assesses whether the patient should be seen, and, if so, at 1) the appropriate level of care (e.g., emergency department, urgent care, telemedicine, in-person PCP [primary care physician], specialist, etc.), 2) the likely diagnostic labs, tests, or imaging the patient may need. 3) It then generates a top three to five differential diagnoses for the patient.

In this case, the patient is calculated to require blood tests and be seen by a PCP. The closest PCP is the next town over but has no availability. Instead of waiting, the system has already predicted the most likely diagnostics the patient will need, identified a nearby facility to get bloodwork, and has a virtual PCP available via the kiosk. The patient receives the required tests and then participates in a telemedicine visit the following day. The virtual PCP immediately uses the lab reports, diagnoses the patient, and prescribes needed medication.

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In the absence of this system, the patient may have had to rely on the pharmacist's judgment of the right level of care to seek. Moreover, the patient may have waited weeks to go to a lab only to be told to return to the provider. Without adding a burden to the provider's already packed schedule, this patient was able to receive the tests and care needed in a matter of days.

Overall, we predict that systems like this will emerge within the next three years to enable the automation of human tasks pertaining to triage and diagnostic resource needs and help address the small doctor-to-patient ratio in developing nations and rural America.

Geoffrey Rutledge, MD, PhD, FACMI

The COVID-19 pandemic led to a dramatic rise in the use of telehealth, including via telephone. People discovered they could get the care they needed from their doctors via remote consultation. Since then, most doctors have reverted to providing most or all their care via traditional office visits, relegating telehealth to virtual urgent care services. People who discovered they could get care from their doctor now look for easier-to-access, more effective, and less expensive telehealth solutions.

In 2024, we will see advances in five areas of patient care. First, there will be a significant rise in the less expensive "virtual-only" solutions, especially for the uninsured and underinsured and especially for the delivery of virtual primary care. Next, there will be greater recognition of virtual primary care's benefits and scope, especially when the care is delivered via synchronous video consultation. Additionally, hybrid models will be expanding that combine virtual and office-based care; those who can afford a more expensive hybrid care provider will switch to them. There will also be greater recognition that telehealth enables trusted ongoing relationships with a doctor and allows broader and more efficient access to primary care services. Finally, many experiments to evaluate the use of home-testing and home-monitoring devices will highlight the most helpful devices. Continuous glucose monitoring systems and home blood pressure monitors will be shown to be most useful and effective.

Sarah J. Bell, RN, MSN, MHA

A consensus is emerging that the next two to three years will bear witness to significant leaps forward in the digital health sector, driven by advancements in AI. These advancements are poised to foster a more patient-centric approach to healthcare, where the onerous tasks of documentation and data review are taken over by AI, allowing clinicians to dedicate more time to meaningful patient interactions. Patients, in turn, will reap the rewards of hybrid care models that seamlessly integrate into their daily lives, providing greater accessibility to care. It is crucial, however, to approach this transformation with meticulous oversight, as data breaches and patient safety incidents have the potential to impede progress in this swiftly expanding realm.

Discussion

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Conclusions

AI can be harnessed to address a range of pressing challenges in healthcare, including staffing shortages, disparities in experience, access gaps in rural America, and increasingly complex patient populations. These challenges create unique openings for AI to provide vital support, particularly to caret teams, enabling them to allocate more of their time to patient interactions and less on administrative tasks like documentation and data review. Moreover, we can anticipate a sustained acceleration in the expansion of the virtual care landscape as hybrid care models continue to evolve, capitalizing on a blend of in-person and virtual care to enhance the efficiency of patient care delivery.

With the persistent demand for AI and virtual care models, there will be an ongoing expansion in the market for companies specializing in AI solutions within the virtual care and hybrid care sectors. Establishing an ecosystem that enables care teams to harness AI and implement advanced care strategies will likely represent the next phase of healthcare technology startup evolution. In this evolving landscape, key differentiators will revolve around ensuring safety of AI models, their capacity to adapt and learn progressively, and the seamless integration of large language models into healthcare technologies.

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Contributors

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