# Innovation in Healthcare Through Information Technologies: A Review

**IMI**
BHUBANESWAR

## Poonam Amrutia[1]

## Abstract

The application of innovative information technologies in healthcare can definitely subside the present limitations of the healthcare industry through better affability and accessibility. It encompasses the use of artificial intelligence, big data, biomedical research including drug invention, medical education, innovative/robotic surgical technology, cutting-edge equipment, telemedicine, virtual consultation, online supportive platforms, etc. The present review is an attempt to identify and analyse the impact of these innovative information technologies and explore the potential scope of improvement in the Indian healthcare system. The database search was performed in Scopus, Web of Science, PubMed, ProQuest, Google Scholar and Wiley Online Library. Initially, 319 articles related to innovative digital healthcare technologies have been sourced. However, 105 articles were taken into consideration for the review due to various exclusion criteria. Through an extensive review of previously published articles, the present study concludes that undoubtedly information technologies and their applications aid providers reduce inefficiencies, increasing quality, increasing access, removing human errors, reducing costs and making diagnosis, treatment and medicine more personalised for patients. It has really improved the quality, quick and convenient healthcare system.

## Keywords

Digital technologies, digital applications, healthcare, innovative, information technology (IT)

[1]Indukaka Ipcowala Institute of Management, Charotar University of Science and Technology (CHARUSAT), Changa, Gujarat, India

**Corresponding author:**
Poonam Amrutia, Indukaka Ipcowala Institute of Management, Charotar University of Science and Technology (CHARUSAT), Changa, Gujarat 388421, India.
E-mail: poonamamrutia.mba@charusat.ac.in

## Introduction

The report 'To Err is Human' released by the Institute of Medicine during 1999, emphasised medical errors which are alarming in terms of keeping the faith of patients in the healthcare system. According to the report, approximately 98,000 deaths per year happen due to human errors (Donaldson, 2008). This happens due to failure of intentional action to be accomplished, faulty practice or conditions that lead individuals to make mistakes to achieve the goal. The report also stated that healthcare is a decade or further behind many other high-risk industries for patients' safety purposes. Way out to the above issue has been discussed in 'Crossing the Quality Chiasm' as implementing the usage of digital technology to improve the current status of healthcare (Institute of Medicine Committee on Quality of Healthcare in America, 2001).

During the 71st World Health Assembly (held in May 2018), the member states of the World Health Organisation signed the resolution that emphasises the need to ensure that innovative digital health solutions complement and enhance existing health service delivery models, reinforced already integrated patient-centred health services, contribute to the betterment of public health and address the lack of research and evidence on the influence of digital health on public and clinical health (Le et al., 2018).

### *Innovative Digital Technologies in Healthcare*

Health information technology (HIT) has become an integral part of the modern practice of medicine as it brings many potential benefits, accessibility and convenience for patients. Healthcare service quality depends on various aspects namely biomedical research and education, infrastructural facilities at hospitals, availability of accessible and ease of treatments, online consultation services, use of artificial intelligence (AI), robotic surgery options, telemedicine, online follow-up service, etc. The prototype may differ from country to country, however, the core principles of treatments remain the same. In this review, the researcher has included innovative technologies and their applications in the healthcare industry. Because healthcare refers to the preservation and enhancement of mental and physical health through various medical services. It encompasses a broad range of aspects including an overall system of medical care and operational aspects.

### *Benefits of Information Technology*

The benefits of HIT include facilitating communication between healthcare providers and patients; improving medication safety, remote care (Choukou et al., 2021), telehealth (Jonnagaddala et al., 2021), telemedicine (Abd-Alrazaq et al., 2021; Galiero et al., 2020) teleconsultation service (Raffaele et al., 2020), tracking, and reporting and promoting quality of care through optimised access to and adherence to guidelines. One of the most significant roles of IT in healthcare is to reduce the risk of medication errors which simultaneously increases patient safety.

Through mediational alerts, follow-up reminders, a better patient tracking system, patients' data sources, efficacy of therapeutic intervention can be analysed. This technology not only simplifies the efforts of healthcare providers but also inspires patients to engage themselves in noticing the results of self-care treatment (Unni et al., 2021). The second section of the study provides the review summary followed by a discussion of research method—how various reviews have been collected systematically. Lastly, the author concludes with present study's limitations and suggestions for further scope.

## Objectives of the Study

The primary objective of this review is to identify and enlist various technologies that marked a new journey in the history of the healthcare system. Second, to analyse how information technologies transform the healthcare system and techniques of treatment. Last, to explore the potential scope of improvement in the Indian healthcare system.

## Review of Literature

As stated in the World Health Organisation's Global Strategy on Digital Health 2020–2025 report (Yaeger et al., 2019), sustainable, safe, reasonable, reliable and moral digital health ought to be an integral part of modern healthcare practices. It should be established with accessible, feasible, transparent, affordable, confidential, and scalable ideologies. The literature review is divided into two main parts namely digital technologies and digital applications.

## Digital Technologies

AI, Blockchain, Big data, Wearable smart devices, Machine Learning, etc., can be defined as digital technologies which aid healthcare providers in getting rid of drawbacks of traditional methods of healthcare system.

### Artificial Intelligence

A bundle of AI technologies are incorporated by healthcare industry which emphasises the simulation of human intellectual practices and also reacts like human beings through machines (Yaeger et al., 2019). Horizons of AI in healthcare industry are spread across surgical robots, robotic process automation, diagnosis and treatment application, virtual patient consultation and medication, image processing, image processing, big data analysis, predictive modelling (Rabello et al., 2022), adherence and administrative applications, networking and deep learning, voice technology, cognitive computing, language processing (Odukoya & Chui, 2013), expert system (Davenport & Kalakota, 2019), etc. Figure 1 illustrates the use of AI to promote healthcare facilities.
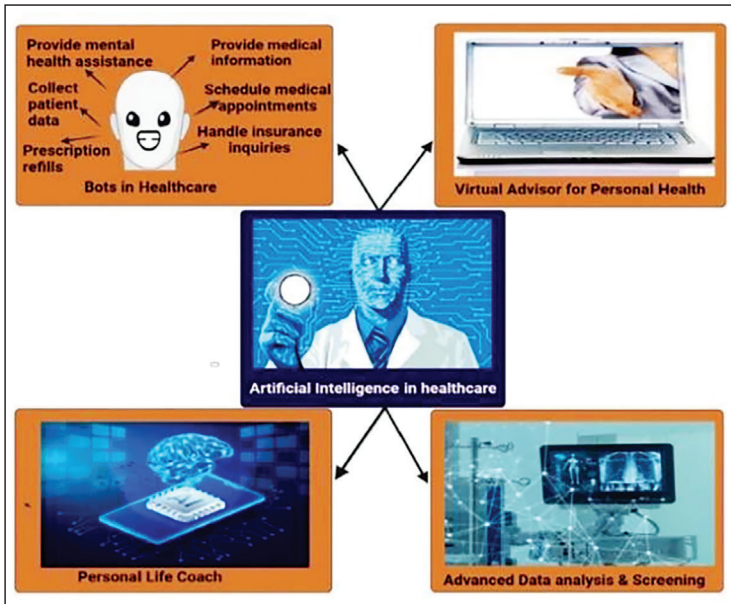
**Figure 1.** Attributes of Artificial Security in E-health.

**Source:** Tagde et al. (2021).

Integration of AI into workplace can enable better understanding and fulfilling the needs of patients with less administrative burden, in-depth analysis, unlocking the power of big-data (Chen & Decary, 2020; He et al., 2019), replacing human efforts through robotic assistance, better quality and efficiency, safety, accuracy, etc. Mostly AI tools are used in key ailment areas such as cardiology, neurology and cancer for early disease discovery, examination and appropriate treatment (Jiang et al., 2017; Park et al., 2020).

The efficacy of AI application during COVID-19 to detect the infectious and its further treatment is illustrated in Figure 2.

## Blockchain

Blockchain is a scattered ledger of digital entries. It stores data in blocks which are interconnected together and form a chain (Chukwu & Garg, 2020; Sharma et al., 2022). The blocks ratify the sequence of transactions and meticulous time. Once the blocks are linked together, no records can be altered as they are now tied up in a chain. Thus, it provides a forum of accountability, safe accumulation and sharing of information on thousands of servers at publicly accessible networks.

In healthcare system, a blockchain network is used to secure the preservation and exchange of students', citizens' data and patients' data through physicians, researchers, scientists, hospitals, pharmacies and laboratories (Haleem et al.,
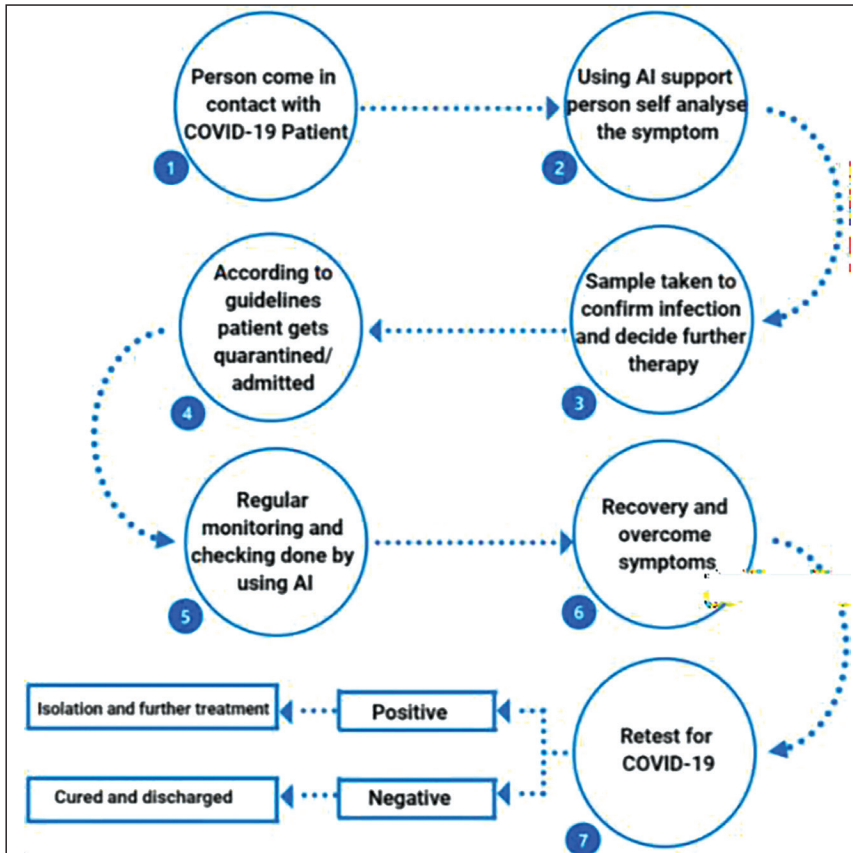
**Figure 2.** Efficacy of AI Application During COVID-19.

**Source:** Chandra et al. (2022).

2021). Concisely, Blockchain provides a platform for universal and disseminated value exchange (Dua, 2023). Pharmaceutical companies can also trace counterfeit medications through Blockchain technologies. Blockchain mitigates healthcare issues by creating a decentralised, user-centric, secure and trustlessness mechanism for record transactions (Velmovitsky et al., 2021). Hence, it is often portrayed as a technological solution to gigantic healthcare information's secure exchange (Gaynor et al., 2020). in an efficient way (WHO Report 2020–2025).

Blockchain and AI technology have proved their significance by enhancing the reach, speed, usability, etc., in various sectors. Industries like automobiles have expanded the use of AI by launching driverless vehicles. Though AI demonstrated itself as more powerful than human beings, which can execute many dynamic and cognitive functions, sometimes doctors diligently restrict the use of AI in healthcare, especially when it influences a patient's well-being.

## Big Data

Big data encompasses diverse, complex and huge sets of information in quantities such as zettabytes, petabytes, terabytes, etc. Properties of big data are measured through variety, velocity, volume and veracity (Sharma et al., 2018). Sources of big data are numerous including healthcare surveillance registries, government and private hospital records and registrations (Hong et al., 2018), social media (Katsas et al., 2022), search engine databases, smart wearable technologies (Loncar-Turukalo et al., 2019), insurance company records, internet of things (IoT) sensors, smartphones (Mahajan et al., 2020), etc.

Big data are more accurate than traditional methods, can improve efficiency of health strategy, advance quality care services, assist in clinical trials, helpful in forecast modelling, address disparities and early detection of diseases (Alhajaj & Moonesar, 2023). Essentially, big data is useful in predictive analytics, machine learning, keeping electronic records, networking, healthcare intelligence, simplification of huge datasets in a meaningful way. IT providers convert this big data in an understandable way through various Hadoop tools namely Apache Hadoop, Spark, Impala, Hive, Mahout, etc. (Senbekov et al., 2020).

## Smart Devices

Health consciousness has caused a paradigm shift in the inculcated use of wearable devices which monitor vital functions of the body. Two striking features of smart devices are support to pursue a healthy lifestyle and constant health monitoring data related to alarming ailment symptoms along with varied physiological parameters by metabolic system tracking. The wearable technologies not only unlock clinical data but also behavioural and self-monitored data of the patients. Hence, wearable health devices have the potential to become a promising mainstream mobile medical market for the upcoming era.

Wider likability of novel smart devices such as smart watches, smart belts, wearable blood glucose monitors mobile applications, radio frequency identification (RFID), ECG monitors, insulin pumps, etc., began with the smartphone (Madanian et al., 2019).

## Digital Applications

The applications of digital health technologies including Blockchain, machine learning, and AI can be termed as hospitals, healthcare, and public health (Supriya & Chattu, 2021). This mainly includes virtual consultation and medications, that is, telemedicine, disease diagnosis, therapeutic, hierarchical treatment, machine learning algorithms used for disease prediction, further research and development, virtual surgery techniques, etc. In this review, the researcher has selected a few ordinary and general applications of digital technologies including virtual consultation, telemedicine, medical education and research (Joshi, 2010), pharmacy and logistics, social media platforms, etc.

## Virtual Consultation

Although virtual consultations have been available since long, it has proved its significance during COVID-19. Virtual consultation is interchangeably used with E-consultation or teleconsultation. This technology allows health provider to consult their patients through telephone/mobile or other similar digital devices, text/image messaging, video conferencing, email, etc. (Monaghesh & Hajizadeh, 2020). This technology has given birth to E-prescription which ensures patient safety (Alotaibi & Federico, 2017; Page et al., 2021), digital patient records and telemedicine.

Virtual consultation is beneficial to both—health providers and patients. Such as enabling patients to express themselves more openly, image sharing, reducing the need for patients' accompanying persons, multi-person interaction opportunities, remote access, reducing time off work for appointments and no transport costly, etc.

## Telemedicine

Telemedicine can also be termed as the usage of telecommunication technologies (Alotaibi & Federico, 2017) to provide and support healthcare when distance separates participants. This application can be one of the economical as well as efficient mean to increases reach and a convenient healthcare system. Healthcare professionals use IT for the information exchange related to diagnosis, treatment and prevention of disease, educational research and evaluation of healthcare workers, with the goal of preserving the health of population (Yaeger et al., 2019). Infrastructural facilities including internet penetration play an important role in telemedicine reach attainment (Dash et al., 2021).

The concept of telemedicine was introduced especially for the remote or rural areas where accessibility is difficult, but people witnessed its peak use during COVID-19 outbreak (Echeverría et al., 2021; Noorbakhsh et al., 2019; Rolston & Meltzer, 2015). And emergencies (Daniel et al., 2015; Kumar & Singh, 2019).

With an intention to restrict the spread of COVID-19 and remote consulting services, Indian Ministry of Health and Family Welfare has acquainted a citizen-friendly national teleconsultation service named eSanjeevani OPD aimed to deliver healthcare services to patients at their place (Masic et al., 2011). Some other examples of telemedicine services include virtual doctor consultation through E-Doctor Seva, Practo, a start-up of BIT Sindri at Dhanbad named Milo Doctor and FOREIGN OPD – The only healthcare brand in India that provides personal consultations with global medicinal experts.

## Medical Education & Research

In views of OTA (Office of Technology Assessment), 'Medical technology is a set of techniques, medicines, equipment, tools and procedures used by the health professionals in providing healthcare to the individuals and systems, in which such technology is used' (Moher et al., 2010). IT can assist medical education in

various means such as in computer and technology-assisted learning, human patient simulators, virtual reality, advances in medicine, novel techniques of operating a complex disease, to facilitate student learning such as virtual surgical tutorials, etc. (Jonnagaddala et al., 2021).

Medical research can be upgraded with the assistance of information technology to uplift the health standard, to explore the simplest and the most effective way of treatment and rehabilitation.

## Social Media Platform

Social media platforms remarkably changed the way patients and healthcare providers way of communicating health-related information (Gijsen et al., 2020). These platforms include various online applications such as Facebook, Twitter, YouTube, Blogger, Wikipedia, etc., and allow the users both creation and usage of content. Social media plays an important role in disseminating health-related information on online platforms. Due to internet connectivity, and extended smart phone usage, it is estimated that today approximately 3 billion users have benefitted from such applications (Hong et al., 2018). According to a report, it is estimated that worldwide, 15,220,700 contents are uploaded every minute (Gaynor et al., 2020).

Developing countries like India dealt with COVID-19 pandemic situation through frugal technological innovations like origination of ventilators at large spectrum, production of PPE kits, Dhanvantari Rath, launch of Arogya Setu mobile app, etc. (Sharma et al., 2022).

## Pharmacy & Logistics

Online pharmacy also known as telepharmacy is rapidly growing area within pharmaceutical industry. Telemedicine falls under the umbrella of telepharmacy. This platform allows pharmacist to evaluate the prescription and providing the ordered medicines (Tin et al., 2018) to patients at their place without unnecessary commuting (Michele et al., 2013). The telepharmacy encompasses telephonic patient counselling, mail order, cooperative drug management, central processing, automated and remote distribution systems, medication therapy management, remote order entry, and 24/7 pharmacist counselling, etc. (Tin et al., 2018). During the COVID-19 pandemic, telepharmacy was soon recognised as a tool which could overcome so many challenges (Unni et al., 2021). including limiting the transformation of viruses, quick availability, etc.

# Method

## Article Sourcing

The articles were sourced from various databases namely Google Scholar, Scopus, Web of Science, PubMed, ProQuest and Wiley Online Library.

## *Inclusion Criteria*

Initially, 319 articles related to digital healthcare technologies have been sourced. All articles were published from 2000 to till date in English language. The keywords used for present review article were digital healthcare technologies, IT in healthcare, big data, telemedicine, blockchain, remote and virtual follow-up, AI, healthcare industry progress, etc.

## *Exclusion Criteria*

However, application of exclusion criteria reduced the size of collected articles up to 105. Exclusion criteria encompass time horizon, scalability of geographical area, purpose of the study, data collection technique, grade of innovation, short articles, wider applicability of technology, practical application including feasibility, adoptability, language barrier, etc.

   As a qualitative measure, all the collected articles were critically analysed through Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Checklist 2009 (Moher et al., 2010) and 2020 (Page et al., 2021). Which ensures that the techniques and end results of systematic reviews reported in the article are adequate, trustworthy and applicable to futuristic research. Similar to PRISMA 2009, PRISMA 2020 has a checklist of 27 items. The difference between both versions is updated and revised wording. PRISMA 2020 uses more comprehensive wording and is more helpful for all fields. It gives reviewers more report precision. Figure 4 shows a flow chart of different stages by which finally, 105 articles were considered appropriate for the review.

## Discussion and Implication

Figure 3 provides a summary of digital technologies and their applications discussed in the present review. The usage of digital technology in healthcare industry can definitely improve the quality, accessibility, convenience, ease of approach and quick treatment. Innovative healthcare treatment produces a lot of benefits along with patient satisfaction but also triggers concern for providers related to patient data privacy and safety. Though the precise impact of information technology on healthcare is difficult due to various aspects and applications, it can be defined through the existing literature notifying the change in nature and principles of interactions between doctors and patients.

   The innovative information technologies contributed immensely to defeating the worldwide COVID-19 pandemic (Ienca & Vayena, 2020; Javaid et al., 2020). In fact, COVID-19 outbreak has hastened the growth of information technology. At the same time, the implication of information technology in healthcare system is not an exception in terms of challenges namely data fragmentation, data lag, data privacy, digital security breaches, risk in over reliance, etc. (Mold et al., 2021; Wang et al., 2021).
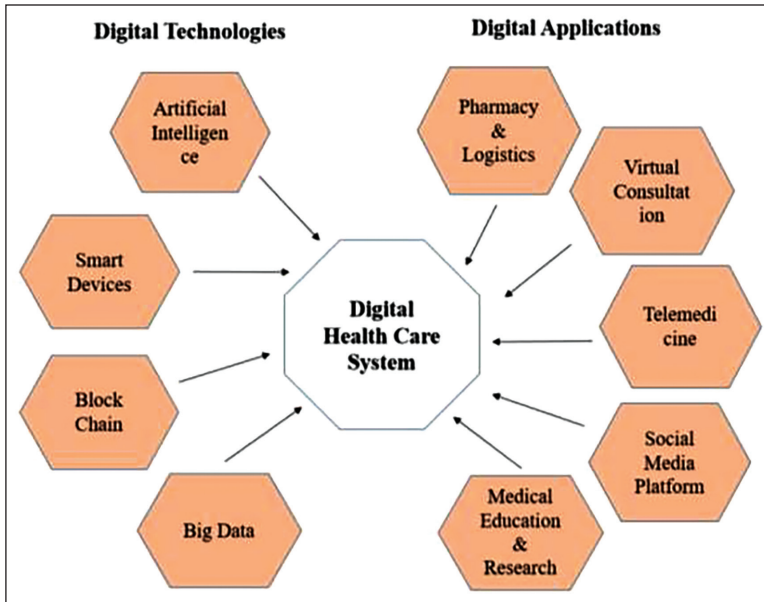
**Figure 3.** Summary of Digital Technologies and Applications of Digital Health Technologies.
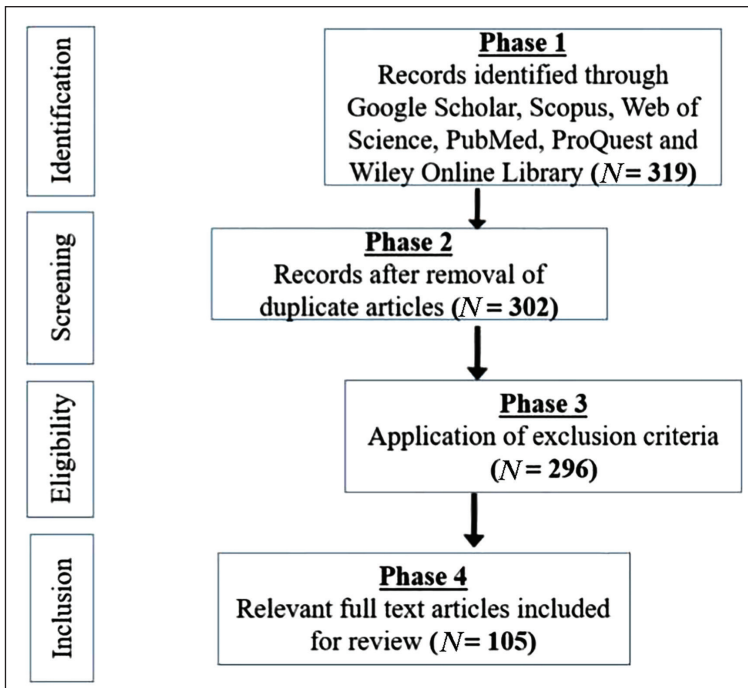


**Figure 4.** Flow Chart Showing Data Source Method.

## Conclusion

In recent decades, information technologies in healthcare were broadly studied and applied in medical education, research, biomedicine, diagnosis and disease treatments. Moreover, such technologies became highly sought during COVID-19 pandemic. The execution of information technologies such as big data, smart devices, telemedicine, telepharmacy, AI, machine learning, blockchain, IoT, etc., and its applications can enrich the quality support with far convenient way of treatment. Since the outbreak of COVID-19, IoT gained momentum as it provides with rapid screening of patients, automatic or programmed treatment through various medical tools and devices, tele-healthcare consultation.

Based on available literature, it can be proposed that with more scientific developments, technology upgradations and the propagation of personalised health devices, information technology will enrich the daily lives of citizens. However, further exploration related to better IT applications and its implications in healthcare industry is still required.

### Acknowledgement

### Declaration of Conflicting Interests

### Funding

### References

Abd-Alrazaq, A., Hassan, A., Abuelezz, I., Ahmed, A., Alzubaidi, M. S., Shah, U., Alhuwail, D., Giannicchi, A., & Househ, M. (2021). Overview of technologies implemented during the first wave of the COVID-19 pandemic: Scoping review. *Journal of Medical Internet Research*, *23*(9), e29136. https://doi.org/10.2196/29136

Alhajaj, K. E., & Moonesar, I. A. (2023). The power of big data mining to improve the health care system in the United Arab Emirates. *Journal of Big Data*, *10*, 12. https://doi.org/10.1186/s40537-022-00681-5

Alotaibi, Y. K., & Federico, F. (2017). The impact of health information technology on patient safety. *Saudi Medical Journal*, *38*(12), 1173–1180. https://doi.org/10.15537/smj.2017.12.20631

Chandra, M., Kumar, K., Thakur, P., Chattopadhyaya, S., Alam, F., & Kumar, S. (2022). Digital technologies, healthcare and COVID-19: Insights from developing and emerging nations. *Health Technol (Berl)*, *12*(2), 547–568. https://doi.org/10.1007/s12553-022-00650-1

Chen, M., & Decary, M. (2020). Artificial intelligence in healthcare: An essential guide for health leaders. *Healthcare Management Forum*, *33*(1), 10–18. https://doi.org/10.1177/0840470419873123

Choukou, M. A., Taha, A., Qadeer, A., & Monnin, C. (2021). Digital health technology for remote care in response to the COVID-19 pandemic: A scoping review. *European Review for Medical and Pharmacological Sciences*, *25*(8), 3386–3394. https://doi.org/10.26355/eurrev_202104_25751

Chukwu, E., & Garg, L. (2020). A systematic review of blockchain in healthcare: Frameworks, prototypes and implementations. *IEEE Access*, *8*, 21196–21214. https://doi.org/10.1109/ACCESS.2020.2969881

Daniel, H., Sulmasy, L. S. Health and Public Policy Committee of the American College of Physicians (2015). Policy recommendations to guide the use of telemedicine in primary care settings: An American College of Physicians position paper. *Annals of Internal Medicine*, *163*(10), 787–789. https://doi.org/10.7326/M15-0498

Dash, S., Aarthy, R., & Mohan, V. (2021). Telemedicine during COVID-19 in India—A new policy and its challenges. *Journal of Public Health Policy*, *42*, 501–509. https://doi.org/10.1057/s41271-021-00287-w

Davenport, T., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future healthcare Journal*, *6*(2), 94–98. https://doi.org/10.7861/futurehosp.6-2-94

Donaldson, M. S. (2008). An overview of to err is human: Re-emphasizing the message of patient safety. In R. G. Hughes (Ed.), *Patient safety and quality: An evidence-based handbook for nurses*. Agency for Healthcare Research and Quality. https://www.ncbi.nlm.nih.gov/books/NBK2673/

Dua, M. (2023). Review of adoption theories in the context of blockchain. *IMIB Journal of Innovation and Management*, *1*(1), 46–57. https://doi.org/10.1177/ijim.221085415

Echeverría, P., Puig, J., Ruiz, J. M., Herms, J., Sarquella, M., Clotet, B., & Negredo, E. (2021). Remote health monitoring in the workplace for early detection of COVID-19 cases during the COVID-19 pandemic using a mobile health application: COVIDApp. *International Journal of Environmental Research and Public Health*, *19*(1), 167. https://doi.org/10.3390/ijerph19010167

Galiero, R., Pafundi, P. C., Nevola, R., Rinaldi, L., Acierno, C., Caturano, A., Salvatore, T., Adinolfi, L. E., Costagliola, C., & Sasso, F. C. (2020). The importance of telemedicine during COVID-19 pandemic: A focus on diabetic retinopathy. *Journal of Diabetes Research*, *2020*, 9036847. https://doi.org/10.1155/2020/9036847

Gaynor, M., Tuttle-Newhall, J., Parker, J., Patel, A., & Tang, C. (2020). Adoption of blockchain in health care. *Journal of Medical Internet Research*, *22*(9), e17423. https://doi.org/10.2196/17423

Gijsen, V., Maddux, M., Lavertu, A., Gonzalez-Hernandez, G., Ram, N., Reeves, B., Robinson, T., Ziesenitz, V., Shakhnovich, V., & Altman, R. (2020). Science: The potential and the challenges of utilizing social media and other electronic communication platforms in health care. *Clinical and Translational Science*, *13*(1), 26–30. https://doi.org/10.1111/cts.12687

Haleem, A., Javaid, M., Singh, R., Suman, R., & Rab, S. (2021). Blockchain technology applications in healthcare: An overview. *International Journal of Intelligent Networks*, *2*, 130–139. https://doi.org/10.1016/j.ijin.2021.09.005

He, J., Baxter, S. L., Xu, J., Xu, J., Zhou, X., & Zhang, K. (2019). The practical implementation of artificial intelligence technologies in medicine. *Nature Medicine*, *25*(1), 30–36. https://doi.org/10.1038/s41591-018-0307-0

Hong, L., Luo, M., Wang, R., Lu, P., Lu, W., & Lu, L. (2018). Big data in health care: Applications and challenges. *Data and Information Management*, *2*(3), 175–197. https://doi.org/10.2478/dim-2018-00148

Ienca, M., & Vayena, E. (2020). On the responsible use of digital data to tackle the COVID-19 pandemic. *Nature Medicine*, *26*(4), 463–464. https://doi.org/10.1038/s41591-020-0832-5

Institute of Medicine (US) Committee on Quality of Health Care in America. (2001). *Crossing the quality chasm: A new health system for the 21st century*. National Academies Press (US). https://pubmed.ncbi.nlm.nih.gov/25057539/

Javaid, M., Haleem, A., Vaishya, R., Bahl, S., Suman, R., & Vaish, A. (2020). Industry 4.0 technologies and their applications in fighting COVID-19 pandemic. *Diabetes & Metabolic Syndrome*, *14*(4), 419–422. https://doi.org/10.1016/j.dsx.2020.04.032

Jiang, F., Jiang, Y., Zhi, H., Dong, Y., Li, H., Ma, S., Wang, Y., Dong, Q., Shen, H., & Wang, Y. (2017). Artificial intelligence in healthcare: Past, present and future. *Stroke and Vascular Neurology*, *2*, e000101. https://doi.org/10.1136/svn-2017-000101

Jonnagaddala, J., Godinho, M. A., & Liaw, S. T. (2021). From telehealth to virtual primary care in Australia? A rapid scoping review. *International Journal of Medical Informatics*, *151*, 104470. https://doi.org/10.1016/j.ijmedinf.2021.104470

Joshi, S. (2010). Use of information technology in medical education. *Webmed Central Medical Education*, *1*(9), WMC00607. https://doi.org/10.9754/journal.wmc.2010.00607

Katsas, I., Apostolakis, I., & Varlamis, I. (2022). Social media in health care: Exploring its use by health-care professionals in Greece. *Informatics for Health & Social Care*, *47*(1), 1–9. https://doi.org/10.1080/17538157.2021.1906256

Kumar, S., & Singh, M. (2019). Big data analytics for healthcare industry: Impact, applications, and tools. *Big Data Mining and Analytics*, *2*(1), 48–57. https://doi.org/10.26599/BDMA.2018.9020031

Loncar-Turukalo, T., Zdravevski, E., Machado da Silva, J., Chouvarda, I., & Trajkovik, V. (2019). Literature on wearable technology for connected health: Scoping review of research trends, advances, and barriers. *Journal of Medical Internet Research*, *21*(9), e14017. https://doi.org/10.2196/14017

Madanian, S., Parry, D. T., Airehrour, D., & Cherrington, M. (2019). mHealth and big-data integration: Promises for healthcare system in India. *BMJ Health & Care Informatics*, *26*(1), e100071. https://doi.org/10.1136/bmjhci-2019-100071

Mahajan, V., Singh, T., & Azad, C. (2020). Using telemedicine during the COVID-19 pandemic. *Indian Pediatrics*, *57*(7), 658–661. https://doi.org/10.1007/s13312-020-1895-6

Masic, I., Pandza, H., Toromanovic, S., Masic, F., Sivic, S., Zunic, L., & Masic, Z. (2011). Information technologies (ITs) in medical education. *Acta Informatica Medica*, *19*(3), 161–167. https://doi.org/10.5455/aim.2011.19.161-167

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & Group, PRISMA. (2010). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *International Journal of Surgery (London, England)*, *8*(5), 336–341. https://doi.org/10.1016/j.ijsu.2010.02.007

Mold, F., Cooke, D., Ip, A., Roy, P., Denton, S., & Armes, J. (2021). COVID-19 and beyond: Virtual consultations in primary care-reflecting on the evidence base for implementation and ensuring reach: Commentary article. *BMJ Health & Care Informatics*, *28*(1), e100256. https://doi.org/10.1136/bmjhci-2020-100256

Monaghesh, E, & Hajizadeh, A. (2020). The role of telehealth during COVID-19 outbreak: A systematic review based on current evidence. *BMC Public Health*, *20*(1), 1193. https://doi.org/10.1186/s12889-020-09301-4

Noorbakhsh-Sabet, N., Zand, R., Zhang, Y., & Abedi, V. (2019). Artificial intelligence transforms the future of health care. *The American Journal of Medicine*, *132*(7), 795–801. https://doi.org/10.1016/j.amjmed.2019.01.017

Odukoya, O. K., & Chui, M. A. (2013). E-prescribing: A focused review and new approach to addressing safety in pharmacies and primary care. *Research in Social and Administrative Pharmacy*, *9*(6), 996–1003. https://doi.org/10.1016/j.sapharm.2012.09.004

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., …, McKenzie, E. (2021). PRISMA 2020 explanation and elaboration: Updated guidance and exemplars for reporting systematic reviews. *BMJ (Clinical research ed.)*, *372*, n160. https://doi.org/10.1136/bmj.n160

Park, C. W., Seo, S. W., Kang, N., Ko, B., Choi, B. W., Park, C. M., Chang, D. K., Kim, H., Kim, H., Lee, H., Jang, J., Ye, J. C., Jeon, J. H., Seo, J. B., Kim, K. J., Jung, K. H., Kim, N., Paek, S., Shin, S. Y., …, Yoon, H. J. (2020). Artificial intelligence in health care: Current applications and issues. *Journal of Korean Medical Science*, *35*(42), e379. https://doi.org/10.3346/jkms.2020.35.e379

Rabello, G. M., Pêgo-Fernandes, P. M., & Jatene, F. B. (2022). Are we preparing for the digital healthcare era? *Sao Paulo Medical Journal = Revista paulista de medicina*, *140*(2), 161–162. https://doi.org/10.1590/1516-3180.2022.140225112021

Rolston, D. M., & Meltzer, J. S. (2015). Telemedicine in the intensive care unit: Its role in emergencies and disaster management. *Critical Care Clinics*, *31*(2), 239–255. https://doi.org/10.1016/j.ccc.2014.12.004

Senbekov, M., Saliev, T., Bukeyeva, Z., Almabayeva, A., Zhanaliyeva, M., Aitenova, N., Toishibekov, Y., & Fakhradiyev, I. (2020). The recent progress and applications of digital technologies in healthcare: A review. *International Journal of Telemedicine and Applications*, 8830200. https://doi.org/10.1155/2020/8830200

Sharma, A., Harrington, R. A., McClellan, M. B., Turakhia, M. P., Eapen, Z. J., Steinhubl, S., Mault, J. R., Majmudar, M. D., Roessig, L., Chandross, K. J., Green, E. M., Patel, B., Hamer, A., Olgin, J., Rumsfeld, J. S., Roe, M. T., & Peterson, E. D. (2018). Using Digital Health Technology to Better Generate Evidence and Deliver Evidence-Based Care. *Journal of the American College of Cardiology*, *71*(23), 2680–2690. https://doi.org/10.1016/j.jacc.2018.03.523

Supriya, M., & Chattu, V. K. (2021). A review of artificial intelligence, big data, and blockchain technology applications in medicine and global health. *Big Data and Cognitive Computing*, *5*(3), 41. https://doi.org/10.3390/bdcc5030041

Tagde, P., Tagde, S., Bhattacharya, T., Tagde, P., Chopra, H., Akter, R., Kaushik, D., & Rahman, M. H. (2021). Blockchain and artificial intelligence technology in e-Health. *Environmental Science and Pollution Research International*, *28*(38), 52810–52831. https://doi.org/10.1007/s11356-021-16223-0

Unni, E. J., Patel, K., Beazer, I. R., & Hung, M. (2021). Telepharmacy during COVID-19: A scoping review. *Pharmacy (Basel, Switzerland)*, *9*(4), 183. https://doi.org/10.3390/pharmacy9040183

Velmovitsky, P. E., Bublitz, F. M., Fadrique, L. X., & Morita, P. P. (2021). Blockchain applications in health care and public health: Increased transparency. *JMIR Medical Informatics*, *9*(6), e20713. https://doi.org/10.2196/20713

Wang, Q., Su, M., Zhang, M., & Li, R. (2021). Integrating digital technologies and public health to fight COVID-19 pandemic: Key technologies, applications, challenges and outlook of digital healthcare. *International Journal of Environmental Research and Public Health*, *18*(11), 6053. https://doi.org/10.3390/ijerph18116053

Yaeger, K., Martini, M., Rasouli, J., & Costa, A. (2019). Emerging blockchain technology solutions for modern healthcare infrastructure. *Journal of Scientific Innovation in Medicine*, *2*(1). https://doi.org/10.29024/jsim.7