

A Systematic Review of Health Informatics Applications in Clinical Practice and Healthcare Management

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Abstract: Healthcare is improved in both healthcare delivery and administrative tasks by integrating technology and data management through health informatics. This analysis looks at how some health informatics systems are used, for example, Electronic Health Records (EHRs), Clinical Decision Support Systems (CDSS), Health Information Exchanges (HIE) and telemedicine platforms. As a result of these technologies, patient safety has improved, quality of care has risen and daily work is more efficient due to updated data, streamlined procedures and evidence being easily used. Issues related to making different systems work together, safeguarding private information and being reluctant to change keep many from using AI widely. It also looks at new technologies like artificial intelligence, block chain and telehealth which could make healthcare better. Overcoming these issues and using these new methods gives health informatics the ability to make healthcare more efficient, personalized and sustainable worldwide.

Keywords: Health Informatics, Electronic Health Records, Clinical Decision Support, Telemedicine, Data Privacy, Interoperability, Artificial Intelligence.

INTRODUCTION

In health informatics, information technology is used to help sort, examine and maintain health records for better results in both health care and its administration. It is located where healthcare, computer science and information management meet to boost the quality, efficiency and organization of patient care [1]. Electronic health records (EHRs), CDSS and telemedicine have made health informatics a key part of healthcare in recent years. Because healthcare is becoming more complex, people expect more personalized care and data analysis is rising, the use and integration of informatics solutions have become more important. Both governments and healthcare organizations have invested a great deal in technologies to fix inefficiencies, cut down on medical errors and promote evidence-based medicine [3]. Because of the COVID-19 pandemic, a clearer need was seen for fast and reliable sharing of health data, distant healthcare and powerful analysis tools.

In clinical environments, using health informatics helps doctors with diagnosis, treatment and monitoring by giving quick access to the required data. With the help of informatics in healthcare, resources are managed more effectively, population health is closely watched and strategies are created with data from many sources. These tools help with daily operations and also improve how satisfied patients are as well as their safety [4]. Even with these advancements, the field encounters big problems such as interoperability, protecting user privacy and users being resistant to what it brings. In addition, emerging technologies such as artificial intelligence (AI), machine learning and the Internet of Things (IoT), introduce new chances and unknowns for the future of healthcare [5].

The purpose of this review article is to thoroughly analyze health informatics in its use for both medical care and administrative duties. It will provide information on the key building blocks and history of the area, list major types of systems and look at their present-day use in health facilities. Furthermore, the review will highlight what health informatics can offer, its limitations and where it's heading which is useful information for professionals, researchers and policymakers working in the field [6].

HEALTH INFORMATICS ORIGINS AND DEVELOPMENT

Health informatics is created to handle medical information effectively in order to increase the effectiveness of healthcare. Up to recently, any patient data was handled by hand which made it difficult for others to review and resulted in a lot of mistakes. With new advancements in medical science and more people to serve, the traditional way of handling information was no longer enough which led to the creation of computer systems [7]. It was in the middle part of the 20th century that health informatics started by trying to convert patient records and hospital

computer systems using digital tools. In the early stages, the main job was to build databases for clinical research and also automate billing tasks. Academic and government bodies started working on including computers in healthcare in the 1960s and 1970s which resulted in initial projects involving EHRs and decision support systems [8]. Because of this, medical informatics became known as health informatics, because it reached beyond just clinical settings.

Between 1980 and 1990, computing ability and internet technology advanced quickly which supported the development of better informatics systems. The medical field saw the first Computerized Provider Order Entry (CPOE), as well as Picture Archiving and Communication Systems (PACS) plus early versions of telemedicine platforms. They were designed to make work more efficient, reduce the risk of medicine errors and allow medical consultations from far away [9]. National and international policies for health IT made the 21st century a defining period. Healthcare providers in the United States quickly adopted EHRs in 2009 due to the incentives provided by the Health Information Technology for Economic and Clinical Health (HITECH) Act. Europe, Asia and other regions also introduced these initiatives which sped up the adoption of digital tools in healthcare all over the world [10].

At the same time, health informatics started to use principles from data science, artificial intelligence and systems engineering. In modern times, healthcare focuses on systems working together, patient-centered care and using information in real-time. At present, precision medicine, managing population health and pandemic response would not be possible without health informatics [11].

Development of Health

informatics

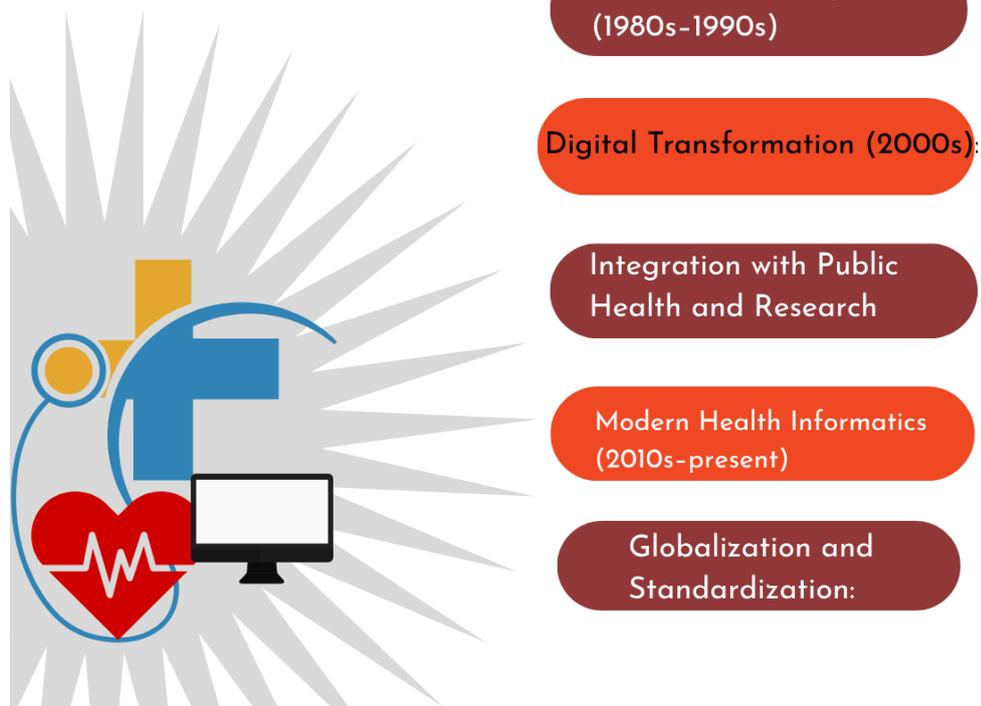


Figure: 1 showing development of health informatics

Knowledge of how health informatics has changed over time prepares us for what lies ahead. As technology has improved, data entry systems have progressed to more advanced and intelligent platforms which shows that data is now seen as an important part of healthcare [12].

A DESCRIPTION OF HEALTH INFORMATICS SYSTEMS

Many types of technologies are included in health informatics systems to assist with gathering, saving, finding and working with medical records for medical treatment and organization. The use of these systems ensures better decisions, improves how doctors talk to each other and benefits patients [13]. Among the most popular systems in this area are Electronic Health Records (EHRs), Clinical Decision Support Systems (CDSS), Health Information Exchange (HIE) and telehealth platforms. In medicine, Electronic Health Records (EHRs) are used to save patients' health information like their medical problems, the treatment given, test results and prescriptions. EHRs are common in the healthcare field to keep care consistent, prevent duplicate care and improve how information is written down. By joining the clinical workflows, healthcare providers can access patient data in real time and give care more effectively [14].

Clinical Decision Support Systems (CDSS) give healthcare staff evidence-based guidance for important clinical decisions. Such systems look at patient files and suggest possibilities of diagnoses, interactions between medications or warn if the guidelines are not followed. CDSS helps to deliver quality care by avoiding mistakes and giving healthcare workers the support to decide rightly [15]. HIE systems allow information about health care to be safely shared across various healthcare organizations and suppliers. Thanks to HIEs, care is more continuous for patients receiving services at several different locations, since all their medical history and test reports are available to medical staff. They help with supervising public health and collecting information at regional and national scales [16].

Integrating telehealth and mobile health (mHealth) into health informatics lets patients participate in their care remotely. They are things such as video consultations, applications designed for chronic disease care and devices that track essential health information. In underserved or rural regions and during health emergencies, telehealth has been very helpful [17]. Every one of these systems supports the provision of healthcare in today's world. How well technology is implemented is affected by interoperability, ease of use, ensuring security and harmony with how healthcare workers operate. Both of these areas complement each other to create a solid foundation for health care management and individual patient care [18].

APPLICATIONS IN HEALTHCARE PRACTICE

Systems in health informatics help doctors and nurses make better, quicker and more accurate choices for their patients. Using technology in clinical settings aids doctors in finding and treating illnesses and monitoring patients which eventually leads to better outcomes and safety [19]. Clinical Decision Support Systems (CDSS) provide direction for clinicians when making choices. From the data of each patient, these systems recommend when potential illnesses, available treatments and likely drug effects should be considered. Practicing based on guidelines helps avoid incorrect diagnoses, makes sure doctors follow best practices and ensures that patients receive care suited to them [20].

Through an EHR and a CDSS, a doctor can check the most current research and medical procedures. Because of this, medical professionals can meet the latest healthcare standards, making sure patients are treated as effectively as possible. Having fast data at hand enables providers to make good choices and give great care [21]. Health informatics systems make it easier to handle day-to-day clinical work by shifting paperwork to electronic systems. Because EHRs remove the task of handwritten charting, doctors and nurses can spend more time talking with patients. Also, using automated systems in healthcare reduces the chance of errors in records and helps with quicker access to data [22].

Primary care systems that use health informatics provide ways to save documents for preventive screening, disease management and monitoring of medication use. In healthcare facilities, they provide a way for doctors, nurses and other professionals to cooperate and discuss patient cases. With medical informatics, information on a patient in oncology or cardiology can be used alongside special guidelines to guide treatment for tough illnesses [23].

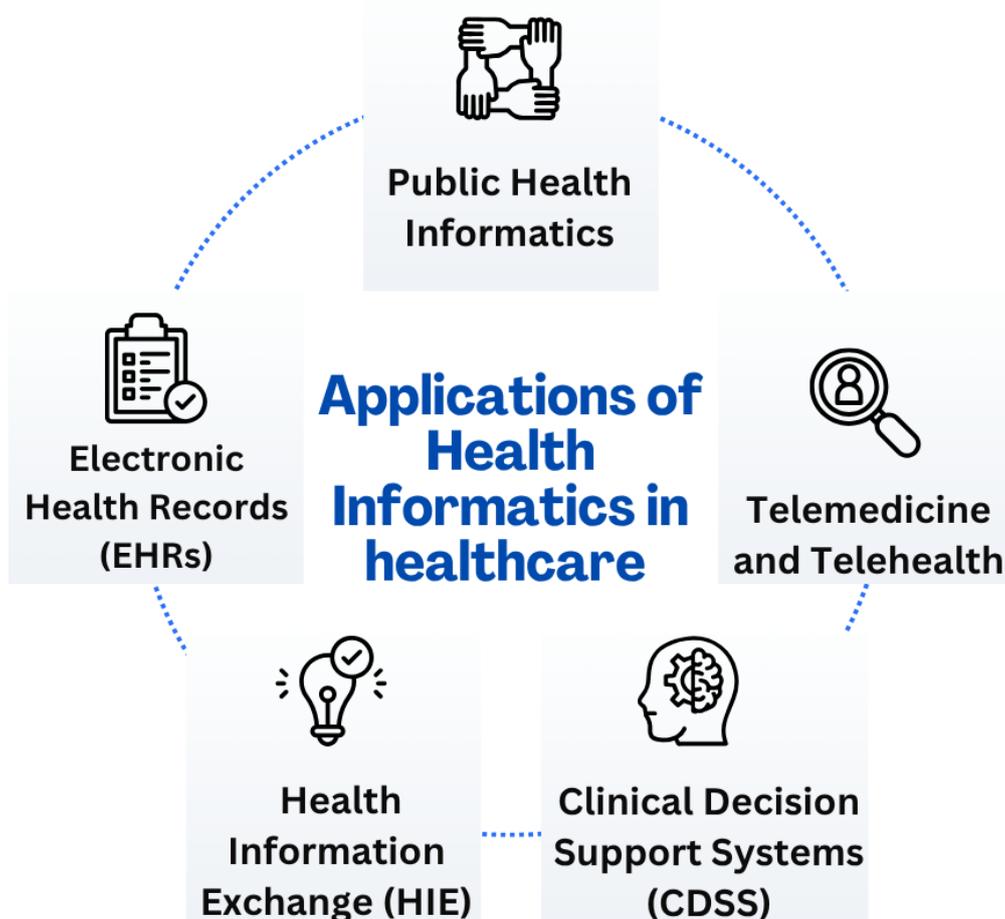


Figure: 2 showing applications of health informatics in healthcare

APPLICATIONS IN MANAGING HEALTHCARE INSTITUTIONS

Effective management of healthcare systems depends on health informatics which helps improve how things are run, divide available resources and support better decision-making at the organizational level. By applying modern technology and data analysis, healthcare managers can simplify tasks, make things less expensive and direct resources where they will have the biggest impact [25].

Fair distribution of staff, important equipment and hospital bed space is easier with health informatics systems. Managers benefit from predictive analytics because it can predict patient volumes which makes budgeting and managing staff easier. By using automated scheduling, it's possible to have staff placed according to need, so more time is spent caring for patients and less is wasted [25]. Tracking operational metrics in real time helps find and fix problems like overcrowding or slow service which keeps care at a high level.

Making decisions in healthcare management relies heavily on data now. Health informatics systems collect a large amount of data and analyze it which helps in making important decisions for policy and strategy [26]. Looking at the age and gender of patients, results of treatments and use of resources, healthcare organizations can find problems, measure improvements and revise their policies. It helps officials make wiser decisions concerning expanding services, budgeting and improving the quality delivered [27].

Monitoring and maintaining public health is made easier with health informatics in healthcare management by combining data from different sources. Keep track of patient results, diseases that affect many individuals and social conditions for health allows healthcare companies to understand risky groups and create targeted approaches to help them. By relying on data, healthcare improved prevention, led to fewer admissions at hospitals and made the community healthier [28]. As well as helping with patient care, health informatics systems simplify business tasks such as billing and keeping records for compliance. Implementing electronic billing systems reduces

mistakes, quickens the process for getting reimbursed and ensures all rules are met, all of which helps healthcare organizations handle their finances better [29].

BENEFITS AND OUTCOMES OF HEALTH INFORMATICS

When health informatics systems are linked to clinical and healthcare management, patients get better care, management becomes more efficient and costs decrease. They benefit healthcare by making it better, more available and sustainable [30].

The industry greatly caters to patient safety due to the excellence of health informatics. When using EHRs, doctors are warned immediately if a patient is allergic to a drug, has a drug interaction or is prescribed too much medicine [31]. With the help of clinically relevant evidence, Clinical Decision Support Systems (CDSS) point healthcare workers in the right direction for treatment. Because the information is given when and where it is needed, it boosts positive patient results and prevents many complications. With the help of informatics, patient information can be accessed easily which helps doctors diagnose more accurately and provide customized treatment, raising the quality of care [32].

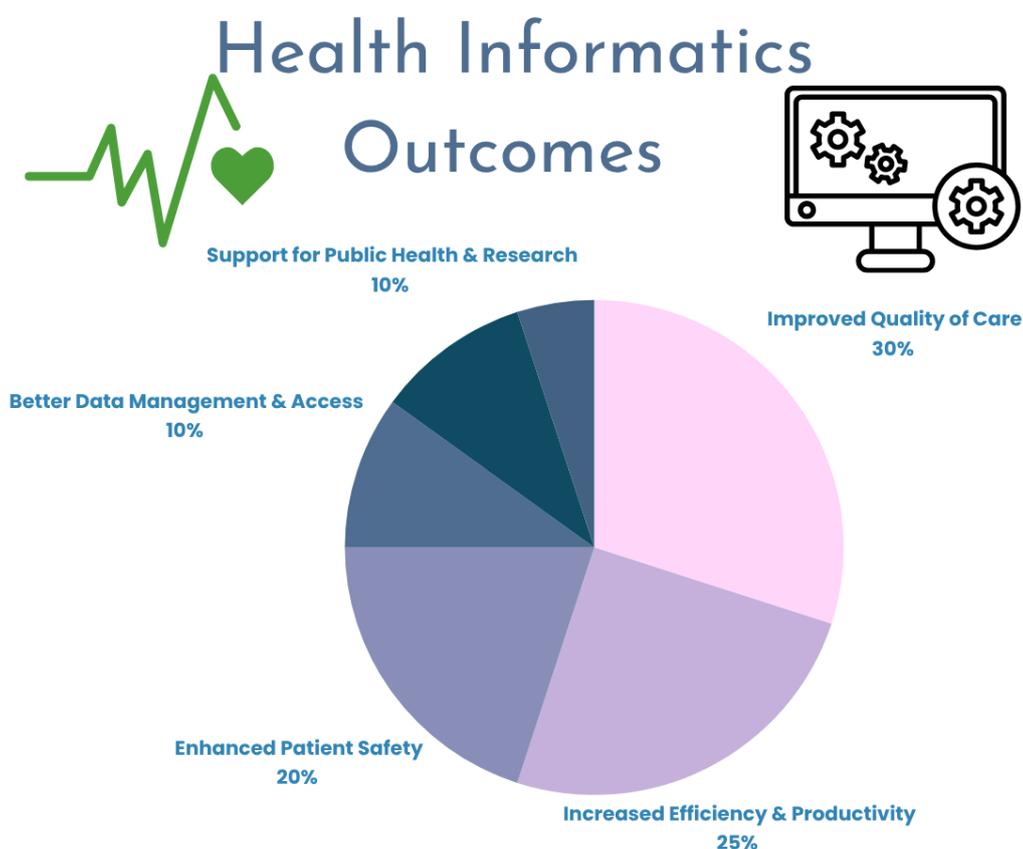


Figure: 3 showing outcomes of health informatics

With health informatics systems, doctors, nurses and other health staff can work together more effectively. These shared platforms, including Health Information Exchanges (HIEs), allow doctors from various fields and locations to quickly review all the patient's information to avoid repeating tests [33]. This is very important for people with long-lasting illnesses or those looked after by several healthcare providers. Patients can better communicate with health professionals and easily access their health records which makes them more involved in looking after themselves [34].

Because of health informatics, there are fewer overlooked mistakes, less paperwork and more efficiency within healthcare institutions which reduces costs. By using digital billing and coding, practices can receive money faster, lose less revenue from delayed payments and reduce expenses on office administration. Thanks to improvements in care quality and a reduction in errors, health informatics helps lower the rate of people returning to the hospital for avoidable reasons and receiving unneeded treatments [35]. The long-term savings in healthcare organizations help ensure that funds are available and properly used which supports the organizations' finances. To sum up,

health informatics makes healthcare services safer, more successful from a medical point of view and lower-cost for both patients and the healthcare system [36].

REASONS FOR NOT ADOPTING AND IMPLEMENTING

Even though these systems bring many benefits, some challenges slow down their acceptance and successful application everywhere in healthcare. Some of these challenges include technology issues, differences between teams and cultural obstacles which all must be handled properly to ensure integration succeeds [37]. Integrating various health informatics systems is very difficult because of problems with interoperability. Because there are many different software systems used in healthcare, it is often hard to share data logically between those systems. When hospitals, clinics and specialists cannot communicate well, it can cause health problems to be detected and treated later. If we can all use the same formats and make our systems work together, it will solve this barrier [38].

Because health data is now stored digitally, privacy and security issues are making it difficult for people to use health informatics. Keeping patient information secure is very important and rules from frameworks such as HIPAA in the US can slow down bringing in new technology. As well, concerns about ethics in collecting and sharing data, getting people's agreement and privacy further worry healthcare providers and patients [39]. Another reason adoption is slow is that healthcare professionals do not always support the idea. Since clinicians and admin are familiar with pen-and-paper methods, a lot of them do not want to adapt to electronic technology as they are worried it might be too complicated or interfere with their current work habits. Having strong training programs and ongoing support helps people become confident with using new systems [40].

Because healthcare is regulated by many rules and requirements, the use of informatics systems can create delays and make things more expensive. Regulators need to review and approve new innovations and different countries have their own rules which can make it tougher for new technologies to be accepted [41]. Overcoming these barriers calls for healthcare organizations, policymakers and technology developers to work together and develop solutions that can be used by many, are secure, are accepted by users and are in line with regulations [42].

INTRODUCING TECHNOLOGY AND WHAT IT OFFERS IN THE FUTURE

Thanks to technology, health informatics is evolving very rapidly. Because data plays an increasing role in healthcare, new technological advancements are helping shape the field, leading to better care for patients, better efficiency in operations and more support for personalized medicine [43].

AI and ML are bringing major changes to health informatics, as systems can review a lot of data and give advice based on predictions. They may assist doctors in spotting medical problems, choosing the best treatment and spotting trends in patient data [44]. For illustration, specialized AI systems are being relied on in places like radiology and pathology to discover irregularities in test pictures or analysis with great accuracy. AI will probably help clinicians create therapies that are custom-made for each patient by analyzing their genetics, lifestyle and health records in the future [45].

Since it is important for health information to be easily shared among diverse systems, interoperability is becoming better. Healthcare providers are capable of offering better coordinated care by letting systems communicate effectively. The use of standard forms for data and open platforms will let healthcare services share patient records with others, preventing duplication and improving follow-up care [46]. Health Information Exchange (HIE) projects will be strengthened, resulting in greater integration of healthcare systems.

With block chain technology, data sharing in healthcare can be done securely, transparently and cannot be changed. Because it is decentralized, patient data is kept secure and shared safely without anyone being able to view it. More efficient management of patient records and a faster way to resolve healthcare payments and claims are also possible through block chain [47].

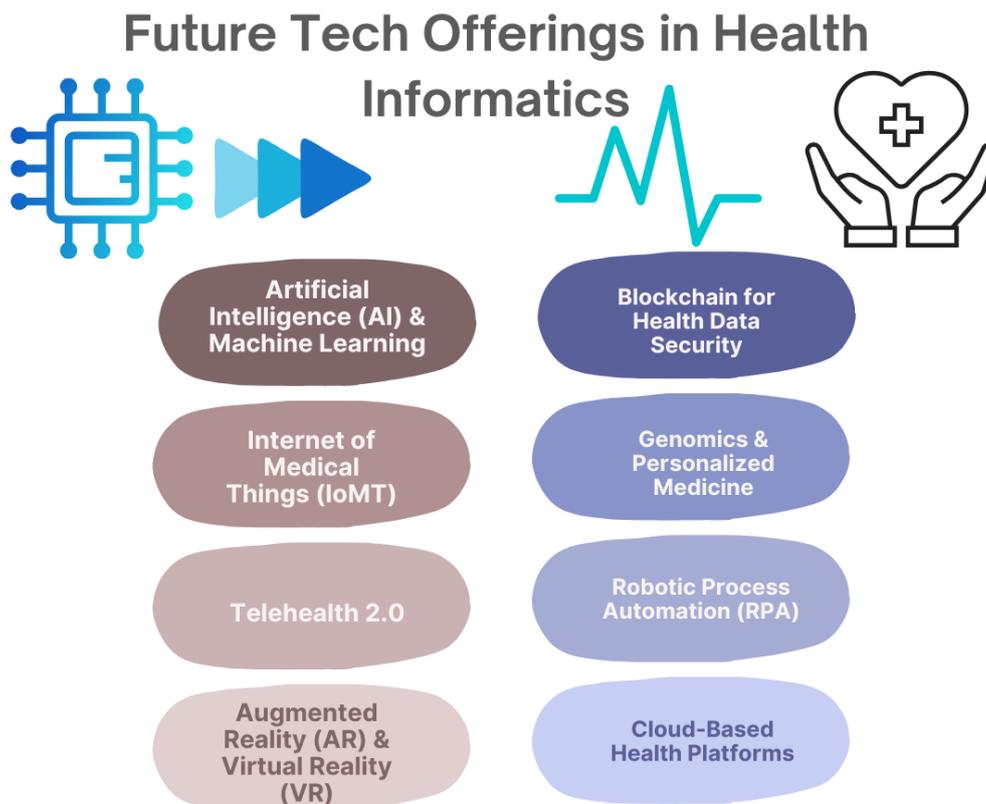


Figure: 4 showing future tech offering in health informatics

Because of COVID-19, telehealth and remote patient monitoring systems have been used more rapidly. As these innovations develop further, more patients in areas that need care will have better access to healthcare. By using wearable devices, remote monitoring systems give healthcare professionals instant updates on vital signs, so chronic conditions can be handled more effectively in real time [48].

CONCLUSION

Health informatics keeps developing which affects the way healthcare is managed and provided to patients. EHRs, CDSS and telehealth platforms, as mentioned before, have improved healthcare quality, made the work more efficient and allowed doctors to make better choices. Using real-time data, lowering the risk of mistakes and supporting research, health informatics helps healthcare workers cooperate and provide customized care.

Even so, setting up health informatics systems is not a simple process because it comes with certain problems. The fact that systems, privacy, security and user attitudes are not yet fully addressed keeps the virus from being fully deployed. To add, managing the laws and ensuring businesses comply is an ongoing challenge. Solving such barriers calls for healthcare providers, officials and technology experts to join forces.

Going forward, technologies such as artificial intelligence (AI), machine learning, block chain and the rise of telehealth are set to improve health informatics. Advancements offer the chance to provide more precise readings, organize care better and provide care that fits the needs of each patient. Better interoperability and sharing of data will help health systems operate more closely, with better care coordination and better outcomes for patients. There are more hurdles to clear, but health informatics is still indispensable in the healthcare field because of its many benefits. Improvements in technology and strong healthcare policies will support health informatics systems to bring improved efficiency, accessibility and focus on patients.

REFERENCES

1. Hovenga E, Grain H. Learning, training and teaching of health informatics and its evidence for informaticians and clinical practice. In *Evidence-Based Health Informatics 2016* (pp. 336-354). IOS Press.
2. Herland M, Khoshgoftaar TM, Wald R. A review of data mining using big data in health informatics. *Journal of Big data*. 2014 Dec; 1:1-35.

3. Gagnon MP, Ngangue P, Payne-Gagnon J, Desmartis M. m-Health adoption by healthcare professionals: a systematic review. *Journal of the American Medical Informatics Association*. 2016 Jan 1; 23(1):212-20.
4. Wang D, Peleg M, Tu SW, Boxwala AA, Greenes RA, Patel VL, Shortliffe EH. Representation primitives, process models and patient data in computer-interpretable clinical practice guidelines: A literature review of guideline representation models. *International journal of medical informatics*. 2002 Dec 18; 68(1-3):59-70.
5. Da Fonseca MH, Kovaleski F, Picinin CT, Pedroso B, Rubbo P. E-health practices and technologies: a systematic review from 2014 to 2019. *InHealthcare 2021 Sep 10 (Vol. 9, No. 9, p. 1192)*. MDPI.
6. Kruse CS, Goswamy R, Raval YJ, Marawi S. Challenges and opportunities of big data in health care: a systematic review. *JMIR medical informatics*. 2016 Nov 21; 4(4):e5359.
7. Darkins A, Ryan P, Kobb R, Foster L, Edmonson E, Wakefield B, Lancaster AE. Care Coordination/Home Telehealth: the systematic implementation of health informatics, home telehealth, and disease management to support the care of veteran patients with chronic conditions. *Telemedicine and e-Health*. 2008 Dec 1; 14(10):1118-26.
8. McCoy AB, Wright A, Eysenbach G, Malin BA, Patterson ES, Xu H, Sittig DF. State of the art in clinical informatics: evidence and examples. *Yearbook of medical informatics*. 2013; 22(01):13-9.
9. Kokol P, Saranto K, Blažun Vošner H. eHealth and health informatics competences: A systemic analysis of literature production based on bibliometrics. *Kybernetes*. 2018 May 2; 47(5):1018-30.
10. Araujo SM, Sousa P, Dutra I. Clinical decision support systems for pressure ulcer management: systematic review. *JMIR medical informatics*. 2020 Oct 16; 8(10):e21621.
11. Yin J, Ngiam KY, Teo HH. Role of artificial intelligence applications in real-life clinical practice: systematic review. *Journal of medical Internet research*. 2021 Apr 22; 23(4):e25759.
12. Clifton DA, Niehaus KE, Charlton P, Colopy GW. Health informatics via machine learning for the clinical management of patients. *Yearbook of medical informatics*. 2015; 24(01):38-43.
13. Evans N, Owolabi K. Clinical informatics tools for healthcare quality improvement: a literature review. *Inkanyiso*. 2018 Nov 1; 10(1):74-89.
14. Renna ME, O'Toole MS, Spaeth PE, Lekander M, Mennin DS. The association between anxiety, traumatic stress, and obsessive-compulsive disorders and chronic inflammation: A systematic review and meta-analysis. *Depress Anxiety*. 2018; 35(11):1081-94.
15. Konnopka A, König H. Economic burden of anxiety disorders: a systematic review and meta-analysis. *PharmacoEconomics*. 2020; 38:25-37.
16. Weaver MD, Vetter C, Rajaratnam SM, O'Brien CS, Qadri S, Benca RM, et al. Sleep disorders, depression and anxiety are associated with adverse safety outcomes in healthcare workers: A prospective cohort study. *J Sleep Res*. 2018; 27(6):e12722.
17. Remes O, Brayne C, Van Der Linde R, Lafortune L. A systematic review of reviews on the prevalence of anxiety disorders in adult populations. *Brain Behav*. 2016; 6(7):e00497
18. Chiang Y-M, Chang Y. Stress, depression, and intention to leave among nurses in different medical units: Implications for healthcare management/nursing practice. *Health Policy*. 2012; 108(2-3):149-57.
19. Maharaj S, Lees T, Lal S. Prevalence and risk factors of depression, anxiety, and stress in a cohort of Australian nurses. *Int J Environ Res Public Health*. 2019; 16(1):61.
20. Brandford AA, Reed DB. Depression in registered nurses: a state of the science. *Workplace Health Saf*. 2016; 64(10):488-511.
21. Bozkurt S, Cahan EM, Seneviratne MG, Sun R, Lossio-Ventura JA, Ioannidis JPA, et al. reporting of demographic data and representativeness in machine learning models using electronic health records. *J Am Med Inf Assoc*. 2020; 27:1878-84.
22. Orwat C, Graefe A, Faulwasser T. Towards pervasive computing in health care—A literature review. *BMC medical informatics and decision making*. 2008 Dec;8:1-8.
23. Tyagi AK, Nair MM. Deep learning for clinical and health informatics. *Computational Analysis and Deep Learning for Medical Care: Principles, Methods, and Applications*. 2021 Jul 28:107-29.
24. Straw I. The automation of bias in medical artificial intelligence (AI): decoding the past to create a better future. *Artif Intell Med*. 2020; 110:101965.
25. Prgomet M, Georgiou A, Westbrook JI. The impact of mobile handheld technology on hospital physicians' work practices and patient care: a systematic review. *Journal of the American Medical Informatics Association*. 2009 Nov 1;16(6):792-801.
26. Handayani PW, Hidayanto AN, Budi I. User acceptance factors of hospital information systems and related technologies: Systematic review. *Informatics for Health and Social Care*. 2018 Oct 2;43(4):401-26.
27. Martinez-Martin N, Luo Z, Kaushal A, Adeli E, Haque A, Kelly SS, et al. Ethical issues in using ambient intelligence in health-care settings. *Lancet Digit Health*. 2021; 3:e115-23.

28. Sapci AH, Sapci HA. Artificial intelligence education and tools for medical and health informatics students: systematic review. *JMIR Medical Education*. 2020 Jun 30;6(1):e19285.
29. Ellahham S, Ellahham N, Simsekler MCE. Application of artificial intelligence in the health care safety context: opportunities and challenges. *Am J Med Qual*. 2019; 35:341–8?
30. Sisk BA, Antes AL, Burrous S, DuBois JM. Parental attitudes toward artificial intelligence-driven precision medicine technologies in pediatric healthcare. *Children*. 2020; 7:145.
31. Cheng VWS, Piper SE, Ottavio A, Davenport TA, Hickie IB. Recommendations for designing health information technologies for mental health drawn from self-determination theory and co-design with culturally diverse populations: template analysis. *J Med Internet Res*. 2021; 23:e23502.
32. Bauer GR, Lizotte DJ. Artificial intelligence, intersectionality, and the future of public health. *Am J Public Health*. 2021; 111:98–100.
33. Trewin S, Basson S, Muller M, Branham S, Treviranus J, Gruen D, et al. Considerations for AI fairness for people with disabilities. *AI Matters*. 2019; 5:40–63.
34. Ross J, Stevenson F, Lau R, Murray E. exploring the challenges of implementing e-health: a protocol for an update of a systematic review of reviews. *BMJ open*. 2015 Apr 1;5(4):e006773.
35. Syzdykova A, Malta A, Zolfo M, Diro E, Oliveira JL. Open-source electronic health record systems for low-resource settings: systematic review. *JMIR medical informatics*. 2017 Nov 13;5(4):e8131.
36. Organopoulou M, Tsironi M, Malliarou M, Alikari V, Zyga S. Investigation of anxiety and burn-out in medical and nursing staff of public hospitals of Peloponnese. *Int J Caring Sci*. 2014; 7(3):799–808.
37. Erfannia L, Barman MP, Hussain S, Barati R, Arji G. How mobile health affects primary healthcare? Questionnaire design and attitude assessment. *Digit Health*. 2020; 6:2055207620942357.
38. Estrin D, Sim I. Open mHealth architecture: an engine for health care innovation. *Science*. 2010; 330(6005):759–60.
39. Milošević M, Shrove MT, Jovanov E. Applications of smartphones for ubiquitous health monitoring and wellbeing management. *JITA-Journal Inform Technol Applications*. 2011; 1(1).
40. Kahn JG, Yang JS, Kahn JS. Mobile health needs and opportunities in developing countries. *Health Aff*. 2010; 29(2):252–8.
41. Fiordelli M, Diviani N, Schulz PJ. Mapping mHealth research: a decade of evolution. *J Med Internet Res*. 2013; 15(5):e2430.
42. Nelson R, Staggers N. Health informatics: An interprofessional approach. Elsevier Health Sciences; 2013 Jun 14.
43. Ayaz M, Pasha MF, Alzahrani MY, Budiarto R, Stiawan D. The Fast Health Interoperability Resources (FHIR) standard: systematic literature review of implementations, applications, challenges and opportunities. *JMIR medical informatics*. 2021 Jul 30;9(7):e21929.
44. Wu DT, Chen AT, Manning JD, Levy-Fix G, Backonja U, Borland D, Caban JJ, Dowding DW, Hochheiser H, Kagan V, Kandaswamy S. Evaluating visual analytics for health informatics applications: a systematic review from the American Medical Informatics Association Visual Analytics Working Group Task Force on Evaluation. *Journal of the American Medical Informatics Association*. 2019 Apr;26(4):314-23.
45. Simpao AF, Ahumada LM, Gálvez JA, Rehman MA. A review of analytics and clinical informatics in health care. *Journal of medical systems*. 2014 Apr;38:1-7.
46. Kay M, Santos J, Takane M, mHealth. New horizons for health through mobile technologies. *World Health Organ*. 2011; 64(7):66–71.
47. Chakeri A, Jalali E, Ghadi MR, Mohamadi M. Evaluating the effect of nurse-led telephone follow-ups (tele-nursing) on the anxiety levels in people with coronavirus. *J Family Med Prim Care*. 2020; 9(10):5351–4.
48. Planas R, Yuguero O. Technological prescription: evaluation of the effectiveness of mobile applications to improve depression and anxiety. Systematic review. *Inform Health Soc Care*. 2021; 46(3):273–90.