

REVIEW ARTICLE

Latest developments, obstacles, and upcoming patterns in the realm of eHealth informatics: Review

Manvi Mishra^{1,*}, Prabhakar Gupta², S. S. Bedi³

¹ Shri Ram Murti Smarak College of Engineering Technology and Research, Bareilly 243001, India

² Shri Ram Murti Smarak College of Engineering and Technology, Bareilly 243001, India

³ IET Mahatma Jyotiba Phule Rohilkhand University, Bareilly 243001, India

* Corresponding author: Manvi Mishra, er.manvimishra@gmail.com

ABSTRACT

The fusion of healthcare and information technology in eHealth informatics has rapidly evolved in recent years, presenting transformative possibilities for healthcare delivery. This article explores advancements, challenges, and emerging trends in this dynamic field, including telemedicine, wearable devices, Artificial intelligence, and data analytics. Despite promising developments such as predictive healthcare and personalized medicine, challenges like data security, interoperability, and ethical concerns must be addressed. Looking forward, the integration of genomics, Virtual Reality, and Argumented Reality is expected to reshape healthcare practices, emphasizing the importance of understanding and navigating these dynamics for an efficient, accessible, and patient-focused healthcare landscape.

Keywords: eHealthcare; eHealth informatics; telemedicine; Internet of Things; artificial intelligence; machine learning

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1. Introduction

eHealth informatics refers to the convergence of electronic communication, information technology, and healthcare practices to improve the quality, accessibility, and efficiency of healthcare services. The term “eHealth” stands for “electronic health,” highlighting the digital nature of the systems and solutions involved. The inclusion of “informatics” emphasizes the use of information and technology to enhance healthcare processes. In the contemporary landscape of healthcare, the convergence of technology and medical practice has given rise to a dynamic field known as eHealth informatics. This field encompasses a wide range of technologies and applications aimed at improving the quality, efficiency, and accessibility of healthcare services^[1]. Before the widespread adoption of eHealth informatics, healthcare faced several problems and limitations that impacted patient care, information management, and overall healthcare delivery. Some of these challenges included: Healthcare relied heavily on paper-based records and manual documentation, leading to inefficiencies in record-keeping, data retrieval, and sharing of patient information between healthcare providers. Access to patient records and medical history was often restricted to specific healthcare facilities or departments, hindering seamless care coordination and leading to redundant tests and procedures. Different healthcare providers often used isolated systems for record-keeping, making it difficult to obtain a

comprehensive view of a patient's health history, leading to fragmented care^[2]. Communication between healthcare professionals, especially across different locations or specialties, was slow and relied on phone calls, faxes, or physical letters, potentially delaying critical decisions. Patients living in remote or underserved areas faced challenges in accessing quality healthcare due to limited medical facilities and specialized services. Without effective data analysis and tracking, the focus was primarily on reactive treatment rather than proactive preventive care and health management. Paper records were vulnerable to loss, damage, or unauthorized access, raising concerns about patient data security and privacy. Without advanced data analytics, patient care plans were often generalized rather than tailored to individual needs, potentially leading to suboptimal outcomes. Healthcare professionals lacked real-time access to evidence-based information and clinical guidelines, which could impact the accuracy and speed of diagnoses and treatment decisions. Besides this Patients had limited access to their own health information and lacked the tools to actively participate in managing their health. Therefore, to overcome aforesaid deficiency in the medical sector the need of eHealth Informatics came into existence.

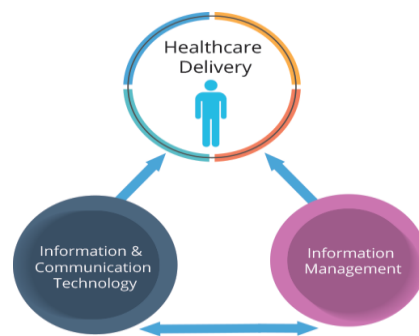


Figure 1. E-Health informatics^[3].

E-health informatics” refers to the interdisciplinary field that integrates information technology with healthcare practices to improve the management, analysis, and utilization of health-related information. It encompasses a wide range of technologies and methodologies aimed at enhancing healthcare delivery, patient outcomes, and population health. **Figure 1** depicts E-Health informatics^[4]. E-health informatics encompasses areas such as electronic health records (EHR), telemedicine, health information exchange (HIE), data analytics, artificial intelligence (AI), and wearable health technologies, among others. The goal of e-health informatics is to leverage digital tools and data-driven insights to optimize healthcare processes, enhance decision-making by healthcare professionals, empower patients in managing their health, and ultimately improve the overall efficiency and effectiveness of healthcare systems.

This multidisciplinary domain encapsulates a spectrum of innovations that have unfolded in recent years, reshaping the way healthcare is accessed, delivered, and experienced. From transformative breakthroughs to formidable challenges, the sphere of eHealth informatics stands at the nexus of pioneering developments, daunting hurdles, and promising trajectories that are poised to redefine the future of healthcare delivery. This article delves into the latest developments, the intricacies of challenges faced, and the emerging patterns that are charting the course for the evolution of eHealth informatics^[5].

The understanding the latest developments, obstacles, and upcoming patterns in the realm of eHealth informatics has become increasingly crucial. As technology continues to permeate every aspect of our lives, the fusion of healthcare and information technology presents a transformative potential. From cutting-edge advancements that promise to revolutionize patient care to complex challenges that demand innovative solutions, the landscape of eHealth informatics is a dynamic arena that holds profound implications for healthcare providers, policymakers, researchers, and individuals alike^[6]. Understanding the latest developments in eHealth informatics enables stakeholders to stay at the forefront of innovation, ensuring that they can harness the power of emerging technologies to improve healthcare accessibility, quality, and

efficiency. By keeping abreast of these advancements, healthcare professionals can make informed decisions about incorporating new tools, methodologies, and practices into their workflows. However, this journey is not without obstacles. The integration of technology into healthcare brings forth a myriad of challenges, including concerns related to data security, patient privacy, interoperability, and ethical considerations. These obstacles require thoughtful navigation and the development of strategies that balance the potential benefits of technology with the preservation of patient rights and well-being^[7].

Furthermore, identifying upcoming patterns in eHealth informatics is essential for proactive planning and strategic decision-making. Anticipating trends in telemedicine, wearable health devices, AI-driven diagnostics, and personalized medicine allows healthcare organizations to adapt their systems, policies, and practices accordingly. By staying ahead of these patterns, healthcare providers can prepare to offer more efficient and effective care, making the most of the opportunities presented by technological advancements.

This article is organized as follows: Section II presents an overview of the existing studies in literature applying e informatics. Section III discusses features of health Informatics. Recent developments of eHealth informatics are depicted in section IV. Obstacles of healthcare system is highlighted in section V. The section VI shows upcoming patterns in the arena of informatics finally, conclusion is given in section VII.

2. Literature review

In recent years, the field of eHealth informatics has witnessed significant advancements that have transformed the landscape of healthcare delivery. The integration of technology and healthcare has led to the emergence of innovative solutions aimed at improving patient care, enhancing data-driven decision-making, and increasing accessibility to medical services. These developments encompass a wide range of applications, including telemedicine, wearable devices, artificial intelligence, and data analytics^[8]. Smart hospitals have the potential to shape health and medical strategies and generate fresh medical benefits through the establishment and quantitative assessment of specific metrics derived from data gleaned from operational hospitals. This necessitates concurrent support from governmental incentives, cohesive interdisciplinary research efforts, and robust involvement from the industry to nurture and advance smart hospital initiatives^[9].



Figure 2. Robust health information systems^[10].

Figure 2 shows robust E-Health care system. Effective healthcare delivery relies significantly on the presence of robust E-health care system. Telemedicine and telehealth have become integral components of healthcare systems worldwide. The COVID-19 pandemic accelerated the adoption of virtual consultations and remote monitoring, highlighting the importance of these technologies in ensuring continuity of care, especially in challenging circumstances.

Wearable devices, such as fitness trackers and smartwatches, have gained popularity among individuals seeking to monitor their health and fitness levels. These devices offer real-time tracking of physical activity, heart rate, and sleep patterns, empowering users to take charge of their well-being.

The application of pixel-level methods for medical image fusion. The implementation involves utilizing principal component analysis in the spatial domain and employing both discrete wavelet transform and stationary wavelet transform in the transform domain. Notably, PRINCIPAL COMPONENT ANALYSIS Exhibits a blurring issue, while the discrete wavelet transform method offers high-quality spectral content. However, the time invariance problem associated with DWT in the transform domain is addressed by employing SWT. Through the assessment of entropy, standard deviation, RMSE, and PSNR values, it is evident that SWT emerges as a superior image fusion technique when compared to PCA and DWT^[11].

Artificial intelligence and machine learning have revolutionized healthcare by enabling accurate disease diagnosis, predicting patient outcomes, and personalizing treatment plans. These technologies leverage vast amounts of medical data to provide insights that aid healthcare professionals in making informed decisions. Deep learning framework designed to autonomously extract features in a hierarchical fashion^[12]. Neural networks are employed to categorize these features, specifically classifying leaves into three categories: absence of disease, bacterial spot, and Septoria leaf spot. The model's effectiveness is evaluated using accuracy as the performance metric, and the results affirm the method's reliability. This approach proves valuable for implementing corrective measures in the management of diseases affecting tomato plants.

Looking ahead, the future trends in eHealth informatics are promising. Predictive and preventive healthcare, driven by AI-powered analytics, holds the potential to identify health risks early and facilitate interventions that can significantly impact patient outcomes. The shift towards remote monitoring and home-based care is likely to continue, offering patients greater convenience and reducing the burden on healthcare facilities^[13]. The incorporation of genomics and personalized medicine into healthcare practices is anticipated to improve the precision of diagnoses and treatment plans. Virtual reality and augmented reality technologies have the potential to revolutionize medical education, training, and patient experiences, further enhancing the quality of care.

Image fusion plays a crucial role in medical imaging applications, aiding radiologists in identifying abnormalities in CT and MR brain images. Various image fusion algorithms have been implemented and their performance has been analyzed across different slices of brain MR images. The findings reveal that fusing Flair and T2 slices of brain MR images yields superior performance in terms of Signal-to-Noise Ratio (SNR) and Peak Signal-to-Noise Ratio (PSNR)^[14]. Notably, based on mean squared error (MSE), optimal results were achieved by combining T1ce and T1 slices for discrete wavelet transform (DWT), T1ce and T2 slices for Laplacian Pyramid, and T2 and Flair slices for principal component analysis (PCA) technique. Future research will explore hybrid techniques for fusion analysis without altering the inherent characteristics of medical images.

The realm of eHealth informatics is undergoing rapid transformation due to recent developments and innovative technologies. Despite challenges, the future holds exciting opportunities to advance healthcare delivery, improve patient outcomes, and shape the way healthcare is experienced and administered.

The advent of eHealth informatics has addressed many of these challenges by leveraging technology to create electronic health records, enable telemedicine, enhance data sharing, improve care coordination, and empower patients to be more engaged in their health journey.

While eHealth informatics offers significant benefits, it also brings its own set of challenges, such as data security concerns, interoperability issues, and the need for proper training and integration within healthcare systems^[15].

3. Features of eHealth informatics

In the realm of eHealth informatics, a holistic approach is paramount, encapsulating not only the technological facets but also the management, analysis, and effective utilization of health-related data. This

transformation, labeled as “eHealth,” signifies a pivotal shift from conventional paper-based health records to electronic systems, emblematic of the modernization permeating healthcare practices through technological integration. Acknowledging its interdisciplinary nature, eHealth necessitates collaborative efforts spanning healthcare professionals, IT experts, data analysts, policymakers, and beyond^[16]. With a global perspective, eHealth champions the exchange of information and healthcare innovations transcending geographic borders, fostering global health initiatives and knowledge dissemination. Rooted in patient-centered care, eHealth prioritizes the enhancement of health outcomes for individuals and communities through technology-driven interventions, while its emphasis on informatics underscores the seamless integration of information technology, data analytics, and communication systems, propelling innovation and efficiency in healthcare delivery.

In summary, “eHealth informatics” serves as a comprehensive term that encapsulates the transformative integration of technology, data, and healthcare practices. It reflects the evolution of healthcare in the digital age, where electronic systems and information-driven solutions play a pivotal role in enhancing patient care, clinical decision-making, and healthcare management^[17].

4. Recent advances in eHealth informatics

The COVID-19 pandemic catalyzed a significant shift towards telemedicine and telehealth solutions, revolutionizing healthcare delivery by integrating virtual consultations, remote monitoring, and digital health platforms into everyday practice. Wearable devices, including smart watches and fitness trackers, have emerged as indispensable tools for health monitoring and management, leveraging sensors to track vital signs, physical activity, and sleep patterns. These devices offer a plethora of benefits, from encouraging individuals to adopt healthier lifestyles through activity tracking to facilitating early detection of potential health issues through continuous monitoring of heart rate and other vital signs^[18]. Moreover, wearables play a crucial role in disease prevention and management by assisting individuals with chronic conditions, providing personalized healthcare insights, and enhancing medication adherence. Beyond individual health benefits, aggregated wearable data holds promise for advancing public health research, monitoring disease outbreaks, and supporting the aging population with features like fall detection and health trend tracking. Additionally, the integration of artificial intelligence and machine learning in healthcare is transforming medical diagnosis, disease prediction, and treatment personalization, while blockchain technology offers potential solutions for enhancing data security, interoperability, and patient consent management. These technological advancements underscore a paradigm shift towards more accessible, personalized, and secure healthcare delivery systems poised to shape the future of medicine.

5. Obstacles of E-healthcare system

Challenges in the eHealth informatics domain are multifaceted and require nuanced solutions to navigate. Data privacy and security concerns loom large as healthcare data becomes increasingly digitized, with fears of breaches and unauthorized access persisting. Data security is the key concern in today’s world. Balancing the imperative of data accessibility with the imperative of safeguarding patient privacy presents an ongoing dilemma. Interoperability emerges as another significant hurdle, as disparate electronic health records (EHR) systems often struggle to communicate effectively, hindering seamless data exchange crucial for comprehensive patient care^[19]. Moreover, navigating the evolving landscape of regulatory and ethical considerations remains complex, with issues such as patient consent, data ownership, and the ethical use of AI in healthcare challenging existing frameworks. Additionally, the digital divide persists, with certain populations lacking access to the technology necessary for eHealth services, thus potentially widening healthcare disparities. Addressing these challenges demands a concerted effort from stakeholders across sectors to ensure that eHealth innovations are not only transformative but also equitable and ethically sound.

So, there is high requirement to tackle these issues so that effective utilization of E healthcare system may be possible.

6. Upcoming patterns in the arena of informatics

The future of healthcare promises a transformative landscape shaped by innovative technologies and personalized approaches. AI-driven analytics and predictive models are poised to revolutionize healthcare delivery by enabling early identification of health risks and facilitating preventive interventions, ultimately alleviating the burden of disease. Moreover, the evolution towards patient-centric care will drive the development of remote monitoring solutions and home-based treatments, empowering individuals to manage their health outside traditional hospital settings. Advancements in genomics and molecular medicine will usher in an era of personalized medicine, tailoring treatment plans to individual genetic profiles for enhanced patient outcomes^[20]. Meanwhile, virtual reality (VR) and augmented reality (AR) stand to revolutionize medical training, pain management, and surgical procedures, offering immersive experiences for both medical practitioners and patients alike. Furthermore, leveraging data analytics for population health will enable the identification of trends, efficient resource allocation, and the design of targeted public health interventions, shaping a more proactive and responsive healthcare ecosystem.

7. Conclusions

In conclusion, delving into the latest developments, obstacles, and upcoming patterns in the realm of eHealth informatics is not merely a choice but a necessity. It empowers stakeholders to navigate the rapidly evolving landscape of healthcare technology, capitalizing on innovations while addressing challenges responsibly^[21]. This proactive approach ensures that the transformative potential of eHealth informatics is harnessed to its fullest, ultimately paving the way for a future where technology and healthcare converge to create a more accessible, efficient, and patient-centered healthcare ecosystem. The ongoing evolution of eHealth informatics is marked by significant technological advancements, including telemedicine, wearable devices, artificial intelligence (AI), and data analytics. These innovations have ushered in a new era of patient-centric care, promising improved healthcare delivery. However, the journey towards this future is not without its share of challenges. Issues such as data security, interoperability, and ethical concerns loom large and necessitate careful consideration and strategic solutions^[21].

Despite the challenges, recent advances have showcased great promise. The integration of predictive healthcare and personalized medicine into the eHealth informatics landscape holds the potential to revolutionize patient care. Furthermore, the anticipated incorporation of emerging technologies like virtual reality (VR) and augmented reality (AR) is expected to further shape the future of healthcare practices^[22]. These technologies, along with the integration of genomics, have the potential to significantly enhance the effectiveness and efficiency of healthcare delivery.

Looking ahead, it is imperative to proactively address challenges related to data security, interoperability, and ethical considerations. Responsible integration of technology is crucial for realizing the full benefits of eHealth informatics. Stakeholders need to collaboratively chart a course that considers both innovation and ethical considerations to ensure that the transformative power of technology is wielded responsibly.

In essence, this comprehensive understanding and proactive approach are key to navigating the interplay of innovations and challenges within eHealth informatics. By doing so, stakeholders can contribute to the creation of an efficient, accessible, and patient-focused healthcare landscape. Through this ongoing transformation, eHealth informatics continues to be a driving force in reshaping healthcare delivery for the better, offering the promise of improved patient care and outcomes.

Conflict of interest

The authors declare no conflict of interest.

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