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Review Article

Data Security and Privacy Protection in Health Information Management: Challenges and Solutions

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Abstract

This study provides a comprehensive review of the current trends and future challenges in the field of Health Information Management (HIM). With advancements in technologies such as big data, cloud computing, and artificial intelligence, the global health information management market is projected to experience rapid growth. Research indicates that HIM not only enhances the efficiency and quality of healthcare services but also contributes to improvements in public health and medical services worldwide. However, despite these significant advancements, the field continues to face numerous challenges, including patient data privacy and security, optimization of user interface design, and the demand for personalized information services. Therefore, this study focuses on these core issues and reviews related research in the field of health information management. It analyzes the advantages and limitations of various methods and technologies and predicts future development trends. Consequently, interdisciplinary collaboration, technological innovation, and personalized services are expected to be key directions for future development. This study not only reviews current trends and challenges in health information management but also provides strategic insights and innovative approaches that contribute to advancing the field, setting the stage for future research and practical improvements in data security and privacy.

Introduction

With the ongoing advancements in the global healthcare sector, Health Information Management (HIM) has increasingly become a core component of this field. HIM involves the collection, storage, retrieval, and dissemination of patient-related information with the aim of enhancing the efficiency and quality of healthcare services. In recent years, the global health information management market is anticipated to grow at an annual rate of 15%, reaching $150 billion by 2027. This growth is primarily attributed to the rapid development of technologies such as big data, cloud computing, and artificial intelligence. For instance, by 2022, approximately 60% of hospitals in the United States had adopted AI-assisted diagnostic systems, significantly improving diagnostic efficiency and reducing medical errors [1].

From an international perspective, various countries have explored and practiced health information management in diverse ways. For example, research communities in Iran have conducted comparative studies on scientific collaboration in medical informatics, health information management, and medical librarianship [2]. Similarly, the global development of health informatics has garnered broad attention, with contributions from organizations such as JAMIA [3]. Furthermore, China has actively engaged in research and practice related to health information exchange platforms, primary healthcare status, and challenges, among other areas [4]. The significance of this research lies in its comprehensive exploration of data security and privacy protection within health information management. By addressing these critical challenges, this study contributes to the enhancement of health information systems, thus promoting more secure and efficient healthcare practices globally. The insights provided aim to

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foster further interdisciplinary innovations and strengthen the field's foundational practices.

Domestically, the education of health information management has also received significant attention. Investigations ranging from online teaching practices to graduate employment quality surveys, and explorations of professional reform pathways, reflect the depth and breadth of education in this field. Moreover, technological and application-related topics, such as intelligent wearable health products, online health communities, and health code information resources in public health emergencies, have become research hotspots [5].

However, despite the substantial progress in health information management over the past decade, several challenges remain unresolved. This study will focus on three core issues: (1) How to ensure the privacy and security of patient data in a rapidly evolving digital healthcare environment; (2) How to optimize user interface design to enhance the usability experience of information systems for healthcare professionals and patients; and (3) How to better meet the health needs of the elderly and chronic disease patients through customized information services. Therefore, this study will review relevant research in the field of health information management, analyzing the advantages and limitations of various methods and technologies. It will delve into the application of health information management in different contexts and predict future development trends. The following sections will provide a detailed account of research findings and practical experiences in each sub-field, aiming to offer readers a comprehensive perspective.

Overview of global health informatics

Global Health Informatics (GHI) is a sub-field of health informatics that focuses on utilizing information technology and data science to enhance public health and healthcare services on a global scale. With technological advancements, large volumes of unstructured data are being collected and analyzed, providing valuable insights for physicians and decision-makers on how to expand operations and predict future treatment trends. Furthermore, GHI is concerned with improving the quality of patient diagnosis and treatment through information systems communication, enhancing public health systems, and assisting government agencies in designing and implementing public health policies.

In 2022, research highlighted the significance of inherent human dignity and inalienable rights as outlined in the Universal Declaration of Human Rights. This perspective offers a macro-level ethical view of global health informatics, underscoring the necessity of ensuring equitable access to healthcare services worldwide [6]. This ethical perspective complements the technological viewpoint presented in another 2022 study, which detailed the implementation of the HL7 FHIR framework, including its applications in healthcare settings such as workflow status and linking [1]. HL7 FHIR not only supports data interoperability but also provides the flexibility to customize health information systems for different countries and regions. These studies collectively illustrate the future development trends of global health informatics driven by both ethical and technological considerations, highlighting the importance of addressing global health equity alongside technological innovation.

In 2023, Siamian's research reviewed the scientific output and collaborative networks of Iranian researchers in the fields of medical informatics, health information management, medical librarianship, and information science. The findings indicated a significant growth in research output over the past decade, with the highest degree of collaboration observed in medical informatics [2]. Similarly, Fraser provided a retrospective on the academic domain of GHI and suggested ways in which journals like JAMIA could enhance global efforts in this field [3].

Comparing these papers reveals a shared emphasis on the importance and application value of health informatics in the global health arena. They all explore how information technology and data science can improve healthcare services and public health. However, each paper has its unique focus: Steffen's work in 2022 concentrates on human rights and global health; the second paper highlights the HL7 FHIR framework; Siamian focuses on Iranian researchers' scientific output and collaboration; and Fraser reviews GHI from an academic perspective.

Key issues in data security and privacy management

Health information management faces significant challenges related to data security and privacy. One of the primary issues is the growing threat of cybersecurity breaches. With the increase in the digitalization of patient records, healthcare institutions are more vulnerable to cyber-attacks, which can compromise sensitive patient information and disrupt operations. According to recent studies, healthcare data breaches can lead to severe consequences, including legal repercussions and loss of trust among patients and stakeholders.

Data breaches are often exacerbated by outdated systems that lack advanced security protocols. Many healthcare facilities, particularly in less-resourced areas, continue to rely on legacy systems that are not equipped to handle modern cybersecurity threats. In contrast, developed countries have made strides in adopting comprehensive data management strategies. For example, hospitals in the United States and parts of Europe have implemented robust encryption protocols, real-time threat monitoring systems, and multi-factor authentication to bolster data security.

The integration of advanced technologies like artificial intelligence and blockchain also plays a crucial role in enhancing data protection. These tools allow for predictive analytics in cybersecurity and immutable audit trails that can prevent unauthorized access or manipulation of data. The aim is to highlight these challenges and point out the advancements seen in developed nations, offering a comparative perspective that underscores the need for widespread adoption of best practices in data security and privacy management globally.

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Research on health information management

HIM is an interdisciplinary field that integrates knowledge from information technology, medicine, and public health to provide effective, safe, and efficient healthcare services. With the rapid advancements in information technology and biotechnology, the importance of HIM has become increasingly prominent. Various studies have employed different methodologies to explore key issues within this field. For example, Li, et al. in 2022 conducted a survey of 500 HIM graduates to assess their employment status and the alignment of their professional skills with job requirements. They utilized quantitative analysis methods and SPSS software for regression analysis, revealing a significant positive correlation between professional skills and job satisfaction. Additionally, Xiao, et al. used a case study methodology to analyze the construction process of a municipal health information exchange platform based on an in-depth investigation of the maternal and child health information management system in Chongqing [7].

In Li, et al.'s 2022 study, they examined the significance of online teaching methods for HIM professionals under special circumstances and found that both online and offline teaching content remained stable and high-quality. Another study by Zhang in 2022 surveyed the employment status of vocational HIM graduates and the adequacy of their professional knowledge and skills for job market demands, offering references for optimizing talent development programs (Zhang, 2022). Against the backdrop of rapid advancements in information and biotechnology, the integration of traditional healthcare technologies with new technologies has led to emerging directions such as smart healthcare and telemedicine. Furthermore, a study introduced the development of a health information management system for maternal and child health in Chongqing, based on a municipal health information exchange platform that spans multiple industries, departments, and institutions [7]. Tang, et al. in 2023, reviewed recent international literature on consumer health informatics, focusing on research papers, reviews, and conference papers from databases such as Web of Science, ScienceDirect, Scopus, and PubMed. Li, et al. in 2023, developed a path model based on the Stimulus-Organism-Response (S-O-R) theory framework to analyze how technological factors of smart wearable health products influence health behavior through user psychological variables. Yang, et al. in 2023, analyzed the personal health information management behavior characteristics of users in online health communities and explored the relationships among elements in the platform-PHIM-health goals model. Finally, Qin, et al. systematically reviewed the development of primary healthcare in China over the past 45 years, summarizing the progress and achievements in implementing primary healthcare [4].

These papers address various aspects of health information management, including education, employment, professional development, information system construction, literature review, product technology impact modeling, user behavior analysis, and historical development. They all emphasize the crucial role of information technology in HIM and propose various methods and strategies to enhance the efficiency and effectiveness of health information management. However, each paper presents unique research focuses and methodologies. For instance, some papers concentrate on education and training, while others focus on the development and application of information systems and technologies [7]. Some papers are dedicated to literature review and analysis, others to user behavior characteristics, and others to historical and developmental studies [4]. These diverse research focuses and methods reflect the complexity and variety within the field of health information management.

Public health and health management

The mechanism for sharing health code information has emerged as a significant topic during public health emergencies. Research by Li and Zhao [5] indicates that current health code information sharing encounters issues of inefficiency across multiple stages. This problem primarily arises from inconsistencies in information collection and processing methods among local governments, leading to discrepancies in information standards [5]. Such barriers to information sharing not only diminish the effectiveness of responding to public health crises but also potentially cause delays in information, thereby impacting the timeliness of preventive measures. Further analysis reveals that the fundamental cause of these issues is the absence of a unified national health information-sharing standard and platform, with local governments experiencing variations in technical capabilities and resource allocation. Therefore, it is recommended to establish a centrally-led health information-sharing platform with standardized technical protocols to ensure the accuracy and timeliness of information.

To more clearly illustrate the differences in health code information-sharing mechanisms across regions, Table 1 presents performance scores for information collection, processing, and application stages in major provinces and cities nationwide. It is evident that Beijing and Shanghai have notably higher scores in the information processing stage, attributed to their advanced information technology infrastructure and well-established management systems. In contrast, some western provinces exhibit lower scores in the information collection stage, reflecting deficiencies in technology and resources.

In a 2023 study, Zhang, et al. investigated the basic physician insurance program implemented in rural areas of Shanxi, Hubei, and Henan provinces by the National Health

Table 1: Performance Scores of Health Code Information Sharing Mechanisms in Major Provinces and Cities Nationwide [5].

Province/ City	Information Collection	Information Processing	Information Application
Beijing	9.00	9.50	9.20
Shanghai	8.80	9.30	9.00
Guangdong	8.50	8.70	8.80
Sichuan	7.20	7.50	7.30
Yunnan	6.80	6.70	6.90

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Commission of China and the Gates Foundation. The aim of this program was to explore effective models for basic services and to support health poverty alleviation efforts. The results indicated a stable increase in standardized management rates for hypertension and diabetes, a reduction in hospitalization costs, and an improvement in healthy lifestyle behaviors. Another study by Chen, et al. in 2023 focused on the self-reported health information needs of university students. The findings revealed that health needs on college campuses are primarily driven by personal and social factors. Social factors mainly include the current pandemic situation, societal phenomena, and government actions, whereas personal factors focus on disease prevention, etiology, and diagnosis. Additionally, a 2023 study analyzed the health code information sharing issues during the COVID-19 pandemic, exploring the mechanisms and countermeasure models related to difficulties in sharing health certificate information. The results indicated that differences in data collection methods and content, as well as discrepancies in information processing and application stages, contribute to challenges in sharing health voucher information resources [5].

In 2024, Ren, et al. examined the role of ideological and political theory courses in cultivating socialist builders and successors, and in promoting the comprehensive development of students in moral, intellectual, physical, aesthetic, and labor aspects. The study emphasized that the essence of such courses lies in imparting principles, focusing on their theoretical, moral, and philosophical content, thus guiding students to understand theoretical principles and philosophical insights. Another study by Yang, et al. in 2024 utilized data mining combined with bioinformatics techniques to compare gene chip databases between patients with adenomyosis and a normal population, identifying differential genes and analyzing the biological processes and potential targets involved, thereby predicting potential drugs for treating adenomyosis. Ma, et al. in 2024 provided a comprehensive exploration of the development, theoretical foundation, and practical application of Lingnan medicinal cuisine, highlighting its unique integration with traditional Chinese medicine. The study also addressed challenges and future directions for Lingnan medicinal cuisine, advocating for technological innovation, policy support, and global integration [8]. Lastly, a 2024 study discussed the impact of data integration on talent management, focusing on sustainable practices in human resources. This research provided practical examples of balancing data-driven strategies with the essential elements of human resource management [9].

These papers address various aspects of public health and health management, including basic health care services, health information needs, and acquisition, health policy formulation and implementation, and the application of new technologies in health management. They all employ empirical research methods, collecting and analyzing data to validate their hypotheses and conclusions. However, each paper has a unique research focus and methodology. For instance, Zhang, et al. focus on the effectiveness of basic physician insurance programs; another study examines the health information needs of university students; another explores issues in health code information sharing; Ren, et al. investigate the role of ideological and political theory courses; another study delves into differential gene queries using gene chip databases; Ma, et al. discuss the development and application of Lingnan medicinal cuisine; and the final study explores the impact of data integration on talent management.

Medical and health information technology

Although healthcare information technology holds significant potential for improving the efficiency and quality of medical services, its application still faces numerous challenges. Firstly, data security is a critical issue. With the widespread adoption of Electronic Health Records (EHRs), the risk of healthcare data breaches has increased. Recent years have seen frequent occurrences of data breaches, which not only threaten patient privacy but may also lead to severe legal consequences [3]. Consequently, there is an urgent need to enhance the application of data encryption technologies and to establish stricter access controls and monitoring mechanisms to ensure data security [2].

Secondly, the issue of technology adaptability cannot be overlooked. Variations in technological infrastructure and personnel competence among different healthcare institutions lead to uneven application of new technologies. For instance, primary healthcare institutions often struggle to fully utilize telemedicine systems due to a lack of technical support and training [1]. Therefore, it is advisable to consider providing technical training and infrastructure support through government or Non-Governmental Organizations (NGOs) to ensure effective technology implementation across healthcare settings [6].

A 2022 study focused on the transitional readiness of Adolescents and Young Adults (AYAs) in managing chronic diseases and how health anxiety affects their Health-Related Quality of Life (HRQoL) [10]. Another study examined the issues faced by individuals with intellectual and developmental disabilities regarding Sexual and Reproductive Health (SRH), and the challenges and support encountered by healthcare providers in SRH education [11]. Additionally, a study aimed to identify health information technology incidents related to multi-patient management and the associated risks [12]. AlKahtani's 2022 study measured the digital health transformation readiness of various hospitals in Eastern Saudi Arabia and compared it with the goals of Saudi Vision 2030 [13]. Kinnunen's 2023 investigation described nurses' perceptions of their information competency regarding health information systems [14]. Nijhof's 2024 study explored the health support experiences of individuals with intellectual disabilities from the perspectives of patients and support workers [15]. Another study assessed the impact of the Lightwave Health Information Management System (LHIMS) implemented at Cape Coast Teaching Hospital on the quality of medical data [16].

The final study explored how to incorporate safety practices into Health Information Technology (HIT) work within primary and community care settings [17]. These

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papers address various aspects of the application and impact of healthcare information technology. They differ in their research focus and methodologies. Some studies concentrate on specific populations or issues, such as chronic disease management in adolescents, sexual and reproductive health for individuals with intellectual disabilities, and risks in multi-patient management. Other studies focus more on the implementation and application of technologies and systems, such as digital health transformation readiness, nurses' information competency, and the impact of electronic health record systems. Collectively, these studies reveal the potential of healthcare information technology to enhance the quality of medical services and patient health but also highlight the challenges and issues that need to be addressed in its implementation and application.

Summary and future directions

In summary, this study provides a comprehensive analysis of several key areas within Health Information Management (HIM). Firstly, in the realm of Global Health Informatics, our systematic review reveals that data interoperability and ethical considerations are the two core elements driving global health information sharing and collaboration [3]. Secondly, within the field of health information management, research indicates that the quality of education and training directly impacts job satisfaction among practitioners. Moreover, the construction of information systems has significantly enhanced the efficiency and safety of medical services. Finally, studies in public health and health management underscore the importance of information-sharing mechanisms in addressing public health emergencies, particularly highlighting the lack of standardized protocols as a major challenge in the implementation of health code systems [5].

Education and training are also pivotal research directions in the HIM field. From online teaching practices in health information management programs to surveys on employment quality among graduates of vocational health information management programs, these studies reflect the critical role of education in preparing future health information technology professionals. Additionally, some research explores the integration of traditional medicine with modern science and the transformative impact of data integration on contemporary talent management like that of Ahmed in 2024. However, despite these advancements, the HIM field continues to face numerous challenges. Issues such as ensuring the security of health information systems [12], managing multiple patient medical events, and addressing health anxiety among service providers require further investigation [10].

Looking ahead, the HIM field is likely to evolve in several directions. Firstly, with the advancement of artificial intelligence and big data technologies, automated and intelligent health information processing is expected to become mainstream [1]. Secondly, interdisciplinary collaboration will become increasingly significant, with the integration of bioinformatics and HIM offering new opportunities for health management. Furthermore, personalized health information services will continue to develop to meet the specific needs of different users. Lastly, with the progression of globalization, cross-national and cross-regional health information exchange and cooperation will become more frequent [13]. In conclusion, the field of health information management is at a juncture filled with opportunities and challenges. Through ongoing research and innovation, there is potential to build a more efficient, secure, and user-friendly health information system, thereby contributing significantly to global health efforts.

In the context of evolving challenges in health information management, the education of students is expected to adapt to incorporate a stronger emphasis on data security and privacy. Curricula will need to include training in advanced cybersecurity measures, risk assessment methodologies, and the use of emerging technologies such as blockchain and artificial intelligence to ensure comprehensive preparation for real-world challenges. This focus will better equip future professionals to handle complex issues related to patient data and system vulnerabilities.

This study, while comprehensive in its review of data security and privacy issues within health information management, has certain limitations. The primary limitation is the focus on secondary data sources and literature, which may not fully capture the rapidly changing landscape of HIM practices. Additionally, the scope of the review did not include extensive case studies or empirical data that could further substantiate the findings. Future research could expand on these aspects by incorporating longitudinal studies and practical applications to validate the proposed insights.

Conclusion

This study has highlighted key challenges and advancements in health information management, focusing on data security, privacy protection, and the integration of advanced technologies. The analysis underscores the importance of implementing robust cybersecurity measures, adopting innovative technologies, and fostering global cooperation to improve health data management. Moving forward, interdisciplinary collaboration and continuous advancements in education and training will be essential to address the dynamic landscape of HIM. Ultimately, the goal is to create a secure, efficient, and patient-centered system that enhances healthcare delivery and safeguards patient data.

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