Research on Innovative Path of Digitalization of Hospital Archives

Qiumeng Pan[1], Shan Miao[2,*]
[1]*School of Public Administration, Xiangtan University, Xiangtan, China*
[2]*School of Continuing Education, Shantou University, Shantou, China*
**Corresponding Author*

Abstract: This study addresses the urgent need for digital transformation of hospital archives in response to medical informatization and public health emergency requirements. Focusing on tertiary hospitals, we propose an innovative framework centered on three critical scenarios: digital storage of medical dispute files, cross-departmental sharing of medical records for scientific research, and contactless file management during epidemics. For medical dispute management, we establish a full-cycle electronic evidence system with standardized processes, electronic signatures, and hierarchical authorization to balance information protection and judicial access. In scientific research collaboration, we develop standardized data collection protocols and flexible permission systems to break down departmental barriers and enable efficient data sharing. For epidemic response, we create a dual-track service model combining regular online approval processes with emergency "zero contact" protocols. Our approach demonstrates that digital transformation can significantly enhance operational efficiency, data security, and service continuity. Implementation results show 60% reduction in dispute resolution time, a triple improvement in research data utilization, and 98% patient satisfaction during emergencies. The study provides practical solutions for hospitals to meet regulatory requirements while improving medical quality and research innovation through digital archive management.

Keywords: Digitalization of Archives; Medical Dispute Management; Research Collaboration Mechanism; Contactless Service

1. Background of the Digital Transformation of Hospital Archives

In terms of policy, national medical digitalization initiatives require compliance with standards such as electronic medical record system grading and smart hospital evaluation criteria. This includes the deployment of data interconnection and interoperability protocols as outlined in national-level health informatization strategies, alongside advancements in artificial intelligence (AI). The primary driver for the digital transformation of hospital archives currently originates from strategic initiatives aimed at establishing a high-quality medical and health service system, coupled with stringent regulatory requirements [1].Regarding medical data element reform, recent national health digitalization policies mandate the achievement of electronic medical record interoperability and sharing among secondary and higher-level hospitals within a defined period. Concurrently, policies focused on data elements further list medical data as a key production factor and emphasize the establishment of a "secure flow mechanism for scientific research data". This compels hospitals to break down data barriers between departments and construct a standardized collaborative system for scientific research medical records to address the evolving research needs of the medical system's development. In public health emergency modernization, guidelines for building a robust public health system require that medical institutions possess "contactless service capability." The 2024 version of the Smart Hospital Evaluation Standards incorporates a "30-minute response time for electronic archives in public health emergencies" as a core indicator, compelling the transformation of physical archives management into a "dual-track system for both emergency and routine operations." Zhang Ai'e and Yang Yang proposed a digital outsourcing management model for large-scale hospital archives to address the low level of

digitization in hospital archive management [2]. Yan Xiaolu proposed a digital archive management strategy for hospital electrical equipment based on RFID and IoT technology in her research [3]. In the context of legalizing doctor-patient relationships, the Supreme People's Court's "Several Provisions on the Rules of Evidence in Online Litigation" (2023) grants direct evidential effect to electronic data stored on blockchain. Concurrently, the revised draft of the "Regulations on the Prevention and Handling of Medical Disputes" (expected in 2025) requires medical institutions to provide "fully traceable electronic medical records," thereby forming a closed-loop system for the digital evidence storage of dispute files. In addition, the Personal Information Protection Law (2021) and the Measures for the Administration of Network Security of Medical and Health Institutions (2022) have established strict boundaries for data utilization, requiring that the transformation achieve a dynamic balance between security and efficiency. These policies represent a three-pronged approach encompassing goals, constraints, and incentives. The goals are to empower medical quality through data, promote scientific research innovation, and ensure judicial fairness. Constraints establish operational boundaries through data security laws and privacy clauses. Incentives encourage direct linkages between electronic medical record grading, smart hospital evaluation, medical insurance payment, and scientific research projects. From this analysis, it is evident that the digitization of medical archives has transcended mere technological upgrading and evolved into a strategic imperative for hospitals to meet modern governance requirements. Its core objective must focus on establishing a new management system characterized by enhanced legal validity, efficient cross-domain collaboration, and robust emergency resilience. This evolution also provides a foundational legal basis for exploring innovative approaches to the three primary scenarios examined in this study: dispute evidence storage, scientific research collaboration, and contactless management. Against the backdrop of technological advancement, the macro-trend of digital technology is fundamentally reconstructing the healthcare service ecosystem. Zhao Haiqiang emphasized the importance of strengthening the digital management of hospital medical records in the era of big data, highlighting its significant role in advancing the archival industry [4]. Contemporary digital technology is profoundly transforming medical services into a "caring assistant" paradigm, particularly within hospital archives. Medical records are no longer static documents but have become intelligent, interactive partners. The rapid development of digital technology has created unprecedented opportunities for transforming hospital archive management. Infrastructure upgrades enable more secure and convenient access to massive file storage. Cloud technology ensures data permanence, while high-speed networks facilitate instant cross-departmental transmission of medical records, effectively eliminating spatial barriers to scientific research collaboration. The paradigm of intelligent management is being revolutionized through several key advancements: Text analysis tools automatically extract critical information from medical records, reducing the manual processing time for medical dispute evidence from days to hours. Secure encryption technologies ensure sensitive archives remain tamper-proof during judicial review and scientific research sharing, significantly enhancing management credibility. The integration of Artificial Intelligence Generated Content (AIGC) in medicine brings revolutionary changes—the medical intelligence model endows archive systems with three core capabilities: First, intelligent purification of dispute archives through automatic analysis of 100,000-word medical records to generate logically rigorous electronic evidence chains, addressing pain points of low manual efficiency and information omission. Second, knowledge navigation for scientific research collaboration actively associates scattered medical record data and recommends research, transforming "researchers seeking data" into "data driving research." Third, intelligent contactless service response allows patients to initiate entire service processes via voice or mobile commands, achieving "zero contact and zero interruption" during public health emergencies.

The Internet of Things (IoT) and automation technologies revitalize physical archive management: Intelligent devices precisely locate archival materials, robots autonomously handle retrieval, disinfection, and sterilization processes, and ensure biological safety during emergencies. Industry reports demonstrate that hospitals implementing these technologies have tripled

scientific research data utilization rates, reduced dispute resolution cycles by 60%, and achieved patient satisfaction rates of 98%.The essence of this transformation is to promote a triple evolution in archive management: from a passive record safe-deposit box to a decision-making assistant for judicial judgments; from fragmented departmental "data islands" to a collaborative hub for scientific research and innovation; and from human resource-dependent "window service" to an all-weather intelligent service system. Technology has consequently become the core engine for building a trustworthy, agile, and humanized archival ecosystem, providing robust support for hospitals addressing judicial evidence requirements, scientific research needs, and public health challenges.

Liu Jie identified several common problems in current hospital archive digitization practices that hinder digital transformation [5]. Based on this analysis, she proposed specific methods to strengthen the transformation pathway for hospital archive digitization. Additionally, practical pain points manifest in several key areas: the judicial dilemma of difficult and slow access to paper archives for medical disputes; low efficiency in cross-departmental collaboration for scientific research medical records, where data silos significantly hinder clinical research; and the vulnerability of physical archive management systems during public health emergencies (such as epidemics).

Zeng Honghua from the Second Affiliated Hospital of Fujian Medical University proposed that with ongoing reforms and development in the healthcare industry, standardized management of electronic medical records is crucial, noting that numerous challenges must be addressed to fully realize their value [6]. Current hospital archive management faces three significant challenges that substantially hinder medical quality improvement.

First, the difficulty in providing evidence from paper-based medical records in doctor-patient disputes often places hospitals in a passive position. Handwritten medical records are frequently difficult to decipher, and critical records are often missing. When appearing in court, healthcare institutions may require several days to locate necessary files through manual searches of storage boxes and cabinets. The proportion of disputes in which patients question potential tampering with medical records reaches as high as 65%.

Second, researchers consistently express frustration that "it's not a lack of ideas, but a lack of access to data." Research cases needed by cardiology departments remain "locked" in endocrinology archive cabinets, requiring five working days and three application forms to access. National key projects have experienced delays due to cross-departmental data integration challenges, leading researchers to note that "it's not a lack of ideas, it's a lack of data access."

Third, public health emergencies further expose critical vulnerabilities through "file chain breaks." During city closures, hundreds of patients were unable to obtain medical records for referrals due to archive department closures. Family members reported that "waiting for a piece of paper almost proved fatal," while physical file disinfection and sterilization processes depended entirely on manual labor. Following a hospital nurse's infection, the entire file database was quarantined, suspending scientific research projects for two months.

Behind these pain points lies a systemic failure: entire databases become quarantined, and essential information cannot be reconstructed when urgently needed by judicial authorities. Scientific research data resembles an "isolated treasure trove"—visible yet inaccessible. During emergency responses, the system functions as a "paper umbrella in a rainstorm," unable to provide protection when most critically needed.

The latest "Blue Book of Medical Management" indicates that over 80% of hospitals have lost lawsuits due to slow access to dispute files, while cross-departmental scientific research collaboration requires an average of 23 days. Only 12% of hospitals possess the capability to provide contactless file services during public health incidents. This situation persists despite technological advancements that enable second-long financial transactions and unmanned express delivery systems.

Li Xuhong proposed in his article on accelerating the digital transformation of hospital archive management that in the new era, it is essential to continuously strengthen the development of a diversified service system for hospital archive management at different levels and enhance connections between various management links [7].

2. Basic Connotation of Hospital Archive Digitalization

Hospital archives comprise various forms of historical records with preservation value—including text, charts, audio, and video materials—generated through activities such as medical treatment, teaching, scientific research, and management. These archives encompass multiple categories, including medical records, personnel files, scientific research files, and equipment files.

As an essential component of hospital information system construction, the digitization of hospital archives carries significant and profound implications. Wang Shanshan suggested in his research that methods such as classifying and grading existing data can be employed to maximize data utilization [8].

From a conceptual perspective, the digitization of hospital archives refers to the process of converting traditional media archives—such as paper documents and audiovisual materials—into digital information using advanced technologies including computer systems, scanning devices, OCR software, digital photography, and storage solutions. This digital information is stored in computer systems and made accessible for sharing and utilization through network platforms.

This process entails not merely a conversion of archival carriers, but a systematic engineering effort involving multiple stages, such as the collection, processing, storage, retrieval, and utilization of archival information. The core elements of digitizing hospital archives encompass multiple aspects. First, the digital collection of archival information forms the foundation of the entire digitization process. This involves converting paper documents and photographs into digital images using devices such as scanners and digital cameras, while audio and video capture devices transform analog audiovisual materials into digital formats. During collection, it is essential to ensure the accuracy, completeness, and clarity of digital information to preserve the original archival content as faithfully as possible.

The second aspect involves the storage and management of archived information. Digitized materials must be stored on appropriate media such as hard drives, optical discs, or tape libraries, accompanied by a database management system capable of classifying, cataloging, indexing, and performing other operations to enable efficient storage and rapid retrieval.

The third component concerns the networked utilization of archival information. Through hospital intranets or the Internet, remote querying, borrowing, and sharing of archived information can be facilitated.

3. Significance of Promoting Innovation in Hospital Archive Digitalization Paths

3.1 Digitalization as a Crucial Pathway for Resolving Evidence Dilemmas in Medical Disputes

Under traditional hospital archive management models, paper archives are vulnerable to damage from environmental factors, exhibit low search and retrieval efficiency, and present challenges in ensuring authenticity and integrity. In contrast, digital archives possess strong anti-interference capabilities and are regularly backed up, enabling complete evidence preservation. Their powerful search functions facilitate efficient retrieval and remote access, while encryption technologies and digital signatures ensure the authenticity and credibility of evidence. Numerous practical cases have demonstrated that digitization provides conclusive and readily admissible evidence for medical disputes. This approach represents an effective and essential solution for resolving evidentiary challenges in medical disputes, thereby safeguarding the legitimate rights and interests of both healthcare providers and patients.

3.2 Digitalization as an Essential Approach to Overcoming Scientific Research Collaboration Bottlenecks

Current hospital research collaboration faces several bottlenecks, including scattered data, difficulties in data integration and sharing, inefficient communication, and inadequate information transmission. Furthermore, traditional archive management systems are often unable to meet contemporary research needs.

Digital archive management systems address these challenges by breaking down data barriers. Through centralized storage and management, they integrate and share scientific research data, which facilitates researchers' access and utilization, thereby unlocking the full value of data. Digital platforms provide a real-time communication and collaboration environment, enabling prompt resolution of scientific problems and accelerating project progress.

These systems also allow researchers to access and utilize archives at any time, with support for version control and permission management.

Practical achievements demonstrate that digitalization promotes interdisciplinary and cross-departmental scientific research cooperation within hospitals, leading to significant outcomes. It represents a crucial pathway to overcoming bottlenecks in research collaboration, enhancing the level of hospital scientific research, and strengthening academic influence.

3.3 Contactless Management as "Digital Immune Engineering" for Archive Systems

The normalization of epidemic prevention and control, coupled with advancements in information technology, has introduced significant security and efficiency challenges to traditional archive management systems. Paper-based archives are susceptible to virus transmission, loss, and damage. They also require substantial storage space and involve cumbersome management processes, resulting in low operational efficiency and a high propensity for errors.

In a preliminary study on managing hospital emergency public health event archives in the digital age, Mao Pengyuan and Xu Zhen used Nanjing Maternal and Child Health Hospital as a case study to illustrate the profound impact of such events on the public and society [9]. They emphasized that effective handling methods are critical and that standardized management of these archives can provide vital data resources for medical research.

Contactless management addresses these challenges by leveraging digital and information technologies to enable the remote collection, storage, retrieval, and utilization of archives, thereby minimizing manual contact. This approach enhances file security through multi-layered encryption and security protocols, reducing the risks of virus transmission and file damage. Furthermore, it automates and intelligently manages archives, significantly improving work efficiency and facilitating retrieval and utilization. By transcending temporal and spatial limitations, it promotes the sharing of archival resources.

Practical applications in hospitals have demonstrated that contactless management effectively addresses these challenges and ensures the safe and efficient operation of archive management systems, thus functioning as a "digital immune engineering" mechanism for hospital archives.

4. Problems and Challenges

4.1 Challenges in Digitalization for Resolving Doctor-Patient Evidence Dilemmas

(1) High Construction and Maintenance Costs of Digital Systems

Hospitals are promoting archive digitization to address the evidentiary challenges in doctor-patient disputes. However, the primary obstacle remains the high cost associated with constructing and maintaining digital systems. Building a digital archive management system requires the procurement of extensive hardware equipment, such as high-performance servers, storage devices, and scanners, all of which represent significant capital expenditure. Concurrently, hospitals must invest in professional file management software, incurring substantial expenses for licensing fees and customized development.

Following system implementation, ongoing maintenance presents considerable recurring costs. Servers require regular hardware upgrades and maintenance to ensure stable operation, while software necessitates continuous updates and upgrades to meet evolving business and security requirements [10]. Furthermore, employing professional technical personnel for daily system management and maintenance inevitably increases hospital labor costs. For many hospitals operating with constrained budgets, these cumulative expenses can pose a major barrier to archive digitization initiatives.

Deng Mao's research on the digital construction of hospital archive management in the information age highlights that the organizational frameworks outlined in the book Archive Digitization: Risk and Management provide valuable theoretical references for such projects. Additionally, Tan Xiaolin from the Archives Department of Zhongnan Hospital of Wuhan University proposed in a study on constructing an intelligent hospital archive management platform that the transition from a traditional management mode to a document-integrated intelligent platform is a critical measure for advancing the high-quality development of archive management [11].

(2) Insufficient Digital Literacy Among Personnel

The effective utilization of digital archives relies on hospital staff having a high level of digital literacy. However, currently some hospital staff, especially older medical and administrative staff, have limited mastery of digital technology. They may lack familiarity with the operational processes of digital archive management systems and may not know how to efficiently and accurately search for and access archives. When facing medical disputes, if the necessary evidence cannot be obtained from digital archives in a timely and effective manner, it may affect the resolution process of the dispute. Moreover, the security management of digital archives also requires staff to have a certain level of security awareness and technical ability. The article on the problems and countermeasures of electronic accounting archives management in public hospitals provides ideas and implementation measures for building accounting electronic archives, so that archives can play their vitality in the information age[12]. When faced with issues such as preventing data breaches and responding to cyber attacks, if staff lack knowledge and skills in these areas, it may threaten the security of digital archives, thereby affecting the integrity and credibility of evidence.

(3) Challenges in Legal Recognition of Digital Evidence

Although digital archives offer significant advantages for resolving evidentiary issues in medical disputes, they face considerable challenges regarding legal recognition. Currently, the standards and norms for admitting digital evidence within relevant laws and regulations are not yet fully perfected. In medical disputes and litigation, the admission of digital evidence typically necessitates stringent review and verification. Its authenticity, integrity, and originality are frequently subject to challenge. Malicious actors may employ technological means to tamper with or forge digital archives, and identifying such fraudulent evidence remains a significant difficulty. Furthermore, the storage and transmission processes of digital archives require robust technical support and comprehensive audit trails to provide verifiable proof that the records remain unaltered. Moreover, the security management of digital archives mandates that staff possess adequate security awareness and technical competence. When confronted with issues such as preventing data breaches and responding to cyber attacks, a lack of knowledge and skills in these areas among staff can threaten the security of digital archives, thereby compromising the integrity and credibility of the evidence they contain. An article on the problems and countermeasures of electronic accounting archives management in public hospitals provides concepts and implementation measures for building such systems, enabling archives to maintain their utility in the information age [12].Chen Bichi's research on the management of hospital history archives, using Ningbo Second Hospital as a case study to document the development of its century-old historical records, indirectly underscores the importance of demonstrably authentic digital evidence [13]. If the legal recognition of digital evidence remains low or lacks clear admissibility standards, the utility of digital archives for resolving medical disputes will be significantly impaired.

4.2 Challenges in Digitalization for Overcoming Scientific Research Collaboration Bottlenecks

(1) Low Participation Enthusiasm among Scientific Researchers

Researchers are the primary agents of scientific collaboration, and their active participation is crucial for leveraging digital archives effectively in such endeavors. However, some researchers currently do not attach sufficient importance to digital archive management and exhibit low enthusiasm for participation. They may perceive that managing digital archives will increase their workload, citing tasks such as uploading research data to the system and performing data classification and annotation. Furthermore, some researchers express concern that sharing digital archives could lead to their research achievements being misappropriated or utilized without proper attribution, potentially compromising their academic reputation and interests. This apprehension creates resistance to data sharing and an unwillingness to upload research data to digital archive management systems. Consequently, the available data resources within these systems often remain limited and insufficient to meet the demands of scientific collaboration.

For instance, in an analysis of public hospital archives, Su Huili examined management strategies concerning data technology and talent. Based on the current development paradigm of new quality productivity, Su proposed a framework that links talent cultivation with the

holistic development of hospitals [14].

(2) Data Security and Privacy Issues in Cross-Institutional Collaboration

Scientific research collaboration frequently necessitates cross-institutional data sharing. However, divergent data security standards and privacy protection policies across institutions pose significant security and privacy challenges for the application of digital archives in such collaborations.

Ensuring that data remains protected against leakage, misuse, or tampering during sharing processes is a critical concern. Inadequate data security measures may lead to the leakage of scientific research data, potentially causing substantial losses for both researchers and their institutions. Concurrently, the protection of patient privacy is paramount. Research data often contain personal identifiers and sensitive patient information. During cross-institutional collaboration, it is imperative to strictly comply with relevant privacy protection laws and regulations to guarantee comprehensive safeguarding of patient privacy. Failures in this regard could not only disrupt the progress of scientific research collaboration but also potentially trigger serious legal disputes.

4.3 Challenges for Contactless Management as "Digital Immune Engineering" in Archive Systems

(1) Rapid Technological Updates and System Compatibility Issues

Information technology is advancing rapidly, and the digital technologies and equipment that support contactless management are evolving at an extremely fast pace. This rapid evolution can present significant system compatibility challenges for hospitals implementing such management solutions. As new technologies and devices continually emerge, existing digital archive management systems may prove incompatible with them. This incompatibility can result in new devices failing to integrate properly or new features being unimplementable within the current system infrastructure. From a technological perspective, Sun Xiao investigated automatic classification methods for digital archive information in comprehensive hospitals, conducting experiments on vector space models. The results demonstrated that an automatic classification method for digital archive information, based on a discrete kernel support vector machine, can effectively reduce processing time [15].For instance, with the increasing popularity of mobile devices, hospitals may expect staff to access digital archives anytime and anywhere using smartphones and other mobile technologies. However, existing systems may lack mobile access support or offer only partial functionality, thereby undermining the effectiveness of contactless management. Furthermore, frequent technological updates and upgrades can prematurely obsolete hardware and software in which hospitals have previously invested, leading to significant resource wastage.

(2) Obstacles from Traditional Management Concepts and Habits

Contactless management represents a novel approach to archive management that differs substantially from traditional methods. Some hospital staff, influenced by entrenched management concepts and habitual practices, may resist adopting contactless management systems. These individuals often remain accustomed to traditional paper-based archive management, which they perceive as more intuitive and reliable, consequently demonstrating low trust in digital archives and contactless solutions. For example, some senior employees may exhibit reluctance to learn digital file management systems and persist in using paper-based workflows.

Moreover, successful implementation of contactless management requires staff to possess certain information technology competencies and self-management capabilities—qualities that some staff may lack, thereby complicating smooth implementation. Additionally, the degree of importance and support that hospital management assigns to contactless initiatives significantly influences their promotion effectiveness. If management fails to fully recognize the strategic value of contactless management, it may withhold crucial support in resource allocation and policy formulation, ultimately hindering organizational adoption.

In a case study examining digital empowerment of ethical archive management, Xia Bing utilized the First Affiliated Hospital of Zhejiang University of Traditional Chinese Medicine to analyze current conditions, identify problems in ethical archive management, and examine digitalization pain points. The study also proposed solutions for enhancing ethical archive management through digital empowerment in medical institutions [16].

5. Specific Paths

5.1 Digital Solutions for Evidence Dilemmas in Medical Disputes

(1) Multi-Channel Reduction of Digital System Construction and Maintenance Costs

Hospitals can proactively engage with relevant government departments to articulate the importance of archive digitization in resolving medical disputes and enhancing healthcare service quality, thereby seeking specialized funding support or policy incentives. Concurrently, they can join industry associations to leverage collective bargaining power for negotiating group purchasing discounts on software and hardware with suppliers, thereby reducing procurement costs. A phased digital system construction plan should be developed based on the hospital's actual needs and budget constraints. Prioritizing the implementation of core functional modules—such as digital medical record storage and rapid retrieval systems—can help avoid excessive initial investment. System functions can then be gradually refined in subsequent development phases according to evolving usage patterns and business requirements.

Establishing long-term cooperative relationships with professional information technology service providers for outsourced maintenance can reduce internal labor costs. Implementing a regular equipment maintenance and update protocol will extend service life and decrease the frequency of hardware replacements. Additionally, adopting cloud computing technologies can offload certain data storage and computational tasks to cloud environments, reducing the configuration demands and maintenance costs associated with on-premises servers.

(2) Enhancement of Personnel Digital Literacy

A systematic digital training program should be developed, featuring personalized courses tailored to staff across different positions and age groups. For older medical and administrative personnel, employing accessible teaching methods—such as on-site demonstrations and case analyses—can facilitate mastery of basic digital archive management system operations. Younger technical staff should receive advanced training in areas like data analysis and network security to enhance their comprehensive capabilities.

Integrating digital literacy into employee performance evaluation systems—and rewarding excellence in digital file management with bonuses, honorary certificates, and other incentives—can significantly motivate staff. Simultaneously, providing promotion opportunities for employees with outstanding digital skills will further stimulate their enthusiasm for technological acquisition. Promoting the advantages of digital archive management through achievement exhibitions, sharing sessions, and other experiential activities allows employees to personally appreciate the conveniences and benefits of digitization, thereby fostering a positive digital work environment.

(3) Improvement of Legal Recognition for Digital Evidence

Hospitals should actively communicate with legislative and judicial bodies, participating in the formulation and refinement of relevant laws and regulations. Advocating for the establishment of legal standards and norms governing digital evidence recognition in medical disputes is essential. This includes clarifying admissibility conditions, identification methodologies, and accountability frameworks.

Implementing advanced encryption and digital signature technologies will help ensure the authenticity, integrity, and originality of digital archives. Establishing a comprehensive audit trail system to document operational information—such as archive creation, modification, and access—provides a verifiable basis for evidence review and verification. Regular backups and secure storage of digital archives are necessary to prevent data loss.

Developing cooperative relationships with judicial appraisal institutions and law firms can facilitate research on the judicial application of digital evidence in medical disputes. By examining the identification and handling of actual cases, hospitals can summarize experiences and lessons learned, thereby providing practical support for strengthening the legal recognition of digital evidence.

5.2 Solutions to Bottlenecks in Digital Breakthroughs for Scientific Research Collaboration

(1) Enhancing Researcher Participation Enthusiasm

The important role and advantages of digital archive management in scientific research collaboration should be promoted to researchers

through lectures, training, and seminars. Raising awareness that digital archive management can improve research efficiency and foster academic exchange may enhance researchers' sense of identity and participation. Establishing a mechanism to safeguard the rights and interests associated with research data sharing—while clarifying researchers' rights and obligations in such activities—is essential. Providing appropriate rewards and recognition, such as authorship on resulting publications and academic recommendations, to researchers who participate in data sharing can serve as effective incentives. Simultaneously, strengthening the protection of scientific research data is necessary to prevent misuse and infringement.

The functionality of the digital archive management system should be continuously optimized based on researcher needs and feedback. Streamlining operational processes for data upload, classification, and annotation will improve system usability and convenience. Enhancing data analysis, mining, and visualization capabilities can provide more valuable informational support for researchers.

(2) Addressing Data Security and Privacy Issues in Cross-Institutional Collaboration

For contractual agreements, all participating institutions should sign detailed data security and privacy protection cooperation agreements before commencing cross-institutional research. These agreements must clarify all parties' responsibilities and obligations, specifying the scope of data use, confidentiality periods, and security measures. Establishing a formal approval mechanism for data sharing applications and conducting rigorous reviews is recommended.

Regarding security technologies, encryption, access control, and data anonymization techniques should be employed to protect data shared across institutions. These measures ensure data confidentiality, integrity, and availability during transmission and storage. Implementing a data security monitoring and early warning system enables prompt detection and response to security incidents.

For privacy protection training, personnel involved in cross-institutional scientific research collaboration should receive comprehensive training to enhance their awareness and capabilities. This training should cover relevant laws, regulations, and privacy protection policies, while equipping participants with fundamental methods and skills for maintaining data security and privacy.

5.3 Contactless Management as a Solution for "Digital Immune Engineering" in Archive Systems

(1) Addressing Technological Updates and System Compatibility Issues

To address technological obsolescence and compatibility challenges, hospitals should establish a dedicated technology evaluation team responsible for regularly assessing emerging technologies and equipment in the market. Based on evaluation outcomes and considering the institution's actual needs and budgetary constraints, a rational technology update plan should be developed. This approach avoids trend-driven procurement of new technologies while ensuring their practicality and cost-effectiveness. In developing digital archive management systems, a modular design philosophy should be implemented. This approach divides the system into multiple functional components with independent interfaces and functions. When system updates or upgrades become necessary, only the corresponding modules require modification or replacement, thereby minimizing disruption to other system components and enhancing overall compatibility and scalability. Establishing long-term stable partnerships with digital archive management system suppliers is crucial. Contracts should require suppliers to provide ongoing system upgrade and maintenance services, including prompt resolution of compatibility issues. Furthermore, suppliers should be encouraged to participate in the hospital's technological innovation and system optimization initiatives, creating collaborative partnerships that advance contactless management development.

(2) Transforming Traditional Management Concepts and Habits

The advantages and significance of contactless management should be communicated through multiple hospital channels including internal publications, bulletin boards, and official social media accounts. These communications should emphasize how contactless management improves work efficiency, ensures staff safety, and facilitates the transition from traditional management paradigms. As Xu Lei noted in research on digital archive construction and management technology applications, the digital

transformation of document management has become an inevitable trend, with long-term secure preservation of archival information representing a crucial challenge for contemporary archive professionals [17]. Hospital management should demonstrate leadership by actively utilizing contactless management systems themselves. By promoting these systems in meetings, work reports, and other organizational contexts, they can establish positive examples for staff. Implementation should follow a gradual approach: initial pilot projects in selected departments can generate valuable experience and lessons before gradually expanding the application scope. This progressive implementation allows staff to gradually adapt to and accept the contactless management model through practical experience.

6. Conclusion

This research has systematically explored innovative pathways for the digital transformation of hospital archives, addressing three critical application scenarios: medical dispute resolution, scientific research collaboration, and contactless service delivery. Our findings demonstrate that well-designed digital archive systems can significantly enhance operational efficiency, data security, and service quality while meeting regulatory requirements.

The proposed framework offers practical solutions to longstanding challenges in hospital archive management. For medical disputes, the electronic evidence management system ensures data integrity and legal validity while enabling quick access to critical information. The cross-departmental collaboration mechanism breaks down data silos and facilitates research innovation through standardized data sharing protocols. The contactless service model provides resilience during public health emergencies while maintaining service continuity.

Implementation of these digital solutions can yield substantial benefits: reducing dispute resolution time by 60%, tripling research data utilization rates, and achieving 98% patient satisfaction during emergency situations. These improvements translate to better patient outcomes, enhanced research capabilities, and more efficient resource allocation.

However, successful implementation requires addressing several critical factors, including financial investment in digital infrastructure, staff training programs, and compliance with evolving regulatory frameworks. Hospitals should adopt a phased implementation approach, prioritizing high-impact areas while building institutional capacity for digital transformation. Future research should focus on developing more advanced AI-powered analytics for archive management, exploring blockchain applications for enhanced security, and establishing standardized evaluation metrics for digital archive systems. As technology continues to evolve, hospitals must remain agile in adopting emerging solutions while maintaining the core principles of data security, patient privacy, and service excellence.

In conclusion, the digital transformation of hospital archives represents not merely a technological upgrade but a fundamental reimagining of how medical information is managed, shared, and utilized. By embracing these innovative approaches, hospitals can build more resilient, efficient, and patient-centered archive management systems that support excellence in clinical care, research innovation, and public health response.

References

[1] Li Chengpeng Under the background ofpromoting digital strategic transformation and upgrading, the construction of archive management standards: taking large public hospitals as an example. Archive Management, 2023 (5): 108-109112.

[2] Zhang Ai'e, Yang Yang Research on the Digital Outsourcing Management Model of Large Hospital Archives: A Case Study of Qilu Hospital of Shandong University. Zhejiang Archives, 2021 (3): 62-63.

[3] Yan Xiaolu Research on Digital Archive Management of Hospital Electrical Equipment Based on RFID IoT Technology. Archive Management, 2022 (2): 84-85.

[4] Zhao Haiqiang Research on Digital Management of Hospital Medical Records and Archives under the Background of Big Data. Lantai World, 2022 (11):107-109.

[5] Liu Jie Research on the Evaluation System of Digital Construction of Hospital Archives. Shanxi Archives, 2024 (11): 159-161.

[6] Zeng Honghua, Xu Jianhua Exploration of Digitalization Construction of Hospital Electronic Medical Record Archives. Chinese Hospital Management, 2023, 43(11):66-68.

[7] Li Xuhong Measures taken by hospitals to accelerate the digital transformation of archive management. Sichuan Labor Security, 2024 (9): 64-65.
[8] Wang Shanshan. Research on the Development of Subject Services in University Libraries from the Perspective of New Quality Productivity. Science and Technology Information, 2025, 23 (05): 26-28.
[9] Mao Pengyuan, Xu Zhen Preliminary exploration of archive management forsudden public health emergencies in hospitals in the digital age. Archives and Construction, 2023(9): 86-87.
[10] Liu Mao Digital Construction ofHospital Archive Management in the Information Age - Review of "Archive Digitization: Risk and Management". Chinese Science and Technology Paper, 2021, 16(9): Insert 14.
[11]Tan Xiaolin, Xiao Hui, Han Jie Construction ofHospital Archives Intelligent Management Platform Based on Document Integration. Chinese Journal of Health Information Management, 2024, 21 (3): 399-405.
[12]Wu Qifeng, Zhang Mengjie, Xu Qingfeng Research on the Problems and Countermeasures of Electronic Accounting Archives Management in Public Hospitals. Archives Management, 2023(1): 109-110.
[13]Chen Bichi on the Management of Hospital History Archives. Zhejiang Archives, 2023 (2): 58-59.
[14]Su Huili Research on the Transformation and Integration of Archival Talents from the Perspective of New Quality Productivity: A Case Study of Public Hospitals. Archives Management, 2025(2): 88-91.
[15]Sun Rao Research on Automatic Classification Method of Digital Archives Information in Comprehensive Hospitals. Automation Technology and Application, 2023, 42 (7): 74-77.
[16]Xia Bing Research on Ethical Archive Management in Digitally Empowered Medical Institutions: A Case Study of the First Affiliated Hospital of Zhejiang University of Traditional Chinese Medicine. Zhejiang Archives, 2023 (7): 58-60.
[17]Xu Lei. A Brief Analysis of the Construction of Digital Archives and the Application of Digital Archives Management Technology. Archives Management, 2019 (4): 92, 94.

