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| RESEARCH ARTICLE

Eliminating Duplicate Medical Records: How Modern Solutions are Revolutionizing Healthcare Data Management

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| ABSTRACT

The healthcare industry faces persistent challenges with duplicate patient records, a critical issue that compromises care quality, patient safety, and operational efficiency. This article examines how innovative technology solutions are revolutionizing healthcare data management through innovative approaches to resolving record duplication. It explores the limitations of traditional probabilistic matching algorithms and presents the evolution toward deterministic solutions that actively engage patients in the identity verification process. Through verification features and groundbreaking decentralized identity management systems, modern solutions are transforming how healthcare organizations manage patient identities. Cloud infrastructure provides the essential foundation for these solutions, offering security, compliance, availability, and scalability crucial for healthcare applications. A real-world case study demonstrates significant improvements in record accuracy, registration efficiency, reduced redundant testing, decreased claim denials, and enhanced patient portal engagement. These innovations represent a paradigm shift in healthcare data management, moving from retrospective duplicate resolution to preventative approaches that address the root causes of record fragmentation.

| KEYWORDS

Patient identity management, duplicate medical records, healthcare data integrity, decentralized identity, patient-mediated verification

| ARTICLE INFORMATION

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1. Introduction

In the complex ecosystem of healthcare information systems, duplicate patient records have persisted as a significant challenge for decades, affecting patient safety and care quality across healthcare institutions worldwide. These duplications fragment critical medical information, potentially leading to dangerous care gaps and contradictory treatment plans. The healthcare industry has long struggled with this data integrity issue, which continues to compromise the reliability of electronic health record (EHR) systems despite technological advancements in healthcare informatics.

The prevalence of duplicate patient records represents a substantial concern for healthcare administrators and clinicians alike. Industry assessments have consistently shown duplicate record rates hovering between 10-12% across typical healthcare systems, though some facilities report much higher rates in their internal audits. This issue has become increasingly complex as healthcare organizations expand through mergers and acquisitions, creating environments where patient data must be reconciled across previously independent record systems with different data structures and identification protocols.

Medical errors stemming from information fragmentation and incomplete medical histories have become alarmingly common in American healthcare. Research published in the BMJ highlights how such systematic failures contribute to patient harm, placing medical errors among the leading causes of death in the United States. The study, conducted by researchers at Johns Hopkins

Medicine, suggests that improved data tracking and analysis of medical errors would reveal their true impact on patient mortality. Their assessment of medical death rate data indicates that errors are a vastly underreported contributor to death, with communication breakdowns and information gaps—often exacerbated by duplicate records—playing a significant role in these adverse events [2].

The economic burden associated with duplicate patient records extends throughout the healthcare system. Each duplicate record generates multiple downstream effects, including redundant diagnostic testing, administrative rework, and billing complications. When clinicians lack confidence in the completeness of available patient information, they often reorder tests and imaging studies as a precautionary measure, contributing to the estimated $765 billion in annual waste within the U.S. healthcare system. Additionally, the staff time dedicated to manually resolving duplicate records represents a substantial operational cost for healthcare facilities already operating with constrained resources.

Patient identification challenges have been extensively documented in healthcare informatics literature. A comprehensive study published in Perspectives in Health Information Management examined the fundamental causes of duplicate record creation, identifying both technical and human factors that contribute to the problem. The research highlighted how variations in registration practices, keyboard entry errors, and inconsistent naming conventions all play roles in generating record duplications. Furthermore, the study emphasized that even sophisticated matching algorithms struggle with common scenarios like name changes, use of nicknames, and demographic data errors, underscoring the complexity of achieving reliable patient matching across systems [1].

As healthcare continues its digital transformation, the challenge of maintaining accurate patient identities across increasingly interconnected systems has taken on new urgency. The promise of coordinated care, clinical decision support, and population health management all depend fundamentally on the ability to access complete and accurate patient information. Modern solutions combining advanced matching algorithms, biometric identification methods, and patient engagement strategies offer promising approaches to addressing this critical healthcare challenge, though implementation varies widely across healthcare organizations.

2. The Challenge of Duplicate Records

Duplicate records occur when the same patient has two or more medical records within a single system. This fragmentation of patient information creates a cascade of complications throughout the healthcare delivery process, affecting clinical decision-making, operational efficiency, and financial performance. When patient data becomes scattered across multiple records, clinicians encounter significant barriers to accessing complete medical histories, potentially missing critical information such as medication allergies, chronic conditions, or recent laboratory results [3]. This information fragmentation directly impacts care quality and increases the risk of adverse events.

Healthcare organizations typically discover the consequences of duplicate records through various operational pain points. One of the most common manifestations is the ordering of redundant diagnostic tests and laboratory procedures. When providers cannot locate previous test results because they exist in a separate record, they often reorder these tests, leading to unnecessary radiation exposure for patients, wasted clinical resources, and inflated healthcare costs. Research from the American Health Information Management Association (AHIMA) indicates that duplicate record rates in healthcare facilities can range from 8 to 12 percent, creating significant data integrity challenges that compromise both care quality and operational efficiency [3].

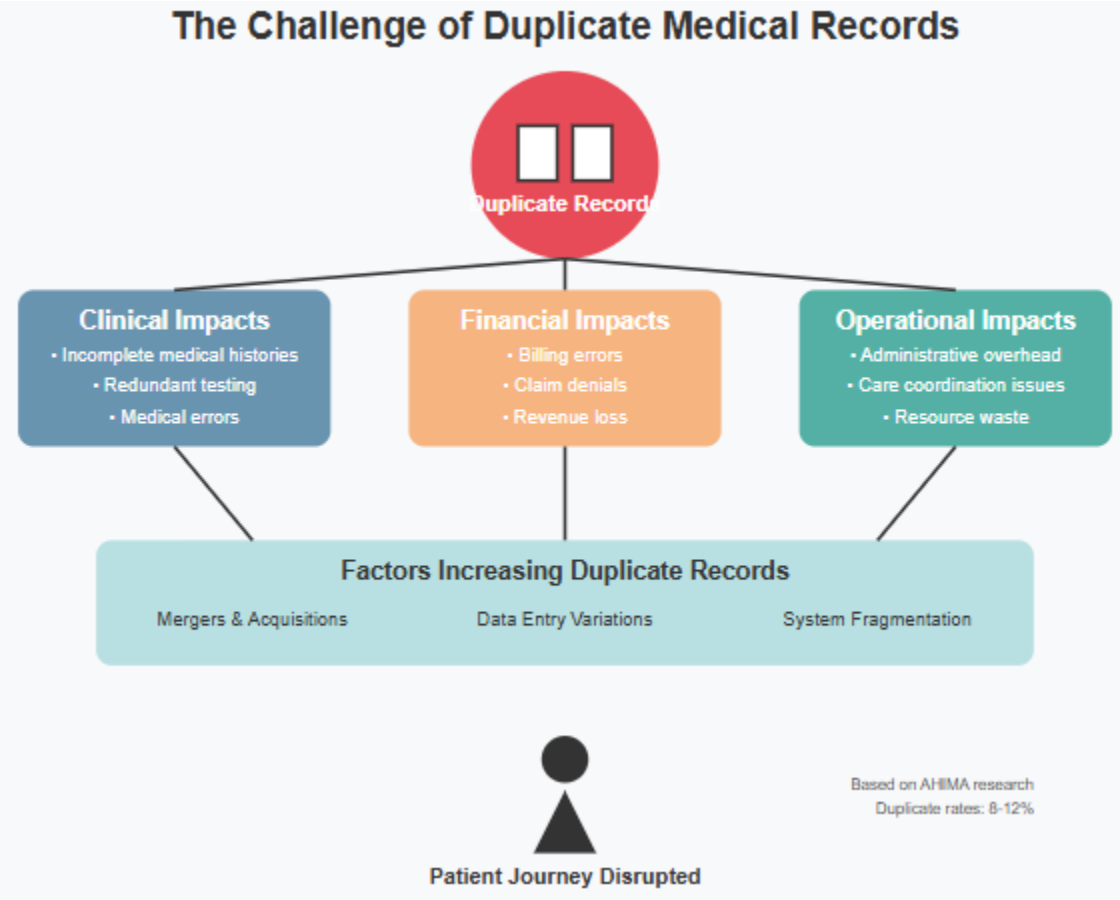
The financial implications of duplicate records extend beyond unnecessary clinical procedures. Revenue cycle management becomes significantly compromised when patient information is fragmented, resulting in increased billing errors, claim denials, and delayed reimbursements. Insurance claims may be rejected due to mismatches between patient identifiers on claims and those in insurers' systems, creating administrative overhead and extending accounts receivable timelines. According to research by the Ponemon Institute, hospitals lose an average of $1.5 million annually due to denied claims and redundant medical procedures that result from patient misidentification issues, with larger health systems facing substantially higher costs [4].

Patient safety concerns represent perhaps the most alarming consequence of duplicate records. When clinicians make decisions based on incomplete or contradictory information spread across multiple records, the risk of medical errors increases substantially. Medication reconciliation becomes particularly challenging, as prescribers may not have visibility into the complete medication history, potentially leading to dangerous drug interactions or inappropriate dosing. Emergency departments face especially acute challenges in this regard, as time-sensitive decisions must often be made without complete information access. Studies have shown that approximately 35 percent of all denied claims result from patient misidentification issues, which corresponds to about 3 percent of a hospital's revenue being put at risk due to these preventable errors [4].

Care coordination across different departments or facilities becomes exceedingly difficult when duplicate records exist. As patients navigate through various care settings—primary care, specialty care, inpatient facilities, and post-acute services—their clinical

information should ideally flow seamlessly to support continuity of care. However, duplicate records create barriers to this information exchange, resulting in care fragmentation and an increased burden on patients to repeatedly provide the same information. This problem is particularly pronounced during care transitions, such as hospital discharges, when accurate information transfer is critical to preventing readmissions.

The challenge of patient identification has grown increasingly complex as healthcare organizations expand through mergers and acquisitions. When health systems integrate previously independent facilities, they must reconcile patient identities across disparate electronic health record systems, each with its identification protocols and data quality issues. The difficulty of accurately matching patient records across these environments without creating new duplicates presents a significant technical and operational challenge. According to AHIMA's guidance on patient identity integrity, healthcare organizations engaged in health information exchange must implement comprehensive governance frameworks and technical solutions to address the complex challenges of cross-organizational patient matching [3].



3. Modern Approach: From Probabilistic to Deterministic

Leading technology companies in patient identity management have been tackling this problem through Enterprise Master Patient Index (EMPI) solutions delivered as SaaS on cloud infrastructure. The traditional approach uses probabilistic algorithms to match patient records across disparate systems, but as vendors have discovered, algorithms alone can only go so far in resolving patient identity challenges [5]. The evolution of this approach represents an important shift in the industry's understanding of patient matching methodologies and their practical limitations in real-world healthcare environments.

The foundation of modern EMPI solutions relies on sophisticated matching algorithms that analyze demographic elements across patient records to determine the likelihood that different records represent the same individual. These probabilistic matching techniques assign weights to various data elements—such as name, date of birth, address, and other identifiers, calculating match probabilities based on the degree of similarity between records. This approach has proven effective for resolving many duplicate scenarios, particularly those involving minor data entry variations or transpositions. However, industry implementation experience

has revealed that even the most sophisticated probabilistic matching algorithms face significant challenges in healthcare settings where data quality issues are prevalent and patient demographics frequently change over time [5].

The limitations of the traditional centralized approach have become increasingly apparent as healthcare organizations pursue higher levels of data integrity. One fundamental constraint is the ability to match data only within certain parameters—algorithms excel at identifying exact matches or close variations but struggle with more complex scenarios involving significant demographic discrepancies. For instance, substantial name changes following marriage, inconsistent use of middle names, or cultural naming variations often fall outside the confidence thresholds of automated matching systems. Research on identity matching in healthcare has demonstrated that conventional approaches to patient matching using demographic data elements face inherent limitations, particularly when patients' information changes frequently or contains errors that propagate through information systems [5].

Another significant limitation is the reliance on reference data that may be incomplete or contain inherent quality issues. Probabilistic matching algorithms depend on the demographic information available within the records being compared, which often varies considerably in completeness and accuracy across different care settings and registration contexts. When core demographic elements are missing, outdated, or incorrectly recorded, even sophisticated algorithms cannot reliably establish identity matches. Studies examining health information exchanges have found that demographic data elements critical for patient matching can vary significantly in availability and format across participating organizations, creating substantial challenges for cross-organizational identity resolution [6].

Perhaps the most consequential limitation is the inability to resolve 100% of ambiguous matches using purely automated methods. Traditional EMPI solutions typically maintain a "potential duplicate" work queue containing record pairs that fall into a gray area—their match probability is too high to rule out a duplicate but too low for automated merging. These ambiguous cases require human intervention, typically by health information management professionals who must manually review and adjudicate each potential match. Research examining patient matching in health information exchanges has identified this dependence on manual review as a significant barrier to achieving high-reliability patient matching at scale, particularly as healthcare organizations participate in increasingly complex data-sharing environments [6].

The inherent limitations of centralized, algorithm-based approaches have prompted vendors to evolve their EMPI solutions toward more deterministic matching methodologies. While probabilistic matching relies on calculating statistical likelihood, deterministic matching seeks absolute confirmation of identity through authoritative sources or direct patient involvement. This shift represents a fundamental rethinking of how patient identity challenges should be addressed, moving beyond purely technical solutions toward approaches that engage patients as active participants in resolving identity discrepancies. Emerging research suggests that multi-factor identity confirmation strategies incorporating both algorithmic matching and patient-mediated verification offer promising approaches to overcoming the limitations of traditional probabilistic methods [6].

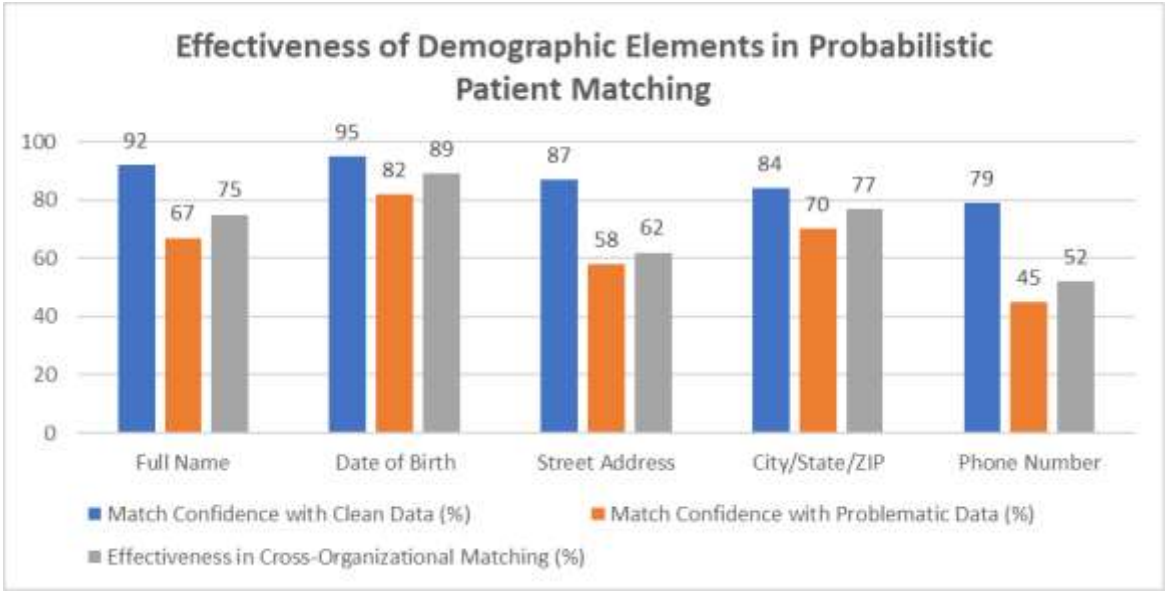


Fig 1: Modern EMPI: Demographic Data Elements Performance in Patient Matching [5, 6]

4. Patient Verification: Bringing Patients into the Solution

Recognizing that "no one knows the patient better than themselves," innovative healthcare technology vendors have developed verification features. These solutions engage patients directly in the identity resolution process by presenting them with multiple-choice questions that help determine if two records should be linked [5]. This approach represents a fundamental paradigm shift in how healthcare organizations address patient identity challenges, moving beyond purely algorithmic solutions to incorporate the patient as an active participant in identity verification.

The verification solution addresses the limitations of traditional EMPI systems by targeting those cases that fall into algorithmic "gray areas"—records that have sufficient similarities to suggest a potential match but contain enough discrepancies to prevent automated linking. Rather than relegating these cases to manual review by health information management staff, the system generates targeted knowledge-based authentication questions that only the actual patient could reliably answer. Research on patient identification in clinical registries has demonstrated that engaging patients in the verification process can significantly reduce the incidence of record duplication and other identity errors that compromise data integrity [5].

The innovation of this approach lies in its recognition that patients themselves represent the most authoritative source for identity confirmation. While algorithms can analyze similarities in demographic data, they cannot access the contextual knowledge that patients possess about their own healthcare experiences. By leveraging this patient knowledge, the verification process can achieve definitive resolution of ambiguous matches that would otherwise remain in perpetual review queues or be subject to potentially erroneous human judgment. Current approaches to patient matching often rely heavily on demographic data elements that may change over time or contain errors, creating inherent limitations that patient-mediated verification can help overcome [5].

The patient engagement approach also addresses several underlying challenges in traditional identity management. First, it provides a mechanism for correcting erroneous demographic information that may be preventing automated matching, as patients can identify and rectify inaccuracies during the verification process. Second, it creates a more sustainable workflow by reducing dependence on limited health information management resources for manual review. Third, it aligns with broader industry movements toward greater patient engagement and information transparency, giving patients visibility into how their information is managed across healthcare systems.

This patient-centric approach achieves what algorithms alone cannot: 100% accuracy in resolving duplicate records for those patients who participate in the verification process. While traditional probabilistic algorithms operate on statistical likelihood, patient-verified matches provide deterministic confirmation of identity. Studies examining patient engagement in healthcare processes have found that involving patients in data verification can substantially improve both accuracy and completeness of medical records, suggesting that patient participation offers a viable pathway to achieving higher levels of data integrity than possible through automated methods alone [7].

By making patients active participants in managing their identity, patient verification technology represents a significant advancement in solving the duplicate record problem. This approach also yields secondary benefits in patient engagement and satisfaction. When patients participate in managing their health information, they report increased feelings of control and ownership over their healthcare experience. Research on patient-centered medical homes has demonstrated that engaging patients as active participants in information management contributes to improved care coordination and patient satisfaction, suggesting that identity verification processes may offer benefits beyond mere technical accuracy [7].

The implementation of patient-driven verification also creates opportunities for healthcare organizations to address other aspects of information governance. During the verification process, patients often identify additional inaccuracies in their records beyond simple demographic errors, allowing for broader data cleanup. This approach aligns with regulatory movements toward greater patient access to health information and supports compliance with initiatives such as the 21st Century Cures Act's provisions on information blocking and patient access to electronic health information.

Identity Resolution Method	Accuracy Rate (%)	Manual Review Required (%)	Time to Resolution (hours)	Patient Satisfaction Score (1-10)	Data Error Correction Rate (%)
Traditional EMPI (Probabilistic)	92	15	48	6.2	45
Manual Review by HIM Staff	94	100	72	5.8	60
Patient-Mediated Verification	99.5	0	2	8.7	85

Hybrid (Algorithmic + Patient Verify)	99.8	5	6	8.4	90

Table 2: Comparative Performance Metrics of Patient Identity Resolution Methods [7, 8]

5. Decentralized Identity: The Future of Healthcare Identity Management

Taking the concept of patient engagement even further, advanced technology providers have introduced decentralized identity management solutions that fundamentally transform how people interact with healthcare systems [8]. This innovative approach represents a departure from traditional centralized identity repositories toward a patient-controlled model that addresses the duplicate record problem at its source rather than attempting to remediate it after the fact.

These solutions build upon emerging decentralized identity technologies to create a system where patients maintain sovereignty over their healthcare identity credentials. Unlike conventional master patient index approaches where healthcare organizations own and control patient identifiers, this decentralized model empowers patients with primary ownership of their identity information. This represents a significant evolution in identity management philosophy, aligning with broader societal trends toward increased individual data ownership and privacy controls. Research into blockchain-based identity frameworks has demonstrated their potential to address the fragmentation of medical records while providing patients with new capabilities to access and share their health information across previously disconnected systems [8].

One of the most transformative aspects of this approach is that patients gain ownership and control of their healthcare data. Rather than having their information fragmented across multiple systems with varying levels of accessibility, patients maintain a unified digital identity that they can selectively share with healthcare providers. This patient-controlled approach addresses a fundamental limitation of traditional healthcare data management: the disconnect between who generates health information (providers), who it pertains to (patients), and who controls access to it (healthcare organizations). By realigning these relationships, decentralized solutions create a more coherent framework for health information management that centers patient agency [9].

Direct data sharing between patients and providers becomes possible through this decentralized framework, eliminating many of the interoperability challenges that have plagued healthcare systems. When patients control their identity credentials, they can authorize specific providers to access relevant portions of their health record without requiring complex technical interfaces between disparate electronic health record systems. This capability is particularly valuable during care transitions or when patients seek services from providers outside their usual care network. Research examining decentralized healthcare information architectures indicates that patient-controlled data sharing can enhance coordination between providers while maintaining appropriate security and privacy controls [9].

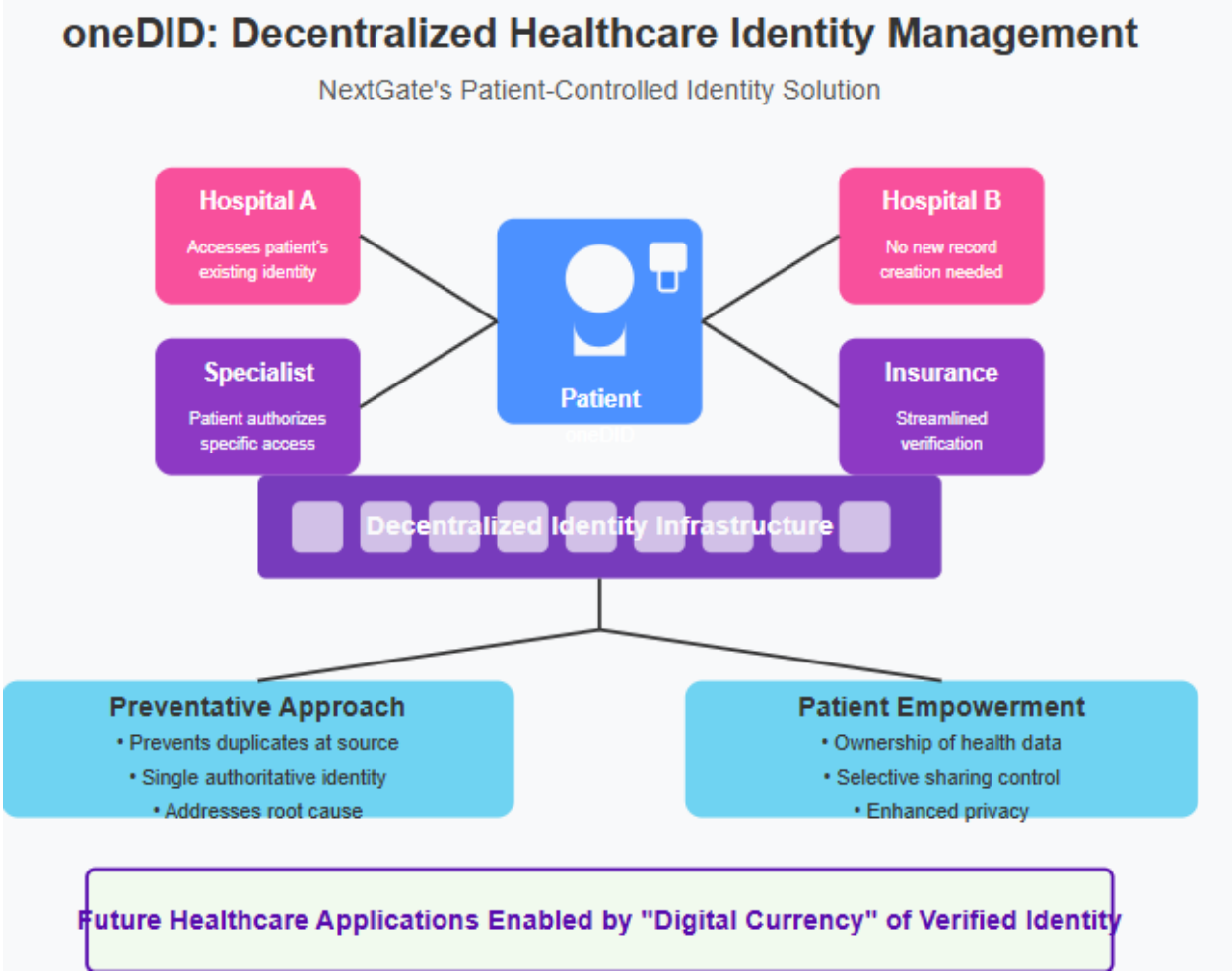
Perhaps most significantly, the creation of duplicate records is prevented at the source through this decentralized approach. By establishing a single authoritative identity that follows patients throughout their healthcare journey, these solutions eliminate the fundamental conditions that lead to record duplication. Healthcare providers connect to the patient's existing digital identity rather than creating new local identifiers for each care encounter, preventing the proliferation of disconnected records that characterizes current healthcare environments. This preventative approach addresses the root cause of duplicate records rather than attempting to remediate them after they occur [8].

The decentralized identity model also creates a new "digital currency" of verified identity information that enables novel applications. When patients possess cryptographically secured identity credentials that can be selectively shared and verified without revealing underlying personal data, new modes of healthcare delivery become possible. These include streamlined registration processes, simplified insurance verification, enhanced telehealth authentication, and improved clinical trial matching. Analysis of blockchain applications in healthcare suggests that these technologies can enable secure, verifiable transactions of health information while maintaining patient privacy and supporting compliance with healthcare regulations [9].

This decentralized approach represents a paradigm shift from traditional methods of managing patient identities and addresses the duplicate record problem at its root. Rather than continuing to invest in increasingly sophisticated algorithms to match fragmented identities after they've been created, it reimagines the entire identity management framework to prevent fragmentation from occurring. Industry analysis suggests that such preventative approaches may ultimately prove more cost-effective and technically viable than remediation-focused solutions, particularly as healthcare delivery becomes more distributed and patient-centered [8].

While the implementation of decentralized identity systems presents technical and organizational challenges, the potential benefits in terms of reduced duplicate records, improved data quality, enhanced patient privacy, and streamlined care delivery make them

a compelling direction for healthcare identity management evolution. As healthcare continues its digital transformation, these solutions point toward a future where patient identity management aligns more closely with patient-centered care principles and modern data ownership expectations.



6. Cloud Infrastructure: The Foundation for Success

The robust cloud infrastructure plays a crucial role in modern patient identity solutions, serving as the technological foundation that enables innovative patient identity management capabilities [10]. As healthcare organizations increasingly migrate critical applications to cloud environments, the underlying infrastructure becomes a key determinant of both operational performance and regulatory compliance. The strategic decision to leverage cloud computing reflects the growing recognition that specialized healthcare solutions require enterprise-grade infrastructure specifically designed to meet the industry's unique requirements.

Data security and compliance with healthcare regulations represents perhaps the most critical aspect of cloud technology's contribution to identity management solutions. Healthcare data management systems must adhere to stringent regulatory frameworks including HIPAA, HITECH, and increasingly FedRAMP for government-affiliated healthcare organizations. Comprehensive security architecture provides the technical controls necessary to maintain compliance with these requirements, including advanced encryption capabilities, granular access controls, and extensive audit logging functionality. Analysis of cloud computing in healthcare has demonstrated that properly configured cloud environments can enhance security and compliance efforts, providing robust safeguards for protected health information while enabling healthcare organizations to meet their regulatory obligations efficiently [10].

High availability represents another crucial advantage that cloud infrastructure brings to modern healthcare solutions. Patient identity management functions are increasingly considered mission-critical within healthcare organizations, as disruptions in identity services can cascade into clinical and operational impacts throughout the enterprise. Redundant architecture, spanning

multiple geographic regions and availability zones, provides the foundation for delivering consistent 99.99% uptime for identity management and verification services. Research on healthcare information exchange has emphasized that reliable infrastructure is essential for supporting the continuous availability of patient identification services, which underpin nearly all clinical and administrative workflows in modern healthcare organizations [11].

The elastic capacity that cloud platforms provide allows technology vendors to scale their solutions dynamically with the evolving needs of healthcare organizations. This elasticity is particularly valuable in the context of patient identity management, where workload demands can fluctuate significantly based on factors such as mergers and acquisitions, onboarding of new facilities, or periodic reconciliation initiatives. Traditional on-premises infrastructure would require substantial overprovisioning to accommodate these peak demands, creating financial inefficiencies. Studies examining cloud adoption in healthcare have identified scalability as one of the primary benefits driving migration to cloud platforms, allowing healthcare IT departments to respond more effectively to changing organizational requirements while optimizing resource utilization [11].

Healthcare technology vendors also benefit from comprehensive cloud ecosystems with numerous services, allowing them to leverage specialized capabilities without developing them internally. This extensive service portfolio includes managed database services optimized for healthcare workloads, advanced analytics capabilities for population-level identity analysis, machine learning services that can enhance matching algorithms, and integration tools that facilitate connections with diverse healthcare systems. Analysis of cloud computing benefits in healthcare has highlighted how access to diverse, integrated cloud services enables healthcare organizations to derive greater value from their data assets while reducing the technical complexity typically associated with advanced analytics and machine learning initiatives [10].

The single-pane-of-glass management capabilities provided by unified console and management tools streamline operational processes. This integrated administrative experience enables efficient monitoring, troubleshooting, and optimization of the infrastructure supporting identity solutions. For healthcare customers, this translates into more responsive support, faster resolution of technical issues, and ultimately higher reliability for the identity services that underpin their clinical and operational workflows. Research on health information technology management has underscored the operational advantages of unified infrastructure management, particularly for healthcare organizations facing resource constraints and increasing IT complexity [11].

As healthcare organizations continue their digital transformation journeys, the strategic importance of selecting appropriate infrastructure partners grows increasingly apparent. The selection of modern cloud platforms represents a recognition that successful healthcare solutions require more than innovative application functionality—they demand an underlying infrastructure specifically designed to address the security, reliability, scalability, and compliance requirements unique to healthcare environments.

7. Real-World Impact: A Case Study

A major integrated health services organization serving over 350 million Americans has implemented advanced patient identity management solutions to address the challenges of patient identification across multiple locations [12]. This implementation represents one of the largest-scale deployments of advanced patient identity management technology in the U.S. healthcare system, providing valuable insights into the practical impacts of these solutions in complex care environments. The organization's extensive network of facilities, diverse patient population, and ambitious quality improvement goals created an ideal testbed for evaluating the capabilities of modern technology in resolving duplicate records and enhancing care coordination.

Prior to implementing these solutions, the organization struggled with duplicate record rates averaging 12% across its enterprise—slightly higher than industry averages but not unusual for a system that had grown through multiple acquisitions and maintained disparate information systems. These duplicates were creating significant operational inefficiencies, clinical risks, and financial challenges that threatened to undermine the organization's strategic objectives. After a comprehensive evaluation of available solutions, they selected an EMPI solution deployed on cloud infrastructure, later expanding to include both patient verification components and decentralized identity capabilities [12].

The implementation of these solutions has enabled automated cleanup of duplicate records throughout the organization, dramatically reducing the manual effort previously required from health information management staff. Case studies of similar patient management system implementations have demonstrated how automation can transform healthcare operations through more efficient record management, reducing the administrative burden on healthcare staff while simultaneously improving data accuracy. These technology-driven improvements support better clinical decision-making while allowing staff to focus more on patient care and less on administrative troubleshooting [12].

The organization has also realized significant benefits in streamlined patient registration processes. By implementing real-time duplicate checking at registration points throughout their network, they have reduced the creation of new duplicate records. Registration staff now receive immediate alerts when a patient's information matches or closely resembles an existing record,

allowing for real-time resolution rather than post-hoc remediation. Research on enhanced patient matching approaches has demonstrated that implementing front-end prevention measures can significantly reduce duplicate creation rates while improving overall registration efficiency [13].

The reduction in duplicate diagnostic and laboratory procedures represents one of the most clinically significant outcomes of the implementation. Studies examining the relationship between patient identification systems and healthcare utilization patterns have consistently shown that improved patient matching capabilities can lead to substantial reductions in redundant testing. These reductions not only decrease healthcare costs but also improve the patient experience by eliminating unnecessary procedures and reducing potential complications associated with repeated testing [13].

The organization has also documented a decreased number of denied medical claims following implementation of modern identity management solutions. By ensuring consistent patient identification across clinical and revenue cycle systems, they have reduced identity-related claim denials. Research on healthcare revenue cycle management has identified accurate patient identification as a critical factor in claims acceptance, with misidentification and record duplication representing common causes of preventable denials. Improvements in these areas can significantly enhance an organization's financial performance while reducing administrative rework [13].

Enhanced support for patient portals has emerged as another valuable outcome of the implementation. By resolving duplicate records and establishing more reliable patient matching, the organization has increased patient portal enrollment and utilization. Analysis of patient engagement platforms has demonstrated that record consolidation can significantly improve the patient digital experience by ensuring that individuals have access to their complete health information. This comprehensive view supports more effective self-management and engagement in care processes [12].

The organization's commitment to becoming a national model for high-quality, cost-effective medical care has been significantly advanced through their partnership with modern technology vendors. The combined benefits of duplicate resolution, reduced redundant testing, improved billing accuracy, and enhanced patient engagement have contributed to substantial operational improvements. Studies examining the economics of health information exchange have documented how investments in improved patient matching can generate positive returns through multiple channels, including reduced administrative costs, lower clinical redundancy, and improved revenue capture [13].

8. Conclusion

The elimination of duplicate patient records represents a critical frontier in healthcare's digital transformation. Innovative solutions, powered by cloud infrastructure, are fundamentally changing how healthcare organizations approach patient identity management. By moving beyond traditional algorithmic approaches to embrace patient-mediated verification and decentralized identity frameworks, these technologies address the root causes of record duplication rather than merely treating the symptoms. The transition from probabilistic to deterministic matching methodologies, particularly through direct patient engagement, offers a pathway to achieve levels of accuracy previously unattainable. Meanwhile, the decentralized identity approach promises to prevent duplicates from being created in the first place while empowering patients with greater control over their health information. As these technologies continue to evolve and gain adoption across healthcare systems, they promise not only to resolve a long-standing problem in healthcare data management but also to create new opportunities for enhanced patient engagement, improved clinical decision-making, and increased operational efficiency. The future of healthcare identity management lies in solutions that combine technological innovation with patient empowerment, ultimately transforming how healthcare information is created, accessed, and shared.

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