

# HEALTHCARE DATA ANALYTICS FOR PHARMACY QUALITY IMPROVEMENT: EXAMINE THE USE OF EHR DATA ANALYTICS IN IDENTIFYING AREAS FOR QUALITY IMPROVEMENT IN PHARMACY PRACTICE, INCLUDING MEDICATION SAFETY, ADHERENCE, AND PATIENT ENGAGEMENT

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## ABSTRACT

The integration of blockchain technology and analytics on healthcare data introduces a transformational impact on improving pharmacy practice quality. The current study explores using blockchain for identifying key areas of quality improvement for pharmacy practice, such as medication safety, adherence, and engagement, by integrating EHR data analytics. The decentralized, immutable nature of blockchain guarantees safety and transparency for the data of patients, allowing data sharing in a safer manner and promoting more accurate tracking of medication usage along with adherence patterns. Consequently, this promotes improved capabilities in risk identification related to medication errors, better adherence monitoring, and increased patient engagement through secure and real-time data exchange by leveraging blockchain and EHR analytics. This will also enlarge the trust, accurateness, and collaboration between providers and patients, hence influencing better outcomes in the handling of medication management, safety of patients, and improvement in quality in the practice of pharmacy. The findings emphasize the importance of adopting blockchain technology to support data-driven decision-making and personalized care interventions in the digital era.

**Keywords:** HER, blockchain, SHA-256, encryption, Hash code.

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## 1. INTRODUCTION

In today's rapidly evolving healthcare landscape, the integration of data analytics into pharmacy practice is redefining quality improvement and patient care. Pharmacy informatics, which involves the systematic application of information technology and data management principles, plays a critical role in enhancing medication safety, adherence, and patient engagement key areas for quality improvement in pharmacy practice. Historically, hospitals relied on traditional server-based databases to manage patient records. While these systems were foundational, they often posed significant security risks, including vulnerabilities to breaches and

unauthorized access. Modern healthcare has since transitioned to Electronic Health Records (EHR), which serve as a cornerstone for comprehensive and personalized care. However, challenges such as ensuring the accuracy, security, and accessibility of EHR data remain, particularly in addressing medication-related issues and improving patient outcomes. Block chain technology, with its decentralized and immutable structure, offers a revolutionary solution to these challenges. By integrating blockchain with EHR analytics, pharmacies can enhance medication safety, monitor adherence more effectively, and foster meaningful patient engagement. This integration ensures secure and transparent data sharing, enabling healthcare providers to track medication use and

adherence patterns accurately while maintaining patient privacy. Medication adherence and patient engagement are critical components of effective healthcare delivery. Non-adherence to prescribed treatments can lead to suboptimal outcomes, increased healthcare costs, and higher risks of complications. Blockchain-enabled analytics provides actionable insights and real-time monitoring, empowering providers to proactively address adherence challenges and improve patient outcomes. This study investigates the combined potential of EHR data analytics and blockchain technology to identify areas for quality improvement in pharmacy practice. It focuses on three critical aspects: improving medication safety through accurate risk identification, enhancing adherence monitoring, and fostering patient engagement. By leveraging these technologies, pharmacy practice can transition to a data-driven, patient-centered approach that prioritizes safety, transparency, and collaboration.

### 1.1. Role of Healthcare Data Analytics in Pharmacy Practice

Healthcare data analytics plays an important role in pharmacy practice by transforming raw data into meaningful insights. By analyzing diverse datasets, including patient medical histories, clinical outcomes, and population health metrics, pharmacists can identify trends that inform decision-making. These insights are essential for improving patient care, optimizing pharmacy operations, and achieving better health outcomes. Pharmacists use data analytics to detect patterns in medication usage, identify adverse drug events, and monitor patient adherence to prescribed therapies. By exploring correlations within medication-related data, they can tailor interventions, improve treatment plans, and minimize risks associated with drug therapy. Additionally, analytics provides a robust framework for tracking key performance metrics, assessing the impact of clinical initiatives, and identifying opportunities to enhance workflow efficiency. The integration of data analytics into pharmacy practice supports a shift toward proactive, evidence-based care. This approach emphasizes personalized treatment, fosters continuous quality improvement, and encourages innovation in medication management. Ultimately, leveraging data analytics enables pharmacists to enhance patient safety, optimize therapeutic strategies, and contribute to improved health outcomes for both individuals and communities.

### 1.2. Pharmacy Informatics and Data Analytics in Enhancing Healthcare Delivery

Pharmacy informatics and data analytics provide diverse and impactful applications that significantly enhance modern healthcare practices. By integrating technology and data-driven insights, pharmacists can optimize drug management, improve clinical decision-making, advance population health strategies, and foster continuous quality improvement. Through medication reconciliation and adverse event detection, informatics platforms and analytics tools enhance medication safety and ensure the accuracy of patient histories. Clinical decision support systems (CDSS) leverage algorithms and evidence-based knowledge to provide pharmacists with

real-time recommendations, reducing errors and improving therapeutic outcomes. Population health management benefits from analytics by identifying high-risk patient groups and enabling targeted interventions such as medication therapy management and preventive screenings. These efforts aim to reduce disease burden and improve health outcomes across communities. Additionally, informatics supports continuous quality improvement by tracking key performance indicators, streamlining workflows, and enhancing adherence to clinical guidelines. Tools like tele pharmacy and remote monitoring further expand access to pharmacy services, particularly in underserved areas, while inventory management optimization ensures the efficient allocation of resources. Pharmacovigilance efforts are strengthened through analytics, helping monitor and mitigate adverse drug reactions. Together, pharmacy informatics and data analytics empower pharmacists to deliver innovative, personalized care that meets the dynamic demands of the healthcare landscape. By leveraging these technologies, pharmacists can improve patient safety, optimize medication regimens, and contribute to better health outcomes for individuals and populations, reinforcing their critical role in advancing healthcare delivery.

### 1.3. Block chain method:

Block chain technology has the potential to revolutionize health informatics by providing a secure, transparent, and decentralized system for managing patient data. As healthcare systems face challenges related to data privacy, security, and interoperability, block chain can offer a solution that ensures patient information is securely stored and only accessible to authorized individuals. By utilizing block chain, health data can be encrypted and linked across multiple parties, maintaining an immutable record of patient interactions while ensuring compliance with regulations like HIPAA. One of the main advantages of block chain in health informatics is its ability to ensure data integrity. Medical personnel can trust that the patient data they are accessing is accurate and has not been tampered with, as each transaction or update in the block chain is recorded chronologically and securely. This can be particularly beneficial when managing complex health conditions or coordinating care between multiple providers. Moreover, block chain can enable better patient privacy management by giving patients more control over their data. Through the use of smart contracts, patients can selectively grant access to their health records, ensuring that only authorized parties such as doctors or insurers can view specific portions of their medical history. This level of control enhances patient trust and empowers individuals to be more engaged in their healthcare.

## 2. SURVEY OF RESEARCH

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### 3. METHODOLOGY

The study of analyzing data in order to draw conclusions is known as data analytics. Data analytics, as it pertains to public health, is the process of analyzing massive amounts of health-related data using statistical methods and data mining technologies. Public health initiatives, decision-making, and the monitoring of disease outbreaks for effective response and prevention may all be enhanced with its help. There is a lot of incomplete, jumbled, unsubstantiated, and poorly arranged data that is accessible to the public. Even before diving into data analysis, there are a number of stages involved in using data from several sources. In order to better understand public health problems and guide the administration of public health policy, this research aims to explain the steps of data analytics and how it is used to different types of data in order to address these challenges. In this study, three different types of data were examined.

Automated face mask recognition using artificial intelligence was the initial source. The results of an online survey made up the second part. Several online data sets that are available to the public were consulted to compile the final source. Artificial intelligence (AI) is the primary generator of this data. In order to get valuable insights about mask-wearing behaviors, this study examines the evolution of AI-assisted.

#### 3.1. Leveraging EHR Data Analytics

Electronic Health Records (EHR) provide a rich repository of patient data that can be harnessed to improve pharmacy quality. By analyzing medication histories, prescription patterns, and clinical outcomes, healthcare providers can identify trends and potential gaps in patient care. Advanced data analytics techniques enable the extraction of actionable insights to enhance medication safety, adherence, and patient engagement. For instance, predictive analytics can identify high-risk patients who may benefit from targeted interventions, while machine learning models can assess the likelihood of adverse drug reactions. Integrating EHR analytics into pharmacy workflows ensures data-driven decision-making that directly impacts patient outcomes.

#### 3.2. Enhancing Medication Safety

Medication safety is a critical component of pharmacy practice, and EHR analytics plays a pivotal role in mitigating risks. Data patterns can reveal drug interactions, over prescriptions, or dosing errors that may otherwise go unnoticed. Incorporating SHA-256 hashing algorithms into this process ensures that patient data remains secure and tamper-proof during analysis. The algorithm transforms sensitive patient information into unique, irreversible hash values, enabling analytics without compromising privacy. By embedding this secure framework, pharmacies can confidently implement safety checks and alerts based on EHR data without exposing confidential patient details.

#### 3.3. Improving Medication Adherence and Patient Engagement

Adherence to prescribed medications is essential for effective treatment, yet many patients fail to follow their regimens. EHR data analytics can monitor prescription fill rates and identify patterns of non-adherence. Machine learning models, combined with secure hashed data, can predict patients at risk of non-compliance and suggest tailored interventions, such as reminders or pharmacist consultations. Furthermore, patient engagement metrics derived from EHRs—such as communication frequency or health literacy indicators—can guide strategies to foster better patient-pharmacist interactions. The use of SHA-256 ensures that these analyses respect patient privacy, building trust and promoting more transparent healthcare practices.

#### 3.4. SHA-256:

SHA 256 is a part of the SHA 2 family of algorithms, where SHA stands for Secure Hash Algorithm. Published in 2001, it was a joint effort between the NSA and NIST to introduce a successor to the SHA 1 family, which was slowly losing strength against brute force attacks. The significance of the 256 in the name stands for the final hash

digest value, i.e. irrespective of the size of plaintext/clear text, the hash value will always be 256 bits. The other algorithms in the SHA family are more or less similar to SHA 256. Now, look into knowing a little more about their guidelines.

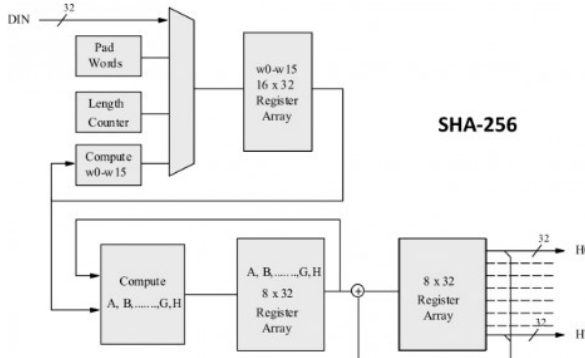


Fig.1. SHA-256 model

**EHR USING SHA 256 ALGORITHM:**

In a EHR Doctor upload patient data flows through a network comprising client devices and potentially a blockchain. Patient health data, such as medical records and diagnostic reports, is transmitted securely across the system. Before data transmission or storage, SHA-256, a cryptographic hash function, is applied to the data. This generates a unique hash value that serves as a digital fingerprint for the data.

$$SHA-256(data)=hash$$

The hash value is then transmitted or stored alongside the data. At various points within the system, including during transmission between components and upon data retrieval, SHA-256 is used to verify the integrity of the data. The received data is hashed using SHA-256, and the resulting hash value is compared with the transmitted hash value. If the hash values match, the integrity of the data is confirmed, ensuring that the data has not been tampered with or altered in transit.

**3.5. Implementing SHA-256 for Secure Data Handling**

The integration of SHA-256 hashing algorithms is vital for maintaining the integrity and security of healthcare analytics. This cryptographic tool ensures that sensitive EHR data remains protected throughout the analysis process. Hashing transforms patient identifiers into fixed-length alphanumeric strings, which prevents unauthorized access to original data while still enabling pattern recognition and predictive modeling. This approach is particularly useful for collaborative research and quality improvement initiatives across institutions, where data sharing is required. By securing patient data with SHA-256, pharmacies can confidently employ advanced analytics to drive quality improvements, enhancing medication safety, adherence, and overall patient care.

**4. IMPLEMENTATION**

The proposed method will be implemented in three phases:

**Phase 1:** Develop and test the block chain-integrated EHR analytics system in a controlled environment.

**Phase 2:** Pilot the system in selected pharmacy settings, focusing on its ability to identify and mitigate medication risks, track adherence, and engage patients.

**Phase 3:** Scale the system across multiple sites, integrating lessons learned from the pilot phase to ensure robustness and scalability.

**4.1. Block chain for Secure and Transparent Data Management**

Block chain technology provides a decentralized and immutable ledger to enhance the security and reliability of healthcare data analytics. Each transaction in the block chain is represented by a block, secured through cryptographic hashing algorithms, such as SHA-256. For example, a patient's prescription data Di is hashed as:

$$H(Di)=SHA-256(Di)-----(eq1)$$

where H(Di) is the fixed-length hash. This ensures data integrity, as any modification to Di results in a completely different hash. The hash values are linked together in a chain:

$$Bi=\{H(Di),H(Bi-1)\}-----(eq2)$$

where Bi is the current block, and H(Bi-1) is the hash of the previous block. This structure enables secure tracking of medication histories and ensures data authenticity, crucial for improving pharmacy quality. Block chain-based analytics utilize smart contracts to automate processes such as flagging potential medication errors or non-adherence, enabling real-time interventions.

**4.2. Distributed Analytics for Quality Improvement**

Block chain facilitates distributed healthcare data analytics by enabling multiple stakeholders pharmacies, healthcare providers, and patients to securely access data. Analytical models leverage hashed and encrypted data stored on the blockchain to ensure privacy compliance. For instance, consider a predictive model P that evaluates medication adherence A:

$$P(A)=f(H(Di),H(Di+1),...,H(Dn))-----(eq3)$$

where f represents a machine learning function trained on hashed data. This ensures that original patient data remains confidential while deriving insights. The immutable nature of block chain ensures accountability, as every analytical decision is logged and traceable. This enhances trust and allows pharmacies to implement data-driven quality improvements, such as optimizing prescription regimens, ensuring adherence, and engaging patients in personalized care plans.

By combining the analytical power of EHR systems with the security and transparency of block chain technology, this method aims to create a comprehensive, patient-centered framework for pharmacy quality improvement.

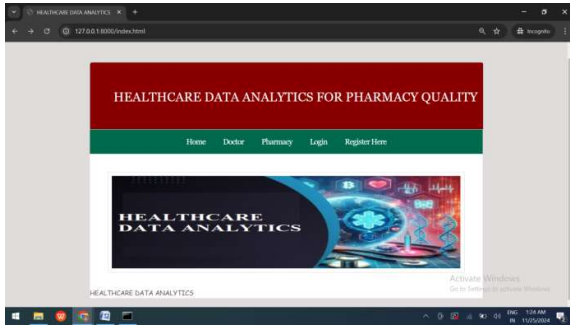


Fig.2. Home page.

**4.3. Protecting Patient Confidentiality and Data Security in Pharmacy Informatics with blockchain**

Protecting patient confidentiality and ensuring data security is paramount in pharmacy informatics. Pharmacies are entrusted with sensitive health information, making it essential to implement rigorous safeguards to prevent unauthorized access or data breaches. Adherence to strict regulations, such as the Health Insurance Portability and Accountability Act (HIPAA), is crucial in ensuring that patient data is handled appropriately. HIPAA mandates that pharmacies maintain robust security measures, including encryption, secure storage, and limited access to sensitive information. By following these regulations and adopting best practices in cyber security, pharmacies can uphold patient trust and maintain the integrity of their data systems.

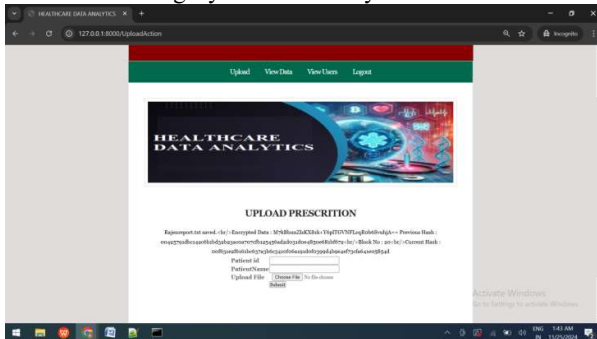


Fig.3. Hash code generation using blockchain.

**4.4. Block chain in Healthcare with Electronic Health Records**

Block chain technology holds immense potential for transforming healthcare, particularly in the management of Electronic Health Records (EHRs). Traditional EHR systems often struggle with data security, interoperability, and patient privacy concerns. Block chain, with its decentralized and immutable digital ledger, offers a solution to these challenges. By utilizing cryptographic techniques, block chain ensures that patient data is secure, tamper-proof, and protected from unauthorized access, making it a more resilient alternative to centralized databases vulnerable to cyber attacks. In addition to enhancing data security, block chain can improve the interoperability of EHR systems. It enables secure and seamless sharing of patient information across different healthcare providers, ensuring that data is accessible when needed while maintaining its integrity. This inter connections can help reduce data silos and

promote better coordination of care, which is essential for providing high-quality healthcare services.

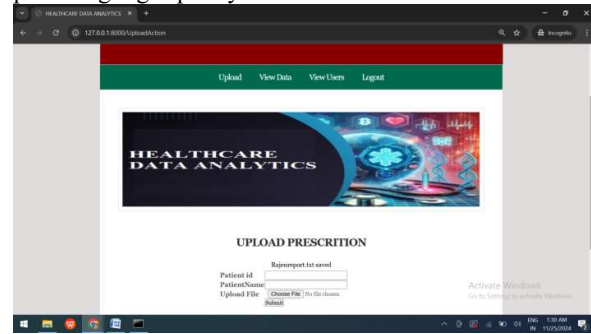


Fig.4. Secure upload data from user.

Another key benefit of block chain in healthcare is the increased control it provides to patients. Block chain allows patients to own and manage their health data, giving them the power to decide who can access their records. This level of transparency and patient autonomy helps build trust in the healthcare system, addressing concerns about privacy and data misuse.

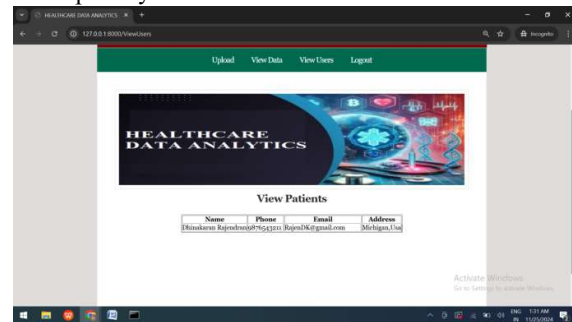


Fig.5. Data visible in admin portal

Moreover, block chain offers a transparent and immutable audit trail for all data transactions, making it easier to track any changes to EHRs. This enhances accountability, reduces the risk of errors or fraud, and improves overall healthcare quality. With the potential to streamline administrative processes, block chain also presents a cost-effective solution for healthcare providers by reducing the need for intermediaries and manual record-keeping. Overall, block chain presents a transformative approach to EHR management. While challenges in adoption remain, its ability to enhance security, interoperability, and patient control makes it a promising technology for the future of healthcare systems.

**CONCLUSION**

In conclusion, leveraging EHR data analytics integrated with SHA-256 algorithms offers a secure and efficient pathway for enhancing pharmacy quality improvement. By harnessing advanced data analytics, pharmacies can identify critical areas for improvement, such as medication safety, adherence, and patient engagement, while ensuring patient privacy and data integrity through robust cryptographic protections. The use of SHA-256 ensures that sensitive patient data remains secure during analysis, fostering trust and compliance in healthcare processes. This approach not only enables targeted interventions for improved patient outcomes but also facilitates scalable, privacy-preserving analytics for broader applications in

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pharmacy practice. Through these innovations, data-driven methodologies are poised to transform healthcare delivery and elevate the standard of care in pharmacy settings.

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