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Toward Robust Information: Data Quality in Healthcare Systems

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Abstract

In healthcare, data moves with the patients they reference, creating interdependencies between healthcare organizations. This means that poor data management in one organization can have a negative cascading effect on other organizations and the quality of care a patient receives. The large number of different data sources in healthcare leads to significant complexity in their management. As a result, there is currently a reactive approach to data quality management, which contributes to a lack of trust in data, as users only become aware of data quality issues when they first try to use the data. This paper examines the issues that define and control data quality and the mechanisms that can be developed to achieve and maintain good data quality in light of the literature.

Keywords: Healthcare Data, Data Quality, Data Governance

1. Introduction

Data quality is of utmost importance in healthcare, as it has a direct impact on patient care, clinical decision-making, and overall healthcare outcomes (Provost and Murray, 2022). The presence of inaccurate or incomplete data can lead to serious consequences, such as misdiagnosis, ineffective treatments, and compromised patient safety. Thus, it is crucial for healthcare organizations to ensure high-quality data to provide optimal care and make informed decisions (Howie et al., 2014).

High-quality data is essential in healthcare to ensure patient safety. Healthcare professionals depend on accurate and reliable data to make critical decisions regarding patient care (D'Amore et al., 2021). Improper documentation of allergies or incorrect medication dosages in a patient's record can result in adverse drug reactions or other medical errors. Maintaining high data quality standards can significantly decrease healthcare organizations' risks and promote patient safety (Strasberg et al., 2021).

Additionally, data quality is crucial for effective clinical decision-making. Healthcare providers depend on data to evaluate patient conditions, identify patterns, and determine the most suitable treatment options. Poor-quality data can cause inaccurate diagnoses or inappropriate treatment choices. Ensuring data accuracy, completeness, and consistency enables healthcare organizations to enhance clinical decision quality, ultimately leading to improved patient outcomes (Lu, 2014).

Data quality is pivotal also in population health management. To conduct studies, analyze patterns, and generate evidence-based advice, researchers rely substantially on accurate and thorough data. Population health management projects require reliable data to identify at-risk groups, evaluate health outcomes, and implement targeted treatments. These initiatives may be jeopardized due to lack of high-quality data, resulting in poor research outputs and less effective public health management approaches (Rodriguez-Lainz et al., 2018).

Moreover, high-quality healthcare data is required to guarantee that healthcare businesses comply with regulatory requirements and standards (Bali et al., 2017). Several nations have laws requiring secure, thorough, and accurate healthcare data. Failure to comply with these regulations can result in legal and financial penalties, as well as reputational harm. Healthcare businesses may assure compliance and maintain confidence among patients, regulators, and stakeholders by emphasizing data quality.

Given all of these concerns, it is apparent that data quality plays particularly a vital role in the healthcare sector. Creating a properly developed strategic data management strategy and a robust data governance policy is one of the most critical stages in enhancing data quality.

However, data quality and data governance are issues that have only recently gained attention, not only in healthcare but also in other sectors. Currently, a lot of organizations lack strategies for data governance and strategic data management. This study investigates data quality in the healthcare industry and presents a sample data governance

strategy, based on literature research, to enhance data quality.

The structure of the paper is as follows: Section 2 presents an expository literature survey on healthcare data quality. Section 3 examines the definition, scope, and challenges of data quality in the healthcare sector. In Section 4, a pragmatic strategy is proposed to enhance data quality and systematic data governance in healthcare institutions. Lastly, Section 5 concludes by presenting the insights and future perspectives gained from the study.

2. Related works

In order for healthcare organizations to effectively carry out their operations and improve patient outcomes, it is crucial that they have access to accurate, complete, and timely data. Furthermore, as the healthcare industry transitions from a volume-based to a value-based business model, data will play a pivotal role in this transition. This emphasizes the importance of implementing robust data governance mechanisms and assessing the quality of data within healthcare organizations' Health Information Systems or Electronic Health Records. It is also necessary for healthcare leaders to recognize that high-quality analytics tools can contribute significantly to improving healthcare delivery, management and policy making by supporting clinical decision-making processes with evidence-based medicine approaches. However, it should be noted that there are certain challenges associated with data governance in healthcare which need further research and allocation of resources specifically targeting areas where limited or erroneous data tend to exist.

Mavrogiorgou et al. present a unique technique for analyzing the quality of multiple data sources, including their derived data quality, in their study. They concentrate on automating data source identification, interaction, and access. The success of the mechanism is assessed by an experiment, specifically in the context of acquiring data from medical sources inside Healthcare 4.0. They also emphasize the importance of data quality in the healthcare industry, highlighting the necessity for trustworthy health data from a variety of IoT sources. It argues for the significance of using an automated technique to evaluate the quality of different data sources, with the goal of ensuring the dependability of health-related information for citizens and patients (Mavrogiorgou et al., 2019). In another study, the authors describe a study in which ten data quality scores were used to ensure that only doctors supplying data that reaches specified quality standards were included in the database used by researchers (De Lusignan et. Al, 2002). The study found that feedback of four of the ten markers had a significant effect on data quality, and that more detailed feedback appeared to have a greater effect. The authors conclude that the lessons learned from this approach may help improve the quality of electronic medical records in the United Kingdom and elsewhere. In their study (Were and Moturi, 2017), Were and Moturi emphasize that maintaining data quality is vital for health service delivery planning in the health sector, where especially electronic data plays a critical role. The authors highlight regulators' reliance on technology and electronic data. They argue that improving data governance in regulatory bodies requires introducing additional data quality monitoring methods, limiting data access, and obtaining governance support. Finally, once again, they highlight the critical importance of data quality in healthcare and offer developing country healthcare professional regulators a plan for implementing a formal data governance program. Jhonson et al. underline that secondary use of EHR data is only justified if the data are of high enough quality to support the intended application. They also show how to quantify the impact of data quality concerns on how healthcare organizations should prioritize data quality improvement efforts to focus on the areas with the greatest influence on validity (Johnson et al., 2017). While (Taylor et al., 2021) does not specifically discuss data quality in healthcare, it does stress the need of leveraging NHS data to inform and improve health services. The authors argue that by streamlining the process of accessing data for health services research and providing clarity to data controllers, they can maintain stringent governance while also accelerating scientific studies and progress, resulting in faster application of findings and improvements in healthcare. As a result, they underline once more that both data quality and data governance are critical aspects in ensuring that the results and improvements obtained from NHS data are accurate and dependable. According to Oktavinia et al. health data governance is critical for enhancing patient care and healthcare performance by assuring high-quality health data for research, decision-making, and national health plans. The correctness and quality of data are critical, and micro-level governance prioritizes consistency, availability, data integrity, usability, and security. Data quality, compliance, and business transformation are the three pillars of data governance in healthcare (Oktaviana et al., 2022). Zhang and Koru discuss the importance of data quality in the healthcare sector and presents a taxonomy of data defects to assess Medicaid data quality. They argue that a lack of data quality can lead to imprecise, useless, or even misleading results and suboptimal decision making, which can detract from the quality, effectiveness, and efficiency of healthcare services. The authors also discuss the need for systematic approaches to understanding and assessing data quality as the volume and utilization of health data steadily increases (Zhang and Koru, 2022). Hickey et al. highlight in their work that data quality is an important consideration in implementing electronic healthcare records and data governance. They discuss how poor-quality data can lead to inadequate care being provided and worse patient outcomes and present a new framework for data quality governance in healthcare records which is suitable for organizations undergoing digital transformation and supports building in quality processes from the start into the EHR-based system (Hickey et al, 2021). Finally, the study of Shiloach et al. dig into the specific techniques used by the American College of Surgeons National Surgical Quality Improvement Program

(ACS NSQIP) to ensure the collection of high-quality data (Shiloach et al., 2010).

These techniques include data collector training and continuous data reliability checks. The study goes on to look at how to calculate and use inter-rater reliability to improve data accuracy. The publication emphasizes the critical importance of data quality in healthcare, notably in assessing medical care quality and assuring meaningful quality evaluation and benchmarking. The ACS NSQIP program infrastructure is focused on gathering highly reliable clinical data, and the publication gives a detailed overview of the many processes used to assure high-quality data collection.

3. Data quality and its significance in healthcare data governance

Data quality refers to the overall condition and reliability of data. It includes attributes such as accuracy, completeness, consistency, timeliness, and relevance. High data quality denotes error-free, consistent, and inclusive data, thus making it appropriate for its intended purpose, including analysis, decision-making, or other applications. Ensuring data quality is essential, as low-quality data can result in erroneous conclusions, ineffective decision-making, and compromised business processes. Effective data quality management involves implementing processes and utilizing practices to maintain and improve the accuracy of data within an organization.

In the realm of data governance, data quality plays a vital role in guaranteeing the dependability and utility of data for decision-making and operational processes. Data governance envelops the standards, procedures, and structures that guarantee efficient management of data across an organization.

The significance of data quality in data governance lies in its ability to ensure that the data an organization uses are precise, reliable, and consistent. High-quality data is crucial in making informed decisions and conducting meaningful analysis. Without dependable data, organizations run the risk of making flawed decisions that can severely impact their operations and overall success.

The health sector differs significantly from other sectors in terms of its characteristics. Although common problems are shared, data quality in the health sector has distinct underlying factors which are cited as follows:

1. Inadequate Data Collection Processes: One of the primary causes of suboptimal data quality in healthcare is substandard data collection processes. This may comprise mistakes during data entry, incomplete or missing data, or erratic data recording practices. Such issues might arise due to human error, lack of standardized procedures, or inadequate training of healthcare professionals entrusted with data collection (Botha et al., 2014).
2. Lack of Data Governance: Another significant factor in data quality issues is the absence of appropriate data governance in healthcare organizations. Data governance establishes policies, procedures, and responsibilities to manage and ensure data quality. In the absence of a strong data governance framework, there may be no clear accountability for data quality, resulting in inconsistencies, inaccuracies, and subpar data management practices (Elkin-Koren and Gal, 2019).
3. System Integration Challenges: Healthcare systems often depend on various software applications and databases for storing and managing patient data. If these systems are incompatible or not adequately integrated, data quality issues can arise. For instance, data can be lost or duplicated during the transfer between systems, leading to discrepancies and inaccuracies. Furthermore, as different systems may follow different data standards or formats, it can be challenging to maintain consistent and high-quality data (Petersen et al., 2019).
4. Lack of Data Standardization: The absence of standardization of data elements and formats across healthcare institutions can impede data quality (Noyes et al., 2019). When various healthcare providers use different terminologies, coding systems, or data structures, aggregating and analyzing data becomes challenging. This lack of consistency can result in data inconsistencies, making it challenging to compare and share data across different healthcare settings.
5. Insufficient Data Validation and Quality Checks: Inadequate data validation and quality checks represent a significant obstacle to maintaining high-quality data in healthcare (Zhang and Koru 2020). In the absence of proper validation processes, errors or inconsistencies in data can go unnoticed. This may lead to erroneous patient identification, invalid or out-of-range data values, or inconsistent data formats. Implementing robust data validation and quality control measures can help detect and correct such issues, ensuring accurate and reliable healthcare data.
6. Limited Interoperability: Interoperability enables diverse healthcare applications and systems to seamlessly exchange and use data. Restricted interoperability may deteriorate data quality by obstructing the data flow between different healthcare entities (Scheibner et al., 2021). When electronic health records cannot be easily shared between hospitals or clinics, patient data becomes fragmented and incomplete, potentially diminishing healthcare's accuracy and effectiveness.

Data accuracy and completeness present significant challenges in healthcare. The manual data entry dependency of healthcare professionals could lead to errors, including typos, incorrect data entry, or missing information, despite the use of electronic forms. To address this, healthcare organizations should opt for automated data capture methods such as barcode scanning or electronic data interchange, reducing manual entry reliance and improving data accuracy and completeness.

Interoperability of healthcare systems and data sources remains a challenge. The collection and storage of data in diverse systems and formats, including Electronic Health Records (EHRs), laboratory information systems, and radiology systems, often leads to fragmented data due to a lack of seamless communication between them. Healthcare organizations must invest in interoperability solutions such as health information exchanges and standardized data

formats to ensure accurate and complete data across various systems.

Data accuracy and completeness can also be impacted by errors and omissions made by healthcare professionals during data entry. Because of heavy workloads and time constraints, critical data points may be overlooked or skipped by healthcare professionals, leading to incomplete records. To address this challenge, healthcare organizations should prioritize data entry training and provide tools and reminders to ensure comprehensive and accurate data capture.

The complexity and sheer volume of healthcare data pose additional obstacles. Healthcare generates extensive amounts of data, which encompasses clinical notes, diagnostic images, lab results, and more. Managing and organizing data in the healthcare industry can be overwhelming, especially when organizations lack a comprehensive data management framework. The implementation of data governance practices such as data validation, cleansing, and stewardship can alleviate this challenge and ensure data accuracy and completeness.

Integral to ensuring data accuracy and completeness is patient engagement and participation. Patients are typically the main providers of their health information, but they may forget or omit critical information when interacting with healthcare providers, which could lead to incomplete or inaccurate data. Healthcare organizations have the potential to allow patients to actively manage their health information through patient portals, mobile apps, and digital tools. Encouraging patients to regularly review and update their data can notably improve data accuracy and completeness.

4. A pragmatic strategy to improve data quality

Research conducted through literature indicates that failure to align data governance and quality with an organization's business strategies has a negative impact on achieving goals. Those in roles with a comprehensive overview of the organization and expertise in data quality management must make data quality decisions. Effective data quality practices are essential. Managing data is becoming increasingly challenging for corporate decision-makers due to its growing volume and rapidly changing characteristics. In addition to the generally accepted principles for data governance, which are only now beginning to find a place on management level, the following strategy has been developed especially for healthcare sector based on a literature review. The strategy aims to change practice so that a continuous cycle of proactive management of data ensures that only high-quality health information is available to all who use it. It is believed that this strategy, presented here as an example, will serve as a valuable reference for healthcare sector's decision makers and managers across all organizations.

The proposed strategy is built around three core concepts: 1) Data, 2) People and Systems, and 3) Governance. All of the steps given below have been designed assuming that at least two of these three concepts will play a leading role.

1. Data validation and verification procedures: One action that should be taken to improve data quality in healthcare is the implementation of data validation and verification processes. This involves using automated tools and algorithms to check the accuracy and completeness of data entered into electronic health records (EHRs) or other healthcare systems. Data validation and verification can help identify and correct errors, inconsistencies, and missing information, ensuring that the data is reliable and trustworthy. For example, validation rules can be set up to check for proper formatting of patient demographics, such as ensuring that dates of birth are entered in the correct format and fall within a reasonable range. By implementing best practices for data validation and verification, healthcare organizations can improve the quality of their data, leading to better decision-making, improved patient care, and enhanced operational efficiency. The following practices are recommended to be considered to improve the efficiency of data validation and verification procedures:

- Establish clear data validation and verification policies: Healthcare organizations should develop comprehensive policies that outline the standards and procedures for data validation and verification. These policies should define the roles and responsibilities of staff involved in the process and provide guidelines for handling data discrepancies.
- Use standardized data formats and coding systems: Standardization is key to ensuring consistent and accurate data. Healthcare organizations should adopt standardized data formats and coding systems, such as HL7 (Health Level Seven) for data exchange and SNOMED CT (Systematized Nomenclature of Medicine - Clinical Terms) for clinical coding. This helps to minimize errors and facilitates interoperability between different systems.
- Implement automated validation and verification tools: Manual data validation and verification processes are time-consuming and prone to errors. Healthcare organizations should invest in automated tools and software solutions that can perform checks and validations on data in real-time. These tools can flag inconsistencies, missing values, and potential errors, allowing for prompt corrective actions.
- Improve data entry and data management practices: Human factors play an important role in data entry phase which is very crucial in validation and verification of data. Training all relevant stakeholder employees has a remarkable impact on data quality. For this reason, they should be provided with the necessary tools and resources to improve data entry and data management practices including data entry guidelines, standardized data formats, and data quality training programs.

2. Data Governance: Data governance refers to the overall management of data within an organization, including the policies, processes, and procedures that ensure data is accurate, consistent, and reliable. Data governance involves defining policies, procedures, and responsibilities for managing and ensuring the quality of data within an organization. In the context of healthcare, data governance helps to establish standards and guidelines for data

collection, storage, and usage, which are essential for maintaining data quality. To offer a well-defined and robust data governance for the healthcare institution, the following approaches should be considered:

- Develop a data governance framework: It will be responsible to outline the roles, responsibilities, processes policies, and controls for managing data quality. This includes establishing data stewardship, data ownership, and data management policies. This framework should be aligned with regulatory requirements and industry best practices. A well-defined data governance framework ensures accountability and promotes a culture of data quality.
- Establish a dedicated data governance team: This team should include representatives from various departments, including IT, clinical, and administrative staff and it will be responsible for defining data quality standards, monitoring data quality metrics, and implementing data quality improvement initiatives. Data stewards are responsible for overseeing the quality and integrity of data within an organization. They ensure that data is accurate, complete, and consistent by monitoring data entry processes, resolving data quality issues, and implementing data quality improvement initiatives. Data governance provides the framework and support for effective data stewardship, enabling healthcare organizations to have dedicated individuals or teams responsible for maintaining high-quality healthcare data.
- Creation of data ownership and accountability: It defines roles and responsibilities for data management, ensuring that there are clear lines of ownership and accountability for data quality. This includes assigning data stewards, establishing data governance committees, and implementing data quality metrics and reporting mechanisms. By clearly defining data ownership and accountability, data governance facilitates the proactive management of data quality in healthcare.

3. Data Integrity and Security: Healthcare data is highly sensitive and confidential, and it is essential to protect it from unauthorized access, tampering, or loss. Data governance frameworks include measures to safeguard data privacy and security, such as access controls, encryption, and regular data backups. By implementing robust data governance practices, healthcare organizations can maintain the integrity and security of their data, which is crucial for maintaining high-quality healthcare data.
4. Data Quality Procedures:

- Defining data quality requirements: It starts by clearly defining the data quality requirements specific to each healthcare institution and its objectives. This involves identifying the critical data elements, establishing quality standards, and determining the acceptable levels of accuracy, completeness, and consistency for each data element.
- Assessing the current data quality: A thorough assessment of the existing data quality should be conducted with a regular schedule. This can be done through data profiling, data audits, and data quality measurements. Audits can help identify data entry errors, duplicate records, and other anomalies that may affect data quality. A schedule for conducting audits should be determined while ensuring that they are performed by trained professionals.
- Implement data quality monitoring and reporting mechanisms: It helps to identify and address data integrity issues in healthcare. This involves regularly monitoring data quality metrics, such as data completeness, accuracy, consistency, and timeliness. Healthcare organizations can leverage technology solutions, such as data analytics and reporting tools, to automate the monitoring and reporting of data quality metrics.

5. Data Quality Metrics: Data quality metrics are indispensable tools in the healthcare industry, serving as a standardized framework for assessing and enhancing the accuracy, completeness, consistency, and timeliness of healthcare data. These metrics are instrumental in evaluating and monitoring the integrity of patient records, ensuring their reliability for clinical decision-making and patient care (Dungey et al., 2015).

Regular measurement and tracking of data quality metrics enable healthcare organizations to proactively identify trends, patterns, and potential issues that could compromise data integrity. By doing so, they can implement corrective measures and interventions, thus maintaining data accuracy and reliability over time. For example, monitoring data completeness metrics aids in identifying and rectifying missing or incomplete patient information, ensuring comprehensive and robust records.

Furthermore, data quality metrics serve as a benchmark for comparing data quality across different healthcare systems and organizations. Establishing industry-wide standards simplifies the assessment and comparison of data quality among various entities, facilitating collaboration, data sharing, and system integration. By evaluating and monitoring healthcare data quality, organizations ensure that data remains trustworthy and suitable for supporting clinical decision-making and enhancing patient care. In essence, the strategic use of data quality metrics is paramount in upholding the reliability and accuracy of healthcare data.

6. Investing in staff training and education: All staff members who handle or input data should be trained on the importance of data quality and the best practices for validation and verification. Healthcare professionals, including physicians, nurses, and administrative staff, should receive training on data entry best practices, data quality standards, and the importance of accurate and complete documentation. Training programs can help healthcare professionals understand the impact of data quality on patient care and outcomes, and provide them with the necessary skills and knowledge to ensure data integrity. By investing in staff training and education, healthcare organizations can empower their workforce to take ownership of data quality and contribute to improving the overall accuracy and reliability of healthcare data.
7. Continuously improve data quality by implementing data quality improvement initiatives: This includes identifying root causes of data quality issues, developing corrective action plans, and monitoring the effectiveness of these plans over time. To ensure the data is

fit for its intended purpose and trustworthy for decision-making and analysis, healthcare institutions must distinctly establish the data quality requirements pertinent to their objectives.

By following this strategy, healthcare institutions can improve data quality, enhance patient safety, and ensure compliance with regulatory requirements.

5. Conclusion

This study emphasizes the importance of data quality in the healthcare industry. Quality of data impacts patient care, clinical decision-making, and healthcare outcomes. Poor data quality can result in serious consequences such as misdiagnosis, ineffective treatments, and jeopardized patient safety.

Numerous challenges exist in maintaining data quality within the healthcare industry and are discussed in this study. These challenges encompass concerns surrounding data collection, governance, and standardization, as well as system integration, quality checks, interoperability, and the impact of patient engagement on data accuracy and completeness. These factors underscore the complexity of upholding high-quality healthcare data.

To improve data quality and address associated challenges, we present a comprehensive and pragmatic strategy specifically customized to healthcare organizations. The strategy incorporates various measures such as data validation and verification procedures, establishment of a data governance framework, defining data ownership and accountability, data integrity and security measures, data quality processes, and implementation of data quality metrics. Additionally, the strategy underscores the significance of investing in staff training and education, as well as continuously striving for improvements in data quality.

In essence, this article provides a useful guide for managers and decision makers in the healthcare industry who want to improve the quality of data within their organizations. By following the suggested approach, healthcare institutions can not only enhance patient care and clinical decision-making but also guarantee adherence to regulatory standards. As data quality remains crucial in healthcare, organizations must prioritize data governance and systematic data management to ensure optimal healthcare outcomes and patient safety. The insights presented in this article establish the groundwork for a more robust and dependable healthcare data ecosystem, guaranteeing that healthcare data is accurate, complete, and consistent for the benefit of patients and the wider healthcare

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