

Data Integration In Health Information Systems: Implications For Quality Care And Decision Making

Abdulaziz Alrasheed¹, Sarah Fadhel Bu Zaid², Ahmed Abdullah Atiah Alghamdi³, Salma Khalid Alqazih⁴, Shaqra Yahia Essa Maydi⁵, Ibrahim Mouaidi⁶, Mohammed Moraya Alshahrani⁷, Khalil Mattar Abu Taim⁸, Abdurrrhman Hassan Ali Qahtani⁹, Abdulrahman Abbad Alharbi¹⁰, Kholud Omar Kjmani¹¹

¹Dept of Public Health, MOH

²King Faisal University

³Technician-Health Informatics, Medical Services, Al Nakheel Medical Center

⁴Health Informatics, Esehha Health Information Company

⁵Nurse, Al Ahad General Hospital

⁶Health Information Technician, Abu Arish General Hospital

⁷Health Informatics, Armed Forces Hospital Southern Region

⁸Revenue Cycle Manager, Care Medical, Care Medical Company

⁹Customer Success Manager

¹⁰Technician-Medical Secretary, Taibah University

¹¹Health Informatics, Median Medical Services

Abstract

This study highlights the critical importance of a complete and operational Health Information System (HIS) in effective public health decision-making, concentrating on urban cardiovascular disease (CVD) outcomes in three cities participating in the CARDIO4cities project. A global approach was executed to assess the processing of data and concepts related to HIS, with the objective of optimizing data utilization and hence improving CVD management in urban environments. Key performance indicators (KPIs) were customized for each city, based on a universal Theory of Change (ToC). The assessment included essential aspects such as data ownership, sharing, availability, quality, collection methodologies, and the organizations participating in these processes. The study revealed common concerns among cities by mapping existing methods for data collecting, processing, and storage, as well as creating flowcharts that illustrate data flows and challenges. Significant findings revealed deficiencies in system interoperability and data integrity issues, attributable to inaccuracies, inadequate datasets, and uneven management procedures.

The recognized obstacles to successful HIS adoption encompassed disjointed systems, technological resistance from stakeholders, inadequate human resources, and apprehensions about data security. Nevertheless, the advantages of HIS, including cost savings, immediate access to information, the advancement of evidence-based policies, and improved knowledge management, were highlighted. The study offered recommendations aimed at harmonizing interoperability via standardized protocols such as FHIR, enhancing workforce capacity, promoting transparent governance, facilitating digital transitions, and establishing parallel data systems to elevate data management quality. These measures seek to promote the sustainable control of cardiovascular disease risk factors, including hypertension, obesity, and dyslipidemia. The results indicate the shift of HIS from conventional paper-based systems to more cohesive digital platforms. This progress requires active collaboration among stakeholders, extensive policy reforms, and localized adaptations to tackle fragmentation, hence facilitating health enhancements through effective data management systems.

Keywords: Data Integrity, Digital Transformation, Health Information Systems (HIS), Key Performance Indicators (KPIs), Theory of Change (ToC), Knowledge Management.

Introduction

Effective public health decision-making based on data necessitates a comprehensive and functional Health Information System (HIS). We apply a global strategy to three locations and give an evaluation of data processing and overarching Health Information System ideas. The assessments supported the data strategy of each city's CARDIO4cities project, which seeks to improve urban population health by employing additional cardiovascular disease (CVD) data to inform decision-making. Concerning a specified set of key performance indicators (KPIs), our aims were to examine data ownership and sharing, data availability and quality, and data collection techniques and entities. (Hussein et al., 2023)

Key Performance Indicators (KPIs) were tailored for each location, grounded in a universal Theory of Change (ToC) and a comprehensive global evaluation and indicator framework. Proposals for alterations and enhancements will certainly improve the current situation if the sources and methods for data are initially assessed. The current protocols for data collection, analysis, and storage were assessed to delineate the data. A flow chart was created to depict the data flows and challenges associated with each system. The outcomes were subsequently compared among cities to identify any disparities and similarities. The primary challenges confronting all Health Information Systems (HISs) were interoperability among diverse systems and data integrity. (Torab-Miandoab et al., 2023)

The identified data quality issues were from inaccurate, missing, and incomplete data, which were associated with misinterpretations of indicators, incomplete data entry forms, or an absence of a consistent data management routine. Harmonizing Health Information Systems (HISs) to ensure interoperability can facilitate data collection and analysis of health data, thereby establishing a robust platform for health management decision-making. (Sheikh et al., 2021)

This review aims to conduct an HIS evaluation by analyzing, mapping, and validating current methods to visualize outcomes and ascertain governmental bodies' inclination to obtain political endorsement. In addition, this review aims to ensure that interoperability facilitates health data collection and analysis, serving as a robust platform for health management decisions...

Health Information Systems

Health information systems (HIS) are essential instruments utilized by organizations and stakeholders within the healthcare sector to eradicate data fragmentation and enhance health protocols by integrating diverse departments and health functions for superior healthcare delivery. The Health Information System has undergone significant transformations throughout time due to several factors influencing individuals' ability to afford high-quality healthcare services, including political, economic, socio-technical, and technological elements. HIS has enabled the healthcare sector to consolidate information systems and protocols related to health. (Jia et al., 2021)

HIS is often characterized as a system that improves the quality of healthcare services by facilitating management and operational procedures to acquire critical information and integrate humans, technology, and processes. Several authors assert this, referencing HIS's remarkable capacity to deliver integrated healthcare. Haux modestly characterized HIS as a system that administers data to disseminate insights and information within the healthcare context. Almunawar and Anshari defined Health Information Systems (HIS) as any healthcare system that manages data and disseminates knowledge and information. Malaquias and Filho underscored the importance of HIS, highlighting its development to fulfill the need for storing, processing, and retrieving information from system data to enhance operations, improve services, and facilitate decision-making. (Wager et al., 2021)

Lippeveld popularized the term "integrated effort to collect, process, report, and utilize health information and knowledge to influence policy-making, program action, and research" when defining Health Information Systems (HIS). The World Health Organization (WHO) and various other authors

have progressively adopted and contextualized this phrase. The definition of HIS has remained unchanged since its inception; instead, it has been interpreted across many contexts, notwithstanding Haule and Muhanga's claim of worldwide variation. (AlQudah et al., 2021)

Malaquias and Filho reiterated this definition in the current literature. To facilitate decision-making and assist in the administration of health organizations, these scholars affirmed that HIS is "a collection of interrelated components that gather, process, store, and disseminate information." Health Information System (HIS) is characterized as "a system of interrelated components that gather, process, store, and disseminate data and information to facilitate decision-making, aid in the management of health organizations, and improve healthcare applications," consistent with the description employed in this study. However, it is crucial to acknowledge that HIS encompasses a wide range. (He et al., 2021)

The term is often of minimal importance because to its association with external applications related to health improvements and policymaking. Consequently, emphasis should be placed on the contribution of the definition to all facets of health development rather than the definition itself. Notwithstanding its extensive implementation, driven by the promise of enhancing healthcare and revolutionizing its processes, HIS is nevertheless seen as inadequate in its present condition. Persistent restrictions and technological resistance have rendered HIS incapable of achieving its objectives. The current research underscores the constraints of Health Information Systems (HIS) that hinder their utilization and implementation in the healthcare sector, revealing many challenges across multiple categories, including insufficient human resources and technological integration. (Tran et al., 2021)

Although several authors have acknowledged the unique capacity of HIS to integrate treatment and unify the health process, these perspectives seem to be compromised by the presence of impediments. The fragmentation, instability of updates, and absence of standards in the current HIS deployment hinder its capacity to deliver healthcare. Consequently, several publications identified the barriers hindering HIS as inadequate communication networks, underutilization of HIS, security and confidentiality concerns, and insufficient awareness of HIS's capabilities. The objective of this article is to ascertain pertinent and current information regarding the deployment of Health Information Systems as a collaborative effort to augment and refine healthcare delivery capabilities. This research systematically analyzes the existing literature to get comprehensive conclusions regarding HIS value... (Haldane et al., 2021)

The Evolution of Health Information Systems

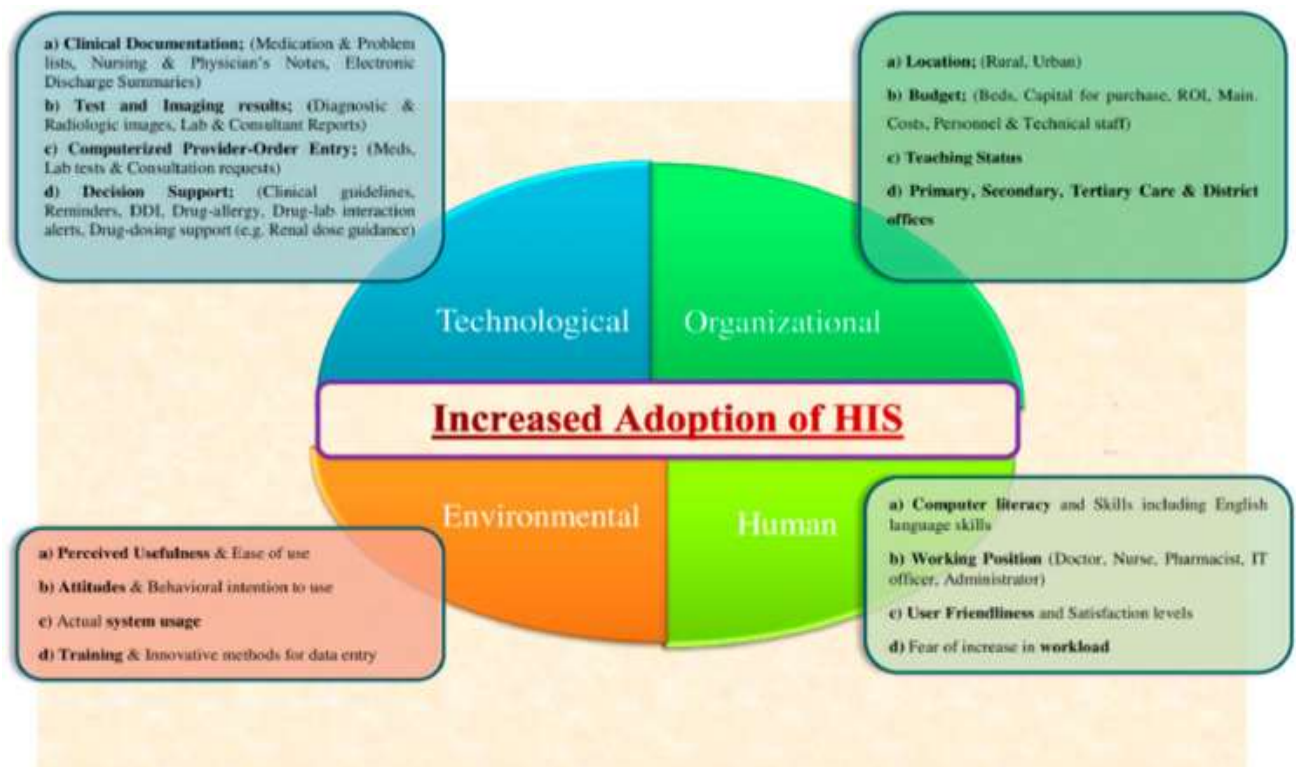
Health Information Systems (HIS) have consistently been founded on the principle that enhanced healthcare services are achievable via the integration of information systems and business processes. Almunawar and Anshari contend that several elements, including political, social, technological, and economic dimensions, have profoundly influenced the attributes of the healthcare industry. The implementation and operation of HIS are thought to be significantly affected by the technological aspect, particularly the computerized component. Panerai asserts that instead of being responsible for HIS's success, this singular quality is solely culpable for its shortcomings. (Johnson et al., 2023)

The ownership of HIS is contested in the literature; some authors assert that the IT sector possesses HIS. While information technology has enabled significant progress in various industries, it has also resulted in multiple grievances. Several organizations, particularly in the healthcare sector, have recently acknowledged the significance of IT in enhancing and optimizing health operations, but they seek the appropriation of their integrated information systems. HIS was established as a "collection of interconnected components that gather, process, store, and disseminate information to facilitate decision-making and assist in the management of health organizations." The unavoidable transformations and advancements in the worldwide landscape resulted in the establishment of HIS. The recognition that multiple interconnected and disparate elements coexist within a system effectively encapsulates and consolidates this discord. The HIS in this case is a well-established system comprising several components, including technological aspects. (Zhao et al., 2022)

Numerous individuals perceive Health Information Systems (HIS) only as computer technology due to its historical progression. This notion has further exacerbated the misinterpretation

of HIS's origins and the failure to differentiate between the conceptual framework and the real HIS technology. Literature indicates that Health Information Systems (HIS) have been in existence for at least 200 years prior to the advent of computers, traceable to the initial mortality records of the 18th century. This demonstrates how the commercialization of "electronic medical records" (EMR) in the 1970s facilitated the evolution of digitalized Health Information Systems (HIS). Namageyo-Funa, Aketch, commended the advancement of technology in the healthcare sector, elucidating how the implementation of digitalized Health Information Systems (HIS) significantly transformed the recording and accessibility of health data. Despite these limitations, the existing body of research continues to affirm the importance of a robust and enduring HIS for medical applications universally. (Lal et al., 2022)

The adoption of Health Information Systems (HIS) is propelled by the necessity for technological digitalization, especially among stakeholders like as clinicians and decision-makers. The planning, management, and administrative departments are the primary drivers of HIS adoption at the organizational level. The socio-technical factors identified as complex drivers for Health Information System adoptions are centered on environmental and human influences. The introduction of Health Information Systems (HIS) is necessitated in numerous healthcare sectors due to recognized aspects related to attitudes, literacy, and usability... (Soroya et al., 2021)



Relationships between the factors that drive adoption and an efficient health information system. (Thapa et al., 2021)

HIS Structural Deployment

The objective of HIS's unified front is to enhance healthcare delivery through the assimilation and dissemination of health information. The Health Information System (HIS) has multiple subsystems that assist various stakeholders in healthcare. The sub-systems, dedicated to certain activities, perform various services including civil registrations, disease surveillance, outbreak notifications, interventions, and the interchange of health information within the healthcare sector. Moreover, it streamlines and integrates various duties and operations inside the healthcare environment, encompassing scheduling, billing, management, and documentation of diverse data and information for stakeholders. Health data from diverse Health Information System scenarios is disseminated to stakeholders. (Naeem et al., 2021)

These include, but are not limited to, Internet information systems, hospital and patient information systems, and health institution systems. Sligo Gauld perceived HIS as a panacea that augments medicinal applications within the healthcare sector. Notwithstanding HIS's ostensibly boundless potential, it has been characterized as imbalanced and lacking subsystem interactions. Accurate health information is crucial for numerous policy and decision-making processes. Suresh and Singh assert that the Health Information System (HIS) renders health information accessible to all stakeholders in the healthcare sector, including governmental entities, hence influencing the delivery of healthcare services. Moreover, the existing literature underscores the vital importance of the human element and demonstrates that trustworthy health information forms the foundation for decision-making .(Wager et al., 2021)

Furthermore, contemporary HIS can be categorized into two components: the non-computer element, which operates at a separate level, and the computer-related element, which employs ICT-related tools. The levels comprise operational, tactical, and strategic. The strategic implementation of Health Information Systems (HIS) offers analytical capabilities such as financial forecasting, performance assessment, simulation frameworks, and intelligent decision-making support. The system performs managerial functions at the tactical level and executes administrative, scheduling, invoicing, recording, procurement, automation, and payroll operations at the operational level... (Do Nascimento et al., 2022)



HIS deployment levels. (Santana et al., 2021)

Health Information Systems Benefits

Numerous critical procedures and sectors within the healthcare industry are encompassed by HIS, a cohesive system that provides various benefits. Included are the accessibility of patients and medical records, reduction of expenses and time, and implementation of evidence-based health policies and activities. Numerous authors have affirmed that the advantages of HIS are well-recognized and impactful in the healthcare sector. Moreover, these numerous advantages are what draw many health organizations to Health Information Systems (HIS). (Alolayyan et al., 2022)

Investments in Health Information Systems (HIS) have facilitated effective decision-making, real-time comprehensive health information for superior healthcare applications, efficient healthcare policies, enhanced monitoring and evaluation, health innovations, resource allocations, surveillance

services, and improved governance and accountability. HIS should be pertinent to the interchange of data, information, and general knowledge within the healthcare environment. The integration of numerous technologies has enhanced the value of HIS core qualities. Current study demonstrates that the function of HIS extends beyond mere payment provision... (Pradhan et al., 2021)

Information System

A vital activity influencing healthcare outcomes is the integration and distribution of health data and information within the healthcare system. Information Systems are essential for the integration and distribution of health information necessary for healthcare stakeholders within the healthcare environment. The implementation of Information Systems is endorsed by multiple continents largely to integrate variable data from diverse sources into the systems. The implementation of these systems has mostly concentrated on integrating diverse and separate components, such as individuals, organizations, procedures, and technology, into a unified framework. (Zaabar et al., 2021)

An evaluation of the existing literature indicates that this has seldom been uncomplicated, as integration into this system has consistently posed challenges in numerous contexts. A multitude of individuals perceived the integration phenomenon within the context of Health Information Systems (HIS) as challenging, attributing this difficulty to the worldwide reorganization of the healthcare sector. The evolution and advancement of the healthcare business necessitate robust allied health information systems that combine diverse information systems and technologies. To enhance healthcare applications, allied health information systems must integrate diverse information systems within their area. (Shahid et al., 2022)

Healthcare companies anticipate that these systems will be resilient and sustainable; nevertheless, to fulfill these expectations, an integrated information system is necessary to consolidate all independent, flexible, and agile health information systems, thereby mitigating obstacles for Health Information Systems (HIS). An integrated, coordinated Health Information System (HIS) is essential as it bolsters Health Information Networks (HIN), hence augmenting and refining healthcare applications. Consequently, numerous healthcare institutions are enhancing their Health Information Systems to render them more resilient and sustainable. Implementing a robust information system in the healthcare sector is challenging, and the flow of information is crucial for seamless and efficient operations... (Al Kuwaiti et al., 2023)

Knowledge Management

Knowledge management is the process of generating value and establishing a sustainable competitive advantage for a corporation by emphasizing the development, communication, and application of knowledge processes to attain certain objectives. Research indicates that the ability of knowledge management to facilitate information sharing is a crucial determinant of organizational performance. Expertise to enhance healthcare applications is in high demand within the healthcare sector. Numerous studies indicate that the deployment of knowledge management in the healthcare sector is anticipated to enhance the effectiveness of medical care. (Li et al., 2021)

A diverse array of stakeholders, including governments, the World Health Organization (WHO), and healthcare practitioners, relies on the management of healthcare knowledge to support healthcare applications. Kim Newby-Bennett asserts that the objective of knowledge management is to efficiently accelerate information transfer. Nevertheless, it is challenging and requires a facilitator to synthesize knowledge from multiple sources. In the healthcare sector, the Health Information System (HIS) is an essential instrument for generating health information from aggregated health data. Dixon asserts that collaboration in information technology and the codification of knowledge facilitate effective transformations within the healthcare sector. Some authors have identified information and communication technology in the healthcare industry as a crucial element in establishing a sustainable health system. (AlQudah et al., 2021)

The relationship between knowledge management and HIS is considered balanced and complimentary due to its facilitation of knowledge transfer. The enhancement of a healthcare application via HIS is crucial to the importance of knowledge management. HIS functions as an

effective information system for management, patients, health, healthcare units, and medication knowledge within the information society. The authors demonstrated how Health Information Systems (HIS) facilitate knowledge management in the healthcare sector to improve applications. (Stoumpos et al., 2023)

The potential of HIS in the healthcare sector is evidenced by its role as an integrated information system and a significant enabler of healthcare knowledge management. Notable achievements have been observed at several tiers of its structural implementation since the establishment of HIS and the recording of its progression. The introduction of Health Information Systems has enhanced clinical procedures and patient outcomes across many healthcare environments. Health Information Systems (HIS) are crucial for enhancing global healthcare. The implementation of HIS is crucial for numerous healthcare functions. The solutions offered by HIS in response to the digitalization and transformation confronting the healthcare system substantiate this necessity. (Tagde et al., 2021)

Despite the necessity of HIS and its potential in the healthcare sector, several challenges hinder its full realization. Numerous authors assert that mitigating the personal and technological barriers hindering the implementation of Health Information Systems necessitates the involvement and contribution of healthcare professionals, including physicians. Nevertheless, HIS is perceived to be lagging in delivering high-quality healthcare due to its design prioritizing health enhancement. This study evaluates the traits and capacities of Health Information Systems (HIS), highlighting their advantages in enhancing healthcare, despite the associated downsides. (Ahmat et al., 2022)

Since its establishment, HIS has experienced significant advancement to enable the digitization of many healthcare processes. The structural implementation has facilitated several healthcare applications at all levels of the health system. The introduction of HIS has facilitated various advantages, including cost reduction, data management, precision medicine, convenient access to medical records, and the capacity for autonomous and intelligent decision-making. (Johnson et al., 2023)

HIS primarily functions as the principal facilitator of knowledge management and healthcare information systems. Identifying the characteristics and evolution of HIS is crucial for enhancing its utilization and realizing its full potential. This study can provide a basis for various HIS deployments, acting as a framework for the organization and execution of HIS implementation. The current research underscores the imperative of elucidating the role of technology, such as Health Information Systems (HIS), due to the limited understanding around it, which has adversely affected healthcare coordination. Insufficient planning that fails to consider the requirements of those executing HIS becomes an additional barrier to the optimization of these systems within the healthcare environment. (Shin et al., 2022)

Cawthon and Mion associated diminished health outcomes and increased expenses with the lack of health literacy integration in the Health Information Systems (HIS). To mitigate these issues, the insights derived from this study might be implemented and associated with HIS projects. Consequently, the findings of this study can inform the planning of HIS implementation and enhance its capacity to improve healthcare. Furthermore, the findings of this study, which emphasize the comprehensive portrayal of Health Information Systems (HIS) in the acquisition and distribution of health data and information, can enhance the proficiency of healthcare stakeholders, including patients. (Marques et al., 2024)

An element of healthcare information and knowledge that influences healthcare delivery is absorption and diffusion. The design and development of HIS have positioned it to facilitate information sharing among players in the healthcare sector. The implementation of Health Information Systems (HIS) in the healthcare sector has enabled effective information and knowledge management, while also advancing many healthcare initiatives, remaining firmly entrenched in the business. Nonetheless, several issues that hinder its optimization and compromise its objectives have adversely affected its global implementation and execution. (Haldane et al., 2021)

The unforeseen emergence of pandemics such as COVID-19 and the uncontrollable advancement of technology have resulted in disputed gradients in the positioning of HIS. These phenomena have not only influenced HIS acceptability but have also curtailed its potential for comprehensive utilization. Despite extensive research on HIS, these phenomena, coupled with several intrinsic challenges like as cost and fragmentation, remain prevalent and substantial, underscoring the necessity of this study. (Shahid et al., 2022)

The rise in acceptance and utilization of health information technology (health IT) in the US has bolstered patient-centric care, enhancing patient engagement, health outcomes, and healthcare delivery. A multitude of regulations and programs, encompassing federal initiatives and legislation alongside quality improvement efforts centered on value-based care, have facilitated the rise in the adoption and utilization of health IT. (Al Kuwaiti et al., 2023)

The adoption of certified electronic health record (EHR) technology by hospitals and healthcare professionals was stimulated by the Health Information Technology for Economic and Clinical Health (HITECH) Act of 2009, which represented a collaborative initiative among public-private partnerships and diverse grant programs aimed at enhancing the technological infrastructure of healthcare institutions nationwide. The HITECH Act mandated the Centers for Medicare and Medicaid Services (CMS) to establish the EHR Incentive Program and empowered the Office of the Assistant Secretary for Technology Policy/Office of the National Coordinator for Health IT (ASTP) to develop the Health IT Certification Program. (Zhao et al., 2022)

Significant advancements in health IT have facilitated a safer and more effective healthcare environment. These developments have facilitated real-time sharing of patient data across healthcare practitioners, despite ongoing hurdles, thereby enhancing patient outcomes. This report examines the accomplishments and challenges faced in the implementation of health IT within the broader framework of US legislation, laws, and initiatives. The term "health IT" encompasses a wide array of technology designed to improve health care outcomes. (Zhao et al., 2022)

The transformative period in healthcare communication and data exchange is characterized by the proliferation of interoperable interactions among healthcare providers. The results indicate that the interoperable exchange and the implementation and utilization of health IT have progressed for both hospitals and office-based practitioners. However, physicians practicing in outpatient settings have consistently lagged behind those in hospitals. Due to the sluggish progress in physician interoperable exchange, it is essential to monitor growth to direct targeted initiatives and support. Furthermore, previous research examining disparities in interoperable interchange between hospitals and physicians indicates that resource-rich providers excel compared to their resource-poor counterparts, who continue to encounter challenges necessitating intervention. (Haldane et al., 2021)

Despite a notable increase in hospital-to-hospital interoperable exchanges, the majority of hospitals continue to have interoperability challenges, particularly those with limited resources, which struggle to successfully utilize application programming interfaces (APIs) for information communication. Moreover, more than 50% of physicians indicated that the utilization of electronic patient health information enhanced the quality of practice, care coordination, and efficiency. Nonetheless, most physicians indicated facing obstacles in exchanges. (Zhao et al., 2022)

Although 91% of family medicine physicians deemed the utilization of external information for patient care to be rather straightforward, over 80% reported difficulties in locating and incorporating essential information into their electronic health records. These findings underscore the imperative of exploring data integration-enhancing interventions to provide seamless access to and utilization of patient data from external sources. (Shahid et al., 2022)

The increasing adoption of e-prescribing exemplifies a further advancement in digital health care practices aimed at improving prescription accuracy, efficiency, and patient safety. Compliance with the early e-prescribing criteria of the Medicare Promoting Interoperability Program is associated with a reduced occurrence of adverse drug events, indicating that e-prescribing may improve patient adherence and medication precision. The expansion has been significantly facilitated by the

advancement of EPCS and the integration of e-prescribing within EHRs. Currently, nearly all individuals utilize e-prescribing, and the adoption of EPCS is rapidly increasing due to federal and state initiatives, along with the integration of systems within EHRs. (Al Kuwaiti et al., 2023)

However, there remains potential for enhancement, particularly in ensuring uniform acceptance across various medical environments. To maximize the benefits of e-prescribing in enhancing patient care, next initiatives must focus on addressing these challenges. The implementation of EPCS has contributed to combating the opioid problem and has encouraged more secure prescribing practices. Prescription drug monitoring programs (PDMPs) provide real-time data to assist medical professionals in making informed prescribing decisions and have become essential tools in addressing the opioid epidemic. (Zhao et al., 2022)

While PDMPs have shown potential in reducing improper prescribing, their effectiveness is enhanced when integrated with EHRs, highlighting the importance of usability and accessibility for healthcare providers. Physician Drug Monitoring Programs (PDMPs) are extensively utilized by physicians, who cite benefits including enhanced clinical decision-making and improved patient care, with a reduction in prescribing practices. The introduction of EPCS and related initiatives, such as PDMPs, has enhanced patient-centric care by reducing incorrect prescribing of controlled substances and prescription overdoses. (Zhao et al., 2022)

Despite the widespread acclaim for e-prescribing medications, particularly those with controlled substances, there is a necessity for enhancement. To provide a unified strategy across our healthcare system, the National Council for Prescription Drug Programs' prescription rules must be revised to align with Medicare and other governmental programs. This alignment would ensure that these technologies for enhancing patient care function optimally and provide accurate, efficient, and compliant e-prescribing and monitoring of controlled substances. (Haldane et al., 2021)

The Health Information Technology Advisory Committee Taskforce on Pharmacy Interoperability and Emerging Therapeutics has recommended the inclusion of electronic prior authorizations in Health IT Certification requirements to enhance prescribing decisions and reduce the burden associated with medication prior approvals. Legislative mandates underscore the necessity of establishing real-time benefit systems to improve medication affordability and transparency. Providers and pharmacies may benefit from incorporating additional information into e-prescriptions, such as the indication or rationale for providing a medication, to enhance patient-centered care. (Shahid et al., 2022)

This will ensure secure and effective care while improving communication between the patient and the pharmacist regarding the medication's intended purpose. These enhancements and modifications are anticipated to render e-prescribing a more comprehensive drug management instrument that facilitates patient-centered treatment. It would help to eliminate existing deficiencies in prescription services, safeguard patient privacy and security, and improve reciprocal access between stakeholders. (Zhao et al., 2022)

The World Health Report indicates that hospitals are vital healthcare providers, significantly contributing to equitable healthcare distribution and enhancing the justice index within the healthcare system through the promotion of clinical research and the facilitation of healthcare integration and coordination. Furthermore, enhanced hospital performance assists health systems at every level in achieving their intermediate and ultimate goals. (Zhao et al., 2022)

A hospital management information system (HMIS) is crucial for the administration of patient care services and related administrative chores to oversee all facets of a hospital's operations. By automating and generating the necessary reports for operational control, performance assessment, quality management, planning, and decision-making, it can enhance the overall efficiency of the system (the optimal utilization of resources to achieve maximum output). Patient health reports are crucial for epidemiological studies, including risk assessment via cohort and case-control studies, inside health organizations that offer tertiary care and research. Organizations may also own supported Health

Management Information Systems (HMIS) for the execution of clinical trials, related pharmaceuticals, and surgical interventions .(Al Kuwaiti et al., 2023)

The HMIS must be constructed to correspond with the organization's mission, goals, strategic objectives, and operational protocols. All hospital stakeholders must be incorporated in the design phase of the HMIS implementation to guarantee that the system encompasses all requisite features and functionalities for effective workflow management. The HMIS serves as a crucial instrument for generating monitoring and evaluation reports and providing insights for decision-making, utilized as a strategy to alter clinical practices and the behavior of healthcare professionals. The objective of performance evaluation and feedback is to enhance professional performance, hence improving patient safety and healthcare quality (Haldane et al., 2021).

A critical operation in the implementation of HMIS for its success is the training of users in the pertinent module. The workflow must be standardized, and software support for the workflow must be ensured. Data quality and validation are essential for HMIS. Effective HMIS for specific organizations could be extended for application in analogous organizations both nationally and internationally. Notwithstanding the importance of HMIS, several hospitals employ it solely for daily reporting and service automation, and others leverage it comprehensively for continuous development . (Zhao et al., 2022)

Regular reporting, dissemination of information through indices and indicators, and soliciting feedback from healthcare provider organizations should facilitate the removal of barriers to enhanced performance. A health information system is a framework that integrates data collection, processing, reporting, and utilization to enhance the efficacy and efficiency of healthcare through superior management across all levels of health services. These systems facilitate enhanced care coordination, superior information organization, timely, accurate, and comprehensive data, analytical capabilities, reduced medical errors, decreased costs, continuity of care, information exchange, prompt and convenient access to providers and information across various times and locations, and improved communication between patients and health professionals. (Shahid et al., 2022)

The implementation of health information systems offers distinct benefits for healthcare companies. The current ecosystems exhibit heterogeneity due to the private nature of the systems in use, which differ among healthcare facilities and were designed for localized access. A patient's medical records may be disseminated to an indefinite number of medical institutions. The medical records of a hospital are not transferable or accessible to other healthcare institutions. In the absence of the patient's consciousness and ability to provide necessary information for an informed and tailored decision regarding the optimal course of action, the health professional lacks access to the entirety of the patient's medical records in that situation. (Zhao et al., 2022)

A healthcare professional requires access to information distributed across several institutions to make an informed judgment regarding which procedures to undertake. Rectifying an institutional error stemming from insufficient information will be increasingly challenging, if not unfeasible. To facilitate universal access to patient health information, it is essential to establish integration mechanisms among diverse health information systems. (Haldane et al., 2021)

The interchange of information among different healthcare levels is linked to the efficacy, safety, and quality of patient treatment. Interoperability is the ability of systems to connect and exchange information seamlessly, whether in implementation or access. Effective management of health services, public health, patient safety, treatment quality, and clinical research relies on the interoperability of health information systems. Redundant, disjointed, and inaccessible medical information due to insufficient interoperability may jeopardize the quality of patient care and lead to financial inefficiencies. (Al Kuwaiti et al., 2023)

Integration of Health Information Systems to Promote Health

To improve patient health care management, health information systems (HISs) integrate concepts and data. Decision-making relies on HISs, which perform four primary functions: data generation,

compilation, analysis and synthesis, and communication and use. Health Information Systems (HIS) are an effective means of acquiring information from the medical sector. It ensures the quality of the data. (Torab-Miandoab et al., 2023)

Data can be sent across systems to facilitate continuous care. The insufficient data flow between these systems is due to their lack of integration. The objective of integrated Health Information Systems (HISs) is to deliver services to customers via interconnected systems that enable seamless workflow, cohesive information exchange, and informed healthcare decision-making. Integrated Health Information Systems are widely recognized for enhancing quality and safety outcomes. Information systems save expenses, encompass diverse geographic regions, and provide prompt and convenient access to healthcare services. Moreover, information systems possess the capability to serve as a mechanism for enhancing health... (Sheikh et al., 2021)

"The empowerment of individuals to improve their health and exert greater control over it." An individual or collective must possess the ability to identify and attain their objectives, satisfy their needs, and adjust to or manage their environment to achieve a state of complete physical, mental, and social well-being. Health education, health screening, and disease prevention are three domains of community-level health promotion that could benefit from the integration of Health Information Systems (HISs)... (Mahajan et al., 2023)

Health education

Integrated health information systems (HISs) aid healthcare providers in addressing specific health concerns, including obesity, diet, hypertension, and cholesterol levels. Providers can access patient data from multiple tiers of the healthcare system using information systems. Client data is disseminated across the healthcare sector using integrated Health Information Systems (HISs). While education may not necessitate an information system, it provides the content of educational resources and functions as a valuable tool for information integration and health advancement... (Løken et al., 2022)

Health screening

Health promotion programs seek to manage chronic illnesses such as cancer, diabetes, cardiovascular disease, and stroke. Geographical data, demographic data, sickness risk factor data, and other pertinent data can be integrated through information systems. Data aggregation assists decision-makers in managing screening programs... (He et al., 2021)

Prevention of disease

Information systems facilitate the gathering, processing, and dissemination of data essential for guiding, supporting, and evaluating health promotion and disease prevention efforts. These systems ought to share information regarding trends, risk factor identification, prevalence, and the incidence and mortality of illnesses. Health information systems (HISs) were developed to meet consumer demands, facilitate epidemiological research, enhance service quality, reduce costs, and optimize information management. (El Khatib et al., 2022)

The utilization of standards and middleware facilitates systems integration and enhances health, as integration can occur at various levels, including technical, management, functional, and non-functional. To integrate Health Information Systems and facilitate interoperability among diverse systems, standards for language, security, and data transmission are important. Middleware facilitates the integration of Health Information Systems (HISs), hence obviating the necessity to duplicate identical components in inter-system interactions. It is recommended to assess the extent of integration among information systems and their capacity to uphold information integrity. (Stoumpos et al., 2023)

The extensive and rapidly advancing field of health informatics encompasses numerous facets of healthcare. Health informatics, at the forefront of the medical technology revolution, amalgamates communications, information technology (IT), and healthcare to enhance patient care. Significant technical advancement has transpired throughout numerous industries, including healthcare. To provide patients with superior and more efficient outcomes, technology has dominated the healthcare

sector. Examples encompass surgical robotic arms and nanorobots that administer drugs via the bloodstream .(Wager et al., 2021)

AI is utilized in healthcare for the automation of administrative functions. It guarantees that healthcare professionals focus on essential tasks, allowing physicians, aides, and nurses to engage in other significant activities. Healthcare administration could gain advantages from voice-to-text transcriptions. They facilitate the automation of non-clinical duties such as generating chart notes, recommending medications, and soliciting diagnostic tests. Every individual possesses a digital profile encompassing information regarding their background, medical history, allergies, laboratory findings, and additional particulars. Records are transmitted via secure information networks and are accessible to both public and private sector providers. Physicians can modify records over time without the need for additional documentation or concerns regarding data duplication, as each record consists of a singular editable file .(Kawu et al., 2023)

For years, the collection of extensive data for medical purposes has been costly and labor-intensive. The ever-evolving technology of today has facilitated the collection of data, the compilation of comprehensive medical reports, and the transformation of this information into valuable insights for enhancing therapy. Electronic Health Records (EHRs) can monitor drugs to ensure patients adhere to their prescribed regimens, and they can issue alerts and reminders when a patient requires new laboratory tests. A "health information system" refers to any system that gathers, saves, maintains, and communicates data pertinent to individuals' health or the functions of organizations that facilitate the healthcare sector through computer hardware and software. (Marwaha et al., 2022)

Humans are used to verbal and tactile communication. In healthcare informatics, patients can contact medical experts through many applications, including email, instant messaging, fax machines, pagers, and telephones. Health informatics solutions are crucial for managers to enhance practice management and facilitate their tasks. The healthcare sector employs time management approaches, while health informatics facilitates process structure and simplicity to ensure timely completion. Healthcare personnel may discover that health informatics aids in the management of their time and workload. Patient health outcomes improve with the appropriate guidance of health research and technology. Investigating breakthrough informatics solutions to improve patient-provider communication is a fundamental strategy for advancing the healthcare sector (Stoumpos et al., 2023).

Healthcare Data Integration is Important: Enhancing Patient Care & Operational Efficiency

Healthcare has become increasingly complex in contemporary society. Maintaining organization may prove difficult due to the multitude of systems tracking test results, treatment protocols, and patient data. Healthcare data integration can facilitate this process. The objective is to integrate all different patient data into a unified system, enabling medical personnel to swiftly get a comprehensive overview. This is essential since it optimizes the process, conserves time, and reduces errors while aiding providers in making improved decisions. Let us examine the transformative impact of healthcare data integration on both medical professionals and patients (Nwosu., 2024).

Understanding Healthcare Data Integration

Healthcare data integration refers to the consolidation of patient records, test results, treatment protocols, insurance details, and more information from many systems into a unified central platform. This consolidated approach minimizes errors, accelerates administrative processes, and assists healthcare providers in making educated decisions... (Balogun et al., 2024)

The Importance of Data Integration in Healthcare

Improving the readability and accessibility of patient information is a primary rationale for the significance of healthcare data integration. Real-time information exchange is problematic in conventional healthcare systems due to the fragmentation of patient records among multiple departments and organizations. Over time, a patient may be admitted to multiple hospitals or consult various specialists. Healthcare personnel may struggle to obtain comprehensive and accurate information regarding a patient's history in the absence of a unified data system, potentially leading to

misdiagnoses, unnecessary tests, and medication errors. According to a report by the Office of the National Coordinator for Health Information Technology (ONC), over 96% of hospitals in the United States have adopted electronic health records (EHR) systems. Nonetheless, data integration remains challenging due to the dispersed systems. (v et al., 2024)

Healthcare professionals can promptly obtain a comprehensive picture of a patient's medical history through the integration of healthcare data, facilitating improved treatment delivery. The enhanced information flow reduces administrative burdens, hence conserving time and augmenting overall operating efficiency. Moreover, healthcare organizations can identify trends, deficiencies, and opportunities for enhancement by leveraging data to guide their decisions. Healthcare enterprises consistently contend with rigorous compliance mandates that often divert attention from more critical responsibilities. Integration plays a crucial role in alleviating this challenge... (Kuswari et al., 2025)

Enhancing Data Accuracy and Consistency

Data integrity in the healthcare sector is a critical consideration. Data integrity refers to the quality, consistency, and reliability of data throughout its lifecycle. Given that any error or inconsistency in a patient's record can lead to significant consequences, including erroneous treatment plans, misdiagnoses, or perilous drug interactions, ensuring data integrity is paramount in the healthcare sector. (Aryee et al., 2025)

Healthcare data integration ensures real-time changes and synchronization of all records across several platforms. This mitigates the risks associated with data discrepancies by ensuring that the information is accurate, consistent, and up-to-date. To ensure that all individuals involved in the patient's care are aligned, integrated systems can promptly notify all relevant parties when a patient's treatment plan is modified. Research conducted by the Healthcare Information and Management Systems Society (HIMSS) indicates that healthcare practitioners utilizing integrated systems experienced a 10-15% enhancement in patient outcomes and a 20-30% reduction in medication errors... (Prabu et al., 2024).

Improving Patient Outcomes

The primary objective of healthcare data integration is to enhance patient outcomes. Healthcare practitioners may enhance diagnoses, create more personalized treatment plans, and improve care delivery with prompt access to trustworthy, up-to-date information. A physician can more effectively identify potential effects and suggest the optimal treatment plan if they have immediate access to a patient's comprehensive medical history, encompassing prior operations, allergies, and chronic conditions. Enhanced communication among healthcare providers is an additional advantage of data integration, which improves coordination and reduces the likelihood of redundant testing or conflicting treatment protocols. Minimizing waste and the likelihood of medical errors enhances patient care and contributes to the reduction of healthcare costs... (Shittu et al., 2024).

Facilitating Compliance with Regulations

Various regulations designed to protect patient confidentiality and ensure service quality apply to healthcare organizations. In the United States, compliance with regulations such as the Health Insurance Portability and Accountability Act (HIPAA) is crucial for maintaining patient trust and preventing substantial penalties. Healthcare data integration is essential to ensure that data is securely stored, sent, and accessed exclusively by authorized individuals. (Yu et al., 2021)

An integrated healthcare system can streamline compliance by facilitating encrypted data transfer, maintaining audit trails, and automatically monitoring access records. This ensures that healthcare organizations comply with regulatory mandates while safeguarding confidential patient information. Enhancing time and resource efficiency while achieving corporate objectives can be significantly facilitated by an intelligent and user-friendly middleware that acts as a conduit between data and actionable insights. Utilizing intelligent middleware to link disparate healthcare systems, healthcare integration software like BridgeGate Health can facilitate the process and enhance overall efficiency and quality of care. (Bhati et al., 2023)

In conclusion, healthcare integration solutions are an essential necessity in modern healthcare systems, rather than solely a technological advancement. The importance of data integration, which yields more accurate, accessible, and efficient patient information, cannot be overstated. Healthcare data integration can revolutionize patient care delivery, save operational expenses, and facilitate regulatory compliance by ensuring data integrity and enhancing care standards. Implementing data integration is crucial for healthcare providers aiming to thrive in the digital age and enhance patient outcomes and services... (Bekbolatova et al., 2024)

Data Integration in Health Information Systems: Implications for Quality Care and Decision Making

The World Health Organization's (WHO) action framework identifies health information as one of the six essential components of a comprehensive health system. A health information system (HIS) is a paper-based or electronic system designed to gather, transfer, and manage medical data. The 2015 Global Observatory for eHealth survey indicates that 66% of the 125 surveyed nations possess a health information system policy or plan. A well-maintained, operational, and reliable Health Information System (HIS) provides complete and trustworthy data that can be readily examined and employed for data-driven decision-making and the development and implementation of sustainable health interventions. Consequently, prompt access to trustworthy public health data is imperative. (Dicuonzo et al., 2023)

Unfortunately, routine health data is often outdated, unreliable, and deficient. High-quality data must be timely, accessible to key stakeholders, accurate, comprehensive, and pertinent. It must also derive from a credible source. Nevertheless, some conditions, such as access to information, the ability to evaluate and apply that information effectively, and the relevance to incorporate local evidence, may not be fulfilled when utilizing data to influence policy decisions. Enhanced technical tools and sufficient data literacy are essential to ensure data quality and the utilization of evidence. (Alowais et al., 2023)

Evidence-based interventions are crucial for effectively mitigating the widespread impact of cardiovascular disease (CVD), the foremost cause of global mortality. In 2019, around 17.9 million individuals succumbed to cardiovascular diseases (CVDs), with low and middle-income countries (LMICs) representing three-quarters of these fatalities. The CARDIO4Cities strategy seeks to integrate data-generating digital innovations into existing Health Information Systems (HISs) and encourage the utilization of cardiovascular disease (CVD) data to inform health system decision-making, thereby advancing cardiovascular population health. (Al Naqbi et al., 2024)

The CARDIO4Cities method is founded on six pillars: quality of care, early access, policy reform, data and digital technologies, intersectoral collaboration, and local ownership. From 2018 to 2020, CARDIO4Cities validated its methodology and demonstrated enhancements in hypertension management in São Paulo (from 12.3% to 31.2%), Dakar (from 6.7% to 19.4%), and Ulaanbaatar (from 3.1% to 19.7%) following 1-2 years of implementation. This resulted in an estimated reduction of 3.0–12.0% in incidences of coronary heart disease (CHD) and 3.3–12.8% in strokes. In 2021, the methodology encompassed the evaluation of supplementary cardiovascular disease risk factors, including obesity (BMI), dyslipidemia (LDL cholesterol), and type II diabetes (blood glucose levels) (Wager et al., 2021).

CARDIO4Cities delivers solutions tailored to local needs, alongside stringent monitoring and evaluation (M&E) initiatives that provide data to facilitate data-driven decision-making. It is imperative to map, evaluate, and analyze current procedures for data collection, storage, and quality control prior to integrating improved methods into a Health Information System (HIS). It is essential to examine the interoperability of the HIS when it comprises many concurrent sub-systems. A swift evaluation of baseline circumstances concerning Health Information Systems (HIS) and cardiovascular disease (CVD) data flows was conducted in three cities: Dakar, Senegal; São Paulo, Brazil; and Ho Chi Minh City, Vietnam, to obtain an overview of the existing HIS and CVD data flows and to identify any deficiencies or obstacles. This was executed in consideration of the global application of the CARDIO4Cities concept in many contexts. The three locations were selected due to their geographical

diversity, the prior completion of cardiovascular disease and urban health programs by the same funding agency, and the establishment of robust cooperation. (Hussein et al., 2023)

This article delineates a global methodology for assessing data processing and Health Information System ideas. This elucidates the analytical results and details the local adaptations of the methodology for the selected three cities. Within the context of sustainable data-driven decision-making, the discourse situates the findings within the essential frameworks necessary to monitor and evaluate the care continuum of the cardiovascular risk factor hypertension (i.e., screening, diagnosis, treatment, and management). Resolving data quality issues may be achievable with the use of a temporary parallel approach to data collection and standardized aggregation. These comparative parallel systems should be utilized momentarily to enable long-term, sustainable solutions via a process of transformation and capacity development. (Bhati et al., 2023)

Enhancing data quality necessitates the integration of capacity building with the implementation of transparent data governance and accountability. Regular refresher training is crucial due to the potential loss of skills and knowledge caused by frequent workforce turnover. Training should encompass specific and practical techniques for data collection, integration, reporting, and quality assurance. It is essential to enhance accountability for data quality and establish clear governance. Regular monitoring visits, delegating particular roles to team members, comprehending the impact of data quality, and fostering a collective knowledge of its significance for the health system are few methods to achieve this. (Torab-Miandoab et al., 2023)

Imposing more responsibilities on already overworked health professionals necessitates meticulous evaluation of supplementary financial and human resources. It may also be necessary to amend job descriptions or incorporate incentives for undertaking additional tasks. Digital technology can enhance data quality by eliminating human processing stages and media disruptions, which can lead to errors, delays, and additional costs, when substituting paper-based procedures. Implementing software or other technological innovations necessitates meticulous alignment with existing operational protocols. The simultaneous use of paper-based and electronic methods during a transition period may increase the workload and necessitate more resources. Moreover, vulnerabilities in electronic processes may pose further threats to patient safety, which must be considered during their development and implementation. (Wager et al., 2021)

Interoperability, as defined by the Healthcare Information and Management System Society, refers to the capability of diverse information systems, devices, and applications to access, exchange, integrate, and collaborate using data in a coordinated fashion. Fragmented systems have often emerged to address specific demands without a clear long-term strategic framework, leading to limited interoperability. Definitions of indicators and data collection methods may differ. The unification of the HIS could facilitate improved patient and health system outcomes and provide a robust basis for health management decisions. The integration into a unified interoperability layer may also be included. Data from many electronic databases can be linked and aggregated. (Kuswari et al., 2025).

Harmonization facilitates the collection and analysis of health data and is crucial for acquiring a comprehensive understanding of population health for informed decision-making. A single interoperability layer mitigates information gaps and reduces wasteful data collecting and expenses. Data standardization may facilitate interoperability, as indicated by Fast Healthcare Interoperability Resources (FHIR). Similar to the aforementioned method for data from IoT medical devices, it is advisable to develop a complete strategy to attain data interoperability by integrating high-quality data from diverse sources. Identifying the individuals requiring data for decision-making is essential regarding data ownership and access. This necessitates collaboration and communication among many public and commercial sector stakeholders, contingent upon the nature of local HIS suppliers (Giordano et al., 2021).

References

1. Ahmat, A., Okoroafor, S. C., Kazanga, I., Asamani, J. A., Millogo, J. J. S., Illou, M. M. A., ... & Nyoni, J. (2022). The health workforce status in the WHO African Region: findings of a cross-sectional study. *BMJ Global Health*, 7(Suppl 1), e008317.
2. Al Kuwaiti, A., Nazer, K., Al-Reedy, A., Al-Shehri, S., Al-Muhanna, A., Subbarayalu, A. V., ... & Al-Muhanna, F. A. (2023). A review of the role of artificial intelligence in healthcare. *Journal of personalized medicine*, 13(6), 951.
3. Al Naqbi, H., Bahroun, Z., & Ahmed, V. (2024). Enhancing work productivity through generative artificial intelligence: A comprehensive literature review. *Sustainability*, 16(3), 1166.
4. Alolayyan, M., Al-Rwaidan, R., Hamadneh, S., Ahmad, A., AlHamad, A., Al-Hawary, S., & Alshurideh, M. (2022). The mediating role of operational flexibility on the relationship between quality of health information technology and management capability. *Uncertain Supply Chain Management*, 10(4), 1131-1140.
5. Alowais, S. A., Alghamdi, S. S., Alsuhbany, N., Alqahtani, T., Alshaya, A. I., Almohareb, S. N., ... & Albekairy, A. M. (2023). Revolutionizing healthcare: the role of artificial intelligence in clinical practice. *BMC medical education*, 23(1), 689.
6. AlQudah, A. A., Al-Emran, M., & Shaalan, K. (2021). Technology acceptance in healthcare: a systematic review. *Applied Sciences*, 11(22), 10537.
7. AlQudah, A. A., Al-Emran, M., & Shaalan, K. (2021). Technology acceptance in healthcare: a systematic review. *Applied Sciences*, 11(22), 10537.
8. Alubaie, M. A., Sayed, M. Y., Alnakhli, R. E., Alshaia, F. I. N., Aldossary, S. B., Alsubaie, N. M., ... & Alahmary, M. D. A. (2024). The Efficiency and Accuracy Gains of Real-Time Health Data Integration in Healthcare Management: A Comprehensive Review of Current Practices and Future Directions. *Egyptian Journal of Chemistry*, 67(13), 1725-1729.
9. Aryee, S., Owusu, G., Wang, X., & Moqbel, M. (2025). Revolutionizing Healthcare: Data Integration on Hospital Care Efficiency.
10. Balogun, O. D., Mustapha, A. Y., Tomoh, B. O., Soyegbe, O. S., Nwokedi, C. N., Mbata, A. O., & Iguma, D. R. (2024). Enhancing Operational Efficiency in Healthcare: The Role of Advanced Data Analytics. *International Journal of Pharma Growth Research Review*, 1(6), 33-40.
11. Bekbolatova, M., Mayer, J., Ong, C. W., & Toma, M. (2024, January). Transformative potential of AI in healthcare: definitions, applications, and navigating the ethical landscape and public perspectives. In *Healthcare* (Vol. 12, No. 2, p. 125). MDPI.
12. Bhati, D., Deogade, M. S., & Kanyal, D. (2023). Improving patient outcomes through effective hospital administration: a comprehensive review. *Cureus*, 15(10), e47731.
13. Bhati, D., Deogade, M. S., & Kanyal, D. (2023). Improving patient outcomes through effective hospital administration: a comprehensive review. *Cureus*, 15(10), e47731.
14. Dicuonzo, G., Donofrio, F., Fusco, A., & Shini, M. (2023). Healthcare system: Moving forward with artificial intelligence. *Technovation*, 120, 102510.
15. Do Nascimento, I. J. B., Pizarro, A. B., Almeida, J. M., Azzopardi-Muscat, N., Gonçalves, M. A., Björklund, M., & Novillo-Ortiz, D. (2022). Infodemics and health misinformation: a systematic review of reviews. *Bulletin of the World Health Organization*, 100(9), 544.
16. El Khatib, M., Hamidi, S., Al Ameeri, I., Al Zaabi, H., & Al Marqab, R. (2022). Digital disruption and big data in healthcare-opportunities and challenges. *ClinicoEconomics and Outcomes Research*, 563-574.
17. Giordano, C., Brennan, M., Mohamed, B., Rashidi, P., Modave, F., & Tighe, P. (2021). Accessing artificial intelligence for clinical decision-making. *Frontiers in digital health*, 3, 645232.
18. Haldane, V., De Foo, C., Abdalla, S. M., Jung, A. S., Tan, M., Wu, S., ... & Legido-Quigley, H. (2021). Health systems resilience in managing the COVID-19 pandemic: lessons from 28 countries. *Nature medicine*, 27(6), 964-980.

19. He, W., Zhang, Z. J., & Li, W. (2021). Information technology solutions, challenges, and suggestions for tackling the COVID-19 pandemic. *International journal of information management*, 57, 102287.
20. He, W., Zhang, Z. J., & Li, W. (2021). Information technology solutions, challenges, and suggestions for tackling the COVID-19 pandemic. *International journal of information management*, 57, 102287.
21. Hussein, R. N., Nassreddine, G., & Younis, J. (2023). The Impact of Information Technology Integration on the Decision-Making Process. *Journal of Techniques*, 5(1), 144-155.
22. Hussein, R. N., Nassreddine, G., & Younis, J. (2023). The Impact of Information Technology Integration on the Decision-Making Process. *Journal of Techniques*, 5(1), 144-155.
23. Jia, X., Pang, Y., & Liu, L. S. (2021, December). Online health information seeking behavior: a systematic review. In *Healthcare* (Vol. 9, No. 12, p. 1740). MDPI.
24. Johnson, A. E., Bulgarelli, L., Shen, L., Gayles, A., Shammout, A., Horng, S., ... & Mark, R. G. (2023). MIMIC-IV, a freely accessible electronic health record dataset. *Scientific data*, 10(1), 1.
25. Johnson, D., Goodman, R., Patrinely, J., Stone, C., Zimmerman, E., Donald, R., ... & Wheless, L. (2023). Assessing the accuracy and reliability of AI-generated medical responses: an evaluation of the Chat-GPT model. *Research square*, rs-3.
26. Kawu, A. A., Hederman, L., Doyle, J., & O'Sullivan, D. (2023). Patient generated health data and electronic health record integration, governance and socio-technical issues: A narrative review. *Informatics in Medicine Unlocked*, 37, 101153.
27. Kuswari, M., Gantino, R., & Maratis, J. (2025). Maximizing healthcare service information system: Understanding the influence of integration on efficiency. *ADI Journal on Recent Innovation*, 6(2), 108-117.
28. Kuswari, M., Gantino, R., & Maratis, J. (2025). Maximizing healthcare service information system: Understanding the influence of integration on efficiency. *ADI Journal on Recent Innovation*, 6(2), 108-117.
29. Lal, A., Ashworth, H. C., Dada, S., Hoemeke, L., & Tambo, E. (2022). Optimizing pandemic preparedness and response through health information systems: lessons learned from Ebola to COVID-19. *Disaster medicine and public health preparedness*, 16(1), 333-340.
30. Li, S., Cui, G., Kaminga, A. C., Cheng, S., & Xu, H. (2021). Associations between health literacy, ehealth literacy, and covid-19-related health behaviors among Chinese college students: cross-sectional online study. *Journal of medical Internet research*, 23(5), e25600.
31. Løken, T. D., Helgesen, M. K., & Bjørkquist, C. (2022). Collective competence as an enabler for service integration in health and social care services. *Journal of Multidisciplinary Healthcare*, 2817-2830.
32. Mahajan, H. B., Rashid, A. S., Junnarkar, A. A., Uke, N., Deshpande, S. D., Futane, P. R., ... & Alhayani, B. (2023). RETRACTED ARTICLE: Integration of Healthcare 4.0 and blockchain into secure cloud-based electronic health records systems. *Applied Nanoscience*, 13(3), 2329-2342.
33. Marques, L., Costa, B., Pereira, M., Silva, A., Santos, J., Saldanha, L., ... & Vale, N. (2024). Advancing precision medicine: a review of innovative in silico approaches for drug development, clinical pharmacology and personalized healthcare. *Pharmaceutics*, 16(3), 332.
34. Marwaha, J. S., Landman, A. B., Brat, G. A., Dunn, T., & Gordon, W. J. (2022). Deploying digital health tools within large, complex health systems: key considerations for adoption and implementation. *NPJ digital medicine*, 5(1), 13.
35. Naeem, S. B., Bhatti, R., & Khan, A. (2021). An exploration of how fake news is taking over social media and putting public health at risk. *Health Information & Libraries Journal*, 38(2), 143-149.
36. Nwosu, N. T. (2024). Reducing operational costs in healthcare through advanced BI tools and data integration. *World Journal of Advanced Research and Reviews*, 22(3), 1144-1156.
37. Prabhu, M., Diviya, M., Bhuvaneswari, R., Reddy, D. S., Venkatesan, K., & Natarajan, A. K. (2024). The Impact and Integration of Cloud Computing for Enhanced Patient Care and

- Operational Efficiency. In *Technologies for Sustainable Healthcare Development* (pp. 277-299). IGI Global Scientific Publishing.
38. Pradhan, B., Bhattacharyya, S., & Pal, K. (2021). IoT-based applications in healthcare devices. *Journal of healthcare engineering*, 2021(1), 6632599.
39. Santana, S., Brach, C., Harris, L., Ochiai, E., Blakey, C., Bevington, F., ... & Pronk, N. (2021). Updating health literacy for healthy people 2030: defining its importance for a new decade in public health. *Journal of Public Health Management and Practice*, 27(Supplement 6), S258-S264.
40. Shahid, R., Shoker, M., Chu, L. M., Frehlick, R., Ward, H., & Pahwa, P. (2022). Impact of low health literacy on patients' health outcomes: a multicenter cohort study. *BMC health services research*, 22(1), 1148.
41. Sheikh, A., Anderson, M., Albala, S., Casadei, B., Franklin, B. D., Richards, M., ... & Mossialos, E. (2021). Health information technology and digital innovation for national learning health and care systems. *The Lancet Digital Health*, 3(6), e383-e396.
42. Sheikh, A., Anderson, M., Albala, S., Casadei, B., Franklin, B. D., Richards, M., ... & Mossialos, E. (2021). Health information technology and digital innovation for national learning health and care systems. *The Lancet Digital Health*, 3(6), e383-e396.
43. Shin, D. W., Cho, J., Park, J. H., & Cho, B. (2022). National General Health Screening Program in Korea: history, current status, and future direction. *Precision and Future Medicine*, 6(1), 9-31.
44. Shittu, R. A., Ehidiemen, A. J., Ojo, O. O., Zouo, S. J. C., Olamijuwon, J., Omowole, B. M., & Olufemi-Phillips, A. Q. (2024). The role of business intelligence tools in improving healthcare patient outcomes and operations. *World Journal of Advanced Research and Reviews*, 24(2), 1039-1060.
45. Soroya, S. H., Farooq, A., Mahmood, K., Isoaho, J., & Zara, S. E. (2021). From information seeking to information avoidance: Understanding the health information behavior during a global health crisis. *Information processing & management*, 58(2), 102440.
46. Stoumpos, A. I., Kitsios, F., & Talias, M. A. (2023). Digital transformation in healthcare: technology acceptance and its applications. *International journal of environmental research and public health*, 20(4), 3407.
47. Stoumpos, A. I., Kitsios, F., & Talias, M. A. (2023). Digital transformation in healthcare: technology acceptance and its applications. *International journal of environmental research and public health*, 20(4), 3407.
48. Tagde, P., Tagde, S., Bhattacharya, T., Tagde, P., Chopra, H., Akter, R., ... & Rahman, M. H. (2021). Blockchain and artificial intelligence technology in e-Health. *Environmental Science and Pollution Research*, 28(38), 52810-52831.
49. Thapa, D. K., Visentin, D. C., Kornhaber, R., West, S., & Cleary, M. (2021). The influence of online health information on health decisions: a systematic review. *Patient education and counseling*, 104(4), 770-784.
50. Torab-Miandoab, A., Samad-Soltani, T., Jodati, A., & Rezaei-Hachesu, P. (2023). Interoperability of heterogeneous health information systems: a systematic literature review. *BMC medical informatics and decision making*, 23(1), 18.
51. Torab-Miandoab, A., Samad-Soltani, T., Jodati, A., & Rezaei-Hachesu, P. (2023). Interoperability of heterogeneous health information systems: a systematic literature review. *BMC medical informatics and decision making*, 23(1), 18.
52. Torab-Miandoab, A., Samad-Soltani, T., Jodati, A., & Rezaei-Hachesu, P. (2023). Interoperability of heterogeneous health information systems: a systematic literature review. *BMC medical informatics and decision making*, 23(1), 18.
53. Tran, T. N. T., Felfernig, A., Trattner, C., & Holzinger, A. (2021). Recommender systems in the healthcare domain: state-of-the-art and research issues. *Journal of Intelligent Information Systems*, 57(1), 171-201.
54. Wager, K. A., Lee, F. W., & Glaser, J. P. (2021). *Health care information systems: a practical approach for health care management*. John Wiley & Sons.

55. Wager, K. A., Lee, F. W., & Glaser, J. P. (2021). Health care information systems: a practical approach for health care management. John Wiley & Sons.
56. Wager, K. A., Lee, F. W., & Glaser, J. P. (2021). Health care information systems: a practical approach for health care management. John Wiley & Sons.
57. Wager, K. A., Lee, F. W., & Glaser, J. P. (2021). Health care information systems: a practical approach for health care management. John Wiley & Sons.
58. Wager, K. A., Lee, F. W., & Glaser, J. P. (2021). Health care information systems: a practical approach for health care management. John Wiley & Sons.
59. Yu, W., Zhao, G., Liu, Q., & Song, Y. (2021). Role of big data analytics capability in developing integrated hospital supply chains and operational flexibility: An organizational information processing theory perspective. *Technological Forecasting and Social Change*, 163, 120417.
60. Zaabar, B., Cheikhrouhou, O., Jamil, F., Ammi, M., & Abid, M. (2021). HealthBlock: A secure blockchain-based healthcare data management system. *Computer Networks*, 200, 108500.
61. Zhao, Y. C., Zhao, M., & Song, S. (2022). Online health information seeking behaviors among older adults: systematic scoping review. *Journal of medical internet research*, 24(2), e34790.