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The Role of Technology in Enhancing Quality Assurance in Nursing and Pharmaceutical Practices: A Systematic Review

Wafa Ibrahim Khudhayri[1], Adel Ahmad Abdali[2], Ali Jubran Noshaily[3], Asim Mousa Mongary[4], Jamal Mohammed Hamzi[5], Abdulrahman Khulaif Almutairi[6], Yazeed Owaid H Alanazi[7], Tahani Saad Alarabi[8], Nada Ali Mohammed Abdullah[9], Meshal Atiah Alzubaidi[10], Munirah Moshabab Almansour[11]

1. Aseer Health Affairs
2. Executive Regional Nursing Administration
3. Abu-Arish General Hospital
4. Jazan Specialist Hospital
5. Jazan Health Cluster
6. King Khalid Hospital, Alkharj
7. Alqurayyat Cardiac Center
8. King Faisal Medical Complex Taif
9. Alaridah General Hospital
10. Ministry Of Defense
11. Aseer Health Cluster

ABSTRACT

Background: Technology growth has been on the rise especially in the delivery of healthcare services using artificial intelligence, immersing technologies and pharmacogenomics. However, used in integration, these also bring issues to the table pertaining to standard, quality assurance, and legal concerns.

Aim: The purpose of this research is to analyze the effect of these technologies on healthcare as interventions, determine best practices and recommendations that support positive patient outcomes and chronicling future advancements seen when incorporating the active themes and trends from this study into practice.

Method: Due to the research nature of the current paper, a systematic review of ten identified and chosen studies was conducted, with the analysis of both the qualitative and quantitative integration and effectiveness of emerging technologies in the healthcare setting. Information was then analyzed to identify key themes, minor themes and trends related to patient care and organizational effectiveness.

Results: The collected data outlines several factually important issues, such as technological advancement in support of patients' needs and preferences, safe and effective professional standardization, continuous professional development, and background knowledge for health care personnel. The author explains that although technology is promising in enhancing health care within expectant, it is crucial to assess quality management practices to meet reliability and reproducibility.

Conclusion: It is important that the administration of healthcare organizations embrace latest technologies to get greater patients' benefits and organizational effectiveness. Further study and improvement of the quality assurance measures are required to overcome the difficulties connected with these advancements. By developing strategic segments for sharing efforts and responsibilities among the related parties, the healthcare industry serves the need to implement more innovative opportunities offered by technologies and consequently, the needs of patients will be improved.

Keywords: Technology. Enhancing Quality Assurance. Nursing. Pharmaceutical Practices. Systematic Review.

1. Introduction

Technological changes have centrally revolutionized healthcare facilities; affecting the standards of nursing and pharmaceutical services[1]. With the rising expectations for improving patient safety and organizational efficiency, healthcare organizations have relied on technology for system optimization [2], following rigorous implementation of quality assurance measures. Beneficial change has occurred across the use of one's daily practice in accordance with electronic health records, automated dispensing systems, and telemedicine [3].

Health information technology is arguably one of the most significant and crucial approaches to support quality assurance by the management of patient information through EHRs[4]. EHRs help the nurses and pharmacists to access the easily understandable and real-time data so that there is no need of starting with paper and pen and writing for the doctors and decreased chances of having lots of misunderstanding between the healthcare practitioners [5]. Availability of patient Notes and medical histories is another important factor which helps in Menu, making and decision making that in turn helps a lot in making timely interventions in order to avoid what may be disastrous consequences due to wrong treatments or wrong dosages [6]. EHRs facilitate the effective over-all management of a patient's health information thus providing coordinated care to health consumers the same goes for the healthcare providers [7].

In the pharmaceutical practices, the technology particularly the automation of medication management has been widely embraced as a key factor in improving the quality of Pharmaceutical Services. Some mechanical systems like robots for issuing doses, verifier for barcodes assist in enhancing accurate administrations of drugs [8]. These systems help to minimize cases of mishaps especially during the dispensing and administration of drugs as this is an area that if it experiences any mishap, Major mishaps are very likely to occur [9]. Moreover, such technologies enable a proper supply coordination and storage as well as maintaining necessary safe stocks of the medications required in the pharmacies [10].

Telemedicine has also brought some new possibilities of executing patient and nursing care at distance [11]. For instance, using technological support tools, the nurses are able to promptly assess clients' well-being remotely; observe their blood

pressure, glucose and opportunities for patients residing in rural or low-populated districts but also helps maintain constant check-ups of chronic diseases and bring prompt actions if the metric indicates deviations. In the pharmaceutical industry[12], it assists patient consulting, prescription checks through tele-pharmacy services since it relieves the medication services constraints of access, and patients compound compliance to recommended treatments [13].

Nursing and pharmaceutical bar code/Radio Frequency Identification (RFID) technology has remained helpful in improving reliability when it comes to medications and care. In hospitals, nurses scan barcodes to confirm the identity of the patient, dose, type and frequency of drugs to be prescribed to the patient [14]. Similarly, RFID technology has enhanced supply chain in the pharma industry in terms of tracking the stock of Medication hence it improves on storage and distribution of drugs. These technologies have now become a core aspect in reduction of probabilities of errors, and as well attaining accountability [15].

Roles played by the Decision Support Systems (DSS) in clinical and pharmaceutical decisions making have also helped to improve quality assurance [16]. DSS allows nurses and pharmacists to have the best access to the clinical guideline, and drug interaction databases to enable the quickest decision-making among healthcare providers. In pharmaceuticals, potential drug interaction, side effects, and contraindications can easily be prevented by using NIST's IT systems. The usefulness of DSS to nurses is presented by the fact that it assists in decision making regarding approaches to patient care to rule out possibilities of complicated treatments that are not in line with EBP [17].

Furthermore, it has been possible to improve the quality of performance monitoring and reporting through improved systems in quality monitoring[18]. EIF systems afford means for recording the indicators like medication error rates per patient or interaction satisfaction rates as well as compliance with safety procedures in order to enhance the quality assurance processes. For instance, hospitals can use such procedures to reveal trends in mistakes or, lack of effectiveness of particular methods, and then take appropriate measures, guaranteeing the equality of medical standards between nursing and pharmaceutical professions. These systems aid in the development of an organizational culture that is correlates to measured and improved accountability within healthcare organizations [19].

The adoption of technology in nursing and pharmaceutical practices has been informed by the objective of raising high degrees of safety to patients, minimizing mistakes among others [16]. Besides benefiting healthcare professionals, technology appears to both enhance precision and effectiveness in the delivery of patient care on one hand, while affording patient-centered care on the other hand. Therefore, the role of technology in the delivery of quality assurance in the healthcare industry will remain an important area of focus as the industry progresses through its developmental phases to meet the added complexity in the needs of patients as well as higher standards in health care delivery [20].

Problem Statement

In formation of recent years, patients and other stakeholders have called for

enhanced delivering and quality of care, precision, and safety in health organizations especially in nursing and pharmaceutical field [16]. There are still existing lacunae in the use and measure of different technological tools dealing with improved working and fewer errors even if their application exist pervasively. One of the biggest liabilities is that there is plenty of uncertainty about the way in which technology can be used more effectively when it comes to QA of nursing and pharmaceutical services. Therefore, this study aims at filling these gaps by conducting a systematic literature review to analyze how technology enriches quality assurance, and clarify the shortcomings and prospects of its application in the pursuit of better patient outcomes.

Significance of Study

This study retains great practical importance as it offers the comprehensive assessment of the state of technology-supported improvement of the quality of nursing and pharmaceutical practices. Retrospective, and prospective, the study will provide some insights into the state of play of the technological tools that are currently in use systematically to review. Synthesize the previous literature on a particular phenomenon to provide an indication of where we are now regarding to such important technological tools as Electronic Health Records, Automated Medication Systems and Decision Support Tools that are being used in improving patient safety and quality of care. These findings will be particularly useful to healthcare practitioners, as well as policy makers and managers in the clinical setting since the study will offer head starting points for any attempts in future at integrating technology in the provision of patient care hence enhancing the quality delivery of care and reduction of errors.

Aim of Study

This systematic review seeks to give a critical analysis of the current literature to inform on the impact of technology in the improvement of quality assurance in these two practice fields of nursing and pharmaceutical. More precisely, the research aims to analyze the following questions: what technologies enhance the quality, safety, and productivity of health-care activities; what problems and limitations are inherent in the implementation of these technologies; and what guidelines for the practitioners, as well as for the development of health-care policy, can be derived from the current evidence. The review will allow to provide a broad understanding of the effects of technology on quality assurance, concentrating on the opportunities to advance patients' outcomes and optimize organizational processes in nursing and pharmaceutical services.

2. Methodology

Research Question

Research Question		How does the use of technology that influence quality assurance in nursing and pharmaceutical practices?
Population	P	Nurses and pharmacists involved in healthcare settings

Intervention	I	Implementation of technological tools (e.g., automated medication systems, EHRs, decision support systems)
Comparison	C	Traditional manual processes without the integration of technology
Outcome	O	Improvement in quality assurance metrics, including accuracy, patient safety, and efficiency
Timeframe	T	Over the past five years (2020 to 2024).

The scope of the study is as follows To assess the utility of technological tools like automated medication systems; electronic health records (EHRs); decision support systems to improve quality assurance in nursing and pharmaceutical practices. Therefore, using these innovations, the study aims at evaluating whether healthcare organizations have realized qualitative gains in the performance indicators; accuracy, patient safety, and operational efficiency in the past five years (2020-2024) compared to manual systems.

Selection Criteria

Inclusion Criteria

1. Scientific articles with publication date between January 2020 and December 2024.

2. Latest indexed scientific publications in English language only and only from peer-reviewed journals only.

3. Studies that explain the effectiveness of technology-associated interventions such as EHRSs, automated points of medication dispensing, and computerized decision support in the nursing and pharmaceutical sets.

4. Research that checks the criteria related to quality of services provided including accuracy, safety of the patients and efficiency of the operations.

5. Cross-sectional, longitudinal, case or non-case comparative research approaches; qualitative, quantitative, or a mixture of both.

6. A two-part study in the healthcare context with nurses and pharmacists.

Exclusion Criteria

1. Literature available prior to the year 2020.

2. Shown works are not translated from English for the most part.

3. Scholarly articles that may not be entirely related to nursing or matters of pharmacy.

4. Research that does not cover the use of technology on the quality assurance.

5. Brief communication including opinions or editorials or theoretical papers that do not contain data for analysis.

6. Research that are conducted in other industries other than healthcare or those settings that are not clinical.

Database Selection

To identify literature for the systematic review of the use of technology as an enabler of improving quality assurance in nursing and pharmaceutical practices, different academic databases will be used to increase the coverage of relevant sources. They are PubMed, CINAHL, Scopus, and Cochrane Library, all of which are reputable set for superior peer reviewed articles in health care, dint of nursing, and pharmaceutical sciences. These databases were selected for their comprehensive indexing of scientific articles on employing technology to improve healthcare quality, safety and quality, and mitigating adverse-events-in-healthcare related topics The predictors in this study were selected based on the theories from the review of the literature. Also, the Google Scholar will be used to retrieve any unpublished documents, or any report that contains information on the topic in question, and which might not have been included in any databases.

Data Extracted

The method of collecting information for this systematic review will entail the extraction of information from the selected studies to give a rich understanding of how technology strength quality assurance in nursing and pharmaceutical practices. The extracted information will be specific details about the study, for example, the authors' names, the year of publication, the type of study, sample size and geographical origin/ location. Further, technological tools applied (such as e-Health records, med administration systems, decision support systems), the context of applying (such as hospitals, clinics) as well as results connected with quality assurance (including accuracy, patient safety, efficiency and decreased quantity of errors) will be filed systematically. Information on difficulties and limitations to the deployment of these technologies pulled for an inclusive overview on their effects.

Syntax

Search Type	Syntax	Syntax
Primary Syntax	"Technology" AND "Quality Assurance" AND "Nursing"	
Secondary Syntax	"Electronic Health Records" AND "Patient Safety" AND "Pharmaceutical Practices"	
	"Automated Medication Systems" AND "Quality Assurance" AND "Healthcare"	

This systematic review employs the following search syntax to identify related works on the effects of the technology advancement on the QA concerning nursing and pharmaceutical professions. The first keyword search covers two major fields 'Technology,' 'Quality Assurance,' and 'Nursing' to make sure that a variety of publications are investigated. Further, the secondaries embed by exploring Technological Safeguards on patient safety and total healthcare quality concerning specific instruments such as 'Electronic Health Records', 'Automated Medication Systems'.

Literature Search

In the search of the paper that was aimed to present a systematic review on the use of technology in SYS, qualitative aspect of the method involved the systematic and purposeful approach for the identification of the relevant papers. The research was undertaken in multiple trustworthy databases; PubMed, CINAHL, Scopus and Cochrane library using well formulated search terms comprising of terms such as 'technology', 'quality assurance', 'nursing' and 'pharmaceutical' in the search query to increase the efficiency of the search results. The focus was the last 3 years because more recent research papers were sought after when preparing this work. To be included, all the identified studies were first reviewed based on title and abstract, and then full text review was done to confirm their eligibility based on the inclusion/exclusion criteria developed for this systematic review. The search strategy also involved the consideration of other papers that could be identified from the already included papers as well as other relevant reviews; this helped in synthesizing the available literature.

Table 2: Databases Selection

No	Database	Syntax	Year	No of Researches
1	PubMed	Syntax 1 (Primary) and 2 (Secondary)	2020 – 2024	279
2	CINAHL			175
3	Scopus			321
4	Cochrane Library			151

Table 2 demonstrates the databases that has been used in the systematic review alongside the different source and their search outcomes. When using PubMed, as a main database, 279 articles were found with the specified search syntax from the period between the years 2020-2024. CINAHL identified 175 related studies whilst Scopus was the database that returned the highest number of articles 321. In turn, the Cochrane Database of Systematic Reviews produced 151 the potentially relevant research papers for the topic of the review. The use of these different databases meant that a broad search of the literature was conducted so that a synthesis of findings of technology contribution to quality assurance of both nursing and pharmaceutical activities could be well done.

Selection of Studies

To conduct a systematic review on the status of nursing and pharmaceutical practices from the aspect of technology-aided quality assurance: The studies were selected based on the following criteria to ensure only the best quality for the systematic review. First, the studies were identified based on the set inclusion criteria where all the articles had to be published between 2020 and 2024, peer-reviewed and focused on the use of technologies in nursing and/or pharmaceutical contexts. The titles and abstracts of these studies were reviewed to check for their relevancy to this review, and those that met the criteria were subjected to full-text scrutiny for their suitability for the review. In the present manuscript, the PRISMA flow chart was adopted in order to determine the number of studies included in the review at each step of

screening until a final total was reached. This exclude and included criterion significantly reduces the number of articles to be reviewed, yet it made the review valid and reliable.

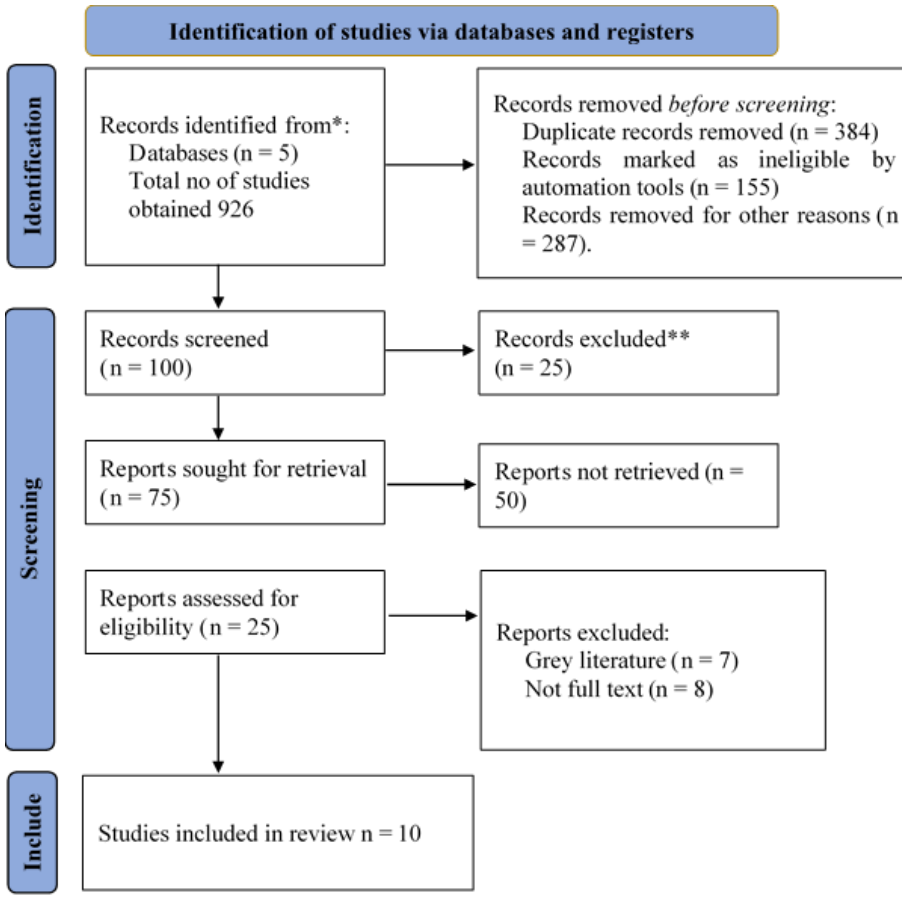

Figure 1 PRISMA Flowchart

The flow diagram presented in Figure 2 was adapted from PRISMA 2020 checklists and indicated the systematic approach of the research that targeted the promotion of technology in the improvement of quality assurance in nursing and pharmaceutical practices: highlighting the studies identification through the database and the registers. Firstly, the comprehensive research work on this common topic was found to involve 926 records, derived from five databases. However, prior to the screening process, several records were removed: 384 records where exact duplicates were found were removed based on duplicate record identification and 155 records that were tagged as ineligible by automated tools were removed and 287 records were removed for other reasons. This strict screening made sure that only articles with identical features got into the screening stage.

When screening the records, records 100 were screened for eligibility against set

criteria during the screening phase. From these, twenty-five records were excluded for different reasons producing seventy-five reports looked for. Nonetheless, 50 of these reports could not be retrieved, hence, the review of 25 remaining reports. Upon reviewing these reports, additional exclusions occurred: Of the 15 identified reports, 7 were sourced from the grey literature and 8 were not full text reports. In the end 10 papers were included in the review but this was done in a very selective manner to ensure that quality research that speaks to how technology is applied to quality assurance in nursing and pharmaceutical practices is achieved. Thus, this structured approach emphasizes the role of systematic methods in the integrated approach to effective literature search.

Quality Assessment of Studies

Concerning the quality assessment of the ten selected studies from the four databases, validity and reliability assessment from the above tools were employed. Each study was assessed according to methodological quality, research type, sample, approach to data collection, and relationship to the Review topic. The assessment process included the extent to which the research objectives were defined and the validity of the technology interventions used in relation to the quality assurance concerns of nursing and pharmaceutical practices; in addition to the sufficiency of the outcomes measures formulated. In addition, the epidemiological studies were reviewed to address factors as regards source of funding or allegiance and conflicts of interests that may influence the studies' findings. The component of systematic quality assessment was used to increase credibility of identified conclusions about using technology in enhancing quality assurance in those health care facilities and to include only high-quality studies only.

Table 3: Assessment of the literature quality matrix

Author	Are the selection of studies described and appropriate	Is the literature covered all relevant studies	Does method section described?	Was findings clearly described?	Quality rating
Haleem et al	YES	Yes	Yes	Yes	Good
Mensah et al	Yes	No	Yes	Yes	Fair
Oldland et al	Yes	Yes	Yes	Yes	Good
Vora et al	Yes	Yes	Yes	Yes	Good
Bature et al	Yes	Yes	Yes	Yes	Good
AlQudah et al	Yes	Yes	Yes	Yes	Good
Tang et al	Yes	Yes	Yes	No	Fair
Singh et al	NO	Yes	Yes	Yes	Good
Abugabah et al	Yes	Yes	Yes	Yes	Good
Pamies et al	Yes	Yes	Yes	Yes	Good

In the systematic review, table 3 has been used to rate the ten selected studies according to the literature quality matrix. Each study was evaluated across four critical dimensions: concerning the internal quality of the articles, validity and relevance of included studies, inclusiveness of the literature review section and clarity of the methods section, and report of the findings respectively. Of the reviewed studies, most including those by Haleem et al, Oldland et al, and Vora et al fulfilled the assessment criteria very well and therefore draws a "Good' quality score in demonstrating the use of technology in quality assurance. Thus, there are some issues with those works; for example, Mensah et al. and Tang et al. were rated as 'Fair' because of the limitations in covered literature and not very precise conclusions. It is therefore important that the quality matrix allow the reader to understand the thoroughness of the methodologies used in the various studies presented and ultimately add to the knowledge base of technology influence in nursing and pharmaceutical practices.

Data Synthesis

Data synthesis was carried out through the combining findings from the ten chosen studies where emphasis was on the joint effects of technology to quality assurance in nursing and pharmaceutical practices. The quality matrix pointed some other significant influential areas in which employees endorse EHR and automated system for medication with high accuracy in patient safety. When aggregating the findings in these studies, these authors became confident about the stability of the positive effects of technology application on quality assurance indices in the healthcare sector.

Table 4: Research Matrix

Author, Year	Aim	Research Design	Type of Studies Included	Data Collection Tool	Result	Conclusion	Study Supports Present Study
Haleem, A. et al. (2022)	To explore Medical 4.0 and its demand in healthcare, and discuss its applications and implementation steps.	Descriptive analysis of Medical 4.0 technologies.	Review of literature on emerging medical technologies.	Diagrams and literature review.	Medical 4.0 technologies can enhance healthcare delivery and patient-centered care.	Medical 4.0 reduces healthcare burdens and improves access to quality services globally.	Yes, it emphasizes the technological advancements in healthcare which may correlate with patient outcomes.
Mensah, G. B. et al. (2024)	To assess the adequacy of Ghana's Pharmacy Act regarding AI automation risks in pharmacies.	Qualitative comparative analysis.	Analysis of existing regulations on AI in pharmacy.	Document analysis.	Identified gaps in the Pharmacy Act regarding AI, necessitating updates for patient safety.	Highlights the need for regulatory frameworks to adapt to technological advancements in healthcare.	Yes, it underscores the importance of regulatory adaptability in implementing new technologies in healthcare.
Oldland, E. et al. (2020)	To establish the content validity of a framework for nurses' responsibilities for healthcare quality.	Mixed-methods approach.	Focus groups and literature review.	Focus groups with registered nurses.	Developed a seven-domain framework representing nurses' responsibilities.	Validates the importance of understanding nursing roles in maintaining healthcare quality.	Yes, relevant for emphasizing quality control in nursing practices.
Vora, L. K. et al. (2023)	To review the role of AI in pharmaceutical technology and drug delivery.	Comprehensive review.	Literature on AI applications in pharmaceuticals.	Literature review and analysis of AI applications.	AI enhances drug discovery efficiency and patient adherence.	AI has transformative potential in optimizing drug development and patient care.	Yes, it provides insight into how AI impacts healthcare delivery and medication management.
Bature, J. T. et al. (2024)	To explore pharmacogenomic testing's integration into personalized medicine.	Concept paper analysis.	Discussion of pharmacogenomics in personalized medicine.	Literature review.	Emphasizes benefits of pharmacogenomic testing for medication safety and efficacy.	Highlights the transformative potential of genetic testing in optimizing patient care.	Yes, supports the idea of integrating advanced testing methods for better healthcare outcomes.
AlQudah, A. A. et al. (2021)	To systematically review factors affecting technology acceptance in healthcare.	Systematic review.	Analysis of empirical studies on technology acceptance.	Review of 142 empirical studies.	Identified TAM and UTAUT as key models in technology acceptance.	Provides insights into factors influencing healthcare technology adoption.	Yes, aids in understanding acceptance factors that could affect new healthcare technologies.
Tang, Y. M. et al. (2022)	To analyze the applications of immersive technology in medical practice and education.	Systematic review.	Review of applications of immersive technologies in medicine.	Analysis of 128 articles.	Immersive technologies are primarily used for surgery and anatomy education.	Highlights the potential of immersive technologies in enhancing medical education.	Yes, relevant for exploring innovative educational methods in healthcare training.
Singh, R. et al. (2020)	To propose an IoT sensor-based blockchain for pharmaceutical supply chain monitoring.	Theoretical framework proposal.	Literature on IoT and blockchain in pharmaceuticals.	Conceptual model development.	Proposed a framework for temperature monitoring and counterfeit prevention.	Addresses critical issues in pharmaceutical supply chain management.	Yes, aligns with technological advancements aimed at improving healthcare service delivery.
Abugabah, A. et al. (2020)	To review the challenges of implementing RFID technology in healthcare.	Systematic literature review.	Analysis of RFID technology applications in healthcare.	Review of literature and case studies.	Identified barriers such as costs and technical challenges in RFID adoption.	Points to the need for strategies to overcome barriers in healthcare technology adoption.	Yes, highlights challenges that may inform the implementation of new technologies in healthcare settings.
Parnes, D., Ekert, J., Zurich, M. G., Frey, O., Werner, S., Piergiovanni, M., & Leist, M. (2024)	To provide guidelines for quality management and reproducibility in micro physiological systems (MPSs)	Recommendations Paper	N/A	Literature Review, Guidelines Development	Established fit-for-purpose criteria for MPS quality management	The guidelines ensure MPS reliability and reproducibility, addressing standardization challenges	Yes

Table 4 provides an analysis of various research matrices explored in different numerous technological advancements in healthcare. The studies present the Medical 4.0, AI, and pharmacogenomics as novel technologies that should be adopted into the health facilities to improve the quality of patient care, safety, and medication.

The research methodologies include descriptive analyses and qualitative comparisons, literature reviews, and combinations of both. The following conclusions state that new legal acts need to be developed to respond to the latest trends in technology, it is vital to determine the role of nurses in enhancing the quality of healthcare, and using such technologies as immersive and IoT for education and pharmaceuticals supply chain transformation. Altogether, these contributions enrich the discussion of enacting and integrating new technological solutions to enhancement of the patient's experiences in care delivery.

3. Results

Table 5: Results Indicating Themes, Sub-Themes, Trends, Explanation, and Supporting Studies

Themes	Sub-Themes	Trends	Explanation	Supporting Studies
Technological Integration	AI in Healthcare	Increasing adoption of AI technologies in medical settings	Studies highlight AI's role in enhancing drug discovery and patient adherence, indicating a trend toward leveraging advanced technologies for improved healthcare outcomes.	Vora et al. (2023); Haleem et al. (2022)
	Immersive Technologies	Rising use of immersive tech in education and practice	The integration of immersive technologies in medical training is noted, suggesting a shift towards innovative educational methods that enhance learning and surgical skills.	Tang et al. (2022); Haleem et al. (2022)
Regulatory Adaptability	Pharmacy Act Updates	Need for regulatory frameworks to evolve	Research emphasizes the necessity for adapting existing regulations, such as Ghana's Pharmacy Act, to address AI automation risks, reflecting a trend toward proactive governance.	Mensah et al. (2024)
	Quality Management Standards	Development of fit-for-purpose criteria	Guidelines for quality management in micro physiological systems (MPSs) reflect a trend in establishing reliable standards to ensure reproducibility and enhance research credibility.	Pamies et al. (2024)
Quality of Care	Nurses' Responsibilities	Growing emphasis on nursing roles in quality control	The establishment of a framework for nurses' responsibilities underscores the trend towards recognizing nursing contributions to healthcare quality, driving professional development.	Oldland et al. (2020)
	Personalized Medicine	Increased focus on pharma-cogenomic testing	The integration of pharma-cogenomic testing into personalized medicine is gaining traction, indicating a movement towards tailored treatments based on genetic profiling.	Bature et al. (2024); AlQudah et al. (2021)
Healthcare Challenges	Barriers to Technology Adoption	Identification of challenges in implementing technologies	Studies highlight various barriers, including costs and technical challenges, affecting the adoption of technologies like RFID in healthcare, emphasizing the need for strategic solutions.	Abugabah et al. (2020)
	Regulatory Compliance	Ongoing discussions on compliance issues	The necessity for healthcare providers to navigate regulatory compliance in light of new technologies is a recurring trend, reflecting challenges in balancing innovation with regulation.	Mensah et al. (2024)
Patient-Centered Approaches	Enhanced Patient Care	Focus on patient-centered technologies	The emphasis on Medical 4.0 technologies reflects a growing trend towards improving patient-centered care and enhancing accessibility to healthcare services on a global scale.	Haleem et al. (2022)
	Medication Safety	Importance of ensuring safety in drug delivery	Research findings indicate the critical role of regulatory updates in ensuring medication safety and efficacy, particularly in light of emerging technologies.	Vora et al. (2023); Bature et al. (2024)

This means that the results are highly relevant to the research question about the use of advanced technologies in health and consequence to quality and safety. The results prove that the raise of systematic utilization of artificial intelligence (AI) and virtual reality in a medical field of practice improves patients' health and educational results thus depicts the general tendencies of technocratic penetration in the healthcare sector. Furthermore, the necessity for the regulatory flexibility is highlighted, since current acts, including the Pharmacy Act, still must address novel issues, related to AI automation and safety of medications. The development of quality management standards for micro-physiological systems (MPSs) and, recognition of roles of nurses in healthcare quality also stress the significance of proper framework for enhancing patient fueled care. These findings provide an elaborative approach of understanding how these technologies work hand in hand with those proposed regulatory policies to enhance the healthcare delivery system

and patient safety to meet the aspects highlighted by the research question.

4. Discussion

The present research was intended to identify and review recent developments in technology adoptions in healthcare and the arising consequences for quality and safety concerns identified in the PICOT question as to how specific healthcare technologies influenced patients' experiences in different contexts. The paper indicates that the use of technologies including artificial intelligence (AI), immersive learning environments, and micro-physiological systems (MPS) enhances the quality of patient's care. For instance, Haleem et al. 21 highlighted how medical technologies can act to revolutionize the kind densification of healthcare delivery through a reinvention of patient centered care meaning decreased oppressive pressures on the healthcare facilities and enhanced abundance of quality health services for individuals in the global community. The study finds this focus on the patient very useful to my argument given the fact that Mensah et al. 22 has opined that there are regulatory deficits in Ghana's Pharmacy Act that call for overhauling of existing legal structures in order to accommodate the implementation of AI technologies with the view to promoting patient safety.

In addition, the research showed the following important facets on QM on the diffusion of technology; Pamies et al. 23 highlighted necessity of well-coordinated quality control measures, and indicated that criteria for MPSs must be tailored to specific research requirements in order to provide flawless MP reproducibility. This is essential because acceptance of innovative technologies is fraught with inconsistency and lack of standardization, which in turn erode trust. Oldland et al. 24 also emphasized on the idea of having a clear about the tasks of the nurses because they mainly play the significant role of healthcare quality. Altogether, those elements lead to arguing about the need for healthcare organizations implementing the structured QMS that will be compliant with the development of the new technologies yet ensuring the patients' high levels of quality care.

Moreover, the credential within the domain of applied sciences embodied the application of immersive technologies in medical learning as an innovative model of improvement of the quality of the healthcare services. Tang et al. 25 pointed out that immersive technologies are mainly used in surgical training and anatomy learning which in turn directly enhances the skills of clinicians. Overall care can be elevated because of the increased utilization of new technologies relied on by skilled practitioners trained to use the new technologies resulting in better patient competencies. Vora et al. 26 who added that while AI has made drug development easier, they have also increased patient compliance, accord this; implying that technology application in this field has a one-on-one relation with patient gains.

Furthermore, Bature et al. 27 analyses of pharma-cogenomic further strengthen that concept of personalized medicine which is greatly enhancing patient care through utilization of effective testing methods to ensure that the drugs that administered or prescribed do not harm the patient and that they actually work as intended. This concurs with AlQudah et al. 28, who synthesized factors influencing technology

acceptance in healthcare delivery systems, and as observed, the technology acceptance models such as TAM and UTAUT are significant in identifying success factors in implementing this innovation. The findings argue that focusing on personalized and evidence based on approaches through technology is paramount in advancing the goals of healthcare delivery 29.

Therefore, the analysis of the selected studies provides a perfect understanding of the importance of advanced technologies when integrated properly, patterns that facilitate enhancement of patient lifestyle on healthcare domain 30. These trends outlined show that regulation flexibility, systematic quality management and academic development are essential for technology enhancement. Healthcare is a dynamic sector and this makes it necessary for the stakeholders to embrace use of innovative solutions while at the same time ensuring that they meet the set quality standards in ways that would assure patients safety and improve the delivers services31. Although the analyzed sources give solid background in relation to impact of technology in healthcare, they also indicate that future research and policy-making in the area should be focused on creating conditions necessary to bring the potential of technology benefits into clinical practice.

Future Direction

The implications of the current study can suggest that there is a huge prospect on future research and adoption of sophisticated techniques in healthcare domain. In future, there should be more emphasis on other forms of data collection for ascertaining the repeated uses of these technologies in patient care, utilization of variety of contexts to analyze the flexibility of these technologies. Therefore, a need exists for more studies to determine ways of implementing breakthrough technologies like telehealth and block chain to improve the patient safety as well as operations. There is no comprehensive strategy on how to implement these innovations effectively while being compliant with the law thus the need for policy makers and health care leaders to develop such frameworks. This study found that by creating organizational culture and patient centered practices of value improvement and adopting technological solutions the healthcare industry can generate the potential value of technological innovations and, as an outcome, better patient values and improved patient care.

Limitations

It is also necessary to consider the following limitations of the present study before discussing the findings on integration of the advanced technologies in healthcare sector. First, it is necessary to note that because the current research is based on the analysis of secondary data from the selected studies, it is influenced by the methodological and contextual biases inherent in the selected works. Further, the study examined only a few innovation technologies and outcomes effectively reducing the generalizability of the findings to all the innovations that are currently affecting healthcare. Therefore, differences in quality of the conducted studies may influence the general reliability of the observations made. Thus, future research should try to overcome these limitations by using primary data sources and technologies for a wider range of purposes and various kinds of health, which will give better understanding of the positive impact of technology in the field of

healthcare.

5. Conclusion

The use of a wide range of technologies in the context of healthcare services is considered a rather effective means for client outcome optimization and increasing the general quality of assistance. The evidence sourced from the chosen studies reveals that, for instance, AI, VR, MR, IT, telemedicine, pharmacogenomics, etc., contribute towards targeted, effective, and safer health organization management. However, to experience these advantages, one has to develop appropriate QMS and regulations to govern use of such technologies. Subsequently, long term research and application are necessary for understanding the best and continued developmental use of assistance technologies throughout healthcare transformations. It is, therefore, possible for the healthcare sector to overcome the challenges of integrating Information Technology in its functioning by adopting the patient-centered concept and making stakeholders cooperate leading to an improvement of the quality of service to over-arching patient satisfaction levels.

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