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HEALTHCARE MANAGEMENT: IMPACTS OF TECHNOLOGY ON OPERATIONAL EFFICIENCY AND QUALITY OF CARE

Bárbara Conceição Martins de Oliveira, José Songlei Silva Rocha
Corresponding author: barbaramedexercicio@gmail.com
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ABSTRACT

Digital transformation has become a key driver for the modernization of healthcare management, directly influencing operational efficiency and quality of care. This study conducted an integrative literature review with a narrative meta-synthesis to analyze evidence published between 2020 and 2025 on the impact of digital technologies in healthcare services, hospital management, and public health systems. Searches across national and international databases resulted in 21 included studies. Findings demonstrate that technologies such as electronic health records, hospital information systems, artificial intelligence, Internet of Things, and nursing informatics tools consistently improve process organization, reduce rework, decrease delays, enhance diagnostic accuracy, reduce adverse events, and strengthen interprofessional communication. The review indicates that operational efficiency and quality of care are interdependent dimensions that benefit substantially from digitalization. However, the impact of these technologies depends on institutional digital maturity, data quality, system interoperability, and user acceptance. The results highlight that the strategic integration of digital technologies is essential for building more efficient, safer, and patient-centered health systems.

Keywords: Health management; Health technology; Operational efficiency; Quality of care; Digital transformation

INTRODUCTION

Digital transformation in healthcare has emerged as one of the most critical pillars for modernizing care systems and optimizing management processes. The incorporation of technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), clinical information systems, predictive analytics, and electronic health records has shown significant impacts on operational efficiency, hospital management, and the quality of patient care. In recent years, research has indicated that proper digitalization of

healthcare services can reduce costs, minimize clinical errors, enhance workflow processes, and strengthen patient safety [1–3].

Recent studies demonstrate that emerging technologies and integrated digital systems enable a profound reorganization of clinical and administrative routines, increasing team productivity and improving the responsiveness of healthcare services [1,4–6]. When guided by strategic planning, digital transformation enhances operational predictability, strengthens governance, and supports data-driven decision-making—an essential component of contemporary hospital management. Mauro (2024) observed that the combined use of IoT, AI, and analytics generated substantial improvements in administrative processes, in addition to reducing structural inefficiencies [1]. Similarly, Amaya (2025) demonstrated that the digitalization of hospital workflows in Peru increased operational efficiency and reduced average patient wait times [2].

Beyond operational gains, technology exerts a direct influence on the quality of care, particularly in dimensions related to patient safety, diagnostic accuracy, team communication, and standardization of clinical practices. The digital maturity of healthcare institutions has been associated with superior performance indicators, lower occurrence of adverse events, and greater reliability of care delivery [10–12]. Snowdon et al. (2024) found that hospitals with higher digital maturity exhibited lower rates of care-related failures and greater adherence to safety practices [11]. Other studies reinforce that digital solutions applied in primary care enhance care coordination, expand access, and reduce inequities, directly improving population-level outcomes [12].

Within the domain of patient safety, technological tools applied to nursing, clinical documentation, and decision support have shown consistent results. Shi et al. (2025) demonstrated that nursing informatics systems decrease adverse events and reduce length of stay [13]. Complementarily, Vanderhout et al. (2025) showed that implementing electronic health records improves the quality of recorded information, reduces inconsistencies, and strengthens communication among professionals [14]. AI-based clinical decision support technologies were also associated with greater diagnostic accuracy and reduced decision-making variability, reinforcing their relevance to care quality [17].

Despite these benefits, the impact of technology depends on structural, human, and organizational factors. Digital readiness among leaders and technology acceptance among healthcare teams are decisive for the success of digital initiatives and for the effective integration of systems into daily healthcare operations [4,8]. Steenkamp et al. (2025) highlight that leaders with strong digital competence can guide change processes more efficiently, reducing resistance and promoting continuous innovation [4]. Likewise, Stoumpos et al. (2023) argue that technological acceptance directly influences productivity and adherence to clinical protocols [8].

In the global context, digitalization has played a fundamental role in improving healthcare systems in countries with different socioeconomic profiles. Studies show that

population health indicators and service performance improve significantly in environments where digital transformation is consolidated and supported by structured public policies [19]. This trend underscores the need to deepen the understanding of how technologies directly impact operational efficiency and care quality across diverse hospital management and public health scenarios.

Given this context, conducting an integrative review that broadly and critically synthesizes recent evidence on the impacts of digital health technologies on service efficiency and care quality becomes essential. Therefore, this study aims to map, analyze, and integrate scientific findings published between 2020 and 2025, identifying how different technological solutions have contributed to improving organizational processes, strengthening patient safety, reducing costs, and supporting more efficient and effective models of care.

METHODOLOGY

This study is characterized as an Integrative Literature Review, conducted according to the method proposed by Whittemore and Knafl, structured to gather, evaluate, and synthesize scientific evidence regarding the impacts of technology on operational efficiency and quality of care in health services. A narrative meta-synthesis approach was adopted, as the included studies presented methodological heterogeneity—ranging from quantitative, qualitative, and mixed-methods research to analytical reviews—which makes this approach the most suitable for critically and comprehensively integrating findings.

The review process followed five main stages: identification of the theme and formulation of the guiding question; establishment of inclusion and exclusion criteria; definition and execution of the database search; selection of eligible studies; and integrative synthesis of results. The guiding question was defined based on the PICo strategy, considering: Population composed of healthcare services, hospitals, professionals, and care systems; Interest related to technologies applied to health, such as artificial intelligence, Internet of Things, electronic health records (EHR), hospital information systems (HIS), nursing informatics, digital management tools, and decision-support platforms; and Context involving healthcare management, hospital management, and public health. Thus, the review sought to answer the following question: *"How do health technologies impact operational efficiency and quality of care in hospital services and public health systems?"*

Searches were conducted between November and December 2025 and included studies published from January 2020 to December 2025, a period marked by accelerated digital transformation worldwide driven by the COVID-19 pandemic. Scientific databases consulted included PubMed/MEDLINE, ScienceDirect/Elsevier, BMC/BioMed Central, SpringerLink, JMIR, Frontiers in Public Health, SAGE Journals, PLoS One, MDPI, KoreaScience, RGSA, Journals MPCI, and PSPP Journals, selected

for their relevance to research in technology, healthcare management, and quality of care. Combined descriptors in Portuguese and English were used, such as: *health technology*, *digital health*, *operational efficiency*, *quality of care*, *hospital management*, *health information systems*, *electronic health records*, *artificial intelligence in healthcare*, *clinical decision support systems*, and *digital transformation in healthcare*, associated using Boolean operators AND and OR.

Inclusion criteria were: (1) original articles or analytical reviews; (2) published between 2020 and 2025; (3) available in full text; (4) evaluating technologies applied to management, care processes, hospital operations, or quality of care; and (5) studies aligned with the objectives of this review. Exclusion criteria included editorials, letters to the editor, opinion papers, studies unrelated to management or quality of care, clinically therapeutic studies without managerial implications, and duplicate publications. After the initial search, all titles and abstracts were screened, followed by independent full-text evaluation. Of the studies identified, 21 met all eligibility criteria and comprised the final sample.

Data extraction was performed using a standardized matrix containing information on authors, year, country, type of technology evaluated, objectives, methods, outcomes related to operational efficiency and/or quality of care, main findings, and conclusions. Study synthesis was conducted through a narrative meta-synthesis, integrating findings in an interpretive and thematic manner. The studies were analyzed according to the convergence of results related to process improvement, cost reduction, decreased clinical errors, optimization of workflow, strengthening of patient safety, and enhancement of governance and decision-making.

Finally, the discussion was developed based on similarities and divergences among the studies, highlighting contemporary trends in health management technology as well as gaps and opportunities for future research. Methodological rigor was maintained to ensure reproducibility, clarity, and consistency in the synthesis of included evidence.

RESULTS

The search conducted across scientific databases identified 214 potentially relevant studies. After screening titles, abstracts, and full texts, 21 articles fully met the inclusion criteria and comprised the final sample. These studies examined different technologies applied to healthcare management, including artificial intelligence, Internet of Things (IoT), electronic health records (EHR), hospital information systems (HIS), nursing informatics, digital administrative solutions, and clinical decision-support tools. Table 1 presents the general characterization of the included studies.

Table 1. General characterization of included studies (n = 21)

Nº	Author/Year	Main Technology	Evaluated Dimension
1	Mauro (2024)	IoT, AI, Analytics	Operational efficiency
2	Amaya (2025)	Hospital digitalization	Operational efficiency
3	Iqbal (2024)	IT technologies	Operational efficiency
4	Steenkamp (2025)	Digital readiness	Operational efficiency
5	Sinha (2024)	Emerging technologies	Efficiency/Quality
6	Javaid (2024)	Health informatics	Operational efficiency
7	Delgado (2024)	Public digital transformation	Operational efficiency
8	Stoumpos (2023)	Technology adoption	Efficiency/Quality
9	Bellei (2025)	Digital management solutions	Operational efficiency
10	Natakusumah (2022)	Digital transformation	Quality of care
11	Snowdon (2024)	Digital maturity	Quality/Safety
12	Silva (2024)	Digital health in primary care	Quality of care
13	Shi (2025)	Nursing informatics	Quality of care
14	Vanderhout (2025)	Electronic health record (EHR)	Quality of care
15	Syamsuriansyah (2025)	Information quality	Safety and quality
16	Kruse (2025)	Health IT in emergency settings	Quality of care
17	Marinescu (2025)	AI-CDSS	Efficiency/Quality
18	Jeilani (2025)	Technology adoption	Operational efficiency
19	Bocean (2025)	Macro-level digital transformation	Efficiency/Quality
20	Alharbi (2025)	Electronic health record	Operational efficiency
21	Förstel (2024)	HIS and data quality	Efficiency/Quality

The integrated analysis of the 21 studies revealed consistent patterns regarding how digital health technologies influence both operational efficiency and quality of care. Interpretation of the findings identified **four major thematic axes**, presented below.

1. Technologies and Operational Efficiency

The studies that assessed operational outcomes (n=10) showed strong convergence: in all of them, technological adoption resulted in greater agility, cost reduction, decreased rework, and improved resource allocation.

Mauro (2024) demonstrated that combined IoT, AI, and analytics solutions reduce administrative delays and increase operational predictability, while Amaya (2025) showed that hospital digitalization improves internal workflow and reduces average patient wait times. Administrative technologies also stood out: IT systems evaluated by Iqbal (2024) reduced duplicated processes, and health informatics solutions analyzed by Javaid (2024) decreased communication failures.

In public-sector environments, Delgado (2024) indicated that digitalization enhances coordination and transparency, generating measurable gains in decision-making speed and safety. Similarly, Bellei (2025) found that digital platforms improve resource allocation and strengthen indicator-based management. Another relevant aspect was the influence of leadership digital readiness: Steenkamp (2025) showed that technologically prepared leaders accelerate the adoption of digital tools, increasing their effectiveness in organizational routines.

Overall, the meta-synthesis demonstrates that **operational efficiency is the dimension most directly benefited by technology**, regardless of tool type or country context.

2. Technologies and Quality of Care

Thirteen studies identified a direct positive impact on care quality, including clinical communication, patient safety, continuity of care, and diagnostic accuracy.

Natakusumah (2022) showed that digital transformation reduces care-related errors and improves standardization. Snowdon (2024) found a strong relationship between digital maturity and safety, indicating that highly digitalized hospitals exhibit fewer failures and adverse events. In primary care, Silva (2024) demonstrated that digital technologies improve access, coordination, and service resolution, resulting in better clinical follow-up.

Nursing stood out as well: Shi (2025) showed that nursing informatics reduces adverse events and shortens hospital stays, while Syamsuriansyah (2025) reinforced that information quality is a determining factor in reducing clinical errors.

Electronic health records were highlighted in two studies. Vanderhout (2025) showed that EHR implementation improves documentation and interprofessional communication, while Alharbi (2025) found strong correlations between EHR use and increased efficiency, demonstrating its dual impact.

AI-based technologies, such as clinical decision-support systems, were notable for reducing diagnostic variability and increasing decision-making precision, as demonstrated by Marinescu (2025).

Thus, the meta-synthesis confirms that **technological adoption systematically improves care quality**, reinforcing the role of digital tools in patient safety and patient-centered care.

3. Digital Transformation and Patient Safety

Safety emerged as a direct consequence of digitalization. Five studies emphasized that technologies that improve traceability and information quality reduce clinical errors and enhance the reliability of records.

Snowdon (2024) found that institutions with high digital maturity have lower adverse event rates, while Förstel (2024) showed that HIS systems with consistent data reduce documentation failures and strengthen information integrity. In emergency settings, Kruse (2025) observed that clinical technologies reduce critical response time and improve diagnostic accuracy—two direct indicators of safety.

The findings support the notion that **patient safety is not merely influenced by technology—it increasingly depends on it**.

4. Organizational Factors and Digital Maturity

Five studies emphasized that technology only generates meaningful impact when supported by adequate organizational conditions. The literature shows that:

- **Leadership digital readiness** facilitates implementation and reduces resistance (Steenkamp, 2025).
- **Innovative organizational culture** increases adoption and accelerates system integration (Stoumpos, 2023).
- **Data quality and interoperability** are essential for effective digital tools (Syamsuriansyah, 2025; Förstel, 2024).
- **Professional adoption** (Jeilani, 2025) is a critical variable for long-term project sustainability.

Thus, the impact of digital transformation depends not only on technology itself but also on the institutional environment in which it is implemented.

DISCUSSION

The findings of this integrative review demonstrate that digital transformation in healthcare has produced consistent and multidimensional impacts on both operational efficiency and quality of care, confirming the global trend described in recent literature. The technologies analyzed in the 21 included studies—ranging from hospital information

systems and electronic health records to artificial intelligence, IoT, and nursing informatics solutions—converge toward a scenario in which digitalization becomes a central element in modernizing healthcare management and enhancing the quality of patient care.

Regarding operational efficiency, the findings show that digital technologies enable process reorganization, reduce rework, and increase team productivity. Studies by Mauro (2024), Amaya (2025), and Iqbal (2024) demonstrated that IoT, IT systems, and workflow digitalization can significantly improve organizational performance by reducing waiting times, eliminating redundancies, and optimizing resource utilization. These results reflect a growing trend in the adoption of automation and predictive analytics tools that support managers in making faster, evidence-based decisions, thereby strengthening governance and the analytical capacity of health services. The relationship between leadership digital readiness and operational performance reinforces the notion that digital transformation is not only technological but also organizational, depending on managerial and cultural competencies for its full impact.

With regard to quality of care, the results indicate that technologies applied to clinical documentation, decision support, and information security have played a key role in reducing adverse events and improving clinical practice. Studies by Natakusumah (2022), Silva (2024), Shi (2025), and Snowdon (2024) show that digital systems can increase diagnostic accuracy, reduce medication errors, enhance team communication, and promote greater continuity of care. Institutional digital maturity, highlighted by Snowdon (2024), appears as a critical element to ensure that the benefits of technology translate into concrete improvements in patient safety. These findings support previous research indicating that information quality and system interoperability are essential pillars for safer, more efficient, and patient-centered care.

Another key element emerging from this review is the role of clinical decision-support technologies, especially artificial intelligence–based tools (AI-CDSS), which have been shown to increase diagnostic accuracy and reduce variability among professionals, as reported by Marinescu (2025). Such technologies represent a significant advancement in clinical practice, particularly in complex environments such as emergency departments and critical care units, where time and accuracy directly influence patient survival and prognosis. The growing adoption of these tools highlights the transition of health systems toward more intelligent models of care, capable of integrating large volumes of data and converting information into precise clinical action.

When analyzing the studies collectively, it becomes evident that operational efficiency and quality of care are not isolated dimensions but interdependent. More efficient processes, faster communication, and more reliable data strengthen care quality; in turn, safer and more precise care reduces rework, waste, and institutional risks. The findings of this review reinforce that both dimensions benefit simultaneously from technological adoption, underscoring the need for integrated digital strategies that consider both management and care delivery.

It is important to emphasize that the magnitude of technological impact is directly related to institutional digital maturity, a factor identified as decisive in studies such as those by Steenkamp (2025) and Stoumpos (2023). Institutions with innovative cultures, trained leadership, and engaged teams achieve superior outcomes, highlighting that technology alone does not guarantee transformation. Digital transformation is a complex process that requires investment in workforce training, interoperability, data infrastructure, and change management. This observation is particularly relevant in public-sector contexts and in low- and middle-income countries, where structural limitations may compromise full technological implementation.

The findings also point to important gaps in the literature. Few studies conducted detailed economic evaluations, although some indicated reductions in costs and improvements in resource optimization. Additionally, there is a scarcity of research comparing different types of technologies or assessing long-term impacts. Multicenter studies and cost-effectiveness analyses remain limited, suggesting opportunities for future research.

Overall, the results of this review demonstrate that digital transformation represents a strategic driver for strengthening health systems, contributing to safer care environments, more efficient processes, and more informed decision-making. The adoption of digital technologies, when integrated with institutional policies and consolidated management strategies, has the potential to reduce inequalities, expand access, and promote more integrated and higher-quality models of care.

CONCLUSION

This integrative review demonstrated that digital transformation in healthcare plays a decisive role in modernizing care delivery systems and qualifying both hospital and public-sector management. The 21 studies analyzed consistently show that digital Technologies, including electronic health records, hospital information systems, artificial intelligence, Internet of Things devices, nursing informatics tools, and integrated clinical decision-support platforms, promote substantial improvements in operational efficiency, quality of care, and patient safety.

The findings reveal that technological adoption reduces delays, optimizes workflows, decreases rework, and enhances resource utilization, strengthening the ability of healthcare services to respond more quickly and accurately to care demands. Additionally, digital tools improve diagnostic accuracy, reduce clinical errors, enhance continuity of care, and support more efficient communication among professionals. This combination of effects demonstrates that efficiency and quality are not independent dimensions but deeply interrelated and strengthened by digitalization.

However, it was observed that the impact of technology depends on strategic organizational factors such as institutional digital maturity, staff technology acceptance,

information quality, system interoperability, and leadership capacity to drive transformation processes. Institutions with innovative cultures and environments conducive to technological adoption achieve more substantial and sustainable outcomes, highlighting the importance of change management as a complementary axis to digital tool implementation.

Overall, this review confirms that digital health technology is a structural driver for increasing the responsiveness of health systems, supporting clinical decision-making, strengthening governance, reducing inequalities, improving user experience, and promoting safer, evidence-based care. The consolidation of these tools, combined with robust institutional policies and sustained investments in infrastructure and workforce training, represents a solid pathway toward more efficient, integrated, and patient-centered health systems.

The results also indicate the need for future research that explores detailed economic analyses, comparisons between different technological models, multicenter studies, and long-term evaluations to deepen the understanding of the actual impact of digitalization on health systems across different contexts and levels of complexity.

Thus, it is concluded that the strategic incorporation of digital technologies constitutes an essential element for advancing contemporary healthcare management, providing crucial support for building smarter, more sustainable, and quality-oriented models of care.

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