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Evidence of the cost-effectiveness of digital health interventions in hospital services: an integrative review

Evidências de custo-efetividade de intervenções de saúde digital em serviços hospitalares: uma revisão integrativa

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ABSTRACT

Aim: To conduct an integrative review to examine the evidence on how the implementation of health information systems can influence cost reduction in hospital services. **Methods:** Integrative review in the MEDLINE, Embase and LILACS databases, including studies on digital technologies and their effects on the costs and efficiency of hospital services. **Results:** Of the 62 studies identified, 45 met the inclusion criteria. Most indicated cost reduction (64.3%) and gains for management and healthcare professionals (35.7%). Most studies were published after 2020. **Conclusion:** The expansion of digital health, intensified after the COVID-19 pandemic, has driven the adoption of information systems in hospitals. These technologies are frequently associated with cost reduction and greater service efficiency. Furthermore, they suggest improvements in management and the work of healthcare professionals. They also generate relevant benefits in the quality of patient care.

Keywords: Digital Health; Efficiency; Hospital Costs; Integrative Review.

RESUMO

Objetivo: Realizar uma revisão integrativa para examinar as evidências sobre como a implementação de sistemas de informação em saúde pode influenciar a redução de custos nos serviços hospitalares. **Métodos:** Revisão integrativa nas bases MEDLINE, Embase e LILACS, incluindo estudos sobre tecnologias digitais e seus efeitos nos custos e na eficiência dos serviços hospitalares. **Resultados:** Dos 62 estudos identificados, 45 atenderam aos critérios de inclusão. A maioria indicou redução de custos (64,3%) e ganhos para a gestão e profissionais de saúde (35,7%). A maioria dos estudos foi publicada após 2020. **Conclusões:** A expansão da Saúde Digital, intensificada após a pandemia de COVID-19, tem impulsionado a adoção de sistemas de informação em hospitais. Essas tecnologias são frequentemente associadas à redução de custos e à maior eficiência dos serviços. Além disso, contribuem para melhorias na gestão e no trabalho dos profissionais de saúde. Também geram benefícios relevantes na qualidade do cuidado aos pacientes.

Descritores: Saúde Digital; Eficiência; Custos Hospitalares; Revisão Integrativa.

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1 INTRODUCTION

The United Nations (UN) adopted the 2030 Agenda for Sustainable Development in 2015, highlighting the need to broaden access to information and communication technologies (ICT) and to enhance global interconnectedness as key enablers of sustainable development. This directive aims to accelerate human progress, mitigate digital exclusion and lay the groundwork for knowledge-based societies. Recently, the World Health Organization (WHO) launched the Global Initiative on Digital Health (GIDH), with the goal of promoting a more coordinated and systematic approach to address the challenges associated with the digitalization of health services [1]. WHO defines digital health services as the safe, effective and cost-efficient use of digital technology and systems to provide access to health and related areas such as health monitoring, epidemiological surveillance, education, and research [2].

The adoption of health information systems in hospital settings, such as the integration of telehealth systems with electronic health records (EHR), is important, but it requires robust evaluation processes capable of generating evidence on the economic impacts of these interventions [3]. Such evidence is essential for guiding decisions and justifying more substantial investments in the sector.

The aims of this integrative review were to identify and synthesize evidence related to operational costs, cost savings and the efficiency resulting from the implementation of health information systems supporting hospital services.

2 METHODS

This integrative review had the following guiding research question: "What is the impact on efficiency and costs resulting from the implementation of health information systems supporting hospital services?"

The literature search was conducted in the following databases: MEDLINE (via PubMed), Embase (accessed through the portal of the Coordination for the Improvement of Higher Education Personnel, CAPES), and LILACS (via the Virtual Health Library, VHL). Search strategies were developed using a combination of controlled and uncontrolled terms, as described in Appendix A, available at https://doi.org/10.5281/zenodo.20041712.

The review employed an adapted version of the PICO strategy, an acronym for Population (P), Intervention (I), Comparison (C), and Outcomes (O). For the purposes of this review, a methodological framework [4] was adopted. It is important to note that only the P, I, and O elements were considered in this strategy, as illustrated below: P (hospital services; physicians, managers, and nurses processes), I (telehealth; electronic health records; digital health platforms); O (cost-benefit analysis; cost-efficiency analysis; costs and cost analysis; opportunity cost of health technology; efficiency analysis).

2.1 Selection of Studies

The initial selection of publications was conducted in successive stages performed by two independent reviewers to ensure impartiality in the screening of studies. In cases of disagreement between the reviewers, decisions were made through consensus meetings to ensure consistency and validity in the adopted inclusion and exclusion criteria.

2.2 Title and abstract screening

In the first stage, the screening of studies was performed blindly using the Rayyan software [5], based on the reading of titles and abstracts. In the second stage, articles whose titles and abstracts raised doubts about eligibility were submitted to full-text reading for a more thorough evaluation. Both reviewers actively participated in all phases of the selection process.

2.3 Full-Text Review

The articles selected for full-text review were analyzed to identify those that effectively addressed the research question. During this stage, the reasons for excluding studies that did not meet the eligibility criteria were properly documented, ensuring transparency and traceability in the selection process.

2.4 Data Extraction

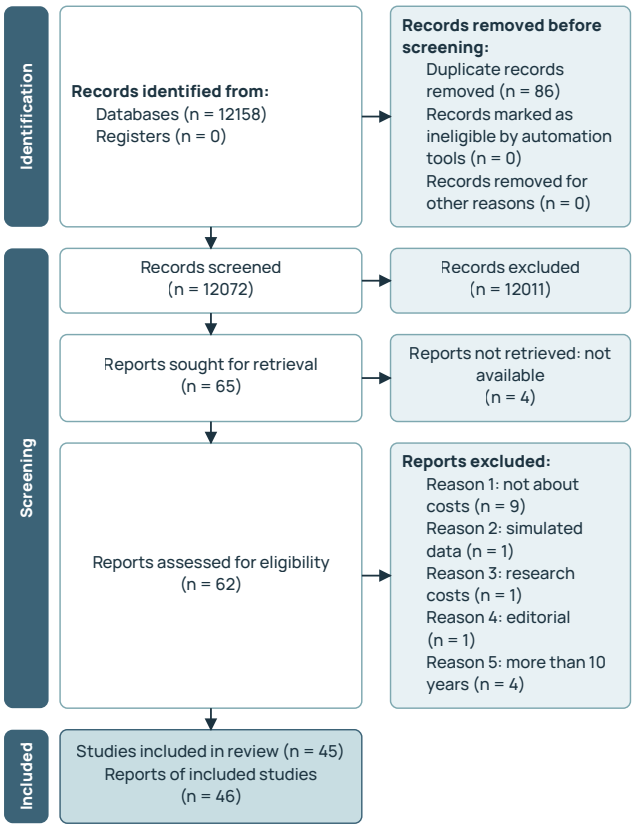
A standardized data extraction tool was developed, containing the following elements: study identification; full reference (authors, year of publication, journal, and DOI); country of origin; objectives; methodological design; characteristics of the studied population; number of participants (total, control group, and intervention group); type of intervention; type of comparator; primary outcome; secondary outcomes; main results; and conclusions.

Ethical approval and informed consent were not required for this study, as the research is an integrative literature review and does not involve direct human subjects research or the collection of new primary data. All data were extracted from previously published, publicly available academic and clinical sources.

3 RESULTS

An adapted workflow diagram, based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [6], with the total number of articles searched is shown in Figure 1.

Figure 1. Flow diagram based on PRISMA statements



Source: Prepared by the authors (2026).

The search strategies resulted in the retrieval of 96 titles from Embase, 2,572 from MEDLINE, and 9,490 from LILACS, totaling 12,158 records. With the aid of Rayyan software, 86 duplicates were identified and removed, leaving 12,072 publications for the initial screening based on title and abstract.

After this screening, 65 studies were selected for full-text review, distributed as follows: 2 from LILACS, 19 from Embase, and 44 from MEDLINE. Among these, four publications were not available in open-access databases; the corresponding authors were contacted, but no response was received, resulting in the exclusion of these studies from the analysis. During the full-text review, 16 publications were excluded due to the following reasons: nine did not address cost-related aspects; one used a Markov model with simulated data; one dealt exclusively with research-related costs; one was an editorial; four had been published more than 10 years ago. Additionally, two publications were identified as parts of the same study, one describing the protocol and the other presenting the results. At the end of the full-text review process, 45 studies were included in the review and submitted to the data extraction phase.

Among the 45 selected studies, 22 (48.9%) were identified as research protocols and two were published only as abstracts in conference proceedings, with no quantitative results available for analysis. Although the use of health information systems has progressively increased over the years, a more substantial growth was observed during the COVID-19 pandemic, with several studies developed between 2020 and 2023, many of which are still ongoing. There are already a substantial number of studies presenting relevant cost benefits. The studies included in this review are summarized in Table 2.

Table 1. Characteristics of the studies included in the review according to region

Region	
Europe	64.4%
North America	17.8%
Oceania	6.7%
South America (Brazil)	4.4%
Asia	4.4%
Africa	2.3%
Study design	
Protocol	48.9%
Clinical trial	26.7%
Observational study	24.4%
Study population	
Heart failure	13.4%
Anxiety and depression	8.9%
Other heart diseases	6.7%
Other affections	71%

Source: Prepared by the authors (2026).

3.1 Study Characteristics

Table 1 presents the main characteristics of the included studies, categorized by geographic region, methodological design, and studied populations. It is noteworthy that approximately 82% of the studies were conducted in Europe and the United States altogether, indicating a predominance of research in high-income settings with well-established technological infrastructure.

The populations studied were diverse, with a particular emphasis on individuals with chronic conditions, reflecting the relevance of health information in the management of long-term illnesses with high impact on healthcare systems. Regarding the identified information systems employed on supporting healthcare services, the most common were digital teleconsultation platforms (33.4%), mobile health apps (33.3%) and telemonitoring platforms (13.4%), reflecting the main types of digital interventions analyzed in the included studies. No study identified addressed the implementation of an electronic health record.

Table 2. Summary of non-protocol studies included in the review, Brazil, 2023

Study	Country	Favorable intervention?	Device	Cost outcome
E02 [7]	Netherlands	no	Computer	US$ 279 (intervention) [R$ 1,411] vs. US$ 74 (control) per participant
E03 [8]	Brazil	yes	Computer	U$21.94 per protocol [R$ 111]
E04 [9]	Germany	yes	Computer	€323 per patient [R$ 1,865]
E05 [10]	United Kingdom	no	Touchscreen device	£2,065.90 per patient [R$ 13,973]
E07 [11]	United Kingdom	yes	Telephone	£35.41 teleconsultation [R$ 239] vs. £51.12 consultation in person
E08 [12]	United States	no	Devices attached for pressure, oximetry, blood glucose	Mean difference of -$9,537 [R$ 48,237]
E12 [13]	United States	yes	Device controlled by physicians and nurses	TPCU ($13.18) [R$ 66] vs. NTPCU ($12.301)
E14 [14]	Netherlands	yes	Computer	Mean difference of € -647 [R$ 3,735]
E17 [15]	United Kingdom	no	Telephone	No information
E18 [16]	Germany	no	Computer	18.5-39.5 x 10^3 € (intervention) [~R$ 115.10^3] vs. 12.8-22.0 x 10^3 € (control)
E19 [17]	Australia	yes	Telephone	$213 (intervention) [R$ 1,077] vs. $444 (control)
E24 [18]	United Kingdom	yes	Computer	Saving £12,460 [R$ 84,271]
E25 [19]	Finland	yes	Computer	Reduce €48 per consultation [R$ 277]
E26 [20]	Finland	yes	Computer	€ 211 (control) [R$ 1,067] vs. € 32 (intervention)
E28 [21]	Japan	inconclusive	Cell phone	Incremental cost-effectiveness ratio for 1 year was estimated to 2.9 million yen [R$ 90K]
E34 [22]	Netherlands, Denmark, France, Switzerland, and Spain	yes	Cell phone	€71.046 (intervention) [R$ 360] vs. €86.345 (control)
E35 [23]	United States	inconclusive	Computer	The total costs charged to patients were similar in the control and intervention groups
E37 [24]	Paraguay	yes	Computer	2.6 US$ (intervention: ECG, tomography, ultrasound) vs. 11.8 US$ for ECG, 68.6 US$ for tomography and 21.5 US$ for ultrasound (average impact of 31 U$) [R$ 156.8]
E38 [25]	Netherlands	inconclusive	Cell phone	€224 (intervention) [R$ 1,293] vs. €156 (control)
E41 [26]	United Kingdom	inconclusive	Telephone	£482.00 per month [R$ 3,260]
E44 [27]	Australia	yes	Telephone	$279 (intervention) [R$ 1,411] vs. $21 (control)
E48 [28]	Georgia	yes	Computer	Saving $101,110
E57 [29]	United States	inconclusive	Computer	No information

Source: Prepared by the authors (2026).

Of the 45 studies retrieved, 23 (51%) had published results, while 22 were just research protocols without presenting quantitative data. Among the 23 studies with published results, 12 (52%) were randomized clinical trials (i.e., the best evidence) and 11 (48%) were observational studies.

In terms of economic effectiveness, of the 23 studies with published results there were: three (13%) presented inconclusive findings; five (21.7%) found no cost reduction from the use of digital systems; one study (4.3%), although it did not find a statistically significant difference in costs, classified the intervention as cost-effective; nevertheless 14 studies (60.9%) were identified as cost-effective, showing significant cost reductions associated with the implementation of digital health systems.

Among the 14 studies that classified digital interventions as cost-effective, the distribution of comparison methodologies was as follows: 29% (4 studies) compared the costs of in-person consultations with teleconsultations; 21% (3 studies) compared the cost of in-person diagnosis with telediagnosis; 14% (2 studies) compared telemonitoring with face-to-face monitoring; 7.1% (1 study) evaluated the cost-effectiveness of a web portal-based care program with recommendations and pre- and post-operative monitoring, compared to usual care; 7.1% (1 study) analyzed whether telephone-based coaching to increase physical activity in insufficiently active adults was cost-effective; 7.1% (1 study) investigated videoconferencing between healthcare units (e.g., hospital and rehabilitation center) as a cost-effective alternative to in-person care; 7.1% (1 study) assessed the use of wearable devices (e.g., heart rate monitor or accelerometer to measure steps) in cardiac telerehabilitation programs, comparing them with traditional rehabilitation; 7.1% (1 study) studied the cost-effectiveness of a telephone advice line for patients with inflammatory bowel disease, compared to the traditional face-to-face consultation model.

The methods used to calculate economic impacts varied across studies: Comparative Analysis Matrix, followed by median and linear regression; Statistical method of Analysis of covariance (ANCOVA); Micro-costing approach to calculate intervention costs, associated with a web portal; Bottom-up micro-costing approach to calculate intervention costs and mixed model variance analysis.

Regarding the cost-effectiveness relationship and the partnerships involved in the studies, it was observed that 42% of the projects included external partners to enable independent evaluations, while 58% were conducted with internal partners. External partners are considered those without a direct affiliation to the project or the institution conducting the research, such as universities, companies or external healthcare organizations. The analyzed studies reported both primary and secondary impacts resulting from the implementation of digital systems. The results highlight a wide range of effects on hospital service costs and efficiency, as presented in Table 3, below.

Table 3. Primary and secondary results of cost-effective studies

Primary results	
Indicator	**Value**
Percentage of studies reporting cost-effectiveness	60.9%
Average savings per patient/intervention*	US$ 2,845 [R$ 14,390]
Percentage of resource savings	56%
Secondary results	
Outcome	**Percentage**
Benefits for healthcare management and professionals	35.7%
Improvement in patients' health and quality of life	21.43%
Reduction in consultation time	21.43%
Reduction in outpatient and inpatient days	21.43%
Patient satisfaction with digital care	21.43%
Reduction in referrals to specialists	14.29%
Improved access to hospital services	7.14%
Increased productivity	7.14%
Avoidance of unnecessary patient travel to hospitals	7.14%

*This value was calculated by summing the savings per patient/intervention and computing the average across studies.

Source: Prepared by the authors (2026).

4 DISCUSSION

The analysis of the studies included in this integrative review showed that, although the use of health information systems in healthcare was already on the rise, there was a sharp increase in their adoption following the COVID-19 pandemic. This increase is evidenced by the substantial number of studies initiated between 2020 and 2023 [30]. Among the studies that assessed the efficiency and costs of health information systems, digital telemedicine services stood out as the most frequently addressed. The most common modalities were teleconsultations (33.4%) and telemonitoring (13.4%). The predominance of telemedicine services can be explained by both its advanced stage of development and broad application across various care contexts [31].

In relation to cost-effectiveness assessment, the results are very relevant, showing that 60.9% of the studies reported clear cost-effectiveness, with the average savings per patient/intervention to be about US$ 2,845 (R$ 14,390) and the percentage of resource savings reaching about 56%.

Regarding the impacts on health management and professionals, these results show the importance of measuring the value of digital interventions for the advancement of digital transformation of healthcare

services. This has provided a relevant opportunity to assess the actual impact of digital health systems innovations. Understanding the impact on costs and other effects of these digital health systems is essential to inform public policies and guide sustainable investments, focusing on quality, equity and efficiency in health systems [32,33]. As in other industries, healthcare should adopt the practice of measuring the impact of digital services interventions to help justify investments required to transform health systems and to provide guidance toward those that show larger cost benefits to patients and healthcare.

However, it is noteworthy that some of the retrieved studies are still in the protocol phase or at early stages of development, indicating that the field of measuring the impact on costs is still in the process of consolidation. The clear understanding of the impact of digital health interventions will also support responsible innovation, by both bringing the necessary transparency on the use of limited resources and legitimating innovations that are effectively contributing to improving health, going beyond the technology hype.

Regarding Brazil, this circumstance suggests a long road ahead, in which the systematic and standard collection of clinical and financial data will be essential for accurately assessing outcomes and eventually help justify future decisions in Brazil regarding the adoption of digital health systems. Understanding the fundamentals of health information systems impact in the functioning of hospital services in Brazil is an essential first step to start addressing the analysis of artificial intelligence technology to support patient care efficiency and quality.

5 CONCLUSIONS

These findings demonstrate substantial relevance, especially when considering large-scale projects currently underway in the United States, Europe and other international contexts. The results of this integrative review highlight the potential of health information systems to support the development of more robust public policies and to guide structured and sustainable investments.

Beyond the considerable cost savings, the results analyzed in this review also indicate secondary positive effects of technological implementation, with relevant practical implications for health service management. Among the reported benefits are reduction in queues and waiting times, increased access to services, decrease in unnecessary specialist referrals, improvement in care efficiency, reduction in stay in health facilities, and enhanced clinical effectiveness.

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EDITORIAL NOTES

The Journal of Health Informatics is a scientific journal maintained by the Brazilian Society of Health Informatics (Sociedade Brasileira de Informática em Saúde), a non-profit scientific association dedicated to the development of Health Informatics and Digital Health in Brazil. The editorial process is conducted with scientific independence, free from institutional, commercial, or sponsor interference, and follows international best practices in publication ethics.

This article was double-blind peer reviewed by specialists in the field. The editorial team used artificial intelligence tools, under human supervision, in the initial screening, in checking the text, references and numbers and, when needed, in redrawing figures, charts and tables, which the authors approved in the proof. The tools and safeguards are described in the journal's Policy on the use of artificial intelligence. Editorial decisions were made by people.

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