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Contribution of IT to Value in Healthcare: a Bibliometric Analysis.

Contribution des technologies de l'information à la création de valeur dans le secteur de la santé : une analyse bibliométrique

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Résumé

Associer de la valeur aux technologies de l'information (TI) est un défi de longue date. Depuis les années 1970, de nombreux chercheurs ont tenté d'explorer cette relation sous différents angles. L'objectif ultime est de fournir des informations qui aideront les organisations de soins de santé à mieux comprendre la valeur générée par les investissements informatiques et à orienter les recherches futures vers des études plus ciblées et efficaces sur la contribution des technologies de l'information sur les soins de santé. Méthodes : Il s'agit de mener une analyse bibliométrique des recherches existantes sur la valeur générée par les technologies de l'information dans les soins de santé pour comprendre comment ces technologies contribuent à la création de valeur. De plus, en utilisant des outils d'analyse contextuelle tels que le logiciel VOSviewer, l'étude vise à catégoriser et à mieux définir le concept de valeur générée par les technologies dans les soins de santé. Résultats : Les résultats révèlent que la valeur générée par les technologies de l'information dans les soins de santé peut être classée en trois catégories distinctes : la valeur organisationnelle, la valeur économique et la valeur sociale. Conclusion : Les résultats de cette discussion pourraient contribuer à une meilleure compréhension des origines et des tendances de la valeur créée par les technologies dans les soins de santé, permettant aux futurs chercheurs de concentrer plus efficacement leurs études sur l'apport de ces technologies sur les soins de santé.

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Abstract

Objective: Associating value with Information Technology (IT) has been a longstanding challenge in healthcare. Since the 1970s, numerous researchers have attempted to explore this relationship from various angles. The ultimate goal is to provide insights that will help healthcare organizations had better comprehend the value generated by IT investments. Methods: This involves conducting a bibliometric analysis of existing research on IT value in healthcare to understand how these technologies contribute to value creation. Additionally, by using content analysis mobilizing VOSviewer software, the study aims to categorize and better define the concept of IT value within healthcare. Results: The findings reveal that the value generated by IT in healthcare can be categorized into three distinct categories: organizational value, economic and financial value and social value. Conclusion: These findings could contribute to a better understanding of the origins and trends of IT value in healthcare, enabling future researchers to focus their studies on the contribution of healthcare information technologies more effectively.

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Introduction

Information technology in healthcare involves using digital solutions and systems to enhance the delivery, efficiency and quality of healthcare services(Asadi et al., 2024). It has significantly impacted both the delivery and management of healthcare (Dal Mas et al., 2020), underscoring the importance of investing in these technologies to facilitate the transition a digital world.

Numerous healthcare organizations have made substantial investments in various forms of information technology, including platforms that promote nursing home innovativeness(Davis et al., 2006) , Electronic Medical Records (Dranove et al., 2015), Electronic Health Records to improve return on investment (Grieger et al., 2007), as well as e-health and m-health solutions (Schweitzer & Synowiec, 2012), among others.

Furthermore, while the impact of these technologies extends beyond merely facilitating administrative tasks (Koppel et al., 2005); healthcare organizations have not systematically identified the broader effects of these investments or their contributions to value creation in the field (Balta et al., 2021).

Linking value to investments in healthcare information technology in the healthcare sector is not a new challenge; it has prompted several researchers to investigate this topic. Notable studies include those examining the relationship between information technology investments and market value (Kohli et al., 2012), as well as those investigating the connection between information technology investments and economic value (Das et al., 2010).

While, several researches have examined the nexus between healthcare information technology and value (Dixon & Cusack, 2023), this research is neither in-depth nor comprehensive. Much of the existing research focuses on specific technologies or limited value dimensions. For example, studies on the diffusion and value of health information technologies often concentrate on electronic health records (EHR) as a specific technology (Bower, 2005). Additionally, earlier research, such as that by Chaudhry et al. (2006), primarily examined three value categories—quality, efficiency, and costs—to assess the effects of health IT. However, this research, conducted between 1995 and 2005, lacks a broader perspective and does not provide a recent update on the impact of these technologies (Chaudhry et al., 2006). Consequently, the value of health IT remains underexplored both within healthcare organizations and in the research literature.

This paper aims to explore the contribution of information technology to value in healthcare through a bibliometric analysis and a content analysis. As the first of its kind to investigate this topic, it will provide a basis for future academic research to build upon and identify new areas of exploration (Lavissière et al., 2020), addressing gaps related to the value created by information technologies within healthcare organizations. Furthermore, this study will enable categorizing the values created by healthcare information technology and their evolution over the time.

The literature review was conducted rigorously, drawing on scholarly articles that examined information and communication technologies to provide a comprehensive overview of these tools in the healthcare sector. Around 30 years ago, automated information systems (AIS) were introduced into the healthcare environment (Manning & McConnell, 1997), and since then, various forms of healthcare information technology (HIT) have emerged. Examples of these technologies include Patient Information Systems, Radiology Information Systems, Patient Data Management Systems, Nursing Information Systems, Anesthetic Documentation Systems, and Laboratory Information Systems are examples of these technologies (Ammenwerth & de Keizer,

2004).These technologies were designed to enhance patient care, streamline processes, or increase the safety of medical interventions. To learn more about these technologies and their functions, the following Table (1) summarizes some information systems used in the healthcare sector:

Table 1: Healthcare Technologies and Their Functions.

Information system	Abbreviation	Task	Author
Computerized Patient Information Systems	CPIS	hold the potential to significantly reduce administrative paperwork, consequently liberating nurses' valuable time	(Darbyshire, 2004).
Computerized Prescriber Order Entry	CPOE	plays a crucial role in ensuring the clarity and legibility of medical orders, thus enhancing safety measures	(Vélez-Díaz-Pallarés et al., 2018)
Lab Information System	LIS	emerges as a cornerstone in refining laboratory operations, thereby augmenting both efficiency and patient care	(Sepulveda & Young, 2013)
Pharmaceutical Information System	PHARM	Centralize crucial drug information, allergies, and their nuanced effects on individual patients, thus ensuring comprehensive and informed care.	(Jara et al., 2010)
Electronic Health Record	EHR	Facilitate clinical research and increase productivity.	(Cowie et al., 2017) (RPA-C et al., 2010)
Electronic Medical Record	EMR	Contribute to cost-effective and effectiveness.	(Randhawa et al., 2019)
Health Information Exchange	HIEs	Increase efficiency of care delivery.	(Alexander et al., 2022)
Personal health record	PHR	Encourage patient self-management of Chronic conditions.	(Roski et al., 2014)
Picture Archiving and Communications System	PACS	Deliver cost-effective solutions informing communicating to the right person in the right place and time.	(Claikens, 2018)
Radiology Information System	RIS	Improve workflow-radiology. It helps avoid valueless effort and focuses radiologist workflow on value-adding activities.	(Halsted & Froehle, 2008)
Laboratory Health Information Exchange	LHIE	Improve overall antiretroviral therapy (ART) treatment and viral suppression (VS), and reduced Black/White disparities. Improve care for everyone can have the added benefit of reducing black/white disparities in HIV care.	(Cunningham et al., 2017)

Recently, during the Covid19 pandemic, the healthcare sector has seen a significant increase in the adoption of innovative technologies. Telemedicine (Galiero et al., 2020) and teleconsultation (Shenoy et al., 2020) have taken center stage, revolutionizing how health services are delivered took its center stage. Telemedicine has led to a slight increase in primary care visits (Zeltzer et al., 2023) and has improved communication between patients and healthcare providers, enabling clearer audio and easier conversation (Abdulwahab & Zedan, 2021). Teleconsultation has also supported cancer care pathways and delivery (Caviola et al., 2023). These solutions facilitate remote consultations and medical advice, bridging the gap between patients and healthcare professionals (Wernhart et al., 2019).

Beyond the shift towards digital health, the healthcare sector has also benefited from innovation and open innovation (Liu et al., 2022). The integration of the Internet of Things (IoT) into healthcare exemplifies this progress (Javaid & Khan, 2021). This integration includes a range of technologies such as big data (Guo & Chen, 2023), cloud computing (Dang et al., 2019), smart sensors (Li et al., 2023), artificial intelligence (AI) (Chen & Decary, 2020), actuators (Tongkaw, 2023), and virtual augmented reality (VAR) (Sun et al., 2023).

Furthermore, innovative health technologies such as virtual reality, robotics, wearable sensors, nanotechnology, and AI have emerged (Katarína et al., 2022). The following Table 2 summarizes these innovations, highlighting their functionalities and examples of their applications in healthcare.

Table *2*: Innovation in healthcare and their functions.

Innovation	Description	Exemple	Author
Artificial Intelligence (AI) Machine learning (ML)	Enhances personalized medicine through data analysis and diagnostics.	AI-Powered Diagnostic Tools AI-driven Natural Language Processing (NLP)	(Katarína et al., 2022)
Internet of Things (IoT)	Facilitates remote monitoring and management of patient health.	Remote Patient Monitoring: IoT devices like wearable health monitors. Smart medication dispensers: IoT-enabled	(Javaid & Khan, 2021)
Robotics	Supports surgical procedures and patient care automation.	Surgical Robots Robotic Prosthetics Robotic Rehabilitation Devices	(Tongkaw, 2023)
Wearable Devices	Collects real-time health data for proactive care.	smartwatches, fitness trackers, and health monitors	(Sun et al., 2023).

This comprehensive transformation highlights the potential of technology to revolutionize healthcare by providing more accessible, efficient, and patient-centered services. Each of these technologies is designed to meet specific needs and offer a competitive advantage to healthcare organizations. However, despite the significant contributions of information technology, the value that it brings to healthcare remains ambiguous and poorly defined. This highlights the need for a thorough deep review to clarify the value created by the information technology in healthcare.

This paper is organized as follows: Section 1 outlines the methodology adopted and key steps for conducting the bibliometric analysis. Section 2 presents the main results and their discussion. Finally, the communication concludes with the implications of this paper.

1. Methodology

The research methodology includes a systematic review of the literature and a bibliometric analysis. The systematic review followed the protocol established by (Kitchenham & Charters, 2007). We examined the literature on the value generated by information technologies over 23 years, employing bibliometric analysis to provide a comprehensive overview of published research in this field (Macke & Genari, 2019).

The research question for the systematic literature review should be defined before beginning the review process (Collaboration, 2016). The guiding question for this review: What value generated by using information technology in healthcare?

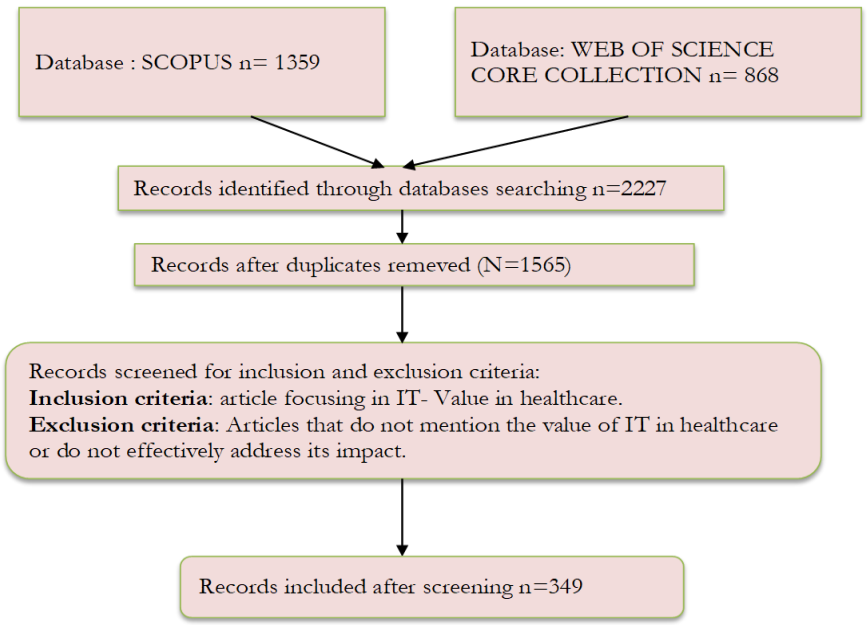
Determining the required characteristics of primary studies:

We restricted our search to English-language articles from the databases Scopus and Web of Science(Zhu & Liu, 2020). Based on the key words establishing a links between technology and value from our research, we created the following matrix for the essential search criteria:

(TITLE-ABS-KEY ("IT value" AND "health") OR TITLE-ABS-KEY ("IT value " AND "healthcare") OR TITLE-ABS-KEY ("health information technology" AND "value") OR TITLE-ABS-KEY ("healthcare information technology" AND "value") OR TITLE-ABS-KEY ("IT value creation" AND "healthcare") OR TITLE-ABS-KEY ("IT value creation" AND "health") OR TITLE-ABS-KEY ("health information technology" AND "value creation") OR TITLE-ABS-KEY ("healthcare information technology" AND "value creation") OR TITLE-ABS-KEY ("health IT" AND "value") OR TITLE-ABS-KEY ("healthcare IT" AND "value") OR TITLE-ABS-KEY ("healthcare IT" AND "value creation") OR TITLE-ABS-KEY ("health IT" AND "value creation")) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English"))

Figure 1 presents the research flow diagram, including inclusion and exclusion criteria.

Figure 1: Flow diagram for study selection



Source: protocol established by (Kitchenham & Charters, 2007)

For the bibliometric analysis, a corpus was compiled using the final sample of 349 documents. This corpus was then analyzed using VOSviewer software, which examines the relationships between words based on their frequency of occurrence (Febrianti et al., 2023). VOSviewer was chosen for its ability to visualize the extracted data through clustering, overlaying, and creating density maps (Ria, 2024), enabling the identification of research gaps and opportunities. The findings will be illustrated and discussed in the sections that follow.

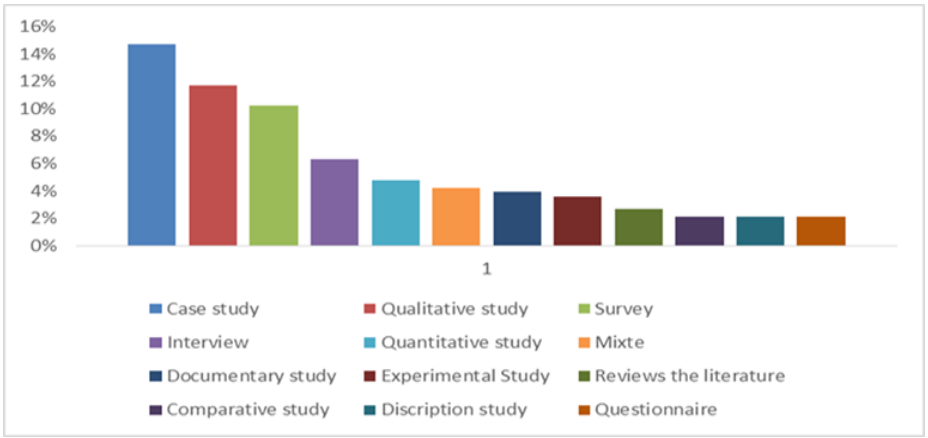
2. Results.

A descriptive analysis was conducted to explore the preliminary results, complemented by a bibliometric analysis to examine the relationships between value and information technologies in the healthcare sector. As shown in Figure 2, the *Journal of the American Medical Informatics Association* is the leading journal for studies on IT value in healthcare, contributing 5% of the articles. *The International Journal of Medical Informatics, with Applied Clinical Informatics* in third place, follows this. Additionally, *The Electronic Journal of Information Systems in Developing Countries* has also contributed to research in this area.

Figure 2: Journal interested in IT –Value in healthcare over 23 years.

Regarding the methodology used, our findings, as represented in Figure 3, show that case studies are the most frequently used, accounting for 15%, followed by qualitative studies at 12%, surveys at 10%, and interviews at 6%. The scoping review is the least used methodology. These results suggest that qualitative methodologies are the most commonly adopted for examining healthcare information technologies.

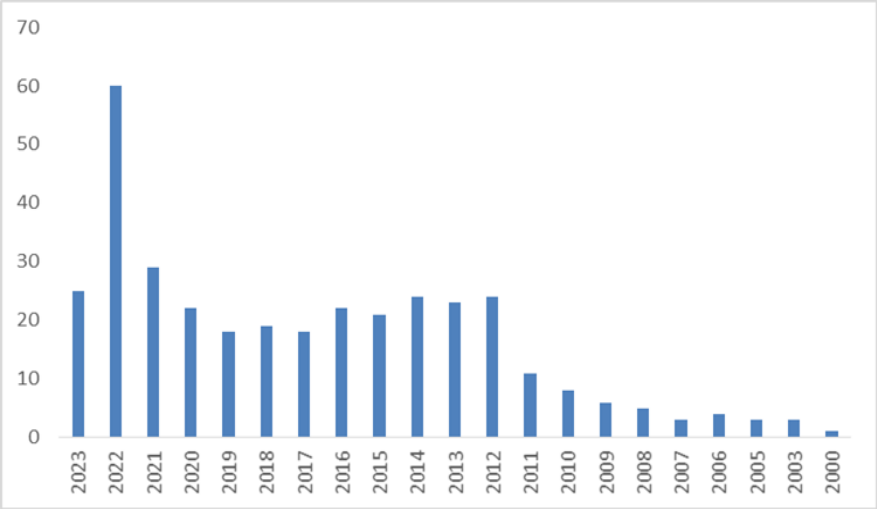
Figure 3: Methodology Used in the studies.



The bar chart in Figure 4 illustrates the distribution of publication years for articles that were included in this study. Each bar on the chart represents the number of articles published in a

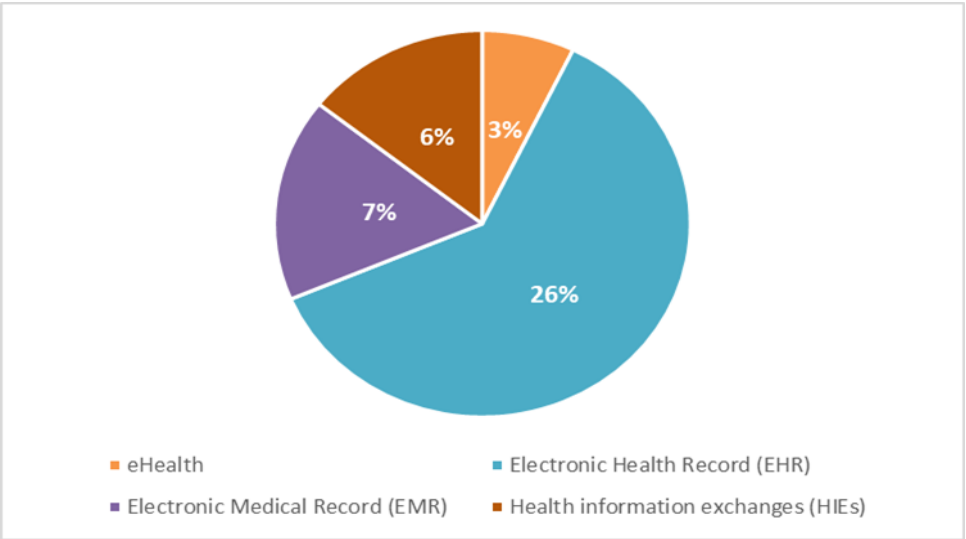
given year from 2000 to 2023. The diagram shows a significant peak in 2022, with the highest number of documents, totaling 60.

Figure 4: Included articles by publication year.



Furthermore, our results show that the most prominent technologies tested for their effectiveness in creating value are Electronic Health Records (EHR) at 26%, Electronic Medical Records (EMR) at 7%, Health Information Exchanges (HIEs) at 6%, and eHealth at 3%. This can be attributed to the significant time these technologies have needed to adapt and be fully integrated into healthcare organizations (Figure 5).

Figure 5: The most tested technologies in the studies reviewed

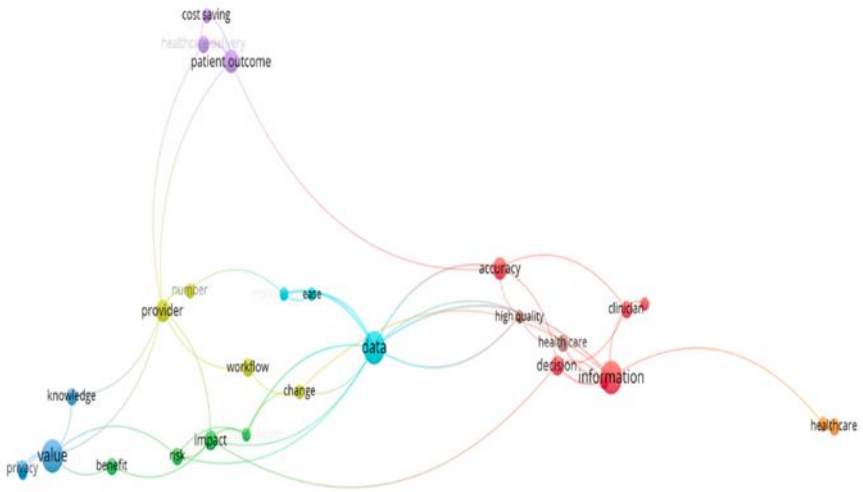


Lastly, the countries most focused on the value generated by healthcare technology can be grouped into three categories: The United States leads with 59%, followed by China at 7%, the United Kingdom at 5%, and India at 3%. The third group includes France and Indonesia, each at 1%, while Sweden and Switzerland have less than 1% (Figure 6).

Figure 6: Geographical regions most focused on the value generated by healthcare technologies.

The textual analysis revealed eight key clusters that illustrate the diverse roles and contributions of health technologies to value in healthcare (Figure 7). These clusters highlight distinct focal points, such as workflow efficiency, privacy, and data management, while also demonstrating the interconnectedness of these areas.

Figure 7: VOSviewer clustering visualization (Clusters are shown in different colors, with central nodes highlighted by a dotted line)



The following Table 3 illustrates the relationship between the clusters, key terms, and their corresponding value categories:

Table 3: Clusters and their associated value categories

Cluster	Organizational Value	Economic value	Social value
Red Cluster	Accuracy, decision making, information-access		Patient-safety
Green Cluster	Risk management		Population health
Blue Cluster	Delay, knowledge		Privacy
Yellow Cluster	Change (organizational cultures), provider satisfaction, workflow-efficient		
Purple Cluster		Cost saving	Healthcare delivery, patient outcome
Light Blue Cluster	Data, easy-sharing, implementation		
Light Green Cluster	Impact, knowledge,		
Dark Blue Cluster	Provider (clear communication), workflow, knowledge		

The use of various technologies in healthcare delivers organizational, economic, and social value. They enhance operations and workflow efficiency (**organizational value**), lower costs and boost patient satisfaction (**economic value**), and broaden access to services and support public health initiatives (**social value**).

Table 4 illustrates the connection between value and technology categories. It shows that the technologies most frequently used in the studies of this bibliometric analysis each contribute to different types of value.

Table 4: Connection between value and technology category

		Technology			
		EHR	**EMR**	**HIEs**	**e-Health**
Value	**Organizational Value**	Quality, performance, Efficiency	Effectiveness; collaboration, Process improvement	Communication, Timeliness, Decision making	accuracy, transparency, controllability
	Economic value	costs, profitability	cost-effective, affordability	Healthcare cost, Cost effectiveness	Cost savings, reduce cost
	Social value	Patient outcomes, trust, Health care delivery, societal benefits	Care access, sustainable, mortality prediction	patient safety, ,equity,	Health promotion, wellbeing

Our results indicate that the concept of IT value in healthcare forms a triptych, comprising three interconnected elements: the value to be created, the healthcare actors involved, and the type of technology used. This tripartite relationship highlights how each component influences and

interacts with the others, shaping the overall impact of IT investments in the healthcare sector. Specifically, the value to be created depends on the type of technology implemented and the healthcare actors utilizing it. Different technologies may offer distinct benefits, such as improved efficiency, cost savings, or enhanced patient care, while various actors, including providers, patients, and administrators, play crucial roles in realizing these benefits. Understanding this interconnectedness helps in tailoring IT solutions to maximize their effectiveness and align with the specific needs of the healthcare environment.

Conclusion

In this communication, the analysis of 349 documents demonstrates that the IT value in healthcare is multidimensional, encompassing organizational, economic, and social aspects.

This study provides significant insights across various dimensions. Academically, it offers a detailed overview of health technologies, enriching the understanding of their diverse applications and impacts. This comprehensive analysis contributes to the field's knowledge base and encourages further research and discussion on the role and effectiveness of these technologies.

For practitioners, the findings reveal the tangible benefits and value that these technologies bring to healthcare delivery. By examining practical outcomes and real-world applications, practitioners can gain a deeper understanding of how these technologies enhance patient care and improve operational efficiency. This insight is crucial for making informed decisions about technology adoption and implementation.

For decision-makers, the study provides a valuable perspective on the potential benefits of health technologies. It enables them to identify and prioritize technologies based on their contributions to healthcare objectives. By focusing on the most impactful technologies, decision-makers can better allocate resources and drive significant improvements in healthcare systems.

Our research has limitations; including the need to expand the databases used in future studies to obtain a more complete view. A wider coverage of the database would improve the robustness of the results and provide a more complete understanding of the field. Future research should fill this gap to improve the accuracy and applicability of the results.

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