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SOFT-HARD TECHNOLOGIES IN HEALTHCARE: AN INTEGRATIVE REVIEW ON INNOVATION IN MEDICAL PRACTICE

TECNOLOGIAS LEVE-DURAS NA SAÚDE: UMA REVISÃO INTEGRATIVA SOBRE INOVAÇÃO NO CUIDADO MÉDICO

TECNOLOGÍAS BLANDAS Y DURAS EN LA ATENCIÓN MÉDICA: UNA REVISIÓN INTEGRADORA SOBRE LA INNOVACIÓN EN LA ATENCIÓN MÉDICA

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ABSTRACT

This study conducted an integrative review to analyze the impact of soft-hard technologies on medical practice and innovation in the healthcare processes. The research was performed using the LILACS, MEDLINE and SciElo databases, covering the period from 2015 to 2024, with standardized descriptors and Boolean strategies. Eight articles were selected, highlighting the importance of soft-hard technologies in promoting safety, efficiency and humanization. Despite limitations such as lack of training and structural challenges, the results reinforce the relevance of these technologies in integrating technical and subjective knowledge, fostering more effective care. It is concluded that soft-hard technologies are essential tools for improving healthcare processes.

KEYWORDS: Biomedical Technologie. Technological Innovation. Quality of Health Care. Health System.

RESUMO

Analisar o impacto das tecnologias leve-duras na prática médica e na inovação dos processos de saúde. Revisão integrativa conduzida nas bases de dados LILACS, MEDLINE e SciElo, entre 2015 e 2024, utilizando descritores padronizados e estratégias booleanas. Foram selecionados oito artigos que destacaram a importância das tecnologias leve-duras na promoção de segurança, eficiência e humanização.

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REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

Apesar das limitações, como a falta de capacitação e desafios estruturais, os resultados reforçam a relevância dessas tecnologias para integrar saberes técnicos e subjetivos, promovendo cuidado mais efetivo. Conclui-se que as tecnologias leve-duras são ferramentas indispensáveis para a melhoria dos processos na área da saúde.

PALAVRAS-CHAVE: *Tecnologia Biomédica. Inovação Tecnológica. Qualidade da Assistência. Sistemas de Saúde.*

RESUMEN
Analizar el impacto de las tecnologías soft-hard en la práctica médica y la innovación en los procesos de salud. Revisión integradora realizada en las bases de datos LILACS, MEDLINE y SciElo, entre 2015 y 2024, utilizando descriptores estandarizados y estrategias booleanas. Se seleccionaron ocho artículos que destacaron la importancia de las tecnologías ligero-duras para promover la seguridad, la eficiencia y la humanización. A pesar de las limitaciones, como la falta de capacitación y los desafíos estructurales, los resultados refuerzan la relevancia de estas tecnologías para integrar conocimientos técnicos y subjetivos, promoviendo una atención más efectiva. Se concluye que las tecnologías soft-hard son herramientas indispensables para mejorar los procesos en el área de salud.

PALABRAS CLAVE*: Tecnología Biomédica. Innovación tecnológica. Calidad de atención. Sistemas de salud.*

INTRODUCTION

The health system relies on the use of technologies, a term that goes beyond electronic equipment and machines. It refers to the application of knowledge, methods and ways of producing health (Merhy; Feuerweker, 2009)

The term “technology” is used to define applied scientific knowledge, which allows comparisons between theory and practice. Technological reasoning determines that work and practices are ordered by previously accumulated knowledge (Campos, 2011).

In health education, professionals use a variety of technologies to support care. These technologies are divided into three categories: light and low complexity, such as reception and interpersonal relationships; light-hard and medium complexity, including care theories and structured materials; and hard and high complexity, such as equipment, regulations and organizational structures (Sabino et al., 2016).

Health technologies are like suitcases (toolboxes), which are knowledge and its developments, both material and non-material. The medical professional must contain in his head

REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

well-structured knowledge such as clinical and epidemiological knowledge, which express soft-hard technologies. By highlighting his health act in the caring dimension and centered on his disciplinary training, the medical work seeks to involve the patient with his knowledge and practices, trying to integrate the user's world into his technological action (Merhy, 2007).

The doctor's performance must always be based on the user's trust in this professional. Concomitantly, the Federal Council of Medicine (2018) determines that the doctor must continually improve his knowledge and use the best of scientific progress for the benefit of the patient, this includes the use of health technologies, and in the context of this article, soft-hard technologies.

In contemporary times, the doctor-patient relationship has changed and is following a trend towards dehumanization in care. This has a direct impact on the training of medical students, since by witnessing such practices, there is the possibility of adopting these attitudes or learning to avoid them in the future as professionals. Thus, the role of soft-hard technologies is fundamental in promoting quality health to the population, involving comprehensive and effective care at the various levels of care (Costa; Azevedo, 2010).

Thus, it is clear that medicine has as one of its bases the most humanized practice and health technologies are of utmost importance to support quality care. Given the above, the objective of this article is to identify and analyze in the literature the role of soft-hard technologies for health and how their use can impact medical care.

METHOD

This is an integrative review that contributes to the construction of a broad analysis of the current literature by allowing discussions about research methods and results in order to direct care practice based on scientific knowledge, as well as reflect on the implementation of future studies (Mendes et al., 2008).

The development includes six stages: (1) Identification of the topic and selection of the research question, (2) establishment of criteria for inclusion and exclusion of studies, (3) categorization of studies, (4) evaluation of studies included in the integrative review, (5) interpretation of results and (6) presentation of the review (Mendes et al., 2008).

In the first stage, the elaboration of the research question was defined through the use of the PICO strategy. This strategy aims to guide the construction of the research question in a

REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

structured manner, while the term PICO represents an acronym for Population (P), Intervention (I), Comparison (C) and Outcomes (O) (outcome/results) (Santos; Pimenta; Nobre, 2007).

. Through the PICO strategy, the following question was defined: “What knowledge is produced in the literature that identifies how soft-hard technologies impact innovation in medical practice and the quality of processes in the health area?” The following table represents the elaboration of the research question through the aforementioned PICO strategy.

Table 1. PICO strategy for formulating the research question. Cáceres, Mato Grosso, Brazil, 2024

Acronym	Definition	Description
P	Population, patient, or problem	Health professionals
I	Intervention or indicator	Use of light-hard technologies
C	Comparison or control	Conventional practices without the use of these technologies
O	Outcomes or results	Innovation and impact on the quality of health practice.

Source: Authors, 2024.

This integrative literature review article was registered in the Open Science Framework (OSF), with registration number 10.17605/OSF.IO/3W6TG. This is a database of review protocols, so that future researchers do not develop work identical to this article, thus avoiding cases of duplicate reviews (Laguna, 2024).

The second stage was organized to define inclusion and exclusion criteria for the works, ensuring the representativeness and relevance of the sample. The inclusion criteria involved full-text articles, freely available in the electronic databases Latin American and Caribbean Health Sciences Literature (LILACS); Scientific Electronic Library Online (SCIELO) and Medical Literature Analysis and Retrieval System Online (MEDLINE), in their original format, in Portuguese, from 2015 to 2024. The searches took place from October to December of 2024. The following were excluded: books, theses, dissertations and reviews of any style.

In addition, the descriptors “Biomedical Technology; Health Systems; Technological Innovation; Medical Technology and Quality of Care” were stipulated according to the Health Sciences Descriptor (DeCS) and it is worth noting that the Boolean operators “AND” and “OR” were applied to cross-reference descriptors and obtain results. The search strategies and filters for refining the search within the databases were applied as follows: In the SciElo platform, the search strategy (“Biomedical Technology”) OR (“Technological Innovation”) OR (“Quality of

REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

Health Care") OR ("Health Systems") was applied; Collections: (Brazil); Language: (Portuguese); Year of publication: (2015 – 2024); SciElo Thematic Areas: (Health Sciences, Human Sciences); Reading type: (Article) . In the LILACS platform, the search strategy used was "Medical Technology" OR "Health System" OR "Access to Health Technology" AND db:("LILACS") AND mj:("Unified Health System" OR "Health Systems" OR "Biomedical Technology" OR "Primary Health Care" OR "Health Care Quality Indicators" OR "Public Health" OR "Health Policy" OR "Health Care" OR "Accessibility to Health Services" OR "Health Assessment" OR "Right to Health" OR "Health Services") AND la:("pt") AND (year_cluster:[2015 TO 2024]) AND instance:"lilacsplus" For the search in the MEDLINE database, the following search strategy was used: "Medical Technology" OR "Health System" OR "Access to Health Technology" AND fulltext:("1" OR "1" OR "1" OR "1") AND db:("MEDLINE") AND mj:("Health Care Quality Indicators" OR "Health Care" OR "Biomedical Technology" OR "Health Care Quality") AND la:("pt") AND (year_cluster:[2015 TO 2024]) AND instance:"lilacsplus".

In the third stage, data were extracted from studies that included the methodology, participants, and results relevant to the research question. For this purpose, the Rayyan software was used to screen titles and abstracts found in database searches (Ouzzani et al., 2016). This contributed to the organization of the studies found based on the inclusion and exclusion criteria. Subsequently, the PRISMA flowchart was used to describe the stages of search, identification, and selection of studies, and the results are presented in Figure 1 (Page et al., 2021).

The fourth stage of the research was refined by completing the critical and detailed evaluation of the selected studies by two independent evaluators. This includes the analysis of methodological validity and the identification of biases. The evidence and possible factors that permeate the use of soft-hard technologies in the health area and the impact on the quality of medical practice were considered (Melnyk, 2015).

Step five compiles the results interpreted in light of existing knowledge; this information can be found in Table 2.

The impact and innovation in medical practice and the quality of healthcare processes caused by the use of soft-hard technologies in healthcare were compared with the available literature. Many gaps in knowledge were identified, suggesting areas for future research.

The final synthesis of the results was presented in a clear and organized manner, allowing an understanding of the main conclusions and implications of the review. The information

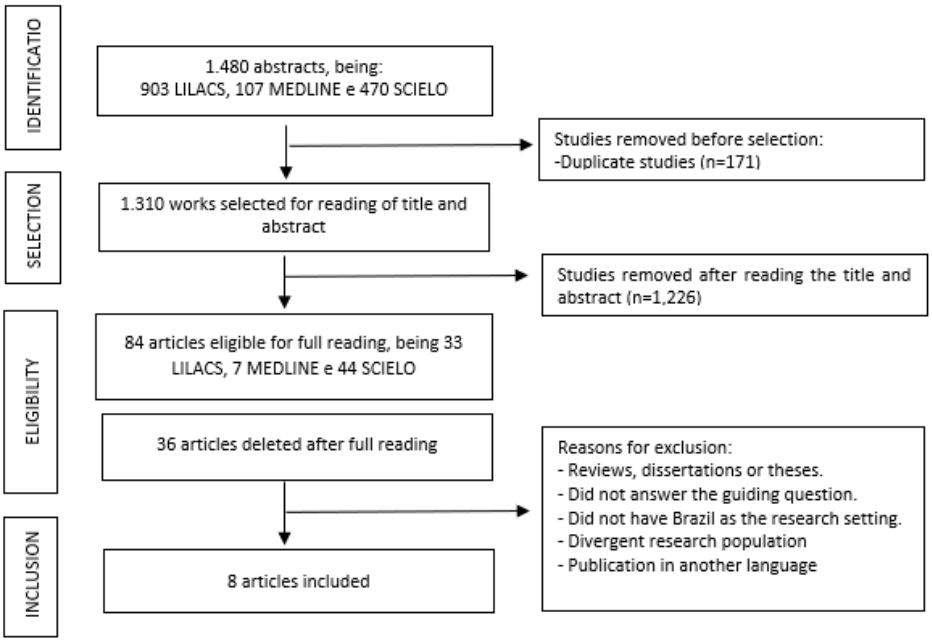
REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

collected highlighted current perceptions and practices, as well as opportunities for improvement in the use of soft-hard technologies in health systems.

RESULTS AND DISCUSSION

Figure 1 shows the PRISMA flowchart (Page et al., 2021) of the database search, selection and inclusion processes of articles, initially totaling 1,480 references distributed in the following databases: LILACS: 903; MEDLINE: 107 and SciElo: 470. Therefore, Table 2 presents the 8 articles selected to compose this integrative review, with all results being interpreted and synthesized through a comparison of data evidenced in the analysis of the articles.

Figure 1. Study selection flowchart, Cáceres, Mato Grosso, Brazil, 2024.



Source: Own authorship, (2024).

The articles selected from the three databases were: 5 articles (62.5%) from SciElo, 2 articles (25%) from LILACS and 1 article (12.5%) from MEDLINE. The year with the highest number of publications used was 2020, with 2 articles (25%), followed by 2026, also with 2 articles (25%) and the years 2024, 2019, 2017 and 2015 with 1 article each (12.5% each).

REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

The works highlighted and selected in this study were described in Table 2, as well as their results, journals and year of publication, article title, authors' names, design and level of evidence (OCEBM, 2011), in addition to the databases from which they were taken, guided by means of a validated model form adapted to the context of the object. (Ursi; Galvao, 2006). Each item received a number to help describe its characteristics. The characterization of the articles found was described in a table prepared by the authors (table 2).

Table 2. Summary of articles according to databases, journal/year of publication, authors, title, design/level of evidence, results. Cáceres, Mato Grosso, Brazil, 2024.

DATABASE	JOURNAL/YEAR OF PUBLICATION	AUTHORS	TITLE	DESIGN/LEVEL OF EVIDENCE (OCEBM)	RESULTS
01 – SciElo	Saúde e Sociedade, 2024	FRANCESCHINI, PKM; SPINK, MJP; GARCIA CC.	A arte de endurecer sem perder a ternura: o uso de tecnologias por obstetrizes na atenção ao parto domiciliar planejado	Exploratory descriptive, qualitative study, level 5 of evidence	Midwives use soft-hard technologies (structured knowledge and intuition) in planned home births. The technological choice is made according to need, prioritizing relational resources and promoting a balance between humanization and safety in the management of labor
02 – LILACS	Revista Nursing, 2020	SOARES, RAQ; *et al*.	Tecnologias em saúde e a produção de cuidados a pessoas que sofrem do coração.	Qualitative study with a cartographic approach and schizoanalysis, level 5 of evidence	Healthcare professionals use soft, soft-hard and hard technologies for the comprehensive care of heart disease patients. The combined use of technical and relational resources enhances care by addressing the physical, emotional and subjective needs of patients

REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

03 – SciElo	Brazilian Journal of Development, 2020	BOAVENTURA, T; *et al.*	Tipologia de tecnologias em saúde presentes nas maternidades segundo perspectivas dos profissionais gestores e enfermeiros.	Qualitative study with comparative analysis, level 4 of evidence	Soft-hard technologies are recognized but face challenges in continuous improvement
04 – MedLine	Einstein (São Paulo), 2019.	VILELA, RPB; JERICÓ, MC.	Implantação das tecnologias para prevenção de erros de medicação em hospital de alta complexidade: análise de custos e resultados	Exploratory descriptive study, retrospective, level 4 evidence	The implementation of soft-hard technologies reduced the incidence of medication errors by 97.5% between 2007 and 2015. Demonstrating the effectiveness of technologies in patient safety and efficiency in preventing higher costs associated with errors
05 – SciElo	Revista de Pesquisa Qualitativa, 2017	FOGAÇA, NR; *et al.*	Operacionalização de grupos de pré-natal: percepção dos profissionais do serviço da Atenção Primária à Saúde.	Qualitative study with thematic analysis, level 4 of evidence	Professionals recognize the importance of using technologies to promote health, but face organizational barriers and underutilize soft-hard technologies. Improvements are needed in planning, training, structure and motivation to strengthen health promotion and educational practices
06 – SciElo	Aquichan, 2016	SABINO, LMM; *et al.*	Uso de tecnologias leve-duras nas práticas de enfermagem: análise de conceito.	Reflective study with conceptual analysis, level 5 of evidence	Soft-hard technology is based on structured knowledge and actions that combine knowledge with subjectivity. Thus, it promotes care directed to the

REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

					patient's needs and results in more ethical and reflective practices, increasing the effectiveness and humanization of care.
07 – LILACS	Saúde em Redes, 2016	MOURÃO NETO, JJ; DIAS, MSA; GOYANNA, NF.	Uso de instrumentos enquanto tecnologia para a saúde.	Theoretical study with a qualitative approach, level 5 of evidence	Soft-hard technologies, such as protocols and process organization tools, optimize healthcare by standardizing actions and records, promoting efficiency and quality. However, their decontextualized use can reduce individualized attention and prioritize mechanical tasks over human interactions
08 – SciElo	Saúde em Debate, 2015.	SILVA, RMM; *et al.*	A integralidade na assistência à saúde da criança na visão dos cuidadores.	Qualitative study with a hermeneutic-dialectical approach, level 5 of evidence	Child health care focuses predominantly on illness, thus, structured knowledge about existing pathologies is an important part of care, although its incipient use reveals the need for psychosocial practices that promote greater resolution

Source: Authors, (2024)

The selected studies emphasize the importance of using soft-hard technologies in promoting health for the general population; the use of structured knowledge, epidemiology, protocols and regulations promotes greater safety for users at different levels of care. The results corroborate all aspects relevant to the use of soft-hard technologies proposed by Merhy, with a focus on clinical medical practices.

REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

On the other hand, recurring challenges include lack of training and organizational obstacles in the face of the various approaches to health technologies that, although their use is recognized as a fundamental practice, their implementation faces significant practical obstacles.

From the analysis of the study data and the articles chosen in the integrative review, three categories were listed, namely: The convergence of soft-hard technologies in health care; Impact of subjectivity and live work on the use of technologies; and Challenges and Potentials in the Implementation of Technologies in Care.

The convergence of soft-hard technologies in healthcare

Midwives use a dynamic combination of technologies to manage planned home births. While soft technologies, such as affection and dialogue, are used transversally, soft-hard technologies (structured knowledge and intuition) and hard technologies (specific instruments and techniques) are applied according to the complexity of labor, demonstrating flexibility in care (Franceschini; Spink; Garcia, 2024).

When caring for patients with heart disease, the combined use of soft-hard technologies (technical knowledge and standards) and hard technologies (highly complex equipment and protocols) is essential to ensure the effectiveness of the treatment (Soares et al., 2020).

It is worth highlighting how the application of soft-hard technologies in the hospital context contributes to the reduction of medication errors. The combined approach includes the use of technological equipment and structured protocols, ensuring greater precision and safety in the medication administration process. Despite this, interaction elements, such as training and effective communication, are also essential to maximize the benefits of the implemented technologies (Vilela; Jericó, 2019).

Although health technologies are available in the context of Primary Care, group activities in prenatal care are harmful due to the lack of integration of these tools, soft-hard technologies, related to health education, lack effective implementation due to organizational and training limitations (Fogaça et al., 2017).

Soft-hard technologies transcend technical and structured application, offering freedom for adaptive actions in care. This convergence between structured and practical knowledge and empirical practice allows the integration of different dimensions of care, such as the use of theories and methodologies that promote not only physical health, but also ethical and reflective interaction between professionals and patients (Sabino et al., 2016).

REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

Healthcare depends on the integration of existing technologies. Soft-hard technologies, such as instruments and protocols, are crucial to standardize and streamline processes, promoting greater efficiency and quality. However, decontextualized use can harm the individuality of care, highlighting the importance of a balance between different technologies (Mourão Netto et al., 2016).

Impact of subjectivity and live work on the use of technologies

In situations where only hard and soft-hard technologies were used, care was limited to the biological sphere, generating possible emotional discomfort in patients. On the other hand, the integration of soft technologies, such as active listening and empathy, resulted in greater acceptance and satisfaction of patients, creating more effective care (Soares et al., 2020).

The use of soft-hard technologies requires the involvement of professionals, enabling adaptation to the needs of each patient. However, the study indicates that subjectivity is often not fully utilized, resulting in gaps in communication and in the team-user bond, which can generate structural challenges due to the excess of mechanical routines (Boaventura et al., 2020).

Although the main focus is on structured technologies, there is evidence that human work, such as adapting to new systems and the active involvement of teams, plays a crucial role in the success of interventions. The significant reduction in errors demonstrates that the alliance between technologies and well-guided human practices enhances results (Vilela; Jericó, 2019).

The use of soft-hard technologies is responsible for creating an interface between structured knowledge and subjective practices. This aspect allows for greater flexibility and personalized care, especially in situations that require quick decisions. When applied correctly, technologies create spaces for valuing the patient as an active subject in the care process (Sabino et al., 2016).

Professionals demonstrate a limited perspective, focused only on the disease, which prevents the full use of soft-hard technologies. The lack of subjectivity in care compromises the personalization of practices and reduces the effectiveness of health actions (Silva et al., 2015).

Challenges and potential in implementing technologies in care

The main challenge was the limitation in the hierarchy of knowledge during childbirth, since hard technologies are only used when indispensable. However, the autonomy of midwives and the combined use of technologies, respecting the singularity of each case, demonstrate great

REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

potential to meet complex demands in humanized childbirth, promoting safety and protagonism of parturients (Franceschini; Spink; Garcia, 2024).

The main challenges include the underutilization of soft-hard technologies, the lack of continuous training, and various limitations. Despite this, there is potential for significant advances in care, as long as professionals are trained and management invests in infrastructure and technological integration (Boaventura et al., 2020).

The implementation of the technologies faced challenges related to costs and staff adaptation, but the results prove the effectiveness of the investment. With an average annual cost of R$55.72 per patient, the positive impact was significant, reducing 97.5% of medication errors and preventing complications that could generate even higher costs (Vilela; Jericó, 2019).

The lack of training, inadequate infrastructure and devaluation of group educational activities represent major challenges. However, soft-hard technologies have great potential to promote autonomy and improve health indicators, provided that there is reorganization of work, collective engagement and greater management support for medical practices (Fogaça et al., 2017).

Although soft-hard technologies are valuable tools, their use is often underestimated or confused with purely mechanical practices. Challenges include the lack of conceptual clarity about their role in care and the resistance of professionals to move away from a strictly technical approach. However, their potential lies in creating a more humanized care, in which structured knowledge is combined with subjectivity to transform care into an ethical and dialogic process (Sabino et al., 2016).

Limitations of the study

One limitation identified in this study is the lack of recent scientific publications, especially in the last five years, that address how the implementation of soft-hard technologies innovate and impact the provision of health services from a medical perspective. This scarcity highlights the need for further research on the role of these tools in health care.

Contributions to the field of medicine and health

This study expands understanding of the use and application of soft-hard technologies and how they impact the quality and processes of health services. The results aim to drive

improvements, highlighting the relevance of these tools for more comprehensive and complete health.

CONCLUSION

This integrative study highlighted the relevance of soft-hard technologies in medical practice and health services, emphasizing their ability to integrate technical knowledge, subjectivity and technological innovation to improve care.

The results showed that the balanced use of these technologies promotes greater safety, precision and humanization in care, being essential for reducing errors and strengthening the bond between health professionals and patients.

The objectives initially outlined were achieved, demonstrating the convergence between structured and subjective tools in improving health processes. In addition, challenges were identified, such as the lack of professional training and organizational limitations, which compromise the full implementation of these tools. On the other hand, the potential of soft-hard technologies to provide more comprehensive and humanized care was widely corroborated.

The practical and theoretical implications of this study reinforce the need for investments in continuing professional training and in the development of infrastructure that favors the application of these technologies. In addition, it points to future research that explores new possibilities for integrating these tools in the health context, promoting a more efficient, ethical and patient-centered system.

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REVISTA SAÚDE E TECNOLOGIA
Revista Científica Multidisciplinar | Journal Health and Technology - JHT - ISSN 2764-7625

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