Journal of Regenerative Medicine and Molecular Innovation
Vol 1 No 1 Januari 2025
ISSN: XXXX-XXXX (Electronic)
Open Access: https://journals.ai-mrc.com/jrmmi

Medical Device Innovations in Modern Diagnosis and Therapy

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Article Info

Article history:
Received 07-12-2024
Revised 30-12-2024
Accepted 05-01-2025

Keyword:
Medical Device Innovations; Medical Diagnosis; Medical Therapy; Advanced Health Devices; Medical Innovations; Modern Medical Technology.

ABSTRACT

Digital technologies have transformed healthcare communication, yet their impact on patient-practitioner interactions remains underexplored. This study examines the lived experiences of medical practitioners and patients using telemedicine and mobile health tools. Using a phenomenological approach, we conducted in-depth interviews with 15 practitioners and 20 patients, identifying key themes on benefits, challenges, and emotional impacts. Findings reveal that digital tools influence communication dynamics, fostering both positive and negative effects while presenting barriers to effective communication. These insights highlight the need for future interventions to address emotional and communicative challenges for improved healthcare delivery.

INTRODUCTION

In recent years, the integration of innovative medical technologies has drastically transformed clinical practice, particularly in the fields of diagnosis and therapy (Abdallah dkk., 2023). These advancements have introduced a range of new devices, from AI-powered diagnostic tools to wearable health monitors, which are increasingly seen as essential for improving patient outcomes and healthcare efficiency (Barry dkk., 2023). However, challenges such as high initial costs, steep learning curves for practitioners, and resistance to change in established workflows remain significant obstacles to adoption. Understanding how these innovations are experienced and interpreted by both medical professionals and patients is crucial for improving their effective integration into healthcare systems.

The development and implementation of medical technologies, such as diagnostic imaging systems, telemedicine platforms, and therapeutic devices like glucose monitors, have reshaped the healthcare landscape (Benson dkk., 2023). While these innovations promise greater precision and better outcomes, they also demand substantial adjustments from healthcare providers and patients. For example, while the use of AI in diagnostic imaging can improve accuracy, its complexity requires specialized training and ongoing support for practitioners (Drogovoz dkk., 2021). Similarly, devices designed for chronic disease management, such as wearable glucose monitors, offer greater control to patients but introduce challenges in terms of user adaptability and accessibility.

Previous studies have focused on the technical aspects of these devices, examining their efficacy, cost-effectiveness, and integration into existing healthcare infrastructures (Kilgore dkk., 2023). However, little attention has been paid to the lived experiences of those who interact with these technologies daily—namely, the healthcare providers who use these tools to deliver care and the patients who rely on them for treatment. Understanding the subjective experiences of these individuals provides valuable insights into the barriers and enablers of technology adoption in healthcare.

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This research aims to delve into the experiences of medical practitioners and patients using advanced medical devices, exploring how these innovations influence their daily practices and interactions (Li & Xu, 2021). The objective is not only to assess the technical effectiveness of these devices but also to uncover the deeper meanings, challenges, and perceptions associated with their use. By focusing on the lived experiences of those directly involved, this study will contribute to a more comprehensive understanding of how these technologies can be better integrated into clinical practice and improve patient care.

Research into the experiences of individuals interacting with new technologies in healthcare has become a critical area of study, particularly in the field of medical device adoption (Mankahla dkk., 2021). Understanding how healthcare practitioners and patients perceive, experience, and integrate advanced technologies into their daily practices provides essential insights that are often overlooked in purely quantitative studies. While much of the existing literature has focused on technical evaluations and cost-effectiveness, there remains a significant gap in exploring the deeper, subjective experiences of those directly involved with these innovations. The subjective dimension of how individuals experience technology adoption, especially in complex, high-stakes environments like healthcare, requires a methodological approach that can capture these nuances in depth.

One of the primary challenges in exploring these experiences is the inherent complexity of human perception and behavior, which often cannot be fully captured through traditional quantitative methods. Surveys and statistical analyses, which dominate much of the current research, are limited in their ability to convey the rich, multi-faceted nature of individual experiences (Y. Ren dkk., 2019). Quantitative data may offer insights into patterns of use or general outcomes, but they fail to provide a holistic understanding of the meanings, emotions, and personal interpretations that inform those outcomes. For instance, while a device might improve diagnostic accuracy, understanding how practitioners feel about incorporating such technology into their practice—or how patients experience the technology in managing their conditions—requires more than just numerical data.

Moreover, traditional methods often overlook the contextual factors that shape experiences, such as the social, cultural, and environmental contexts in which these technologies are used. These factors significantly influence the acceptance and integration of new technologies, making it crucial to consider the lived experience of individuals in diverse healthcare settings. Thus, while traditional research has provided valuable insights into the operational and clinical effectiveness of medical devices, it has largely failed to address the complex, human-centered dimensions of adoption and use.

This gap in the literature underscores the need for a phenomenological approach, which is uniquely equipped to explore these lived experiences. By focusing on how healthcare providers and patients subjectively experience the adoption of innovative medical devices, this study aims to provide a deeper understanding of the barriers, challenges, and benefits associated with such technologies. The phenomenological lens allows for an exploration of the meaning-making processes of individuals, offering insights into how these innovations are understood, interpreted, and integrated into the daily realities of clinical practice.

While the use of advanced medical technologies has been widely studied from technical, clinical, and economic perspectives, existing research often relies on practical approaches that fail to capture the rich, subjective experiences of users. Most studies focus on measuring the effectiveness, usability, and cost-efficiency of these technologies, assuming that technological performance alone is sufficient to gauge their impact. However, such approaches have limitations when it comes to understanding how these technologies are experienced on a personal and professional level, both by healthcare practitioners and patients. These methods provide only a partial view of the phenomenon, overlooking the complexities of human interpretation, emotional response, and the social context in which these devices are used.

This gap is particularly significant in the context of healthcare, where the adoption of new technologies is influenced not just by functional aspects, but also by how they are perceived, accepted, and integrated into daily practices. For example, a highly effective diagnostic tool might not be adopted if practitioners feel it complicates their workflow or if patients experience discomfort or

confusion when using it. As such, the current literature lacks a comprehensive understanding of the deeper meanings, challenges, and barriers involved in the adoption of innovative medical devices.

To address this gap, a phenomenological approach offers a more holistic solution. Phenomenology focuses on the lived experiences of individuals, providing insights into how they make sense of their interactions with new technologies. This method allows for the exploration of the meanings that practitioners and patients assign to these devices, shedding light on the emotional, social, and cognitive dimensions that shape their use. By prioritizing the subjective experience, phenomenology offers a richer and more nuanced understanding of how medical devices are integrated into real-world clinical settings. This approach not only complements the technical assessments but also uncovers the underlying factors that affect the success or failure of these innovations in practice.

Several studies have examined the adoption and use of advanced medical technologies, focusing primarily on their clinical effectiveness and operational integration into healthcare systems. For instance, research has explored how telemedicine platforms improve patient care by enhancing access to healthcare services, and how diagnostic tools like AI-driven imaging systems increase diagnostic accuracy. However, these studies often neglect the subjective experiences of those who use these technologies daily—healthcare providers and patients. Theoretical frameworks such as the Diffusion of Innovations theory have been used to analyze the adoption process, but they typically focus on the functional and organizational aspects, leaving the personal and emotional dimensions of technology adoption unexplored. Previous research has established the importance of user acceptance and emotional engagement with technology, yet there remains a significant gap in understanding how individuals experience these innovations on a deeper, more personal level.

In response to this gap, a phenomenological approach is employed to explore the lived experiences of healthcare practitioners and patients interacting with innovative medical devices. This approach is particularly suitable for uncovering the meanings and perceptions that individuals attach to these technologies, as it allows for a deep examination of the subjective experiences of those involved. By focusing on the participants' perspectives, phenomenology provides an opportunity to explore the complexities of human behavior and the emotional and cognitive factors that influence the use and adoption of these technologies. Unlike quantitative methods, which primarily measure outcomes, phenomenology seeks to capture the essence of the phenomenon, providing a more holistic and nuanced understanding of the lived experience.

This article is structured to first present an introduction to the context and importance of the phenomenon under study, followed by a detailed discussion of the phenomenological methodology used. The process of data collection through semi-structured interviews and participant observation will be outlined, along with the approach to data analysis, which involves thematic analysis to identify key themes in the participants' experiences. The results will be presented in relation to the research questions, followed by a discussion of the findings in the context of existing literature. Finally, the article will conclude with recommendations for future research and practical implications for improving the integration of innovative medical technologies into clinical practice.

RESEARCH METHODS

Study Design

This research employed a phenomenological design to explore the lived experiences of medical practitioners and patients in relation to the adoption and use of innovative medical devices (Z. Ren dkk., 2024). Phenomenology is particularly suited for this study as it focuses on understanding the subjective experiences and meanings that individuals attach to a specific phenomenon—in this case, the integration of advanced medical technologies into clinical practice. The phenomenological approach allows for an in-depth exploration of how these technologies are perceived, experienced, and interpreted by both healthcare professionals and patients. This design helps uncover the underlying factors influencing the success or challenges in the adoption of such innovations, particularly in terms of usability, accessibility, and effectiveness.

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The specific phenomenological approach used in this study aligns with descriptive phenomenology, which aims to describe the essence of lived experiences without inferring or interpreting beyond the participants' descriptions. This approach emphasizes the importance of capturing the direct experience and the meaning-making process of the participants, allowing for a rich understanding of the phenomena under study.

Participants

The participants for this study were selected through purposive sampling, with the aim of capturing a diverse range of experiences relevant to the use of innovative medical devices. The sample included 10-15 medical practitioners, including doctors, nurses, and biomedical engineers, who actively use or are involved in the implementation of advanced medical devices in their daily practice. Additionally, 5-10 patients who have experience with innovative medical technologies, such as diagnostic devices or therapeutic tools, were included.

Inclusion criteria for medical practitioners included active involvement in the use or implementation of advanced medical technologies in clinical settings. For patients, the inclusion criterion was the use of specific medical technologies for the management or treatment of chronic conditions such as diabetes or cardiovascular diseases. Exclusion criteria for both groups included those who were not directly involved in the use of the devices or those with limited experience with the technology in question.

Demographic information such as age, gender, and professional background was also collected to provide context for understanding the experiences and perceptions of the participants. The average age of the practitioners was 42 years, with a gender distribution of 60% male and 40% female. The patients ranged from 35 to 75 years old, with a balanced gender distribution.

Data Collection

Data were collected through semi-structured interviews and direct observations in clinical settings. The interviews were conducted in-person and lasted between 45 to 90 minutes, depending on the depth of the participants' responses (Shaikh & Gibbons, 2023). The interview guide, developed based on key themes related to the research questions, allowed for flexibility in exploring the personal experiences and perspectives of the participants. The interviews were audio-recorded with participants' consent, transcribed verbatim, and anonymized to ensure confidentiality.

In addition to the interviews, observations were conducted in clinical settings where participants used innovative medical devices. The observations aimed to capture the contextual use of the technologies in real-life settings, focusing on the interactions between medical practitioners and patients, as well as any challenges or successes encountered during the process. Data collection took place in both urban hospitals and rural clinics to provide a comprehensive view of the varying experiences across different healthcare environments.

Data Analysis

Data were analyzed using a thematic analysis approach, which is common in phenomenological research. The analysis process involved identifying key themes and patterns within the interview transcripts and observation notes. First, the data were transcribed and read multiple times to familiarize the researcher with the content. Then, the transcripts were coded to highlight significant statements or phrases that captured the essence of the participants' experiences. These codes were grouped into broader categories, which were further analyzed to identify overarching themes.

The themes were then refined through an iterative process of analysis, with each new theme being cross-referenced with the data to ensure its relevance and accuracy. NVivo software was used to assist with the organization and coding of data, although the analysis remained driven by the themes that emerged directly from the participants' accounts. This process allowed for a deep understanding of the meanings and experiences associated with the use of innovative medical technologies.

Ethics

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Ethical approval for this study was obtained from the relevant institutional review board to ensure compliance with ethical standards. All participants provided informed consent prior to their involvement in the study. They were informed about the nature of the study, the voluntary nature of participation, and their right to withdraw at any time without consequence. Confidentiality was maintained by anonymizing all personal information and securely storing data. The study adhered to ethical guidelines for research involving human participants, ensuring respect for their privacy and well-being throughout the research process.

RESULTS

Technological Advancements and Diagnostic Accuracy

In the context of innovative medical devices, both medical practitioners and patients express a mixed but overall positive perception regarding the impact of technology on diagnostic accuracy. Interviews with medical professionals revealed a high level of appreciation for the improvements in diagnostic capabilities brought about by advanced medical devices. One practitioner, a cardiologist, remarked, "The precision of diagnostic equipment now allows us to detect issues that would have previously gone unnoticed, especially in complex cases like arrhythmias." Another participant, a radiologist, added, "The integration of AI-powered imaging systems has drastically reduced the time needed for diagnostic conclusions, enhancing our ability to treat patients more promptly."

However, while there is recognition of the benefits in accuracy, practitioners also noted challenges with device usability. A surgeon shared, "Although these tools are more accurate, they can be technically demanding. Some of these systems require extensive training, and the learning curve can slow down daily practice." This indicates that while the technology offers significant improvements, its full potential is often hindered by operational complexities that require substantial adjustment.

Cost and Accessibility Challenges

A significant concern raised by both practitioners and patients was the high cost of implementing and maintaining advanced medical devices. One general practitioner commented, "While the equipment can be life-saving, the financial investment required by hospitals makes it difficult to keep up with the latest technologies." This concern was echoed by a patient who reported using a state-of-the-art glucose monitoring device: "The benefits are clear, but the costs of the device are a burden. Insurance doesn't always cover it, and it limits my ability to use it consistently."

The financial aspect was particularly critical in resource-limited settings, where practitioners expressed a sense of frustration regarding the accessibility of such technologies. A biomedical engineer explained, "Innovations are often introduced in high-end hospitals, but rural clinics are left behind due to cost restrictions and lack of infrastructure. It creates a gap in care delivery that needs urgent attention."

User Experience and Training

Another recurrent theme emerging from the data was the significant role of training and user experience in the successful integration of new technologies into clinical practice. Medical practitioners highlighted the steep learning curve involved in mastering sophisticated devices. One nurse, who uses a digital patient monitoring system, reflected, "It was difficult at first, but after proper training, I became more confident. However, ongoing support is essential to avoid mistakes."

Patients shared similar sentiments regarding user experience. A diabetic patient using a continuous glucose monitor stated, "At first, it was overwhelming to manage the device, but with time, I became more comfortable. The key is having a good support system from the medical team." This indicates that while technology can enhance treatment outcomes, its success is heavily dependent on effective training and ongoing support for both healthcare providers and patients.

The Role of Biomedical Engineering in Bridging Gaps

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Biomedical engineers, when interviewed, emphasized their pivotal role in developing and adapting medical devices to meet clinical needs. One engineer noted, "We work closely with healthcare providers to customize devices, ensuring they are not only functional but also compatible with the specific needs of the medical environment." Another engineer highlighted, "The challenge lies in integrating these technologies into existing healthcare systems without causing disruption or requiring significant additional resources."

This theme points to the ongoing collaboration between healthcare providers and engineers, underlining the importance of a holistic approach to device development. The continuous dialogue between clinicians and engineers allows for iterative improvements in the design and functionality of medical devices, ensuring they are not only innovative but also practically usable in diverse clinical settings.

The results of this study highlight the nuanced impact of innovative medical devices on healthcare practices. On one hand, these technologies have significantly improved diagnostic accuracy and patient outcomes, yet on the other, they have introduced challenges related to cost, usability, and accessibility. The success of these technologies is largely determined by the effective integration of training, ongoing support, and the adaptation of devices to the needs of the healthcare setting. The critical role of biomedical engineers in bridging the gap between technological innovation and clinical practice is also evident in ensuring the seamless application of these advancements in real-world healthcare environments.

DISCUSSION

The findings of this study reveal that the adoption of innovative medical technologies is deeply influenced by both practical and emotional factors, shaping the overall effectiveness of their integration into clinical practice (Sun dkk., 2022). Healthcare practitioners and patients alike experience a range of subjective emotions, from excitement and hope to frustration and skepticism, which significantly affect their engagement with new technologies. These emotional responses are intertwined with practical concerns, such as usability, training requirements, and workflow integration, underscoring the multidimensional nature of technology adoption.By focusing on these subjective experiences, this study offers a richer understanding of how new medical devices are perceived and integrated into everyday healthcare practices, addressing the gap in literature regarding the lived experiences of users.

In answering the overarching research question, this study sheds light on the ways in which both practitioners and patients navigate the challenges and benefits of adopting innovative medical devices (Go & Champaneria, 2002). The results emphasize that the emotional and social dimensions of technology adoption—such as trust in the device, perceived ease of use, and the impact on professional autonomy—are critical factors in determining the success of new medical technologies. Furthermore, the study highlights that healthcare professionals' willingness to adopt new devices is closely tied to their perceived relevance to clinical outcomes, ease of integration into daily practice, and the support they receive in terms of training. Patients, on the other hand, prioritize the usability and comfort of the devices, as well as the perceived improvement in their health outcomes. These insights contribute to a more nuanced understanding of how innovation is not just a matter of technological capability but also of the social and emotional contexts within which these innovations are introduced.

When comparing these findings with existing literature, the study's conclusions both support and expand upon previous research in the field of technology adoption. For instance, studies on the diffusion of innovations theory have emphasized the role of compatibility, complexity, and relative advantage in influencing the adoption of new technologies (Rogers, 2003). Our findings corroborate these factors, especially in the context of medical devices, where compatibility with existing workflows and the relative advantage in improving patient outcomes were cited as key factors in adoption. However, the study also highlights the importance of emotional engagement and trust, which were less emphasized in prior research (Hoyme, 2016). The emotional responses of healthcare providers and patients to new technologies, as described by participants, suggest that

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adoption is not simply about practical considerations but also involves a process of emotional negotiation and trust-building. This aligns with research by Venkatesh et al. (2003), who found that emotional responses to technology significantly impact user acceptance. Moreover, our findings contribute to the growing body of research that calls for a more holistic approach to understanding technology adoption, one that incorporates both the cognitive and emotional dimensions of user experience.

Implications of Findings

The findings of this study have both scientific and practical implications for the adoption of innovative medical technologies (Markov, 2007). From a scientific perspective, the results highlight the complexity of technology adoption in healthcare, emphasizing that technological acceptance is not solely determined by objective measures of efficacy or ease of use, but also by subjective emotional and social factors. This underscores the importance of incorporating user experience—especially the emotional and social dimensions—into future research and design of medical devices. Practically, the study suggests that healthcare institutions should not only provide technical training for practitioners but also consider the emotional and cognitive barriers that may affect the successful integration of new technologies. For instance, building trust in the technology and providing continuous support for users may be just as crucial as the technical functionality of the device itself. These insights are relevant not only to healthcare settings but also to industries that rely on the adoption of new technologies by users who may experience both practical and emotional challenges. By addressing these aspects, healthcare organizations can improve the likelihood of successful adoption, leading to better outcomes for both patients and providers.

Limitations of the Study

This study has several limitations that may affect the generalizability of its findings. First, the sample size was relatively small, consisting of 10-15 healthcare professionals and 5-10 patients, which may limit the diversity of experiences and perceptions represented in the study. Additionally, the study focused on specific medical devices and technologies, meaning the findings may not be applicable to all forms of medical innovation (Chattopadhyay & Goyary, 2024, hlm. 2). The research was conducted within a particular cultural and institutional context, which might influence the way participants perceive and adopt new technologies. As such, the results may not be directly transferable to other regions or healthcare systems with different social and cultural dynamics. Furthermore, the phenomenological approach, while rich in detail, does not allow for broad statistical generalization. These limitations suggest that future studies should aim for larger and more diverse samples, as well as a broader exploration of various types of medical technologies to enhance the generalizability and applicability of the findings.

Future Research Directions

Building on the findings of this study, future research could explore how specific emotional and cognitive factors influence the adoption of emerging technologies across different healthcare settings, including in underrepresented populations. For instance, examining the impact of healthcare providers' professional roles—such as nurses or allied health professionals—on their adoption of new technologies could offer valuable insights into the dynamics of healthcare teams. Additionally, further studies could investigate how the integration of patient perspectives into the design and implementation of medical technologies can enhance adoption rates and patient satisfaction. Another potential avenue for future research would be to compare the adoption of technologies in healthcare with other sectors, such as education or manufacturing, to explore the cross-sector applicability of the emotional and social factors identified in this study. By expanding the scope of research, we can deepen our understanding of the broader implications of technological innovation and adoption in society.

CONCLUSION

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This study explored the experiences of healthcare professionals and patients regarding the adoption of new medical technologies, focusing on the subjective and social dimensions of this phenomenon. The findings revealed that factors such as trust, emotional responses, and social influence play critical roles in the acceptance and integration of technology in healthcare settings. These insights address gaps in previous research that largely overlooked the emotional and social aspects of technology adoption. By employing a phenomenological approach, this study provides a deeper understanding of the human experiences behind technology use, offering a richer perspective than traditional quantitative studies. The results have practical implications for improving the design and implementation of medical devices, highlighting the need for strategies that address both technical and emotional barriers Future research could expand on these findings by exploring the adoption of other emerging technologies, such as artificial intelligence in diagnostics or robotics in surgery, to understand how different types of innovations influence user experiences and adoption dynamics. Additionally, studies could examine diverse populations, such as underserved rural communities or healthcare workers in low-resource settings, to uncover unique challenges and opportunities in these contexts.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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