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Implementing Noninvasive Medical Technologies in End-of-Life Care: A Scoping Review of Stakeholder Perspectives and Experiences

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Abstract

In end-of-life (EOL) care, it is common practice to discontinue medical devices. However, the integration of noninvasive medical technologies may be acceptable when it enhances patient comfort and overall care quality. This scoping review sought to identify and summarize research on how healthcare professionals, terminally ill patients, and their families perceive, experience, and respond to the introduction of noninvasive medical technologies in EOL care. We conducted a scoping review using systematic searches across Medline (EBSCO), CINAHL, Embase, Academic Search Elite, and the Cochrane Library CDSR on January 27, 2025. Studies were eligible if they were empirical, published in English or Scandinavian languages, and employed qualitative, quantitative, or mixed methods to examine perspectives, experiences, or attitudes toward noninvasive technologies in EOL care. Screening and data extraction were independently performed by three pairs of researchers, with data intended for qualitative synthesis. The searches returned 3,288 unique records, of which 3,194 were excluded at the initial screening stage. Among the 94 full-text articles assessed, none met the inclusion criteria. No empirical studies were identified that specifically addressed the attitudes, experiences, or perspectives regarding noninvasive medical technologies in EOL care. Evidence is lacking on the experiences, perceptions, and attitudes of patients, families, and healthcare professionals toward noninvasive medical technology at the end of life. Research in this area is urgently needed to guide ethical, effective, and patient-centered implementation of such technologies in palliative care.

Keywords: End-of-life care, Palliative care, Palliative medicine, Noninvasive technology, Scoping review

Introduction

End-of-life (EOL) care aims to support patients in achieving a “good death” by minimizing distressing symptoms, including pain, shortness of breath, and anxiety [1–3]. Yet, in the final stages of life, many patients become nonresponsive [4], creating challenges for assessing and managing symptoms. This issue is particularly pronounced in patients receiving palliative sedation, where medication intended to relieve suffering further limits their ability to communicate [5, 6].

Although behavioral unresponsiveness is often interpreted as unconsciousness, research indicates that some level of subjective experience may persist even when a patient cannot respond [7–10]. Failure to detect ongoing awareness may result in unrecognized distress, highlighting the importance of developing approaches to assess

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consciousness in patients who cannot verbally or physically express discomfort [11–18]. Traditional EOL assessments typically rely on observable behaviors, and introducing technological monitoring can be perceived as conflicting with conventional ideas of "dying with dignity" [19]. Evidence shows that even patients who can communicate frequently report pain, dyspnea, or anxiety [20], suggesting that unresponsive patients may continue to experience distress. Families also value awareness of the patient's mental presence during the final phase of life.

Noninvasive brain monitoring, particularly electroencephalography (EEG), has been proposed as a potential method to evaluate consciousness in patients who cannot communicate. EEG is widely used in clinical and research settings where responsiveness may not reliably indicate consciousness, including disorders of consciousness [21, 22], delirium [23–25], anesthesia [26–28], sleep [29–31], and epilepsy [32]. Its bedside feasibility, low invasiveness, and cost-effectiveness make EEG a promising tool for EOL care [33]. Early studies suggest that EEG may provide useful insights into patients' conscious states, which could inform more precise symptom management [34, 35]. Despite these advantages, its use in EOL care remains limited.

Research involving dying patients is ethically sensitive and often controversial [36]. Recruiting patients for studies at the terminal phase is challenging due to ethical considerations, emotional stress on families, and societal attitudes toward death [37]. This has contributed to a significant knowledge gap regarding how patients, families, and healthcare professionals view the introduction of noninvasive technologies in EOL settings. Understanding these perspectives is essential for determining when and how such technologies can be ethically and practically implemented. For instance, ongoing studies are exploring bedside EEG to monitor consciousness in dying patients [38], highlighting the importance of evaluating stakeholder views prior to implementation.

A scoping review provides an ideal framework to explore the existing evidence on the perspectives, attitudes, and experiences of patients, families, and healthcare professionals regarding noninvasive medical technologies at EOL. Mapping this literature can identify gaps, inform ethical implementation, and guide future empirical studies or systematic reviews [39]. Accordingly, this review aimed to address the question: *What is known from empirical studies about the perspectives, attitudes, and experiences of healthcare professionals, terminally ill patients, and their next of kin regarding the use of noninvasive medical technologies in EOL care?*

Materials and Methods

This scoping review followed the methodology outlined by Arksey and O'Malley [40], encompassing five stages: defining the research question, identifying relevant studies, selecting studies, extracting and charting data, and synthesizing and reporting results. We also incorporated contemporary guidance for conducting scoping reviews [39, 41]. The review was reported in line with the PRISMA-ScR checklist [42], and the protocol was registered on the Open Science Framework (https://osf.io/9pyfw/).

Eligibility criteria

Studies were eligible based on the Population-Concept-Context (PCC) framework **(Table 1)**. Included studies were empirical, published in English or Scandinavian languages, and utilized qualitative, quantitative, or mixed-methods approaches. Studies had to examine perspectives, experiences, or attitudes of healthcare professionals, terminally ill patients, or their families regarding the introduction of noninvasive medical technologies in EOL care.

Table 1. Eligibility criteria

Criterion	Inclusion	Exclusion
Population	Patients, next of kin, or healthcare professionals	-
Concept	Perspectives, attitudes, or experiences related to the use of noninvasive medical technology in imminently dying patients	-
Context	Any healthcare institution	-
Type of Studies	Quantitative, qualitative, or mixed-method studies published in peer-reviewed scientific journals	Reviews, protocols, commentaries, editorials, letters, opinion pieces, case studies, guidelines, master's theses, PhD theses, books, or book chapters
Language	English or Scandinavian languages	All other languages
Period	From inception to January 27, 2025	After January 27, 2025

Eligibility criteria

No restrictions were applied regarding the publication period, as the aim was to comprehensively map all available empirical studies [41]. Only full-text research articles written in English or Scandinavian languages were included, reflecting the language proficiency of all reviewers.

Search strategy
The search strategy was developed in collaboration with experienced librarians (Hannah Pope and Anna Kirsten Nygaard). An initial broad search was conducted, followed by a pilot screening of 1,000 abstracts in December 2023 to test both the search strategy and eligibility criteria. Based on this pilot, and after discussion among the authors and librarians, studies related to COVID-19 were excluded. Refinements were made to the search terms and eligibility criteria, resulting in the finalized search strategies for all databases.

Information sources
Systematic searches were conducted in Medline (EBSCO), CINAHL, Embase, Academic Search Elite, and the Cochrane Library CDSR on February 12, 2024, with an updated search carried out on January 27, 2025.

Study selection
Search results were first imported into EndNote to remove duplicates, then uploaded to Rayyan [43] for screening. Titles and abstracts were independently screened for relevance by three pairs of reviewers. Any discrepancies within pairs were resolved through discussion. After independently reviewing the first 100 abstracts, all six reviewers convened to align their assessments and minimize variability in subsequent screening. Full texts of potentially eligible articles were then independently assessed by three reviewers against the inclusion criteria, with disagreements resolved through consensus discussion

Data extraction and charting
A standardized charting form was developed in Word/Excel to extract key study information, including author, year, country, study aim, sample and setting, study design, type of technology, technology use, and findings relevant to the research question. The form was piloted on a subset of studies to ensure clarity and adequacy. Data extraction was conducted by one author and cross-checked by a second to ensure accuracy (https://osf.io/9pyfw/).

Data synthesis
Data from the results and discussion sections of included studies were intended to be summarized qualitatively, following the framework outlined by Arksey and O'Malley [40].

Results and Discussion

The database searches identified a total of 5,561 records. After removing 2,273 duplicates, 3,288 titles and abstracts were screened. Full texts of 94 articles were assessed for eligibility. None of the full-text articles met the inclusion criteria. The primary reasons for exclusion were:

1. The study did not address perspectives, attitudes, or experiences ("not focused on experience").
2. The intervention did not involve the target noninvasive medical technologies ("not focused on technology").
3. The study was conducted in home-based care settings rather than healthcare institutions ("not healthcare institution").
4. The study did not explicitly focus on imminently dying patients ("not imminently dying").
5. The study investigated withdrawal of life-prolonging technology rather than introduction of new technologies ("not introduction of technology").
6. The intervention involved telecommunication or sensory devices not directly affixed to the patient ("not medical technology").
7. The article format was not primary research ("not primary research").

A flow diagram summarizing the study selection process is presented in **Figure 1**.

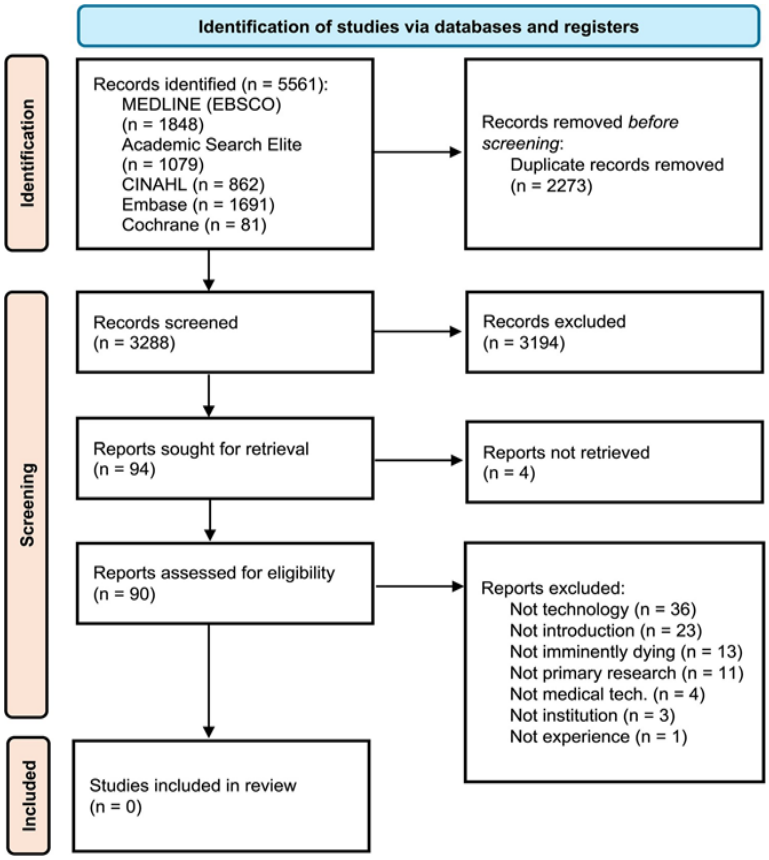

Figure 1. Flowchart of the screening process

This scoping review sought to systematically map empirical studies exploring the perspectives, attitudes, and experiences of healthcare professionals, dying patients, and their next of kin regarding the introduction of noninvasive medical technology in end-of-life (EOL) care.

Our comprehensive search revealed a striking lack of empirical evidence on this topic. While some may view this absence as a limitation, we contend that it represents a meaningful finding, underscoring a significant gap in research. Understanding these perspectives is crucial, particularly given the prevailing practice of minimizing technological interventions as patients near death, and whether this approach aligns with the preferences of patients, families, and professionals.

The lack of published studies suggests that technological advancements in improving patient care across other areas of medicine and nursing have not yet been integrated into EOL care. White *et al*. [36] emphasize that research in this field is both ethically and methodologically challenging, with little attention given to the viewpoints of dying patients and their families. Kars *et al*. [37] further note that healthcare professionals often act as gatekeepers in EOL research, complicating patient recruitment and access. These factors raise ethical considerations: while dying is an inevitable and emotionally weighty process, it remains essential to explore how technological innovations could enhance the quality of care in the final hours of life. There is thus a pressing need to evaluate technologies that can deepen our understanding of patient experience at EOL.

Some indirect evidence suggests that the presence of medical technology may be perceived as detracting from a "peaceful and dignified" death, although family members may also find reassurance in monitoring devices that provide real-time information on the patient's condition [44]. For instance, nurses may view EOL care as inherently "high-touch" rather than "high-tech" [45], potentially influencing their openness to technology and recognition of dying patients [46].

Insights from adjacent fields offer useful guidance. Evidence indicates that digital tools, such as telecommunication platforms or electronic health records, can enhance care coordination and support patient-centered practices when they complement—rather than replace—human interaction [47]. Similarly, the introduction of noninvasive medical technologies in EOL care may be more acceptable when they serve as aids to caregiving rather than substitutes for personal care.

Nurses have reported challenges in identifying subtle signs of pain, agitation, or distress near the EOL, which are critical for effective symptom management [48]. Simultaneously, documentation in electronic patient records often fails to capture pain intensity accurately, and a proportion of patients receive suboptimal pain management [49]. Noninvasive sensor technologies—such as devices monitoring brain activity, respiratory rate, movement, or

sweat—may provide information otherwise inaccessible to clinicians, enabling improved symptom relief. For example, EEG monitoring is commonly used in anesthesia to assess patients' states and could, in theory, provide insights into the awareness and sensory experiences of dying patients [50]. Such technologies may reveal whether patients retain the ability to perceive pain or comprehend the presence of loved ones despite being noncommunicative.

However, the long-standing tradition of "Total Care" in EOL settings cautions that technology may inadvertently shift attention toward measurable parameters at the expense of psychosocial and spiritual care [51]. Analyses of smart sensor applications suggest that their adoption must be intentional, patient-centered, and respectful of autonomy [51]. Thoughtfully applied, technology can enhance attentiveness and support care, complementing relational work without undermining EOL values [52]. These considerations offer a potential framework for responsibly integrating noninvasive medical technologies in a way that aligns with the holistic principles of EOL care.

Discussion and implications

We believe it is important to distinguish between the use of technology as a contributor to overtreatment and the potential of noninvasive medical technologies to enhance symptom management [35]. Traditionally, technology has often been perceived as disruptive to a peaceful dying process—apart from its use for administering sedatives or analgesics. While we acknowledge the sensitivity and complexity inherent in this context, we contend that prevailing assumptions about technology may limit research exploring its potential to improve our understanding of the dying process and enhance patient care [36, 37].

Given the lack of eligible studies identified in this review, we are unable to draw conclusions regarding the perspectives, attitudes, or experiences of healthcare professionals, patients, or their next of kin concerning the introduction of noninvasive medical technologies at the end of life. Nonetheless, this "empty review" offers insight into potential reasons for the absence of empirical evidence. Yaffe *et al*. [53] suggest that empty reviews often arise due to factors such as the novelty of the field, unique circumstances of the study population or context, or overly restrictive inclusion criteria. We believe all these factors contributed to our findings. Although we considered broadening our inclusion criteria to capture more studies, we ultimately prioritized maintaining focus on our central research question.

Several methodological considerations warrant discussion for transparency. Our review specifically targeted empirical studies examining stakeholder perspectives on noninvasive medical technologies in EOL care. Expanding the scope to include grey literature, related technologies (e.g., telehealth or electronic health records), or populations outside the imminently dying phase might have yielded additional material, but would have diluted the specificity of our research aim. Additionally, potential limitations include language restrictions and the possibility that relevant synonyms for "end-of-life" or "noninvasive medical technology" were not captured in our search strategy. We deliberately excluded grey literature to ensure that included studies had undergone ethical review and peer evaluation, reflecting the sensitivity of the field.

The term "noninvasive technology" in palliative care encompasses a wide range of devices, including telemedicine platforms, mobile applications, AI-driven support tools, and wearable sensors [47]. Our review deliberately focused on wearable medical technologies attached to the patient, representing a narrower subset than the broader literature typically considers.

Conclusion

This empty scoping review highlights the absence of primary research on the perspectives, attitudes, and experiences of healthcare professionals, patients, and next of kin regarding the introduction of noninvasive medical technology in EOL care. This gap reflects entrenched assumptions within EOL care that technology may be inherently disruptive, potentially hindering the development of empirically informed, personalized care practices. Addressing this gap will require open discussion about the role of medical monitoring technologies in EOL care and the conduct of empirical research that respects both ethical and practical considerations.

Future studies should investigate the experiences, attitudes, and perspectives of dying patients, their next of kin, and healthcare professionals to guide the responsible introduction of noninvasive medical technologies in EOL settings. Given the lack of existing empirical evidence, conducting a systematic review on this topic is currently not feasible.

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