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Needs Assessment for Ergonomic Patient Repositioning Device Among Bedridden Patients: A Literature Review

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Abstract

Background: Pressure ulcers remain a prevalent and preventable complication among bedridden patients, with manual repositioning every two hours established as the clinical standard of prevention. This practice places substantial physical demands on nurses and informal caregivers, contributing to high rates of work-related musculoskeletal disorders, including low back pain, among those performing repetitive turning tasks. Despite the availability of various assistive devices, most have been developed without systematic assessment of the combined needs of both patients and caregivers as dual users.
Objective: This review aimed to identify clinical, ergonomic, and functional needs for a patient repositioning device among bedridden patients and their caregivers through synthesis of existing literature.
Methods: A literature review was conducted using Scopus, PubMed, and EBSCO, covering publications from 2016 to 2024. Articles published in English addressing repositioning practices, assistive device design or evaluation, caregiver ergonomics, or pressure injury prevention in immobile patients were included. Studies unrelated to repositioning function or device ergonomics were excluded. Eight articles met the inclusion criteria and were included in the final synthesis.
Results: Three primary need domains were consistently identified across the reviewed literature. First, bedridden patients require effective pressure redistribution to prevent tissue injury during prolonged immobility. Second, caregivers need a reduction in biomechanical workload during repositioning, particularly in lumbar and shoulder loading. Third, the device must offer usability features that enable safe, consistent positioning without requiring multiple personnel or specialized training. Current assistive devices inadequately address all three domains simultaneously, with most designs optimizing for one dimension at the expense of others.
Conclusion: Bedridden patients and their caregivers present distinct yet interdependent needs that must be jointly addressed in ergonomic repositioning device development. A dual-user design framework integrating pressure redistribution, biomechanical efficiency, and practical usability represents a critical direction for future nursing research and device innovation.

Keywords: Caregivers, Immobilization, Musculoskeletal Diseases, Pressure Ulcer, Self-Help Devices.

INTRODUCTION

Pressure ulcers are among the most preventable complications of prolonged immobility, affecting an estimated 10 to 17% of hospitalized patients and up to 29% of those receiving long-term care globally.(1,2) Bedridden patients carry a disproportionate burden of this risk, as sustained mechanical pressure over bony prominences progressively impairs tissue perfusion and leads to localized skin and soft tissue injury.(3) The clinical and economic consequences are considerable, including extended hospital stays, increased treatment costs, and higher mortality rates in vulnerable populations.(2) Manual repositioning every two hours remains the cornerstone of pressure ulcer prevention, yet consistent implementation across clinical settings continues to fall short of recommended standards.(4)

In low- and middle-income countries, including Indonesia, the challenge of regular repositioning is compounded by limited nursing staff, heavy reliance on informal family caregivers, and a near-absence of appropriate assistive equipment. Stroke is the leading contributor to long-term immobility in Indonesia, with approximately 2.1 million stroke survivors identified in the 2018 national health survey, the majority of whom require prolonged bedridden care at home.(5) Family caregivers responsible for repositioning these patients frequently report difficulty in physically turning the patient's body, alongside persistent musculoskeletal complaints, particularly low back pain, that impair both the frequency and quality of repositioning.(6) Without ergonomic support and structured guidance, caregiving households bear unsustainable physical demands with minimal clinical assistance.

Work-related musculoskeletal disorders represent a major occupational health burden among nurses and informal caregivers globally, with patient repositioning consistently identified as one of the most physically demanding care activities in clinical and home-based settings. Studies estimate that between 40 and 72% of nurses experience low back pain attributable to patient handling tasks, with repositioning bedridden patients generating lumbar and hand forces that frequently exceed injury thresholds established by the National Institute for Occupational Safety and Health.(7) Biomechanical analyses confirm that the forces required to rotate or laterally slide an immobile patient can surpass safe manual handling limits even when moving a patient of average body weight, placing both professional nurses and untrained family caregivers at sustained risk of musculoskeletal injury.(8) In low-resource settings across Asia, where mechanical lifting equipment remains scarce and nurse-to-patient ratios are low, this physical burden falls disproportionately on informal caregivers who perform repositioning tasks without ergonomic training, assistive support, or occupational protection.(6)

Needs assessment is an established methodological step in evidence-based device development, defined as the systematic process by which user requirements are identified and prioritized before design decisions are committed. In health technology research, bypassing this upstream step has been associated with poor device adoption, low usability in clinical environments, and a persistent gap between technical innovation and practical implementation.(2) Human factors engineering frameworks consistently emphasize that devices developed without structured input from actual end users frequently fail to account for the physical constraints, skill variability, and contextual limitations encountered in real care situations.(9) For patient repositioning specifically, where a device must simultaneously address the safety needs of an immobile patient and the ergonomic limitations of a caregiver performing repetitive manual tasks, needs assessment is not merely preparatory but foundational to any design that seeks genuine clinical adoption and sustained use.

Research on assistive devices for bedridden patients has expanded considerably over the past decade, encompassing evaluations of alternating pressure mattresses, positioning wedges, air-assisted repositioning systems, and purpose-designed positioning devices.(1,4,10,11) These studies, however, have predominantly assessed device performance in isolation, focusing either on patient-centered outcomes such as pressure redistribution or on caregiver-centered outcomes such as biomechanical load reduction, but seldom addressing both simultaneously.(2,8) More critically, no study has systematically mapped what patients, nurses, and informal caregivers actually require from an ergonomic repositioning device prior to design. This upstream gap constrains the clinical relevance of existing device development and may contribute

to persistent low adoption rates despite device availability.

This literature review addresses that gap by synthesizing evidence on the clinical, ergonomic, and functional needs for a patient repositioning device from the perspective of both patients and caregivers as dual users. Rather than evaluating an existing device, this study identifies the needs that a device must be designed to meet, providing an evidence-based foundation for future device development in nursing practice. Therefore, this study aimed to identify clinical, ergonomic, and functional needs for an ergonomic patient repositioning device among bedridden patients through a synthesis of published literature.

METHODS

Search Strategy

A literature review was conducted to identify published studies addressing the needs for ergonomic patient repositioning devices among bedridden patients. Three electronic databases were searched: Scopus, PubMed, and EBSCO. The search was limited to publications from January 2016 to December 2024, covering English-language articles only. The following Boolean search string was applied consistently across all three databases:

("bedridden patient" OR "immobile patient") AND (repositioning OR turning OR "lateral positioning") AND (device OR "assistive technology" OR "ergonomic device") AND ("pressure injury" OR "pressure ulcer" OR decubitus)

Selection Criteria

Inclusion Criteria

Studies were eligible for inclusion if they met all of the following criteria: (1) focused on bedridden or immobile adult patients in hospital, long-term care, or home-care settings; (2) addressed repositioning devices, assistive technologies, or repositioning practices relevant to pressure injury prevention or caregiver ergonomics; (3) reported clinical, biomechanical, ergonomic, or functional outcomes related to repositioning; (4) were published between January 2016 and December 2024; and (5) were available in English as full-text peer-reviewed articles.

Exclusion Criteria

Studies were excluded if they: (1) focused exclusively on intraoperative or surgical patient positioning unrelated to pressure injury prevention; (2) addressed pediatric populations only; (3) reported insufficient methodological detail to allow data extraction; (4) were conference abstracts, editorials, case reports, or grey literature; or (5) were unrelated to repositioning function or device ergonomics upon full-text review.

Screening and Selection Process

The study selection followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. A four-stage screening process was conducted as follows. In Stage 1, records identified from all three databases were compiled and duplicates removed. In Stage 2, titles and abstracts were screened against the inclusion and exclusion criteria. In Stage 3, full-text articles of potentially eligible studies were retrieved and assessed for final eligibility. In Stage 4, the final list of included studies was confirmed. The complete selection process is illustrated in the PRISMA flowchart below.

Data Extraction

Data were extracted from each included study using a standardized extraction form to ensure consistency. The following information was recorded for each study: author and year of publication, country of origin, study design, population characteristics, type of repositioning device or intervention examined, primary outcomes measured, and key findings relevant to the needs assessment.

Quality Assessment

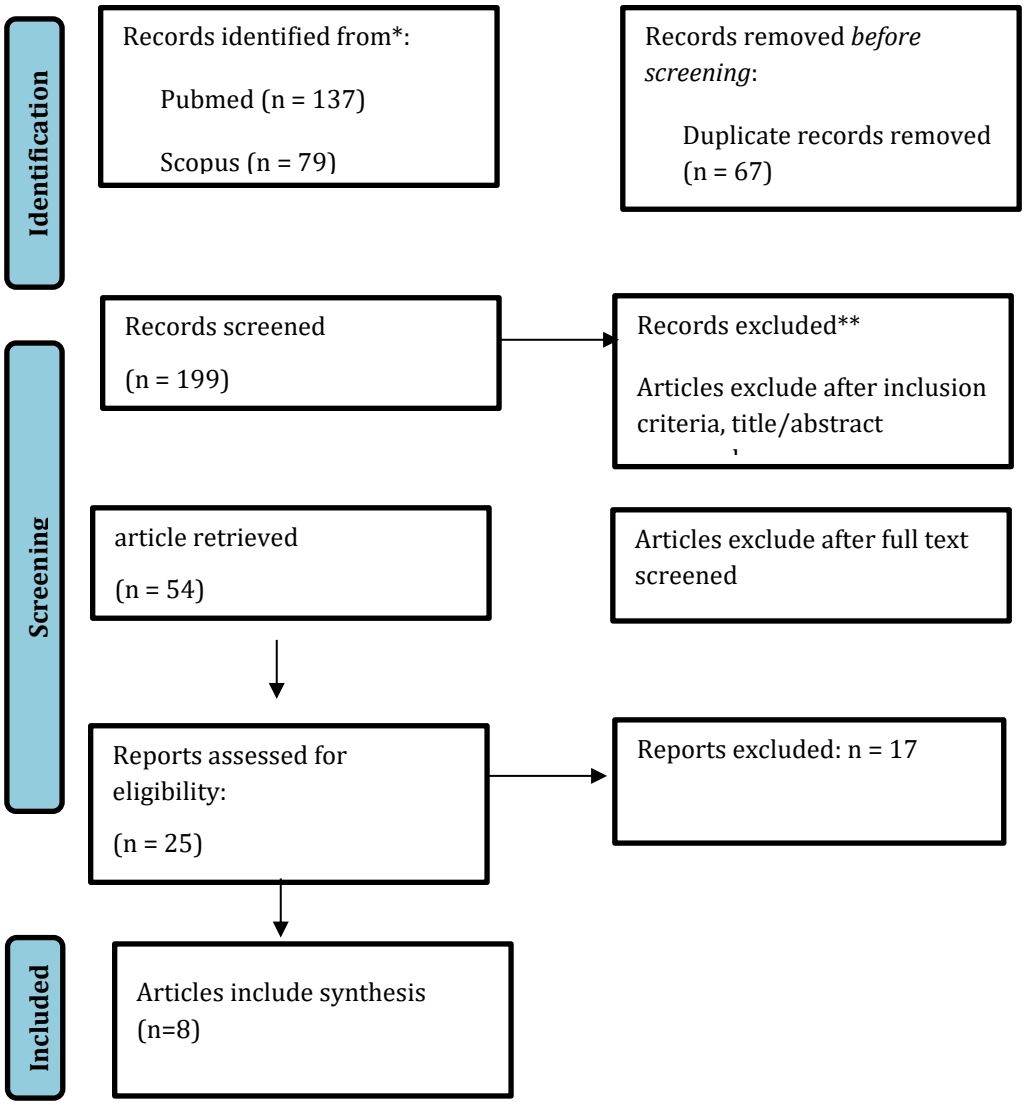
The methodological quality of included studies was assessed using the JBI Critical Appraisal Tools (Joanna Briggs Institute), selected for its applicability across multiple study designs including randomized controlled trials, observational studies, engineering reviews, and experimental studies. Each study was independently evaluated against the relevant JBI checklist, and quality ratings were assigned as high, moderate, or low based on the proportion of criteria met. Studies of low quality were retained in the synthesis but interpreted with appropriate caution.

Data Analysis

The findings of included studies were synthesized using narrative synthesis and thematic analysis. Narrative synthesis was used

to summarize and compare findings across studies in relation to the central research question. Thematic analysis was subsequently applied to group findings into recurring need domains identified across multiple studies. Three primary need domains emerged from this process: pressure redistribution capability, reduction of caregiver biomechanical workload, and device usability for consistent independent use. No meta-analysis was conducted given the heterogeneity of study designs and outcome measures across included studies.

Figure 1. PRISMA Flowchart



RESULT

Study Selection

The database search retrieved a total of 266 records from three electronic databases: PubMed (n=137), Scopus (n=79), and EBSCO (n=50). Following the removal of 67 duplicate records, 199 records remained for title and abstract screening. Of these, 145 records were excluded based on the inclusion criteria after title and abstract review, leaving 54 full-text articles retrieved for eligibility assessment. Full-text screening resulted in the exclusion of 29 articles, yielding 25 reports assessed for final eligibility. Of these, 17 were excluded due to failure to meet the inclusion criteria upon detailed review. A total of eight articles met all inclusion criteria and were included in the final synthesis. The complete selection process is illustrated in Figure 1.

Study Characteristics

The characteristics of the eight included studies are summarized in Table 1. Studies were published between 2016 and 2024, originating from five countries: the United States (n=2), Australia (n=2), the United Kingdom (n=1), Brazil (n=1), China (n=1), and South Korea (n=1). Study designs were heterogeneous, comprising one randomized controlled trial, (1) two observational studies, (2,3) one cohort comparison study, (4) one laboratory engineering study, (5) one experimental thermal study, (6) one engineering review, (7) and one computational modeling study. (8) Sample populations included hospitalized patients at risk of pressure injury, aged care residents, intensive care unit patients, and simulated patient models. All eight studies addressed at least one dimension of repositioning device needs, including pressure redistribution, caregiver workload reduction, or device usability.

Following the article selection process, a critical appraisal was conducted on all eight included studies using the JBI Critical Appraisal Checklists, with specific tools selected according to each study design. The results indicated satisfactory methodological quality overall, with the majority of JBI appraisal scores exceeding 62%. All eight articles were retained in the final synthesis despite variations in methodological quality across study designs, as heterogeneity in design was considered a strength of this review in capturing a broad range of evidence relevant to ergonomic repositioning device needs. Studies scoring below 70% were retained with appropriate interpretive caution applied to their findings during synthesis.

Table 1. Characteristics of Included Studies

No	Author, Year	Country	Study Design	Population	Device/ Intervention	Outcomes	Key Findings
1	Powers, 2016	USA	Cohort comparison	Hospitalized patients at PU risk	Two manual turning methods compared	PU development, caregiver physical effort	Method and frequency of turning significantly affect PU development
2	Kapp et al., 2019	Australia	Observational	Aged care residents	Purpose-designed positioning device vs. standard pillow	Lateral tilt position maintenance (30°)	Purpose-designed device maintained lateral tilt more consistently than standard pillow
3	Nixon et al., 2019	UK	RCT	High-risk hospitalized patients	Alternating pressure mattress vs. high-spec foam	Pressure ulcer incidence	Alternating pressure mattress showed no significant advantage over high-spec foam
4	Sousa et al., 2020	Australia	Observational feasibility	ICU patients at PU risk	Purpose-designed positioning device vs. usual care	Position maintenance, skin integrity	Purpose-designed device improved position consistency with fewer staff required
5	Boyle et al., 2020	UK	Laboratory/engineering	Tissue model	Lateral pressure equalisation support surface	Tissue pressure distribution	Lateral pressure equalisation reduced peak deep tissue stress by up to 43% compared to conventional surfaces
6	Itakura et al., 2022	Brazil	Experimental	Healthy volunteers	Three mattress types	Sacral skin temperature	Thermal changes varied significantly across mattress types, influencing tissue injury risk
7	Mansouri et al., 2024	USA	Engineering review	Bedridden patients	Multiple assistive devices for PU prevention	Device effectiveness, design features	No existing device simultaneously optimized patient pressure relief and caregiver ergonomic efficiency
8	Xiao et al., 2024	China	Computational modeling	Simulated patient model	Air cushion mattress with repositioning assist	Interface pressure, comfort index	Air cushion design reduced interface pressure and supported repositioning assist function

DISCUSSION

This literature review identified three primary need domains for an ergonomic patient repositioning device among bedridden patients: pressure redistribution capability, reduction of caregiver biomechanical workload, and device usability for consistent independent use. These domains represent complementary yet distinct requirements that, taken together, define the foundational specifications for a repositioning device capable of functioning effectively across both clinical and home-based care settings.

Adequate pressure redistribution during repositioning was the most consistently reported patient-centered need across the included literature. Nixon et al. (1) conducted a randomized controlled trial among 2,029 high-risk hospitalized patients and found no statistically significant difference in pressure ulcer incidence between alternating pressure mattresses and high-specification foam mattresses ($p=0.42$). Boyle et al. (3) demonstrated through laboratory testing that lateral pressure equalisation reduced peak deep tissue stress by up to 43% compared to conventional surfaces. Itakura et al. (12) measured sacral skin temperature across three mattress types and reported statistically significant thermal differences between conditions ($p<0.05$). Xiao et al. (13) applied computational modeling to an arrayed air cushion mattress and reported a reduction in interface pressure index alongside improved repositioning mechanics. These findings indicate that pressure redistribution is not achieved by device type alone but depends on the geometry of contact, the dynamic properties of the surface, and the consistency of repositioning practice. This interpretation is reinforced by a Cochrane systematic review by Gillespie et al., (14) which concluded that evidence for repositioning frequency and technique remains insufficient to determine optimal practice without considering the device context, establishing that repositioning practice and device design must be studied and developed as interdependent variables rather than separate clinical concerns. Furthermore, Iblasi et al. (15) established through concept analysis that effective repositioning comprises seven interdependent attributes, including pre-turn assessment, harmonization, anchoring, and documentation, underscoring that pressure redistribution during repositioning depends on a structured sequence of actions that the device must be designed to actively support.

Reducing the physical demands imposed on caregivers during repositioning was identified as a critical but consistently underaddressed need. Mansouri et al. (2) reviewed multiple assistive devices for pressure ulcer prevention and reported that no existing device simultaneously optimized patient pressure redistribution and caregiver ergonomic efficiency. Powers (4) compared two turning methods among hospitalized patients and found that repositioning method directly influenced both pressure ulcer incidence and the physical effort required from nursing staff. Sousa et al. (11) reported that a purpose-designed positioning device reduced the number of staff required per repositioning event from two to one in the majority of cases, without compromising the maintenance of the target lateral tilt angle. These findings are clinically significant because they demonstrate that ergonomic demand during repositioning is modifiable through device design rather than solely through workforce training or staffing policy. This is further supported by Omura et al., (16) who evaluated repositioning care performed by non-professional caregivers using a caregiver-assistive device and found that device use significantly improved repositioning quality while reducing perceived physical effort, providing direct evidence that appropriate device design can effectively compensate for the skill gap between trained nurses and informal caregivers. The finding by Sousa et al. (11) is particularly relevant to home-based care settings in Indonesia, where a single informal family caregiver typically manages all repositioning tasks without professional support, and where reducing the physical demand from a two-person to a one-person task represents a meaningful and achievable improvement in care sustainability.

Device usability emerged as the need domain most directly linked to real-world adoption and sustained clinical effectiveness. Kapp et al. (10) observed that standard hospital pillows failed to maintain the recommended 30-degree lateral tilt in 68% of repositioning events, whereas a purpose-designed positioning device achieved the target position in 89% of cases. Sousa et al. (11) similarly reported that caregivers using the purpose-designed device achieved the target position with lower perceived physical effort and greater confidence compared to those using standard care equipment. Mansouri et al.(2)

further noted that device complexity and equipment dependency were consistently associated with lower adoption rates across clinical settings. The 57-percentage-point gap in positional consistency reported by Kapp et al. (10) reveals that usability is not a secondary design consideration but a direct determinant of clinical effectiveness, as a device that fails to maintain position negates the protective benefit of repositioning regardless of its pressure redistribution properties. Noble and Sweeney (17) identified that limited training opportunities and organizational policy barriers were the primary factors impeding widespread adoption of patient handling assistive devices in practice settings, suggesting that device simplicity and intuitive design are not merely user preferences but adoption prerequisites in real-world care environments. These findings collectively indicate that the most clinically impactful usability features are single-operator capability, minimal assembly requirements, compatibility with standard bed systems, and the ability to maintain patient position stability over time without continuous manual readjustment.

Taken together, the three need domains identified in this review point to a fundamental limitation in the prevailing approach to repositioning device development: the persistent separation between patient-centered and caregiver-centered design objectives. Existing devices have largely been engineered to optimize one dimension at the expense of others, producing tools that are clinically effective but ergonomically burdensome, or ergonomically efficient but positionally inconsistent. A dual-user design framework, in which the needs of both the bedridden patient and the caregiver are simultaneously mapped and integrated into device specifications from the outset, represents a more coherent and clinically grounded pathway for future device development. This framework is especially relevant in Indonesia and similar low-middle income country contexts, where the informal family caregiver rather than the trained nurse is typically the primary repositioning agent. Mamom and Daovisan(18) documented that informal family caregivers of chronically ill bedridden patients reported physical exhaustion as the primary barrier to providing consistent repositioning care, corroborating the evidence from this review that caregiver physical burden is a structural constraint requiring device-level solutions rather than behavioral interventions alone.

This review has several limitations that should be considered when interpreting its findings. The inclusion of eight studies reflects the limited body of literature specifically addressing needs assessment for repositioning devices, which may restrict the comprehensiveness of the needs mapping. The heterogeneity of study designs, ranging from randomized controlled trials to computational modeling, limits direct comparability across findings and precludes meta-analytic synthesis. The majority of included studies were conducted in high-income countries, which may reduce direct applicability to LMIC settings where resource constraints, caregiving structures, and patient demographics differ substantially. Additionally, the exclusion of grey literature and non-English publications may have introduced publication bias.

The findings of this review carry direct implications for nursing practice, device development, and health policy. For clinical nurses and community health practitioners, the identification of usability as a critical need domain reinforces the importance of assessing not only the technical effectiveness of positioning aids but also their practical feasibility within the specific care context in which they will be used. For biomedical engineers and device developers, the dual-user framework proposed by this review provides a structured foundation for needs-based design, in which patient pressure redistribution requirements and caregiver ergonomic constraints are treated as co-equal design specifications from the earliest stage of development. For health policymakers in Indonesia and similar settings, the evidence that informal caregiver physical burden directly undermines repositioning adherence suggests that equipping caregiving households with appropriate assistive devices represents a cost-effective strategy for preventing pressure ulcer complications and reducing long-term care costs.

CONCLUSION

Three interdependent need domains for an ergonomic patient repositioning device among bedridden patients were identified: pressure redistribution capability, reduction of caregiver biomechanical workload, and device usability for consistent independent use. Current assistive devices inadequately address all three domains simultaneously, reflecting a persistent gap between patient-centered and caregiver-centered design objectives. A dual-user design

framework that integrates both perspectives from the earliest stage of device development is essential to produce a repositioning device that is clinically effective, ergonomically safe, and practically adoptable, particularly in home-based care settings where informal caregivers bear the primary repositioning responsibility. There is a pressing need for a simple, accessible device that enables caregivers to perform two-hourly repositioning consistently without requiring multiple personnel or specialized training, while simultaneously protecting caregivers from musculoskeletal injury caused by repetitive manual turning. Future research should translate these identified needs into structured device prototyping and user-centered validation studies involving nurses, patients, and informal caregivers across diverse care settings.

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CONFLICT OF INTEREST

The authors report no financial, personal, or professional conflicts of interest that may have affected the conduct or reporting of this study.

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AUTHOR CONTRIBUTIONS

ID: Conceptualization, Methodology, Investigation, Data Curation, Writing – Original Draft, Project Administration. ALP: Methodology, Validation, Writing – Review & Editing. RW: Data Curation, Review & Editing. NSW: Critical Appraisal, Review & Editing.

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