Pressure-relieving devices to prevent pressure injury in bedridden patients: a literature review

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ABSTRACT

Introduction: Immobility is a factor directly related to pressure injury, that could progress to osteomyelitis, sepsis, decreased the quality of life and increased care costs. Therefore, this study is intended to review primary studies related to using the most effective device to prevent pressure injury in immobile patients, the duration for applying the device and tools for assessing pressure injury risk.

Method: This literature review was sourced from PubMed, ProQuest, and Willey Online Library databases. Studies that met the following criteria were included: experimental research using assistive devices as an intervention to prevent and assess pressure injury published between 2014 and 2020, and the full-text article was available in English.

Result: The total number of articles found was 6,029 articles. Seven articles met the criteria for inclusion in the review. Assistive devices proven to prevent pressure injury included air mattresses, dressings/pads, and wheelchairs equipped with pillows/cushions. The duration of assistive devices was varied from minutes to weeks and assessment for pressure injury mostly used the Braden scale. Air mattresses were the most effective device to prevent pressure injury, with a press time of fewer than 10 minutes. Air mattresses were recommended devices in order to prevent pressure injury for immobile patients in clinical and community practices. In addition, developing air mattresses with advanced technologies is recommended for future work.

Conclusion: The widely used assistive devices to prevent pressure injury were air mattresses or viscoelastic foam mattresses made of silicone. Mattress usage time ranged from 5–7 minutes, while dressings usage could be up to four weeks. The Braden Scale was the leading choice for measuring pressure injury in bedridden patients.

Keywords: air mattresses, cushion, immobilization conditions, pressure injury, ulcer prevention.

INTRODUCTION

Immobility is a factor directly related to pressure injury.¹,² Pressure injury occur due to excessive pressure, friction, or a combination of both,³,⁴ which could progress to osteomyelitis and sepsis.⁵ Various studies reported that the prevalence of pressure injury occurred between 12% to 48% in patients in the hospital.⁶–⁸ Another study found that the prevalence of pressure injury occurring in elderly care facilities was between 4.1 % to 32.2%, which decreased the quality of life³,⁹,¹⁰ and increased care costs.

Prevention of pressure injury must be realized in nursing care. Nurses have a vital role in these preventive efforts. Some methods that can be done are repositioning and using assistive devices such as pillows and specific more advanced assistive devices such as mattresses, foam mattresses, and air mattresses.¹¹ However, the affordability of costs and supporting equipment in hospitals, elderly patients, nursing home residents, especially in remote areas including Indonesia, was considered. Therefore, it is necessary to identify pressure injury prevention assistive devices that can be feasible and affordable by all levels of society when treating family members who are on immobile patients.

Various approaches to prevent pressure injury through assistive devices have been reported in previous studies. Air mattresses in a study were more effective in preventing pressure injury than foam mattresses.¹² Moreover, other assistive devices that have been proven to prevent pressure injury are pillows and dressings, as they can reduce friction and pressure.⁸ Research related to the effectiveness of prevention devices for pressure injury still has been developed. Therefore, this study is intended to review primary studies related to using the most effective device to prevent pressure injury in immobile patients, the duration for applying the device and tools for assessing pressure injury risk.

METHODS

This literature search algorithm used the PICO approach with the keywords bedridden patient, device, cushion, mattress, dressing, prevention, and bedsores (pressure injury or decubitus or pressure sore). Three indexed journal database portals were selected as data sources, namely Pubmed, Proquest, and...
Willey Online Library. This research has several inclusion criteria: (1) RCT; (2) pressure injury prevention devices as intervention; (3) articles published between 2014 and 2020 and full text; (4) pressure injury as an outcome; (5) bedridden patients.

RESULTS

After searching on three databases such as PubMed, ProQuest, and Willey, 6,029 articles were found. The review process, which started from the title and abstract screening stage to the full-text review, was based on the inclusion criteria and obtained seven articles.\textsuperscript{13-19}

Moreover, based on several studies regarding pressure relief assistive devices, the most widely used assistive devices were mattresses, dressings/pads, and wheelchairs equipped with pillows/cushions. Furthermore, the most used mattresses/air mattresses were mattresses with high-tech support surfaces (Alternating Pressure Air mattresses/ APAMs) and low-tech support surfaces (viscoelastic/static) that protected the sacrum, coccyx, and plantar. The benefit of this instrumentation was to reduce pressure injury in long-term bedridden patients. In addition to mattresses, several clinical guidelines recommended layered dressings.\textsuperscript{13}

Subsequently, based on seven studies, six studies had used the Braden Scale pressure-ulcer-risk-assessment tool\textsuperscript{13,15,17-19}, and one article had used the Pressure injury Quality of Life/PU-QoL.\textsuperscript{16} However, PU-QoL was more focused on measuring patients’ quality of life with pressure injury.\textsuperscript{16} In the meantime, the timing of using pressure injury prevention aids was quite variable. APAMs took 5-7 minutes\textsuperscript{14} while the viscoelastic mattress took 2-4 hours\textsuperscript{17} and the use of dressings took 4-8 weeks.\textsuperscript{16} The results of the data extraction of reviewed articles are shown in Table 1.

DISCUSSION

Pressure injury were known as a global problem and a substantial concern for the health care system.\textsuperscript{15} Pressure injury were a severe complication of an acute or chronic disease characterized by high rates of comorbidity and mortality,\textsuperscript{16} especially in elderly and debilitated patients. Furthermore, pressure injury caused pain and discomfort, significantly reduced quality of life, and increased health costs.\textsuperscript{14}

Based on the review, the most assistive devices used in preventing pressure injury were air-filled mattresses or silicone gel foam\textsuperscript{14,17}, silicone foam dressings\textsuperscript{13,19}, and wheelchairs equipped with pillows/cushions.\textsuperscript{18} Nevertheless, mattress and dressing/pads were the most dominant. Furthermore, the type of mattress used was the APAM/ Alternating Pressure Air mattress. This mattress has the advantage of being composed of air cells with a height of 12 cm, supplied by a compressor whose function is to adjust the patient’s weight and its operating mode allows for alternate pumping of one of two cells. This medical device is recommended because it has been certified according to the specific requirements for the apparatus’ safety, performance, and efficacy by an Independent Accredited Test Laboratory (FCBA, France).\textsuperscript{11} In line with Nixon et al’s study, APAM provides significant benefits to the pressure wound healing phase, decreasing over time.\textsuperscript{16} APAM also showed patient compliance.\textsuperscript{16} This evidence, subsequently, has been clarified by Ogawa et al., revealing that the APAM surface filled with alternating compressed air could increase body contact area and reduce interfacial pressure by controlling cell air pressure.\textsuperscript{20} APAM was more effective for preventing pressure injury than other mattresses, such as hospital standard mattresses and reactive low-pressure mattresses.\textsuperscript{20}

Furthermore, the prophylactic use of multi-layer silicone foam dressings/foams to reduce pressure injury received increasing international attention during the last seven years in hospitals.\textsuperscript{13} This silicone foam dressing has the advantage of being soft. When combined with suitable treatment methods, it is statistically and clinically significant in reducing the incidence and severity of Pressure injury in intensive care patients. Kalowes et al. found that this multi-layer dressing was a new and cost-effective innovation and recommended reducing pressure injury in patients.\textsuperscript{19}

The administration time for high-tech mattresses such as APAM takes 5-7 minutes because the air pressure generated from the air pump is around 30-70 mmHg. The function of this air pressure is to maintain skin comfort and blood circulation. This condition can be observed when an immobilized patient lies passively on a foam mattress, while the pressure in the sacrum area will reach 60-
70 mmHg and the heel area will reach 30-45 mmHg. Recent studies declared that applying air and foam mattresses combined by repositioning every two hours had no significant difference in pressure injury incidence. But longer repositioning, with 3 hours intervals, showed a lower incidence of pressure injury than 2-hour intervals using foam mattresses. Regarding the dressings, the adequate administration time is four weeks, but replacement is done. The dressing is changed once a week, or 2-4 times a week if there is an exudate, leakage, lack of adhesion, or any situation compromising dressing integrity. Kalowes et al. discovered that skin checks and dressing changes were carried out every three days or when the dressing became soiled or comes off easily. The sacrum and heel were observed daily by partially removing the dressing. Therefore, the skin could be visualized and assessed for development. Subsequently, instrument scales used to assess the risk of pressure injury include the Braden Scale, PUSH scale, and the Pressure injury Quality of Life scale instrument. However, the Braden Scale remains the most widely applied, developed by Barbara Braden and Nancy Bergstrom. The Braden Scale is recommended because it has a clinically assigned score for healthcare professionals, especially nurses, to assess the risk of developing pressure injury. In addition, the Braden Scale features subscales consisting of sensory perception, humidity, mobility, activity, nutrition, and friction. This scale is assessed daily to record the skin condition, the appearance of the wound (time of appearance and stage), duration of rest, duration of sitting in a chair, frequency of preventive interventions for any therapeutic changes (medical, paramedical), and severe or non-serious adverse events. The Braden Scale assessment is equipped with a specific score limit that indicates the risk of pressure injury, including mild risk (score 13-14), high risk (score 10-12), and very high risk (scores 10-12). Another study conducted by Santamaria et al. strengthens the use of the Braden Scale as a measure of the risk of Pressure injury in bedridden patients.

This study has limitations for instance, the number of reviewed articles was limited and did not compare with other interventions. But this review could give a brief explanation that preventing pressure injury does not always use expensive equipment. Air mattress was one of the devices considered more effective than other assistive devices.

CONCLUSION
The literature review results showed that the widely used assistive devices to prevent pressure injury were air mattresses or viscoelastic foam mattresses made of silicone and silicon foam dressings. Mattress usage time ranged from 5-7 minutes, while dressings usage could be up to four weeks. The Braden Scale was the leading choice for measuring pressure injury in bedridden patients. It is suggested to develop air mattresses with advanced technology such as internet controlling to prevent viral contamination in health staff and patients.

CONFLICT OF INTEREST
The authors declare no conflict of interest in this study.

FUNDING
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ETHICS APPROVAL
This literature review follows the ICMJE protocol of publication ethics before the study is conducted.

AUTHOR CONTRIBUTION
FA: finding data sources, appraising included articles, reporting the result, drafting the published paper. NC: appraise included articles, drafting the publication paper, revised publication paper. W: drafting the publication paper, revised publication paper.

REFERENCES
Table 1. Characteristics of articles.

<table>
<thead>
<tr>
<th>Author/ years</th>
<th>Title</th>
<th>Design</th>
<th>Definition</th>
<th>Assistive Device</th>
<th>Delivery Time</th>
<th>Measuring Scale</th>
<th>Result</th>
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<tbody>
<tr>
<td>1. Santamaria et al. 2018</td>
<td>A randomized controlled trial of the clinical effectiveness of multi-layer silicone foam dressings for the prevention of pressure injuries in high-risk aged care residents: The BorderIII Trial</td>
<td>RCT</td>
<td>The prophylactic use of multi-layer silicone foam dressings to reduce the incidence of PI has received increasing international attention over the past seven years in the hospital setting.</td>
<td>Silicone foam dressing to prevent the development of pressure injuries to the sacrum and heel area</td>
<td>The period for treatment was before the fourth week as most protease inhibitors develop within 4 to 8 weeks</td>
<td>Braden Scale</td>
<td>A total of 288 recently admitted residents were enrolled from 40 Australian nursing homes into a randomized controlled trial. As recommended by international guidelines, residents randomized to standard care (n=150) received pressure injury prevention. Residents randomized to intervention (n = 138) received standard pressure injury prevention care and wore dressings on their sacrum and heels. The mean age of eligible sample patients was 70 years old and over, had no PU at the time of enrollment, was bedridden for at least 15 hours per day, had reduced mobility, had minimal or no positioning abilities, and had a Braden score of &lt;14.</td>
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<td>2. Sauvage et al. 2017</td>
<td>Pressure injury prevention efficacy of an alternating pressure air mattress in elderly patients: E²MAO a randomized study</td>
<td>RCT</td>
<td>The reduction of applied pressure injury was achieved with either a static medium (mattress lining or dynamic medium (Alternating Pressure Air mattress (APAM)).</td>
<td>Compressed air mattress (APAM/Axtair One, compared with viscoelastic foam mattress (VFM) in the prevention of PU in elderly patients at moderate to high risk of PU</td>
<td>According to the Braden Scale, weekly evaluations of PU risk levels were performed (sensory perception, humidity, activity, mobility, nutrition, friction, and shear). Patient comfort perceptions were collected on days 8, 15, 22, and 30 via a satisfaction questionnaire (skin-mattress contact, feeling warmth, discomfort due to motor noise, and sleep disturbances).</td>
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<td>3. Beeckman et al. 2019</td>
<td>A multicentre prospective randomized controlled clinical trial comparing the effectiveness and cost of a static air mattress and alternating air pressure mattress to prevent pressure injury in nursing home residents</td>
<td>RCT</td>
<td>Support surface could be divided into two general categories: high-tech support surfaces (e.g., Alternating air pressure mattresses) and low-tech support surfaces (e.g., static air mattress pads).</td>
<td>Static air mattresses were compared with reciprocating air mattresses in nursing home populations at high risk for pressure injury.</td>
<td>Braden Scale</td>
<td>A consecutive mean age sample of 308 participants was selected based on eligibility criteria: high risk for pressure injury tied to bed and chair, aged &gt;65 years old, and alternating compressed air mattresses. The participants were allocated to the intervention group (n = 154) using a static air support surface, and the control group (n = 154) used an alternating air pressure support surface.</td>
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<td>4. Nixon et al 2019</td>
<td>Comparing alternating pressure mattresses and high-specification foam mattresses to prevent pressure injury in high-risk patients: the Pressure2</td>
<td>RCT</td>
<td>APM provided a small treatment phase benefit that diminished over time. Overall, APM indicated patient compliance, a low incidence of PU was observed.</td>
<td>This article used an alternating pressure (APM) mattress/mattress compared to a high specification foam (HSFM)/viscoelastic mattress</td>
<td>The treatment phase had been projected to last a maximum of 60 days; the last 30 days were post-treatment follow-up</td>
<td>Pressure injury Quality of Life - Prevention (PU-QoL-P) scale instrument</td>
<td>The study took place in one of the service centers and recruited patients from surgery, internal medicine, and nursing, focusing on the mean sample elderly. Patients aged 18 years old, with an estimated length of stay &gt; 3 days.</td>
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<td>5. Jiang et al 2020</td>
<td>A Multicenter Comparative Study of Two Pressure-Redistribution Mattresses with Repositioning Intervals for Critical Care Patients</td>
<td>RCT</td>
<td>The viscoelastic foam mattress used in this study consisted of patented silica gel, two-ply medium-elastic foam, two-ply high-elastic foam, and high-density polyurethane. The thickness of the mattress is approximately 12 cm</td>
<td>This type of Visco mattress effectively spread and reduced pressure on bony prominences and skin surfaces.</td>
<td>4 hours</td>
<td>Braden Scale</td>
<td>The participants were critical care patients admitted to the ICU and at risk of developing a PI. Inclusion criteria were for participants with a mean sample age of at least 18 years and admission to a medical, surgical, or trauma ICU within the previous 24 hours. Other eligibility criteria included an estimated length of stay of at least seven days, as well as limited activity and mobility (Braden Scale activity and mobility score of 1 or 2) or risk of developing a PI.</td>
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<td>6. Brienza et al 2018</td>
<td>A Randomized Clinical Trial of Wheeled Mobility for Pressure Injury Prevention and Better Function</td>
<td>RCT</td>
<td>Proper wheelchair selection and configuration could improve mobility, activity, and participation.</td>
<td>Wheelchair which equipped with a protective skin cushion to protect the ischial/gluteal area.</td>
<td>14 days</td>
<td>Braden Scale</td>
<td>Nursing home residents aged 60 years old and over who used a wheelchair and were at risk for pressure injury (n: 258) and a manual wheelchair as their primary mobility device; had a score of 18 or less on Braden Scale; combined Braden activity and mobility subscale score of 5 or less; wheelchair usage average was 6 hours or more per day, and clinical needs that could be accommodated by using this study.</td>
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<td>Kalowes et al 2016</td>
<td>Five-Layered Soft Silicone Foam Dressing to Prevent pressure Ulcers in the Intensive Care Unit</td>
<td>RCT</td>
<td>In critically ill patients, prevention of pressure injury was a challenge because of the high risk for multiple comorbid conditions, hemodynamic instability, increased medical devices, immobility. Sacral foam dressings to improve standard procedures for preventing pressure injury in ICUs in the United States</td>
<td>A 5-ply soft silicone foam bandage was applied to the sacrum and heel and used to reduce pressure injury</td>
<td>Five plies soft silicone foam dressing applied within 24 hours of admission to the ICU. The skin was checked daily under the dressings and changed every three days unless soiled before</td>
<td>Braden Scale</td>
<td>This article used a practical sample of all critically ill patients admitted to the cardiac, medical, surgical, and trauma ICU in a single bed of 569 beds. Eligible patients (≥18 years, Braden score 30 of 13 and intact sacral skin) were randomized on the admission index (1:1 ratio) to the control group (n = 182) who received the usual preventive care or intervention group (n = 182).</td>
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