Prevention and Treatment of Pressure Ulcers: *Support Surfaces* – an extract from the Clinical Practice Guideline
INTRODUCTION

Foreword

This document presents an extract of the full Clinical Practice Guideline. The methodology used to appraise research and develop the recommendations is presented in the Clinical Practice Guideline, the abridged Quick Reference Guide, and in the methodology report, all available on the International Pressure Ulcer Guideline website (www.internationalguideline.com).

The full Clinical Practice Guideline presents recommendations and summarizes the supporting evidence for pressure ulcer prevention and treatment. The first edition was developed as a four year collaboration between the National Pressure Ulcer Advisory Panel (NPUAP) and the European Pressure Ulcer Advisory Panel (EPUAP). In the second edition of the guideline, the Pan Pacific Pressure Injury Alliance (PPPIA) has joined the NPUAP and EPUAP.

The goal of this international collaboration was to develop evidence-based recommendations for the prevention and treatment of pressure ulcers that could be used by health professionals throughout the world. An explicit scientific methodology was used to identify and critically appraise all available research. In the absence of definitive evidence, expert opinion (often supported by indirect evidence and other guidelines) was used to make recommendations. Drafts of the recommendations and supporting evidence were made available to 986 invited stakeholders (individuals and organizations) around the world. The final guideline is based on available research and the accumulated wisdom of the NPUAP, EPUAP, PPPIA and international stakeholders. In this edition of the guideline, a consensus voting process (GRADE) was used to assign a strength to each recommendation. The strength of recommendation identifies the importance of the recommendation statement based on potential to improve patient outcomes. It provides an indication to the health professional of the confidence one can have that the recommendation will do more good than harm, and can be used to assist in prioritizing pressure ulcer related interventions. Printed copies of the English version of the full Clinical Practice Guideline are available through links provided on the following websites:

- NPUAP website: www.npuap.org
- EPUAP website: www.epuap.org
- Wounds Australia (previously Australian Wound Management Association) website: www.woundsaustralia.com.au
- New Zealand Wound Care Society (NZWCS) website: www.nzwcs.org.nz
- International Pressure Ulcer Guideline website: www.internationalguideline.com

Suggested Citation

The NPUAP, EPUAP and PPPIA welcome the use and adaptation of this guideline at an international, national and local level. We request citation as the source, using the following format for this extract:

Limitations and Appropriate Use of This Guideline

- Guidelines are systematically developed statements to assist health professional and patient consumer decisions about appropriate health care for specific clinical conditions. The recommendations may not be appropriate for use in all circumstances.
- The decision to adopt any particular recommendation must be made by the health professional with consideration to available resources and circumstances of the individual patient. Nothing contained in this guideline is to be considered medical advice for specific cases.
- Because of the rigorous methodology used to develop this guideline, the Guideline Development Group members believe that the research supporting these recommendations is reliable and accurate. Every effort has been made to critically appraise the research contained within this document. However, we do not guarantee the reliability and accuracy of individual studies referenced in this document.
- This guideline is intended for education and information purposes only.
- This guideline contains information that was accurate at the time of publication. Research and technology change rapidly and the recommendations contained in this guideline may be inconsistent with future advances. The health professional is responsible for maintaining a working knowledge of research and technology advances that may affect his or her clinical decision making.
- Generic names of products have been used. Nothing in this guideline is intended as endorsement of a specific product.
- Nothing in this guideline is intended as advice regarding coding standards or reimbursement regulations.
- The guideline does not seek to provide full safety and usage information for products and devices; however commonly available safety and usage tips have been included. Adverse events reported in the included research have been reported in the evidence summaries and caution statements. All products should be used according to manufacturer’s directions.

Abstract

The guideline is the result of a collaborative effort among the National Pressure Ulcer Advisory Panel (NPUAP), European Pressure Ulcer Advisory Panel (EPUAP) and Pan Pacific Pressure Injury Alliance (PPPIA). A comprehensive literature review was conducted on pressure ulcer prevention and treatment. A rigorous scientific methodology was used to appraise available research and make evidence-based recommendations for the prevention and treatment of pressure ulcers. Draft guidelines were made available to 986 invited stakeholder individuals and organizations/societies and stakeholder feedback was considered by the guideline developers. In the final development process, the guideline development team used a consensus voting process (GRADE) to assign strengths of recommendation. Strength of recommendations indicate the extent to which one can be confident that adherence to a recommendation will do more good than harm, and are intended to assist the health professional to prioritize interventions.

The full Clinical Practice Guideline includes 575 explicit recommendations and/or research summaries.

This extract focuses on the evidence presented on support surfaces for prevention and treatment of pressure injuries.
Strengths of Evidence and Strengths of Recommendations

Full explanation of the methodology is available in Appendix 1: Guideline Methodology. Individual studies were assigned a ‘level of evidence’ based on study design and quality. The body of evidence supporting each recommendation was given a ‘strength of evidence’. A consensus voting process (GRADE) involving all the experts formally engaged in the guideline development was used to assign a ‘strength of recommendation’ that indicates the confidence the health professional can have that the recommended practice will improve patient outcomes (i.e., do more good than harm). The overall aim of the ‘strength of recommendation’ is to help health professionals to prioritize interventions.

### Strengths of Evidence

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<th>Level</th>
<th>Description</th>
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<td>A</td>
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<td>B</td>
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<tr>
<td>C</td>
<td>The recommendation is supported by indirect evidence (e.g., studies in healthy humans, humans with other types of chronic wounds, animal models) and/or expert opinion</td>
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### Strengths of Recommendation

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<td>⭐四星</td>
<td>Weak positive recommendation: probably do it</td>
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<tr>
<td>🧑‍🔬二星</td>
<td>Weak negative recommendation: probably don’t do it</td>
</tr>
<tr>
<td>⬛一星</td>
<td>Strong negative recommendation: definitely don’t do it</td>
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### Guideline Website

http://www.internationalguideline.com

The guideline website will remain accessible during the interim period until the next guideline revision. The Quick Reference Guideline, sponsor acknowledgement, and supportive documents (e.g. data extraction tables) to the guideline are available from the website.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>1</td>
</tr>
<tr>
<td>Suggested Citation</td>
<td>1</td>
</tr>
<tr>
<td>Limitations and Appropriate Use of this Guideline</td>
<td>2</td>
</tr>
<tr>
<td>Abstract</td>
<td>2</td>
</tr>
<tr>
<td>Strengths of Evidence and Strengths of Recommendations</td>
<td>3</td>
</tr>
<tr>
<td>Guideline Website</td>
<td>3</td>
</tr>
<tr>
<td>Guideline Developers</td>
<td>5</td>
</tr>
<tr>
<td>Acknowledgements</td>
<td>7</td>
</tr>
<tr>
<td>Sponsor Acknowledgements</td>
<td>8</td>
</tr>
<tr>
<td>Interventions for Prevention and Treatment of Pressure Ulcers: Support Surfaces</td>
<td>9</td>
</tr>
<tr>
<td>Glossary: Support Surfaces Extract</td>
<td>25</td>
</tr>
</tbody>
</table>
INTRODUCTION

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Translation

The following experts from the Clinical Research Center for Hair and Skin Science, Department of Dermatology and Allergy, Charité-Universitätsmedizin Berlin, Germany completed translation and data extraction for papers in languages other than English:

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Stakeholders

Special thanks to the many stakeholders who reviewed the guideline processes and drafts. All stakeholder comments were reviewed by the Guideline Development Group and revisions were made based on the comments received. We appreciate the investment of health professionals, researchers, educators and manufacturers from all over the world who took time to share their expertise and thoughtful critique.
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SUPPORT SURFACES

Introduction

Support surfaces are “specialized devices for pressure redistribution designed for management of tissue loads, microclimate, and/or other therapeutic functions (i.e., any mattress, integrated bed system, mattress replacement, overlay, or seat cushion, or seat cushion overlay)”. In this context, pressure refers to distribution of forces on the individual’s body surface that is in contact with the device. As a person immerses (sinks) into the support surface, their weight can become distributed over a larger area. If the surface also envelops (i.e. conforms to the shape of) the person, the pressure on the individual’s body will become more evenly distributed and less concentrated over bony prominences where pressure ulcers typically develop. In practice, as a person lies or sits on a support surface their weight causes both the support surface and their own soft tissue to deform. The extent to which pressure is concentrated over small areas will determine the degree of potentially damaging deformation. A reactive support surface is a powered or non-powered support surface with the ability to change its load distribution properties only in response to an applied load. An active support surface is a powered support surface that produces alternating pressure through mechanical means and has the ability to change its load distribution properties with or without an applied load.

Support surfaces are typically constructed from a range or combination of materials including foam, gel and fluid, and structures (i.e., bladders and modules that may be arranged in zones corresponding to anatomical locations). Support surfaces can either be powered or non-powered. Power is used in some devices to alter the immersion and envelopment characteristics of the surface, to control the microclimate or, periodically, to redistribute pressure. Powered features designed to influence the microclimate include heating, cooling and controlling moisture. Powered features designed to change reactive load bearing characteristics include air fluidization of granular materials and active control of fluid pressure within bladders. An example of the latter case is a support surface that adjusts air volume in response to the weight and/or morphology of the individual. A powered feature designed to affect microclimate is low-air-loss. Low-air-loss describes a feature where air is circulated beneath a water vapor permeable cover to control the humidity at the interface between the individual and the support surface (microclimate control).

Support surface characteristics such as immersion, envelopment, and heat and moisture permeability will vary substantially from device to device both within and across categories (active or reactive), if they are powered or non-powered, or if they implement such features as alternating pressure and low-air-loss. The Rehabilitation Engineering and Assistive Technology Association of North America (RESNA) in collaboration with the National Pressure Ulcer Advisory Panel (NPUAP) has published standard test methods for quantifying these characteristics. The test results are intended to assist clinicians and consumers in selecting support surfaces that best meet the needs of individual users. The Tissue Viability Society also published similar consensus-based test standards for active surfaces in 2010.

Pressure ulcer risk factors vary from person to person. Support surfaces should be chosen on an individual basis depending on these personal needs. In all cases, the manufacturer’s recommendations for the use and maintenance should be followed. Standards also serve manufacturers as a product development guide and to enhance quality assurance.

Microclimate refers to the temperature and humidity of the interface between the support surface and the individual. Pressure distribution, shear management and microclimate influence a person’s risk of developing a pressure ulcer. The role of microclimate in pressure ulcer development is discussed in the Etiology of Pressure Ulcers section of the full Clinical Practice Guideline.

Reactive support surfaces are designed to reduce the risk of pressure ulcer development by deforming in
response to applied load (i.e., the individual’s weight and/or morphology). The goal is to provide deep immersion and a high degree of envelopment to reduce sustained deformation caused by pressure concentrations over bony prominences.

**Active support surfaces** are designed to reduce the risk of pressure ulcer development by periodically shifting the areas of support from between anatomical locations so that deformation is not sustained over any one area. The weight-shifting feature is typically achieved by cycling air into and out of bladders within the support surface. This feature is called alternating pressure.

Lateral rotation, percussion and vibration are examples of therapeutic functions of support surfaces that are not intended to reduce pressure ulcer risk.

Refer to the Glossary for selected terms and definitions associated with support surfaces. Refer to the NPUAP website (www.npuap.org) for a complete list of terms and definitions developed by the NPUAP Support Surface Initiative (S3I).

### Support Surface Use

Support surfaces are an important element in pressure ulcer treatment because they provide an environment that enhances perfusion of injured tissue. Support surfaces alone neither prevent nor heal pressure ulcers. They are to be used as part of a total management plan for pressure ulcer prevention and treatment.

This section addresses support surface recommendations for individuals at high risk of pressure ulcers or with existing pressure ulcers. The full Clinical Practice Guideline includes additional chapters that discuss support surface use following surgical repair of pressure ulcers and additional recommendations on support surfaces relevant to other specific special-interest populations (e.g. pediatrics).

### General Recommendations for Mattress and Bed Support Surfaces

1. **Select a support surface that meets the individual’s needs.** Consider the individual’s need for pressure redistribution based on the following factors:
   - level of immobility and inactivity;
   - need for microclimate control and shear reduction;
   - size and weight of the individual;
   - risk for development of new pressure ulcers; and
   - number, severity, and location of existing pressure ulcer(s). (Strength of Evidence = C; Strength of Recommendation = ‡‡)

This statement is based on expert opinion. Immobility is the key condition that increases risk of pressure ulcers. This risk is increased when immobile individuals are too weak to turn or reposition themselves, are experiencing pain and discomfort on movement, or when they are unaware of the need to move about in bed. Individuals who must have the head of the bed elevated for medical purposes may benefit from shear reduction surfaces. Individuals with damp skin (e.g., commonly from perspiration, fever and incontinence) may benefit from microclimate control. Further information on microclimate is in the Emerging Therapies for Prevention of Pressure Ulcers section of the full Clinical Practice Guideline.

Selection of support surfaces should consider the individual’s body dimensions, ensuring there is adequate space for repositioning. Further information on selection of support surfaces is in the sections of the full Clinical Practice Guideline for Special Populations, as appropriate.

Individuals should not lie on a pressure ulcer; however, there are instances where the individual cannot be positioned off the ulcer and instances because the individual has ulcers on multiple
anatomical sites. To improve perfusion to injured skin and existing pressure ulcers, support surfaces with additional features (e.g., alternating pressure, low-air-loss or air fluidized) may be needed for individuals with existing full thickness ulcers (i.e., Category/Stage III, IV and unstageable pressure ulcers), while other support surfaces may suffice for partial thickness pressure ulcers (i.e., Category/Stage I and II pressure ulcers). However, selection of a support surface should be individualized based on the factors detailed in the above recommendation statement. See below for recommendations on selecting support surfaces specifically for individuals with existing pressure ulcers.

2. **Choose a support surface that is compatible with the care setting.** (Strength of Evidence = C; Strength of Recommendation = )

   This statement is based on expert opinion. When selecting a support surface, consideration should be given to where the support surface and/or bed will be placed. Consider the weight of the bed, the structure of the building, the width of doors, the availability of uninterrupted electrical power, and safe location for the pump/motor, including its ventilation. Plans should be in place for the contingency of power failure.

   Caregivers should follow supplier’s instructions regarding maintenance schedules and care and use of the support surface. To prevent falls, electrical cords should be kept away from transfer/walk areas. Support surface pumps/motors should not be obstructed by pillows, bedding, blankets, or clothing. The obstructed motor may overheat and fail to operate. These considerations are especially important for individuals in the home care setting and should be reviewed with the individual or caregiver.

3. **Examine the appropriateness and functionality of the support surface on every encounter with the individual.** (Strength of Evidence = C; Strength of Recommendation = )

   This statement is based on expert opinion. It is difficult to determine whether the chosen support surface will work for a given person until that individual is actually on the support surface. Any support surface can fail or be less than adequate for an individual’s needs. Caregivers must monitor for power failure and ‘bottoming out’ and implement the contingency plan if needed.

4. **Identify and prevent potential complications of support surface use.** (Strength of Evidence = C; Strength of Recommendation = )

   Proper selection and operation of support surfaces is the key to preventing complications. Correctly fitting the mattress to the bed base will mitigate entrapment risks. Overlays placed on top of existing mattresses can elevate the surface to the level of side rails. The top of the side rail should be more than 220 mm (8.66 inches) above the uncompressed mattress (International Electrotechnical Commission [IEC] 60601-2-52). The additional height may make it difficult to transfer onto the bed from a seated position. High beds may be difficult to get out of, increasing the risk of falling and injury.

   Beds that produce air flow at the skin interface can accelerate the evaporation of perspiration and can in some cases lead to dehydration. This insensible loss should be considered in daily fluid intake. Beds that lead to a sensation of floating may lead to disorientation and confusion; in such cases, reorientation and explanations of the bed’s function may be helpful. Powered support surfaces can be noisy, may generate heat, and can have motion. One trial conducted in older women confined to bed (n = 10) reported that automated tilted beds were associated with a non-significant change in high frequency components of the heart rate; however, this is an infrequent occurrence (indirect evidence). These factors may be well-tolerated or may not be acceptable.

5. **Verify that the support surface is being used within its functional life span, as indicated by the manufacturer’s recommended test method (or other industry recognized test method) before use of the support surface.** (Strength of Evidence = C; Strength of Recommendation = )

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It is widely recognized that support surfaces have a finite life span. Determining the condition of a support surface can be accomplished through contractual support surface performance verification conducted by the manufacturer, or by hospital staff trained in the use of industry recognized test methods.9,10

6. **Continue to reposition individuals placed on a pressure redistribution support surface.** (Strength of Evidence = C; Strength of Recommendation =  )

This statement is based on expert opinion. Repositioning is still required for pressure relief and comfort when a support surface is in use. However, the frequency of repositioning may alter as a result of using a support surface. The Repositioning and Early Mobilization section of the full Clinical Practice Guideline provides recommendations and discussion on repositioning. The sections of the full Clinical Practice Guideline for Special Populations also provide recommendations for repositioning associated with different support surfaces and medical conditions.

7. **Choose positioning devices and incontinence pads, clothing and bed linen that are compatible with the support surface. Limit the amount of linen and pads placed on the bed.** (Strength of Evidence = C; Strength of Recommendation =  )

This statement is based on expert opinion. Devices with sharp edges should not be used near support surfaces. Foam positioning wedges can be used to raise the head of the bed in some air fluidized beds.

Bed linen, foam devices, and disposable incontinence pads may be necessary to manage comfort, positioning, and moisture or drainage. Consider the individual’s condition and the types of support surfaces being utilized in order to determine the type and amount of linen to be used. A general rule of thumb is “less is best.” In one laboratory study, the impact of adding various combinations of incontinence pads and linen layers to a low-air-loss and to a therapeutic foam support surface was investigated using a pelvic indenter model. The findings indicated statistically significant (p < 0.0001) increases in peak sacral interface pressure for all combinations of additional bed linen and/or incontinence pads compared with a single fitted sheet. The percentage increase in peak sacral interface pressure was larger for low-air-loss beds compared with a high specification foam mattress11 (indirect evidence).

When selecting linens and incontinence pads to place on support surfaces with air fluidized or low-air-loss features, avoid impeding airflow as this will interfere with the thermal performance properties of the surface. If plastic-backed incontinence pads must be used, use them for dignity when the individual is ambulating and remove them when at bedrest, or allow the pad to remain open or placed loosely against the skin to promote as much air flow as possible.12

**Mattress and Bed Support Surfaces for Pressure Ulcer Prevention**

Pressure redistributing support surfaces are designed to either increase the body surface area that comes in contact with the support surface (to reduce interface pressure) or to sequentially alter the parts of the body that bear load, thus reducing the duration of loading at any given anatomical site. Measures of interface pressure (pressure at the interface between the body and the supporting surface) have been frequently reported as surrogate indicators of support surface efficacy. However, the relevance of interface pressure measurement is questionable given wide inter-individual responses to applied loads (see Etiology of Pressure Ulcers section of the full Clinical Practice Guideline).

1. **Use a high specification reactive foam mattress rather than a non high specification reactive foam mattress for all individuals assessed as being at risk for pressure ulcer development.** (Strength of Evidence = A; Strength of Recommendation =  )

Studies that have compared standard and alternative foam mattresses generally fail to provide an adequate description of the “standard hospital mattress” used as a comparator.
A systematic review\(^{13,14}\) pooled the results of five randomized controlled trials (RCTs) comparing foam alternatives with the standard hospital foam mattress. The meta-analysis concluded that high specification foam mattresses are associated with a significant reduction in pressure ulcer incidence in at risk individuals when compared to standard hospital foam mattresses. Studies that have compared standard and alternative foam mattresses varied in quality, and all failed to adequately define a “standard hospital mattress”, limiting comparison between the separate studies. Some of the individual studies only reported Category/Stage II or greater pressure ulcer incidence and some included Category/Stage I pressure ulcers in the reported incidence rate. McInnes et al. (2011)\(^{14}\) concluded that high specification foam mattresses reduced the incidence of pressure ulcers in individuals at risk (risk ratio \([RR] = 0.40\)) (Level I study).

Russell et al. (2003)\(^{15}\) conducted one of the RCTs reported in the McInnes et al. review.\(^{13,14}\) This study involved 1,168 participants from elderly acute care, orthopedic, and rehabilitation wards. The experimental group (\(n = 562\)) received a viscoelastic polymer foam mattress, and the control group (\(n = 604\)) received a standard hospital foam mattress. The primary outcome in this study was non-blanchable erythema (Category/Stage I pressure ulcer). A non-significant decrease in the incidence of Category/Stage I pressure ulcers occurred in participants allocated to the experimental group (10.9% to 8.5%, \(p = 0.17\)). However, survival analysis (at seven days) showed a statistically significant decrease in Category/Stage I pressure ulcers in the experimental group (\(p = 0.042\)) (Level 1 study).

Berthe et al. (2007)\(^{16}\) performed a RCT that included participants in medical and surgical units (\(n = 1,729\)). The experimental group had foam mattresses with block structure, and the control group was on standard hospital mattresses. No significant difference in pressure ulcer incidence was found between the experimental and control group (\(p = 0.154\)). However, the time to develop a pressure ulcer was longer in the group with the alternative foam mattress (31 days) than in the control group (18 days) (\(p < 0.001\)) (Level 1 study).

In a small RCT, Gray et al. (2000)\(^{17}\) compared a new foam mattress (\(n = 50\)) to a standard hospital foam mattress (\(n = 50\)). One hundred participants from surgical, orthopedic, and medical wards were recruited. There was no significant difference between the two groups in Category/Stage II to IV pressure ulcer incidence (2% in both populations). This study has a number of methodological flaws (Level 2 study).

There is no evidence of the superiority of one higher specification foam mattress over any other higher specification foam mattresses. In their systematic review, McInnes et al. (2011)\(^{14}\) pooled five RCTs that compared different higher specification foam mattresses. They found no apparent differences in the incidence of pressure ulcers that develop among individuals resting upon the mattresses.

1.1. **Review the characteristics of foam mattresses used in the facility for pressure ulcer prevention to ensure they are high specification.** (Strength of Evidence = C; Strength of Recommendation = \(\blacksquare\,\blacksquare\))

Table 1 outlines consensus opinion on the minimum characteristics for a product to be considered a high specification foam mattress.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Explanation</th>
<th>High specification mattress</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Classification</strong></td>
<td>Classification according to the Australian Standards (AS2281-1993).(^{19})</td>
<td>Type H/HR(^{19,,20}) H - conventional resilience, heavy duty</td>
</tr>
<tr>
<td>Characteristic</td>
<td>Explanation</td>
<td>HR - high resilience</td>
</tr>
<tr>
<td>------------------------------</td>
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<td>----------------------</td>
</tr>
<tr>
<td><strong>Density – hardness in single layer mattresses</strong></td>
<td><strong>Density</strong> is the weight of the foam in kilograms per cubic meter kg/m³ (pounds per cubic foot [PCF]). <strong>Hardness</strong> is the ability of foam to ‘push back’ and carry weight, and is defined as the amount of force (in Newtons) required to indent a sample of the foam by a specific percentage of the original thickness. This is known as the indentation force deflection (IFD). In Australia and Europe hardness is measured at 40% IFD and in US hardness is measured at 25% IFD. <strong>Density/hardness</strong> defines the grade of foam and is stated with density followed by hardness.</td>
<td>35 kg/m³ (2.18 PCF)</td>
</tr>
<tr>
<td><strong>Support factor</strong></td>
<td>Support factor is a component of comfort that is calculated as a ratio: IFD at 65% IFD at 25% = support factor. A higher value usually indicates a softer feel and good base support.</td>
<td>IFD: 1.75 to 2.4,¹⁹</td>
</tr>
<tr>
<td><strong>Depth</strong></td>
<td>Consider depth of the mattress alongside density/hardness. Different foam grades require different depth to manage upper body weight and prevent ‘bottoming out’.</td>
<td>150 mm (5.9 inches),²² Mattress depth needs increasing to support bariatric load.²³</td>
</tr>
<tr>
<td><strong>Mattress cover</strong></td>
<td><strong>Vapour permeability:</strong> the relevant measurement is moisture vapour transmission rate (MVTR). Increasing the MVTR potentially allows the trans-epidermal water loss (TEWL) of intact skin to transpire through the cover. Decreasing the MVTR of the cover protects the foam from moisture degradation. Changing the MVTR becomes a compromise between managing local climatic conditions and the individual’s TEWL. <strong>Allows for partial immersion in foam</strong> <strong>Wrinkling:</strong> may add additional pressure at skin surface <strong>Shear resistance:</strong> can be reduced with a low friction fabric.²⁵ <strong>Infection control:</strong> • water proofing – prevents contamination of foam • welded seams prevent ingress of fluids • waterfall flap cover over zips • cleaning according to facility protocol and manufacturers guidelines. <strong>Fire retardant properties:</strong> material must meet local standards.</td>
<td>MVTR: minimum 300 g/m²/24hrs. (equivalent to normal TEWL) Often 2 way stretch</td>
</tr>
<tr>
<td><strong>Other considerations</strong></td>
<td><strong>Multi-layering</strong> of various grades / types of foam alters the design features <strong>Low resilience/slow recovery/memory foam/viscoelastic:</strong> increases the surface area contact, redistributes pressure, reduces peak pressures and allows immersion of bony prominences. Has potential to increase skin surface temperature. <strong>Castellated/cross-cut foam:</strong> partial thickness cuts made in a regular block pattern on the top of the foam increases surface contact area, potentially reducing friction and shear.²⁸</td>
<td>Hardness may increase from 130 Newtons for the base layer. Hardness may decrease in upper layers and may be less than the minimum standard for a single layer mattress</td>
</tr>
<tr>
<td>Characteristic</td>
<td>Explanation</td>
<td>High specification mattress</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Side walls</td>
<td>a border or stiffener along the edge increases firmness and assists mobility and transfers</td>
<td></td>
</tr>
<tr>
<td>Safety sides (concave shape)</td>
<td>may reduce risk of falls but may also reduce bed mobility, need to consider facility restraint policy</td>
<td></td>
</tr>
<tr>
<td>Hinging system</td>
<td>wedges removed on inner border to allow for folding/bending of mattress to accommodate back rest, upper and lower leg sections to conform to profiling beds</td>
<td></td>
</tr>
</tbody>
</table>

1.2. Consider using other reactive support surfaces for individuals assessed as being at risk for pressure ulcer development. (Strength of evidence = C; Strength of Recommendation = )

Johnson et al.29, 30 conducted a prospective study (n = 297) investigating the prevalence of facility-acquired pressure ulcers in a community hospital. The study compared pressure ulcer prevalence rates in general surgical and medical telemetry units in which participants were cared for on low-air-loss beds to cardiac, renal and medical pulmonary units that had standard hospital mattresses (specifications were not defined). Although no significant differences in prevalence rates of facility-acquired pressure ulcers were noted, the study did not address confounding issues, including significantly higher Braden Scale scores in the population cared for on low-air-loss beds (Level 3 study).

A small, Dutch study.31 included in the McInnes et al. review.13, 14 compared polyether foam to static air overlay mattress in a sample of nursing home residents (n = 83). The study concluded that fewer participants on the air mattress overlay developed Category/Stage II or greater pressure ulcers but difference was not significant (p = 0.088) (Level 2 study).

Black et al. (2012)32 compared a low-air-loss bed with microclimate control to an integrated powered air redistribution bed without low-air-loss for prevention of pressure ulcers in an intensive care unit (ICU) cohort (n = 52). Findings from this study indicated that the low-air-loss surface was more effective than intermittent pressure mattresses in preventing and treating pressure ulcers (0% versus 18%, p = 0.046) over a short time frame (mean follow up period was 5.7 days) (Level 3 study).

2. Use an active support surface (overlay or mattress) for individuals at higher risk of pressure ulcer development when frequent manual repositioning is not possible. (Strength of Evidence = B; Strength of Recommendation = )

In the McInnes et al. systematic review,13, 14 data from two studies comparing active support surfaces and standard mattresses were pooled. The results suggested that fewer pressure ulcers develop on active support surfaces as compared to standard hospital mattresses. However, the poor quality of these trials must be acknowledged, and the evidence is dated (many of the support surfaces are no longer available).

In one RCT23 reported in the McInnes et al. review,14 Vanderwee et al. (2005)23 compared alternating pressure air mattresses with no turning protocol to high specification foam mattresses with four-hourly repositioning in 447 participants from surgical, internal medicine, and geriatric wards. This study showed no significant difference between the incidence of Category/Stage II or greater pressure ulcers among individuals cared for either on an active support surface (15.6%) or on a high specification foam mattress (15.3%). There were more heel ulcers in the control group and more severe ulcers in the treatment group. However, the high incidence of pressure ulcer development and presence of full thickness ulcers in both groups must be acknowledged (Level 1 study).
In a small RCT also included in the McInnes et al. review, Sanada et al. (2003) assigned 82 participants (individuals who had experienced a stroke, recovering from surgery or with a terminally illness) to either of two types of active support surfaces (n = 29 and n = 26) or a standard hospital mattress (n = 27). Incidence of Category/Stage I to IV pressure ulcers on the active support surfaces was 19.2% and 3.4%, respectively, and 37% on the standard hospital mattress (p < 0.01). However, the methodological flaws in this study should be recognized (Level 2 study).

In another RCT, Vermette et al. (2012) compared an air-inflated overlay with a micro-fluid overlay for preventing pressure ulcers in participants (n = 110) in a range of acute and long term care facilities who were assessed as being at moderate to high risk. There were no statistically significant differences between the two active support surface overlays when compared on pressure ulcer incidence (4% for the air inflated overlay versus 11% for the micro-fluid overlay, p = 0.2706) or participant rated comfort (p = 0.7129). The micro-fluid overlay was reported to be more expensive (p ≤ 0.001) (Level 1 study).

The evidence suggests that active support overlays and mattresses have a similar efficacy in terms of reducing pressure ulcer incidence. Nixon et al. (2006) undertook a multicenter RCT to assess the effectiveness of alternating pressure mattress replacements and alternating pressure mattress overlays. Acute and elective individuals admitted to vascular, orthopedic, medical, and geriatric wards were included in the trial (n = 1,971). The incidence of Category/Stage II or greater pressure ulcers for those on an alternating overlay was 10.7% (106 out of 989) and 10.3% (101 out of 982) for those on an alternating replacement mattress (p = 0.75). No significant difference in pressure ulcer incidence was seen between the alternating overlay and mattress replacement; however more individuals on the overlay requested to be changed to another device, and the alternating pressure mattress was more cost effective than an alternating pressure overlay (data not presented) (Level 1 study).

The currently limited evidence suggests that alternating pressure active support surfaces with different deflation/inflation cycles also have a similar efficacy. In a RCT conducted in 25 hospital wards in Belgium, Demarré et al. (2012) compared alternating low pressure air mattresses with different deflation/inflation cycles. The experimental group (n = 298) were cared for on alternating low pressure air mattresses with a multi-stage deflation/inflation cycle of between 10 and 12 minutes. The control group (n = 312) had alternating low air pressure mattresses with a standard 10 minute deflation/inflation cycle. There was no significant difference in the cumulative incidence of Category/Stage II to IV pressure ulcers between the experimental group and the control group (5.7% versus 5.8%, p = 0.97). The median time to develop a pressure ulcer also was not significantly different between the experimental group and the control group (five days versus eight days, p = 0.182). There appears to be no benefit of alternating low pressure with multi-stage inflation/deflation cycles over a standard cycle alternating low pressure air mattress in preventing pressure ulcers (Level I study).

2.1. Do not use small cell alternating pressure air mattresses or overlays. (Strength of Evidence = B; Strength of Recommendation = ⬤)

The recommendation to avoid using small cell alternating pressure mattresses and overlays has been retracted. In one older study pressure ulcers occurred more frequently in individuals who received a small cell mattress (diameter 1.5 to 2 inches or 3.8 to 5.1 cm) compared with a large cell mattress (diameter 6 inches or 15.25 cm). However, both the mattresses trialled in this study used technology and materials that are outdated and the results cannot be extrapolated to contemporary technologies. In another study, the two trial mattresses with different cell sizes also differed with respect to other components of product design and function. When selecting an alternating pressure mattress or overlay the choice should be individualized according to pressure ulcer risk, comfort of the individual and effectiveness determined through regular skin assessments. Further information is available at http://internationalguideline.com/statements.
Mattress and Bed Support Surfaces for Individuals with Existing Pressure Ulcers

Individuals with an existing pressure ulcer are at higher risk for developing additional pressure ulcers.

1. **Wherever possible, do not position an individual on an existing pressure ulcer. (Strength of Evidence = C; Strength of Recommendation = †)***

   This statement is based on expert opinion. When ulcers are present on two or more turning surfaces (e.g., the sacrum and trochanters) the individual will need to be repositioned on the ulcers, because she or he cannot continuously lie on the same turning surface.36,40

2. **Consider replacing the mattress with a support surface that provides more effective pressure redistribution, shear reduction, and microclimate control for the individual if he or she:**
   - cannot be positioned off the existing pressure ulcer;
   - has pressure ulcers on two or more turning surfaces (e.g. the sacrum and trochanter) that limit turning options;
   - fails to heal or demonstrates ulcer deterioration despite appropriate comprehensive care;
   - is at high risk for additional pressure ulcers; and/or
   - ‘bottoms out’ on the existing support surface. (Strength of Evidence = C; Strength of Recommendation = †)

   This statement is based on expert opinion. Unless the individual’s clinical condition has changed (e.g., the individual is now mobile, awake, and has adequate perfusion), the support surface on which the pressure ulcer developed usually does not provide an appropriate environment for healing. A different support surface is often required to provide better pressure redistribution and control microclimate, thus reducing further ischemia in pressure ulcers.

   When pressure ulcers deteriorate or fail to heal, the clinician should consider replacing the existing support surface with one that will provide a properly matched support surface environment in terms of pressure, shear, and microclimate for the individual. Changing the support surface is only one of several strategies to consider. More frequent repositioning of the individual may be needed (see the Repositioning and Early Mobilization section of the full Clinical Practice Guideline). The individual and his or her pressure ulcer should be re-evaluated (see the Assessment of Pressure Ulcers and Monitoring of Healing section of the full Clinical Practice Guideline). Preventive interventions and local wound care should also be intensified as needed.

   When the individual has pressure ulcers on two or more sites on the trunk of the body, options for repositioning are diminished. The individual will spend relatively more time on unaffected areas of the body therefore prevention becomes even more crucial in individuals at risk of forming additional ulcers. ‘Bottoming out’ on a support surface (i.e., when the support surface does not properly support the individual) is a clear indication that pressure redistribution is inadequate and the surface must be changed.

   Cassino et al. (2013)41 compared two different reactive support overlays for managing individuals with an existing Category/Stage I to IV pressure ulcer. Participants were assigned to a gel overlay (n = 37) or an overlay described as a three dimensional (3D) macro-porous, multilayer, polyester overlay (n = 35) for 12 weeks. Approximately 30% of participants in both groups were suspended from the study due to deteriorating pressure ulcer condition (p = not significant [ns] between groups). There was no significant difference in the number of pressure ulcers that resolved (8.57% for gel versus 13.5% for 3D, p = ns). Although the 3D overlay was reported to be associated with greater reduction in pressure ulcer surface area, the results were not convincing as there were numerous methodological flaws. The researchers cautioned that as neither overlay offloaded pressure, the potential for healing was limited (Level 2 study).

3. **Before replacing the existing mattress:**
• evaluate the effectiveness of previous and current prevention and treatment plans; and
• set treatment goals consistent with the individual’s goals, values, and lifestyle. (Strength of Evidence = C; Strength of Recommendation = ★★★)

Support surfaces may be cumbersome to get in and out of, noisy if powered, or frightening if the surface is moving. Ascertain the individual’s comfort, concerns and preferences when considering a support surface change.

4. Consider using a high specification reactive foam mattress or nonpowered pressure redistribution support surface for individuals with Category/Stage I and II pressure ulcers. (Strength of Evidence = C; Strength of Recommendation = ★★★)

Individuals with an existing pressure ulcer are at higher risk for developing additional pressure ulcers. In many cases, a small Category/Stage I or II pressure ulcer can be easily offloaded with repositioning, such as turning side to side (for sacral ulcers) or using heel elevation. However, clinical judgment may lead the health professional to change surfaces in high risk or hemodynamically unstable individuals with Category/Stage I or II pressure ulcers, particularly if there are multiple ulcers at multiple sites or the individual cannot be moved off the pressure ulcer.

There is no evidence that powered support surfaces with air fluidized, low air loss and/or alternating pressure features are more effective than other high specification support surfaces for the treatment of existing Category/Stage I and II pressure ulcers.

Other powered support surfaces have been used clinically for Category/Stage I and II pressure ulcers. Some evidence found that pressure ulcers heal on powered support surfaces; however, methodological limitations of these studies reduced the ability to recommend these support surfaces for individuals with Category/Stage I and II pressure ulcers (Level 5 studies). Although powered support surfaces may support healing, nonpowered surfaces may be sufficient.

Nixon et al. (2006) reported on 113 participants with Category/Stage II ulcers randomized to receive either an alternating pressure overlay or an alternating pressure mattress replacement. There was no significant difference between groups for median time to healing (20 days for each group, p = 0.86). Complete healing between the two groups was also comparable (35% healed in the mattress group and 34% healed in the overlay group). The findings suggest that for alternating pressure support surfaces neither a mattress nor an overlay is superior when compared on clinical outcomes alone (Level 1 study).

5. Select a support surface that provides enhanced pressure redistribution, shear reduction, and microclimate control for individuals with Category/Stage III, IV, and unstageable pressure ulcers. (Strength of Evidence = B; Strength of Recommendation = ★★★)

Randomized controlled trials compare healing rates for Category/Stage III and IV pressure ulcers on a range of different support surfaces. It is difficult to make definitive recommendations based on these studies due to differences in the support surfaces tested, variations in outcome measures (i.e., complete healing, time to healing, reduction in wound size, or assessment of wound improvement/deterioration), small sample sizes, and other methodological inconsistencies. There is insufficient evidence on which to base definitive recommendations for using one surface over another.

The results of properly designed and conducted RCTs that examined the effects of support surfaces on the healing of Category/Stage III and IV pressure ulcers are summarized below. Most of these studies were published between 1987 and 2005. Since that time, support surface technology has improved for powered surfaces as well as nonpowered surfaces that served as comparisons in these early studies. Despite these limitations, the studies cited below continue to constitute the best available evidence. This guideline update did not identify new RCTs of healing of Category/Stage III and IV pressure ulcers on nonpowered surfaces published between January 2008 and July 2013. The results of recent lower quality studies did not add new insights due to limitations such as low methodological quality of the
design of the study, lack of blinding and lack of standardized treatment. Furthermore, no distinction was made between the treatment of Category/Stage I and II pressure ulcers and Category/Stage III, IV and unstageable pressure ulcers.

**Beds with air fluidized features** produced better healing outcomes for Category/Stage III and IV pressure ulcers than standard beds (Level 2 study), alternating air with foam pad (Level 1 study), and a variety of non-air fluidized support surfaces. In addition to these RCTs published in the 1980s and early 1990s, Ochs et al. (2005) conducted a retrospective chart review study and reported better weekly healing rates associated with beds with air fluidized features. This study had multiple design flaws, and the results should be reviewed with caution (Level 3 study).

**Beds with low-air-loss features** resulted in better healing outcomes for Category/Stage III and IV pressure ulcers than foam mattresses in a 1993 study. Results indicated that there was a 2.5 fold improvement in healing rates on the low-air-loss beds (Level 1 study).

**Mattresses and overlays with alternating pressure features** are recommended and used by clinicians for treatment of pressure ulcers; however, no published studies demonstrating better healing outcomes for Category/Stage III or IV pressure ulcers in comparison to other types of support surfaces were identified.

**Other powered and nonpowered support surfaces** have been used clinically for Category/Stage III, IV, and unstageable pressure ulcers. Pressure ulcers have healed on powered and nonpowered support surfaces (Level 1 study), (Level 3 study), and (Level 5 studies). However, no publications that met inclusion criteria for this guideline revision provided evidence for a statistically significant effect of these surfaces on healing of Category/Stage III, IV, and unstageable pressure ulcers.

6. **Select a support surface that provides enhanced pressure redistribution, shear reduction, and microclimate control for individuals with suspected deep tissue injury if pressure over the area cannot be relieved by repositioning.** (Strength of Evidence = C; Strength of Recommendation = )

This statement is based on expert opinion. Support surface use in suspected deep tissue injury with intact skin has not been rigorously examined in clinical trials. The true level and degree of tissue damage cannot be determined until the deep tissue injury fully evolves. At early stages of evolution (when the skin is still intact), offloading and pressure redistribution may allow reperfusion of ischemic and injured tissue, limiting the extent of infarcted or dead tissue. Infarcted tissue is not salvageable. For all practical purposes, evolving deep tissue injury should be provided the same level of pressure redistribution as a Category/Stage III or IV pressure ulcer. Once the ulcer has fully evolved, support surface needs can be re-evaluated.

**General Recommendations on Seating Support Surfaces**

When a person is seated, her or his body weight is supported by a relatively small surface area (i.e., buttocks, thighs, and feet), leading to high interface pressures combined with limited opportunities to redistribute body weight to other anatomical sites. Prolonged sitting results in a strong predisposition to pressure ulcer development, particularly in the ischial area.

1. **Individualize the selection and periodic re-evaluation of a seating support surface and associated equipment for posture and pressure redistribution with consideration to:**
   - body size and configuration;
   - the effects of posture and deformity on pressure distribution; and
   - mobility and lifestyle needs. (Strength of Evidence = C; Strength of Recommendation = )

2. **Select a stretchable/breathable cushion cover that fits loosely on the top surface of the cushion and is capable of conforming to the body contours.** (Strength of Evidence = C; Strength of Recommendation = )
This statement is based on expert opinion. A tight, nonstretch cover will adversely affect cushion performance. Covers that fit loosely on the top surface and those that are made from a stretch material are better-suited to let the cushion material deform as intended to allow immersion.

2.1. Assess the cushion and cover for heat dissipation. Select a cushion and cover that permit air exchange to minimize temperature and moisture at the buttock interface. (Strength of Evidence = C; Strength of Recommendation = )

This statement is based on expert opinion. Evidence suggests that a rise in tissue temperature increases the susceptibility to pressure ulcers.61,62

3. Inspect and maintain all aspects of a seating support surface to ensure proper functioning and meeting of the individual’s needs. (Strength of Evidence = C; Strength of Recommendation = )

This statement is based on expert opinion. Seating cushions should be inspected for signs of wear on a daily basis. The support surface (chairs and wheelchairs) should be inspected according to the manufacturer’s recommendations.

4. Provide complete and accurate training on use and maintenance of a seating support surface (including wheelchairs) and cushion devices delivered to the individual. (Strength of Evidence = C; Strength of Recommendation = )

Seating Support Surfaces to Prevent Pressure Ulcers

1. Use a pressure redistributing seat cushion for individuals sitting in a chair whose mobility is reduced. (Strength of Evidence = B; Strength of Recommendation = )

Ensure that selection of a pressure redistributing seat cushion is appropriate to the individual. The Special Populations: Bariatric Individuals section of the full Clinical Practice Guideline provides recommendations on selection of equipment for bariatric individuals. The full Clinical Practice Guideline section Special Populations: Individuals with Spinal Cord Injury provides recommendations and discussion on seating surfaces for individuals with SCI.

Geyer et al. (2001)63 conducted a RCT as a pilot study involving 32 elderly residents of two skilled nursing facilities. Among the inclusion criteria was the individual’s ability to tolerate sitting in a wheelchair for at least six hours each day. The experimental group (n = 15) received a pressure redistributing cushion, and the control group (n = 17) received a foam cushion. In total, 16 out of 32 participants developed pressure ulcers, and there were no significant differences between the groups. When looking only at ischial pressure ulcers, the incidence was significantly lower in the experimental group (p < 0.005) (Level 2 study).

Brienza et al. (2010)64 conducted a randomized trial in nursing home clients (n = 180) comparing pressure ulcer incidence over a six month period. The study group were provided with a fitted wheelchair and randomized into skin protection (n = 113) seated on an air, viscous fluid and foam cushion; or a gel and foam cushion. The control group received a 7.6 cm crosscut segmented foam cushion (n = 119). The control group experienced a significantly greater incidence of ischial tuberosity pressure ulcers (6.7% versus 0.9%, p = 0.04). When the ischial tuberosity pressure ulcers were combined with sacral pressure ulcers, the incidence was not significantly different between groups (17.6% control group versus 10.6% experimental group, p = 0.14). Kaplan Meier methods did not demonstrate significant differences in the cumulative incidence of pressure ulcers between the groups. There was no control for conditions outside of chair time, frequency of repositioning was not reported and staff were aware of participation in the study (Level 2 study).

Collins (1999)65 performed a non-randomized controlled trial involving elderly individuals in acute care (n = 40). The experimental group had armchairs with pressure redistribution cushions, padded armrests, and side wings to support the head, and the control group had standard armchairs with
foam on the seat. The experimental group developed significantly fewer pressure ulcers (p < 0.0001) (Level 3 study).

Defloor et al. (2000)\textsuperscript{66} investigated different types of cushion including air, water, hollow fiber, foam, combination gel and foam, and sheepskin (n = 28 cushions) in a laboratory study involving healthy volunteers. Interface pressure was measured after one hour of immobilization. When cushions were combined according to type, the air cushion category had the lowest interface pressure (t = –6.40, 95% CI –9.17 to –4.65, p < 0.01 versus armchair); however, water cushions and foam cushions did not differ significantly to air cushions. Within the foam cushion category (n = 9 cushions) there was a significant difference between the various cushion types, with the two visco-elastic foam cushions having maximum interface pressures approximately 38% higher than the armchair (p < 0.01). Cushions with the lowest maximum interface pressure were described by the manufacturers as polyethylene-urethane (7 cm, 85 kg/m\textsuperscript{3}), polymer (no specifications), vinyl (no specifications) and shock absorbing polyester foam (60 kg/m\textsuperscript{3}). Many of the gel cushions, combination cushions and the synthetic sheepskin had negligible impacts on interface pressures (all p = ns versus armchair) (indirect evidence).

Seating Support Surfaces for Individuals with Existing Pressure Ulcers

1. Refer individuals to a specialist seating professional for evaluation if sitting is unavoidable. (Strength of Evidence = C; Strength of Recommendation = )

2. Select a cushion that effectively redistributes the pressure away from the pressure ulcer. (Strength of Evidence = C; Strength of Recommendation = )

These statements are based on expert opinion. Cushion construction achieves pressure redistribution in one of two basic methods: immersion/envelopment or redirection/off-loading. Envelopment is the capability of a support surface to deform around and encompass the contour of the body. Cushions that utilize envelopment must deflect and deform to immerse the buttocks in the material. Flat cushions must deflect more than contoured cushions. The anthropometrics of the pelvis require about 50mm (2 inches) of immersion for effective envelopment due to the inferior position of the ischial tuberosities (assuming there is no asymmetry in the pelvis). Cushions that redirect loads accomplish this via relief areas in the cushion surface. Some require customization. Off-loading cushions generally require that the individual sit on the cushion in a specific, consistent manner. Therefore, the assessment must include a determination on the individual’s ability to consistently reproduce this position, and confirmation that no significant functional tradeoffs occur.

3. Use alternating pressure seating devices judiciously for individuals with existing pressure ulcers. Weigh the benefits of off-loading against the potential for instability and shear based on the construction and operation of the cushion. (Strength of Evidence = C; Strength of Recommendation = )

Alternating pressure seating devices have been used in many clinical settings.\textsuperscript{45} A study by Burns et al. (1999)\textsuperscript{67} concluded that there is a similar relief in pressure over the ischial tuberosities between a dynamic cushion during the low pressure phase compared with a tilt-in-space wheelchair with a conventional cushion. Individual responses to the high pressure phase may vary. Because the potential for shear across alternating cells exists, the effect on the individual should be carefully observed.

Wheelchairs equipped with an individually adjusted automated seat providing cyclic pressure relief using a protocol of ten minutes normal sitting and ten minutes offloaded sitting may enhance pressure ulcer closure and decrease wound area. A RCT (n = 44) conducted by Maksous et al. (2009)\textsuperscript{68} found significantly more improvement in pressure ulcer area closure and Pressure Ulcer Scale for Healing (PUSH) score in individuals using an automated, cyclic relief seat compared with individuals in a standard wheelchair who performed arm push-ups for pressure relief every 20 or 30 minutes. The group using the cyclic pressure relief seating system achieved a mean 45 ± 21% improvement in mean pressure ulcer surface area compared with 10.2 ± 34.8% improvement in the control group (p<0.001).
As the study did not address possible differences between groups in preventive measures provided when the individuals were not seated, differences in wound care/dressings, and pressure ulcers size at baseline, it was not possible to recommend an adjusted automated seat above a standard wheelchair with a manual pressure relief regimen (Level 2 study).

References

59. Ochs RF, Horn SD, van Rijswijk L, Pietsch C, Smout RJ. Comparison of air-fluidized therapy with other support surfaces used to treat pressure ulcers in nursing home residents. Ostomy Wound Management. 2005;51(2):38-68.
GLOSSARY OF TERMS – SUPPORT SURFACES EXTRACT

Bolster pad: A pad used as a support.

Bony prominence: A bony elevation or projection on an anatomical structure.¹

Bottoming out: Occurs when a reactive or an active support surface provides insufficient support to adequately redistribute pressure due to excessive immersion.² The individual presents as sitting or lying on the underlying structure of the bed or chair.

Coefficient of friction: A measurement of the amount of friction existing between two surfaces.³

Contour seating: A seating product that increases contact area with the body by providing a contour that resembles the typical human form.

Friction (frictional force): The resistance to motion in a parallel direction relative to the common boundary of two surfaces, e.g., when skin is dragged across a coarse surface, such as bed linens.³

Functionality: This refers to the intended, proper use for which the product was designed.

Functional life span: The designated time period for which a support surface was designed and intended to fulfill its original function.

Interface pressure: The force per unit area that acts perpendicularly between the body and a support surface. This parameter is affected by the stiffness of the support surface, the composition of body tissue, and the geometry of the body being supported.¹

Integrated bed system: A bed frame and support surface that are combined into a single unit whereby the surface is unable to function separately.³

Lateral rotation therapy: A continuous, slow rotation cycle that redistributes pressure in high-risk, critically ill individuals. The degree of rotation can be adjusted to the individual’s tolerance, although it is commonly set at 40° in cases of respiratory distress. Specific criteria for the use of this therapy have been established.⁴⁻⁶

Microclimate: The local tissue temperature and moisture (relative humidity) level at the body/support surface interface.³

Offload: To remove pressure from any area.

Overlay: An additional support surface designed to be placed directly on top of an existing surface.

Pressure: Normal force per unit surface area.

Pressure ulcer (pressure injury): a localized injury to the skin and/or underlying tissue, usually over a bony prominence, as a result of pressure or pressure in combination with shear. A number of contributing or confounding factors are also associated with pressure ulcers; the significance of these factors has yet to be elucidated. Previously referred to as decubitus ulcer, bedsore and pressure sore.

Reposition: A change in position in the lying or seated individual, with the purpose of relieving or redistributing pressure and enhancing comfort, undertaken at regular intervals.

Standard hospital mattress: A term used to describe the standard mattress provided within a facility and generally used as the comparative intervention in research trials investigating the effectiveness of pressure redistribution support surfaces. As such, the qualities of a standard hospital mattress vary according to historical and clinical context and are rarely reported in detail in clinical trials. In most cases it is assumed that a standard hospital mattress is a non-powered foam or spring-based mattress.
Strain: A measurement of relative deformation.

Stress: Force transferred per unit area.

Support surface: A specialized device for pressure redistribution designed for management of tissue loads, microclimate, and/or other therapeutic functions. Support surfaces include but are not limited to mattresses, integrated bed systems, mattress replacements or overlays, or seat cushions and seat cushion overlays.

Support surfaces: physical concepts:

- **Active support surface**: A powered support surface that produces alternating pressure through mechanical means and has the ability to change its load distribution properties with or without an applied load.2

- **Coefficient of friction**: A measurement of the amount of friction existing between two surfaces.3

- **Envelopment**: The ability of a support surface to conform to irregularities in the body.3, 7, 8

- **Fatigue**: The reduced capacity of a surface or its components to perform as specified. This change may be the result of intended or unintended use and/or prolonged exposure to chemical, thermal, or physical forces.3

- **Force**: A push/pull vector with magnitude (quantity) and direction (pressure and shear) that is capable of maintaining or altering the position of a body.3, 9

- **Friction (frictional force)**: The resistance to motion in a parallel direction relative to the common boundary of two surfaces.3

- **Immersion**: The depth of penetration (sinking) into a support surface.3, 7, 8

- **Life expectancy**: The defined period of time during which a product is expected to effectively fulfill its designated purpose.3

- **Mechanical load**: The force distribution acting on a surface.3

- **Pressure**: The force per unit area exerted perpendicular to the plane of interest.3

- **Pressure redistribution**: The ability of a support surface on which an individual is placed to distribute load over the contact areas of the human body, thereby reducing the load on areas in contact with the support surface. This term replaces prior terminology of pressure reduction and pressure relief surfaces.3

- **Pressure relief**: see Pressure redistribution.

- **Reactive support surface**: A powered or non-powered support surface with the ability to change its load distribution properties only in response to applied load.3, 10, 11

- **Shear (shear stress)**: The force per unit area exerted parallel to the plane of interest.3, 9

- **Shear strain**: The distortion or deformation of tissue as a result of shear stress.3, 9, 12

Support surfaces: components: The components of any support surface described below may be used alone or in combination.

- **Air**: A low-density fluid with minimal resistance to flow.3

- **Cell/bladder**: A means of encapsulating a support medium.3

- **Closed-cell foam**: A non-permeable structure in which there is a barrier between cells, preventing
gases or liquids from passing through the foam.  

**Elastic foam**: A type of porous polymer material that conforms in proportion to the applied weight. Air enters and exits the foam cells more rapidly due to greater density (non-memory).  

**Elastomer**: Any material that can be repeatedly stretched to at least twice its original length. Upon release, the stretch will return to approximately its original length.  

**Gel**: A semi-solid system of a network of solid aggregates, colloidal dispersions, or polymers, which may exhibit elastic properties. Gels can range from hard to soft.  

**Open cell foam**: A permeable structure in which there is no barrier between cells, and gases or liquids can pass through the foam.  

**Pad**: A cushion-like mass of soft material used for comfort, protection, or positioning.  

**Solid**: A substance that does not flow perceptibly under stress. Under ordinary conditions, it retains its size and shape.  

**Viscoelastic foam**: A type of porous polymer material that conforms in proportion to the applied weight. The air enters the foam cells slowly, which allows the material to respond more slowly than a standard elastic (memory) foam.  

**Viscous fluid**: A fluid with a relatively high resistance to flow of the fluid.  

**Water**: A moderate density fluid with moderate resistance to flow.  

**Support surface features**: A feature is a functional component of a support surface that can be used alone or in combination with other features.  

**Air fluidized**: A feature that provides pressure redistribution via a fluid-like medium created by forcing air through beads, as characterized by immersion and envelopment.  

**Alternating pressure**: A feature that provides pressure redistribution via cyclic changes in loading and unloading, as characterized by frequency, duration, amplitude, and rate of change parameters.  

**Lateral rotation**: A feature that provides rotation about a longitudinal axis, as characterized by degree of turn, duration, and frequency.  

**Low air loss**: A feature that provides a flow of air to assist in managing the heat and humidity (microclimate) of the skin.  

**Multi-zoned surface**: A surface in which different segments can have different pressure redistribution capabilities.  

**Zone**: A segment with a single pressure redistribution capability.  

**Support surface categories**:  

**Active support surface**: A powered support surface with the capability to change its load distribution properties, with or without applied load.  

**Integrated bed system**: A bed frame and support surface that are combined into a single unit, whereby the surface is unable to function separately.  

**Mattress**: A support surface designed to be placed directly on the existing bed frame.  

**Non-powered**: Any support surface that does not use external sources of energy, either electric or battery, for operation.
**Overlay:** An additional support surface designed to be placed directly on top of an existing surface.\(^3,10,11\)

**Powered:** Any support surface requiring or using external sources of energy to operate, either electric or battery.\(^3\)

**Reactive support surface:** A powered or non-powered support surface with the capability to change its load distribution properties only in response to applied load.\(^3\)

**Suspected deep tissue injury:** Purple or maroon localized area of discoloured, intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, or warmer or cooler than adjacent tissue. Deep tissue injury may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark wound bed. The wound may further evolve and become covered by thin eschar. Evolution may be rapid exposing additional layers of tissue even with treatment.

**Unstageable pressure ulcer:** Full thickness tissue loss in which actual depth of the ulcer is completely obscured by slough (yellow, tan, gray, green, or brown) and/or eschar (tan, brown, or black) in the wound bed. Until enough slough and/or eschar is removed to expose the base of the wound, the true depth cannot be determined, but it will be either a Category III or IV pressure ulcer. Stable (dry, adherent, intact, without erythema or fluctuance) eschar on the heels serves as a natural (biological) cover and should not be removed.

**References**

7. Jay E. How different constant low pressure support surfaces address pressure and shear forces. Durable Medical Equipment Review. 1995;2(2):60-7