Identifying the Right Surface for the Right Patient at the Right Time: Literature Review and a Draft Algorithm for Support Surface Selection

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ABSTRACT

The use of support surfaces is an integral component of pressure ulcer prevention programs and treatment recommendations, but there is insufficient evidence to guide support surface selection, particularly for the treatment of pressure ulcers. In an effort to provide clinical guidance for selecting support surfaces to match individual patient needs, the Wound, Ostomy and Continence Nurses Society (WOCN®) set out to develop an evidence- and consensus-based algorithm. With this aim, they assembled a Task Force of key opinion leaders who: 1.) identified and categorized levels of supportive evidence for the use of support surfaces for the prevention and treatment of pressure ulcers; 2.) developed an evidence-based draft algorithm for support surface selection; 3.) developed draft consensus statements for decision points in the draft algorithm not supported by high-level evidence and for providing ancillary information; and 4.) determined face validation of the draft algorithm. The results of these initial steps toward this goal are reported here. The next steps in this process, the gathering of experts in the field to achieve consensus on these draft statements and to provide input and validate the content of the support surface selection algorithm, are presented in a companion article, *Identifying the right surface for the right patient at the right time: Consensus statements and a content-validated algorithm for support surface selection.*

Short title: A Draft Algorithm for Support Surface Selection

Keywords: Support surface, algorithm, pressure ulcer, prevention, treatment

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The content of this document is based on the results of a 1-day roundtable discussion held in Philadelphia, Pennsylvania on March 29, 2014, and multiple web-based teleconferences held prior to and following the roundtable and is part of a larger initiative resulting in a content-validated algorithm. The information contained herein does not necessarily represent the opinions of all authors, Hill-Rom, or Magellan Medical Technology Consultants.

INTRODUCTION

Support surfaces comprise a variety of overlays, mattresses, and integrated bed systems used to redistribute pressure, reduce shearing forces, and control heat and humidity. The use of support surfaces is included in virtually all evidence-based clinical practice guidelines as a component of comprehensive pressure ulcer prevention programs and treatment recommendations.[1-4] Although a number of support surfaces have been shown to reduce the incidence of pressure ulcers or facilitate healing when compared with standard mattresses, there is insufficient evidence to guide support surface selection to match individual patient needs in many situations. Clinical trial findings are often of limited use due to inconsistencies in how the surfaces are classified, limitations in research design, and the age of many studies. Results of 4 high-quality systematic reviews[5-8] document the lack of evidence regarding the superiority of one type of support surface over another, and comparative evidence in the treatment of pressure ulcers is particularly inconclusive.

In an effort to provide clinical guidance for selecting support surfaces to match individual patient needs, the Wound, Ostomy and Continence Nurses Society (WOCN®) sought to develop an evidence- and consensus-based algorithm. With this aim, they assembled a Task Force of key opinion leaders to: 1.) identify and categorize levels of supportive evidence for the use of support surfaces for the prevention and treatment of pressure ulcers; 2.) develop an evidence-based draft algorithm for support surface selection; 3.) develop draft consensus statements for decision points in the draft algorithm not supported by high-level evidence; and 4.) determine face validation of the draft algorithm. The results of these tasks are reported here. Subsequently, a consensus panel of 20 key opinion leaders convened to achieve consensus on the draft statements, to provide feedback and modify the draft algorithm, and to subject the algorithm to

content validation. The results of this Support Surface Consensus Conference are reported in a companion article, *Identifying the right surface for the right patient at the right time: consensus statements and a content-validated algorithm for support surface selection.*

METHODS

Support Surface Consensus Task Force. Three WOCN members with clinical expertise in pressure ulcer prevention (LM, DM, and CW) were invited to act as an Advisory Task Force for the project. They identified relevant terms for a comprehensive literature search, reviewed the literature and identified key publications, categorized levels of supportive evidence for the use of support surfaces for the prevention and treatment of pressure ulcers, formulated the draft algorithm and consensus statements, performed face validation of the algorithm, and served as authors for this manuscript. At the recommendation of the Task Force, Mikel Gray was invited to assist in an advisory role and serve as moderator for the Consensus Conference. Dr. Gray has expertise in facilitating and moderating consensus conferences and is knowledgeable about, but not directly vested in, the issue of support surface selection and did not participate in the voting process. Janice Beitz was invited to assist in an advisory role regarding algorithm development and content validation.

Planning and Facilitation. Magellan Medical Technology Consultants, Inc. of Minneapolis, MN, was contracted to plan and facilitate the developmental process and the Consensus Conference. Magellan supported the Task Force in their advisory role by moderating bi-weekly teleconferences or web conferences; performing the literature search and organizing and circulating search results, publications, draft consensus statements, and draft algorithms;

assisting in facilitating and coordinating the Conference; and providing writing, editorial, and data analysis assistance.

Literature Review. The initial literature search was conducted from December 2013 through April 2014. A comprehensive search of support-surface-related terms published in English since 1993 was conducted using the following electronic databases: Agency for Healthcare Research and Quality (AHRQ) Evidence Reports and Technology Assessments, CINAHL, the Cochrane Database of Systematic Reviews, and MEDLINE. Additional sources included AHRQ publications and the Blue Cross and Blue Shield Center for Clinical Effectiveness (formerly the Technology Evaluation Center). Search terms identified by the Task Force and Boolean functions were incorporated to capture all variations on support surfaces or to serve as search limiters. They were: 1.) bed OR mattress OR sleep surface OR support surface AND: air-fluidized, active, algorithm, alternating-air/pressure, bariatric, bead, clinical pathways, critical care, decision tree, decubitus ulcer, fluid, foam, gel, high/low air loss, hospital, integrated, interactive, interface pressure, nonpowered, overlay, powered, pressure mapping, pressure redistribution, pressure reducing/reduction, pressure relief/relieving, pressure ulcer, reactive, sand, smart, specialty, static air, therapeutic/therapy, tissue interface pressure, tissue tolerance, treatment, and water. 2.) prevention AND: friction, heat, humidity, microclimate, pressure, pressure ulcer, shear, friction coefficient, integrated bed system, pressure redistribution, support surface, tissue tolerance. The MeSH (Medical Subject Heading) term "beds" was also combined with the subheading "adverse effects" and the text words "friction" or "shear." An additional search was conducted for relevant clinical practice guidelines or procedures not previously

identified. Additional relevant publications were submitted by Task Force members or identified as a result of ancestry search.

Search results (n=1309) included systematic reviews, integrative reviews, randomized clinical trials, comparison cohort studies, case studies, clinical practice guidelines, practice surveys, laboratory studies, research studies, technical articles, letters to the editor, and product-related articles. Older reviews, individual case reports, letters to the editor, and single-product evaluations were excluded along with publications deemed not relevant to the topic. The remaining 342 abstracts were reviewed by the Task Force for relevance and redundancy. To obtain a manageable cross-section of key publications for consensus statement development and background information, each publication was ranked as "keep" or "discard" by Task Force members. Seventy-two key publications were rated as "keep" by 3 of 3 members and an additional 70 publications were rated as "keep" by 2 of 3 members.

Identification of Supporting Evidence. Included in the key publications were 4 high-quality systematic reviews with meta-analysis; 2 were retrieved from the Cochrane Collaboration Library of Systematic Reviews[5,6] and 2 were retrieved from the AHRQ.[7,8] As these 4 systematic reviews rigorously evaluated the existing literature and are widely accepted and globally recognized, the Task Force elected to use them as primary resources for identification of existing evidence concerning use of support surfaces for pressure ulcer prevention and treatment, as well as in the generation of a draft algorithm. Key publications, which included individual studies cited in the Cochrane and AHRQ reviews; studies published after the literature review timeframes for the systematic reviews; and clinical practice guidelines; were utilized as supporting documentation.

Evidence-based statements related to general principles and recommendations for support surface usage derived from primary and supporting evidence were formulated and categorized into levels based on strength of evidence as defined in Table 1. Statements supported by A- or B-level evidence were referred to as "evidence-based statements" and considered to be statements of fact. Statements that lacked sufficient evidence to be considered statements of fact, ie, those supported by C-level evidence, were defined as "consensus statements" and would be subjected to voting. As it was anticipated that skin and pressure ulcer risk assessments would be incorporated into the algorithm, general principles for these assessments, mainly best clinical practice from existing guidelines (ie, WOCN,[1] National Pressure Ulcer Advisory Panel [NPUAP],[2] and Association for the Advancement of Wound Care [AAWC][3]), were also included as evidence-based statements, but strength of evidence levels were not determined.

Support Surface Terminology. Inconsistencies in support surface terminology were noted during literature review, making interpretation of the data difficult in some cases. Therefore, prior to developing the draft algorithm and consensus statements, the Task Force set out to identify and define a standard set of terms. Uniform terms and definitions related to support surfaces were developed by the NPUAP Support Surface Standards Initiative (S3I) in 2007 to enable global consistency with support surface device nomenclature.[9] The decision was made to use these terms and definitions at a starting point because they provide a common language regarding support surface design and technology and are designed to be clearly understood by clinicians, engineers, and the support surface industry.

Draft Algorithm and Consensus Statement Development. The Task Force and Drs. Janice Beitz and Mikel Gray convened for a full-day workshop in Philadelphia, PA, on March 29, 2014, to determine the target audience for the support surface algorithm, identify inclusions and exclusions, and develop an initial version of the draft algorithm. When possible, evidence-based statements related to general principles and recommendations for use of support surfaces for prevention or treatment of pressure ulcers were incorporated into the algorithm or were included in the associated tables or as footnotes. Draft consensus statements were developed by the Task Force to support decision points within the draft algorithm that were not supported by moderate to high levels of existing evidence (Levels A or B) or to provide ancillary information. The draft algorithm and consensus statements were subsequently refined during bi-weekly web conferences.

Face Validation. Members of the Task Force, individually and as whole, assessed the face validity of the draft algorithm at multiple points in its development by identifying representative patient scenarios at their facilities and creating hypothetical scenarios and following each patient through the algorithm to ensure that the processes followed (eg, assessments, considerations, reassessments), decision points, and interim and end results (eg, recommendations for use of a particular type of support surface, a change in support surface) were comprehensive, feasible, and appropriate.

RESULTS

Support Surface Terminology

Due to inconsistencies noted during literature review, support surface terminology was a topic of considerable discussion during this developmental phase. Selected terminology regarding components, features (ie, functional components of a support surface that can be used alone or in combination with other features), and categories of support surfaces used or defined in this initiative are listed in Table 2. Additional terms are defined in the Glossary (see Box A). For our purposes, *support surface* was defined as: *a specialized device (ie, any overlay, mattress, or integrated bed system) for pressure redistribution designed for management of pressure, shear, or friction forces on tissue; microclimate; or other therapeutic functions.* Although the NPUAP S3I definition of support surface includes seat cushions and seat cushion overlays, these were not included in this initiative. The NPUAP S3I defines *reactive support surface*[9] but does not define the commonly used term *constant low pressure (CLP) support surface,* a term that is also used in the Cochrane systematic reviews.[5,6] Therefore, a draft definition of this term was developed to obtain consensus. Although the Cochrane systematic reviews include Australian Medical-grade sheepskin overlays under the category of CLP devices, we refer to these overlays separately due to their unique properties and limited availability. No standardized definition for a "standard mattress" was identified. The "standard" used in many comparative support surface studies was often not well defined and the term may differ among care settings and geographic areas; it has also changed over time (eg, spring hospital mattresses being replaced by standard foam).[6,7] Therefore, the Task Force put forth this working definition of standard mattress: *a mattress not intended to prevent or treat pressure ulcers.*

Evidence-based Statements

1. Skin Inspection and Assessment

1.1 A head-to-toe skin inspection should be performed and documented upon entry to a health care setting, focusing on high risk areas such as bony prominences.[1-3]

1.2 Five parameters for skin assessment include skin temperature, skin color, skin texture and turgor, skin integrity, and moisture status.[1-3]

1.3 Skin reassessment should be performed per specific care setting protocol.[1-3]

2. Pressure Ulcer Risk Assessment

2.1. Pressure ulcer risk assessment should be performed upon entry to a health care setting, and repeated on a regularly scheduled basis as per care setting or facility protocol, or when there is a significant change in the individual's condition, such as surgery, decline in health status, or a positive change/improvement.[1-3]

2.2. Use of a valid and reliable risk assessment tool is recommended.[1-3]

2.3. Individuals should be assessed for other intrinsic and extrinsic risk factors for pressure ulcer development.[1-3]

Although pressure is the major causative factor in pressure ulcer formation, a variety of intrinsic and extrinsic factors affect tissue tolerance and therefore, skin breakdown and healing.[14] Individuals should be assessed for risk factors for pressure ulcer development, such as those listed in Table 3.

3. General Recommendations for Support Surfaces

3.1. Support surfaces are not a stand-alone intervention for the prevention and treatment of pressure ulcers, but are to be used in conjunction with proper nutritional support, moisture management, pressure redistribution when in bed and chair, turning

and repositioning, risk identification, and patient and caregiver education.[1,2]

Current pressure ulcer clinical practice guidelines identify use of support surfaces as one of several components of pressure ulcer prevention programs and pressure ulcer treatment care plans.[1,2]

3.2. Support surfaces do not eliminate the need for turning and repositioning.[1,2]

The damaging effects of pressure are related to both its magnitude and duration. It is important to distinguish between the rationale for intervention with a support surface—pressure redistribution away from bony prominences to reduce the magnitude of tissue load—with that of turning and repositioning, which reduces the duration of tissue load.[16] Duration is also addressed with active support surfaces, but even these surfaces do not eliminate the need for turning and repositioning.

3.3. Consider concurrent use of a pressure-redistribution seating surface or cushion of an appropriate type along with the use of any support surface.[1]

3.4. Consider product lifespan when choosing a support surface.[2]

3.5. When choosing a support surface, consider contraindications for use of specific support surfaces as specified by the manufacturer.

Use of specific types of support surfaces may be contraindicated under certain conditions (eg, use of a less stable support surface for individuals with an unstable spine). Likewise, there may be situations where specific types of support surface should be used with caution (eg, use of support surfaces with low air loss [LAL] or air fluidized [AF] features in patients in an agitated state due to the lack of firmness of the surface).

3.6. To achieve the full benefits of a support surface, the support surface must be functioning properly and used correctly according to manufacturer's instructions.[2]

4. Use of Support Surfaces to Prevent Pressure Ulcers

4.1. High-specification foam mattresses are more effective in reducing the incidence of pressure ulcers in persons at risk than standard hospital foam mattresses. (Strength of Evidence = A)

The superior efficacy of high-specification foam mattresses compared to standard hospital foam mattresses has been demonstrated in multiple individual studies in patients at varying levels of risk,[6,7] in a pooled analysis of 5 trials with groups of unequal size and varying risk,[6] and in a pooled analysis of 4 trials conducted in the United Kingdom.[6] A randomized trial comparing 4 preventative schemes to assess the effect of turning with different intervals on the development of pressure ulcers in 838 geriatric nursing home patients demonstrated that turning every 4 hours on a viscoelastic foam mattress significantly decreased the number of Stage II and higher pressure ulcers compared with turning every 2 or 3 hours on a standard institutional mattress.[17]

4.2. There is no evidence of the superiority of any one high-specification foam mattress over an alternative high-specification foam mattress. (Strength of Evidence = A)

A pooled analysis of 5 randomized clinical trials (RCTs) comparing various high-specification foam mattresses (ie, contoured foam, different foam densities) showed no evidence that one particular type of high-specification foam was superior to another.[6]

4.3. Sheepskin overlays (Australian Medical-grade) are effective in reducing the incidence of pressure ulcers compared to standard care. (Strength of Evidence = A)

Medical-grade sheepskin that conforms to Australian Standard AS 4480.1-1997[12] for size, performance criteria, and wool characteristics, which has not been available for purchase in

the United States, is now available through online distributors. Based on a pooled analysis of 3 trials, Medical-grade sheepskin overlays were shown to be effective in reducing the incidence of all grades of pressure ulcers compared to standard care (ie, use of a standard hospital mattress, repositioning, or use of any other pressure-relieving device or prevention strategy with or without other constant low pressure [CLP] devices).[6,7]

4.4. There is insufficient evidence to determine comparative effectiveness of various reactive/CLP support surfaces.

Systematic reviews of head-to-head comparisons of various reactive/CLP support surfaces, including Australian Medical-grade sheepskin and foam; static air-, water-, gel-, or silicone-filled devices do not provide sufficient evidence to determine the comparative effectiveness of these surfaces.[6,7]

4.5. Active support surfaces with an alternating pressure (AP) feature are more effective than standard hospital mattresses in the prevention of pressure ulcers. (Strength of Evidence = B)

Results of 3 low-quality comparative studies showed a lower incidence of pressure ulcers with support surfaces (mattresses or overlays) with an AP feature compared with standard hospital mattresses (foam, high-specification foam, or not specified).[7] A pooled analysis of 2 of these studies showed the reduction in development of pressure ulcers with use of AP devices to be statistically significant compared with standard hospital mattresses (foam or not specified).[6]

4.6. Overlays and mattresses with AP features demonstrate similar efficacy in reducing pressure ulcer incidence. (Strength of Evidence = B)

No significant differences between overlays and mattresses with AP features with regard to

pressure ulcer incidence (Stage II or greater) were seen in one large, high quality study[18] cited in two systematic reviews.[6,7]

4.7. Mattresses with a multi-stage AP feature are more effective than overlays with an AP feature in preventing full thickness pressure ulcers. (Strength of Evidence = A)

The air cells in mattresses with a single-stage AP feature, as well as those in overlays with an AP feature, inflate and deflate in a single step, whereas the air cells of more recent mattresses with a multi-stage AP feature inflate and deflate in a gradual, stepwise fashion, under the premise that tissue damage is decreased by gradual re-perfusion of ischemic tissue.[19] In one large RCT, mattresses with multi- and single-stage AP features were shown to be equally effective in preventing pressure ulcers.[13] Pooled data from this study and that from a second RCT where patients were randomized to an overlay with an AP feature or a viscoelastic foam mattress[20] showed that fewer pressure ulcers and severe pressure ulcers developed on mattresses with a multi-stage AP feature compared to the overlays with an AP feature when controlling for Braden score and age.[21]

4.8. Mattresses with a single-stage AP feature and overlays with an AP feature are equally effective for prevention of partial thickness pressure ulcers. (Strength of Evidence = A)

Pooled data from the two RCTs cited in the previous statement[13,20] showed no difference in time to ulcer development and incidence of superficial pressure ulcers between mattresses and overlays with a single-stage AP feature.[21]

4.9. Postoperative use of a support surface reduces the incidence of surgery-related pressure ulcers. (Strength of Evidence = A)

A meta-analysis of 10 studies (including 7 RCTs) of various design involving a variety of

support surfaces demonstrated a significantly decreased incidence of surgery-related pressure ulcers in patients provided a support surface postoperatively, but not intraoperatively, compared to patients provided a standard foam mattress.[22] However, the quality of the individual studies in this analysis is relatively poor, and other factors and comorbidities may impact development of pressure ulcers in this setting. In addition, there is a large variation with regard to time of reporting incidence among the studies, with some timeframes as short as day 1 to 2 and day 1 to 3, which may not accurately capture the evolution of suspected deep-tissue injury (sDTI). Thus, additional research is needed to determine the impact of postoperative support surface use on the evolution of sDTI.

5. Use of Support Surfaces in the Treatment of Pressure Ulcers

5.1. There is insufficient evidence to suggest that there are differences among the efficacies of reactive/CLP devices, AP devices, LAL therapy, profiling beds, or Australian Medical-grade sheepskin for the treatment of existing pressure ulcers.

The use of support surfaces for the treatment of pressure ulcers has been less frequently studied than their use for prevention in patients at risk. Systematic reviews of head-to-head comparisons of various support surfaces do not provide sufficient evidence to determine the comparative effectiveness of these surfaces. [5,8]

Draft Support Surface Algorithm

During development of the draft support surface algorithm, it was decided that the algorithm be designed for the selection of support surfaces, including overlays, mattresses, and integrated bed systems, for prevention and treatment of pressure ulcers (excluding medical device-related

pressure ulcers). The target audience for use of this algorithm was defined to include nurses; physicians; advanced practitioners such as nurse practitioners, clinical nurse specialists, physician assistants; physical therapists; and occupational therapists. The algorithm was to be designed to be used for adult patients (including morbidly obese individuals) across the entire continuum of care, including acute care (ie, intensive care, medical-surgical, rehabilitation, orthopedics, emergency department), long-term acute care, long-term care/skilled nursing, and home care settings. This algorithm was not to be designed for use in neonates, infants, or children and adolescents less than 16 years of age, and selected settings (operating room and interventional diagnostic suite) where the length of stay is less than 24 hours. Use of seating surfaces and cushions, continuous lateral rotation mattresses, and other special purpose beds or surfaces, such as those for proning, multiple fractures, and unstable spine, would not be incorporated into this algorithm.

The steps in the draft support surface algorithm and applicable supporting references are listed in Table 4. Users enter the algorithm at the point of the initial skin assessment, which is followed by pressure ulcer risk assessment. Based on risk for development of pressure ulcers (Braden score cut-off of 18[24]) or presence of pressure ulcers, users are directed to pathways for pressure ulcer prevention or treatment. Suggested support surface selections based primarily on Braden moisture and mobility subscale scores are provided, as well as guidance regarding performance of skin and pressure ulcer risk reassessments, determining need for a change in or removal from a support surface, and support surface contraindications. Additional information regarding precautions and contraindications was also provided.

Members of the Task Force, individually and as a whole, confirmed the face validity of the draft algorithm by following representative patient scenarios through the algorithm to ensure

that the processes followed, decision points, and interim and end results were comprehensive, feasible, and appropriate. However, the draft algorithm presented here does not represent the final algorithm that has undergone subsequent review by a larger audience and content validation (see accompanying article).

Draft Consensus Statements

A draft consensus definition and consensus statements developed by the Task Force to support decision points within the draft algorithm that were not supported by moderate to high levels of existing evidence or to provide ancillary information are listed in Box B.

DISCUSSION

In an effort to provide clinical guidance for selecting support surfaces to match individual patient needs, we set out to develop an evidence- and consensus-based algorithm. Herein we present the results of our initial steps toward this goal. We identified a limited amount of high-level supportive evidence for the use of support surfaces for the prevention and treatment of pressure ulcers; evidence for treatment of pressure ulcers was particularly scarce. Inconsistencies in support surface terminology were noted, making interpretation of the data difficult at times, and defining terminology to be used was a topic of considerable discussion as a result. Despite the high-level clinical evidence supporting the effectiveness of Australian Medical-grade sheepskin in the prevention of pressure ulcers, there was a spirited debate regarding the inclusion of these overlays as a suggested support surface due to their limited availability and usage in the United States.

Based on available evidence and expert opinion, we developed a draft algorithm for support surface selection. After extensive discussion of the Braden subscale scores, it was felt that nutritional needs, which are critical, are relatively well met in most care settings. Based on level C evidence (expert consensus), it was determined that the moisture and mobility subscale scores were highly indicative of risk for development of pressure ulcers across all care settings. We decided to focus on these subscale scores as a significant component of the algorithm for support surface selection.

The Braden Scale is a valid and reliable predictor of pressure ulcer risk,[23] but alone, its use in clinical practice does not reduce the risk of pressure ulcers to zero.[25,26] As a result, there has been increasing interest in investigating whether patient outcomes may be improved by tailoring pressure ulcer prevention strategies to individual subscale scores.[27-30] It is possible for a patient to have a low risk of pressure ulcer development based on total Braden score, yet have a subscale score that may suggest increased risk, and retrospective studies and literature reviews have suggested that various subscale scores may be predictive of pressure ulcer development.[28,31-34] Limited evidence suggests that subscale scores influence nurses' endorsement of various preventive interventions.[35] However, in practice, the relative contributions of the total Braden score, Braden subscale scores, and clinical judgment, and experience in clinical decision-making are not known. Our draft algorithm was face validated, suggesting that the use of Braden mobility and moisture subscale scores to guide support surface selection is a feasible option.

Following development of the draft algorithm, draft consensus statements were developed to address decision points in the algorithm not supported by high-level evidence and to provide ancillary information. The next steps in the overall process, the gathering of experts in

the field to achieve consensus on these draft statements and to provide input and content validation of the support surface selection algorithm, are presented in the companion article.

LIMITATIONS

High-level evidence regarding comparative efficacy of support surfaces and their optimal usage in specific patient populations and in conjunction with other therapeutic modalities is lacking, particularly for individuals with existing pressure ulcers, therefore there is insufficient published evidence on which to base selection decisions. Many of the comparative studies subjected to substantive review were conducted over a decade ago; support surface technology has changed considerably over time and some of the support surfaces are no longer in use. In addition, inconsistencies in support surface terminology were noted, making interpretation of the data difficult. Although subject to face validation, the draft algorithm presented here does not represent the final algorithm that has undergone subsequent review by a larger audience and content validation (see companion article). Clinical evidence regarding use of the combination of Braden moisture and mobility subscale scores as predictors of pressure ulcer risk or as a means to tailor prevention strategies is also lacking. The presented consensus statements represent drafts that have not yet been voted on for consensus.

CONCLUSION

In an effort to provide clinical guidance for selecting support surfaces to match individual patient needs, the WOCN set out to develop an evidence- and consensus-based algorithm. Based on a limited amount of high-level supportive evidence for the use of support surfaces for the prevention and treatment of pressure ulcers, in addition to expert opinion, a draft algorithm was

developed for support surface selection that utilizes Braden mobility and moisture subscale scores to help guide this selection. The draft algorithm was face validated and draft consensus statements were developed for decision points in the draft algorithm not supported by high-level evidence and to provide ancillary information. The next steps in this process, the gathering of experts in the field to achieve consensus on these draft statements and to provide input and validate the content of the support surface selection algorithm, are presented in the companion article.

KEY POINTS

- High-level evidence regarding comparative efficacy of support surfaces and their optimal usage in specific patient populations and in conjunction with other therapeutic modalities is lacking, particularly for individuals with existing pressure ulcers.
- In an effort to provide clinical guidance for selecting support surfaces to match individual patient needs, an evidence- and consensus-based draft algorithm for support surface selection that utilizes Braden mobility and moisture subscale scores to help guide selection was developed and face validated.
- Draft consensus statements were drafted for decision points in the draft algorithm not supported by high-level evidence and to provide ancillary information.
- The results reported here are part of a larger initiative resulting in a content-validated algorithm, which is reported in a companion article.

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Table 1: Strength of Evidence Levels for Statements Related to Support Surface Usage and Selection

Level	Supported by:
A	Consistent findings from 2 or more randomized controlled trials (RCTs) or a systematic review with meta-analysis (pooled data)
B	Consistent findings from 1 RCT or >1 nonrandomized clinical trial or inconsistent (mixed) evidence from 2 or more RCT or systematic reviews with meta-analysis
C	Expert opinion based on consensus among clinical experts, findings from a single nonrandomized clinical trial, case study, or series of clinical case studies

Table 2: Terminology Related to Support Surfaces[a]

Term	Definition
Support surface	*Project definition:* A specialized device (ie, any overlay, mattress, or integrated bed system) for pressure redistribution designed for management of pressure, shear, or friction forces on tissue; microclimate; or other therapeutic functions
Standard mattress	*Project definition:* A mattress not intended to prevent or treat pressure ulcers
Components of Support Surfaces	
Closed cell foam	Nonpermeable structure in which there is a barrier between cells, preventing gases/liquids from passing through the foam
Open cell ("high-specification") foam	Permeable structure in which there is no barrier between cells and gases/liquids can pass through the foam.[9] Includes elastic (nonmemory) and viscoelastic (memory) foam, types of porous polymer materials that conform in proportion to the applied weight[10]
Gel	Semisolid system consisting of a network of solid aggregates, colloidal dispersions or polymers, which may exhibit elastic properties
Fluid	Substance that has no fixed shape and yields easily to external

	pressure; a gas or (especially) a liquid[11]
Features of Support Surfaces	
Air fluidized (AF)	Provides pressure redistribution via a fluid-like medium created by forcing air through beads as characterized by immersion and envelopment
Alternating pressure (AP)	Provides pressure redistribution via cyclic changes in loading and unloading as characterized by frequency, duration, amplitude, and rate of change parameters
Low air loss (LAL)	Provides a flow of air to assist in managing the heat and humidity (microclimate) of the skin
Zone[b]	A segment with a single pressure redistribution capability
Multi-zoned surface[b]	A surface in which different segments can have different pressure redistribution capabilities
Categories of Support Surfaces	
Reactive support surface[c]	A powered or nonpowered support surface with the capability to change its load distribution properties only in response to applied load
Constant low pressure (CLP) support surface[c]	*Draft definition:* A support surface that is not active (ie, it will move or change load-distribution properties only in response to an applied load Includes alternative, contoured, or textured foam; gel or silicone;

	fiber; viscous fluid; static air-, water-, or bead-filled mattresses or overlays; and Australian Medical-grade sheepskin[5]
Active support surface	A powered support surface, with the capability to change its load distribution properties, with or without applied load
Overlay	An additional support surface designed to be placed directly on top of an existing surface
Integrated bed system	A bed frame and support surface that are combined into a single unit whereby the surface is unable to function separately

[a] Unless otherwise noted, all information is adapted from the National Pressure Ulcer Advisory Panel Support Surface Standards Initiative.[9]

[b] May refer to reactive or CLP support surfaces with or without an LAL feature, or active support surfaces with an AP feature.

[c] The definitions for *reactive* and *CLP support surface* were later combined during the Consensus Conference, with a reactive/CLP support surface being defined as: *a powered or non powered support surface that provides pressure redistribution in response to an applied load (patient) through immersion and envelopment* (see companion article). Due to the distinct properties and limited availability of Australian Medical-grade sheepskin overlays, these devices are discussed separately from other CLP products.

Table 3. Intrinsic and Extrinsic Risk Factors for Pressure Ulcer Development[1-3,14,15]

Intrinsic Factors	**Extrinsic Factors**
• Advanced age • Reduced mobility or activity levels • Presence of fever • Poor dietary intake of protein/impaired nutritional status • Diastolic pressure <60 mmHg • Anemia • Generalized edema • Hemodynamic instability • Comorbid conditions (ie, renal disease, diabetes, cardiovascular disease, pulmonary disease, neuromuscular disease, connective tissue and skin disorders, immunosuppression, etc.) • Presence of new-onset infection (ie, urinary tract, pneumonia, *Clostridium difficile*) • History of pressure ulcers • Smoking history or current smoker	• Pressure • Shear • Friction • Heat • Moisture (ie, sweat, urine, feces, wound drainage, etc.) • Recent surgery, particularly operative procedures lasting >3 hours

Table 4: Steps in the Draft Support Surface Algorithm

Algorithm Step	**Supporting References**
Skin and Pressure Ulcer Risk Assessment	
1. Assess and document a complete skin assessment for intact/nonintact skin.	1-3
2. Assess and document a pressure ulcer risk assessment using the Braden scale.	1-3, 14
3. Following risk assessment, if patient not at risk for development of pressure ulcers (Braden >18) and has intact skin, continue using current support surface, pending skin reassessment as per care setting.	
4. Following risk assessment, if patient is at risk for development of pressure ulcers (Braden ≤18) and has intact skin, use support surface (preventative).	1-3
Following risk assessment of a patient with nonintact skin:	
5. Determine presence and location of pressure ulcers.	
6. If no pressure ulcer(s) are present, and patient is not at risk for development of pressure ulcers (Braden >18), treat per facility/department protocol.	
7. If no pressure ulcer(s) are present, but patient is at risk for development of pressure ulcers (Braden ≤18), treat per facility/department protocol and consider use of a support surface.	1-3
8. If pressure ulcer(s) are present but not on the trunk, treat per facility/department protocol and consider use of a support surface (treatment).	

9. If pressure ulcer(s) are present and on the trunk, consider use of a support surface (treatment).	1-3
Prevention of Pressure Ulcers	
1. Consider Braden subscale scores for moisture and mobility (≥3 or ≤2).[a]	
2. Support surface options: high-specification foam or Australian Medical-grade sheepskin, constant low pressure (CLP), alternating pressure (AP), or low air loss (LAL).	6, 7, 17, 21
3. If Braden moisture or mobility subscale score is ≤2, choose support surface based on: Current patient characteristics and risk factors: weight and weight distribution, fall/entrapment risk, risk for developing new pressure ulcers; previous support surface usage; contraindications. Suggested support surface options: CLP, AP, or LAL; choice dependent on specific score combination.	
4. If Braden moisture and mobility subscale scores are both ≥3, select high-specification foam or Australian Medical-grade sheepskin.	
5. Skin reassessment as per care setting.	1-3
6. Pressure ulcer risk assessment (consider patient weight and weight distribution as well as comorbidities and other contextual factors).	1-3, 14
7. For intact skin not at risk for development of pressure ulcers (Braden >18), off support surface.	
8. For intact skin at risk for development of pressure ulcers (Braden ≤18), continue using current support surface.	1-3
9. For nonintact skin not at risk for development of pressure ulcers (Braden >18), continue using current support surface.	

10. For nonintact skin at risk for development of pressure ulcers (Braden ≤18), switch to support surface (treatment).	
Treatment of Pressure Ulcers	
1. Consider Braden moisture and mobility subscale scores (≥3 or ≤2).	
Treatment support surface options: high-specification foam, CLP, AP, LAL, or air fluidized (AF).	5,8
2. If Braden moisture or mobility subscale score is ≤2, choose support surface based on: current patient characteristics and risk factors: weight and weight distribution, fall/entrapment risk, risk for developing new pressure ulcers; previous support surface usage; contraindications. Suggested support surface options: CLP, AP, LAL, or AF; choice dependent on specific score combination**.**	
3. If Braden moisture and mobility subscale scores are both ≥3, select high-specification foam.	
4. Skin reassessment as per care setting.	1-3
5. Pressure ulcer risk assessment (consider patient weight and weight distribution as well as comorbidities and other contextual factors).	1-3, 14
6. For intact skin not at risk for development of pressure ulcers (Braden >18), use preventive support surface.	
7. For intact skin at risk for development of pressure ulcers (Braden ≤18), use preventive support surface.	
8. For nonintact skin not at risk for development of pressure ulcers (Braden >18), keep on treatment support surface or consider a change to a different	

support surface.	
9. For nonintact skin at risk for development of pressure ulcers, (Braden ≤18), modify treatment support surface.	
10. Skin reassessment as per care setting.	1-3

[a] Braden moisture subscale scores are as follows: 1 = constantly moist; 2 = very moist; 3 = occasionally moist; 4 = rarely moist. Braden mobility subscale scores are as follows: 1 = completely immobile; 2 = very limited; 3 = slightly limited; 4 = no limitation.[23] Refer to Appendix 1 for complete Braden scale descriptors.

BOX A

GLOSSARY TERMS

Australian Medical-grade sheepskin: Sheepskin that conforms to Australian Standard AS 4480.1-1997 for size; performance criteria (ie, laundering temperature range up to 60° or 80°C); urine resistance; wool type, wool length (30mm), and final finish; and labeling.[12]

Envelopment: The ability of a support surface to conform to irregularities in the body.[2]

Friction: The resistance to motion in a parallel direction relative to the common boundary of 2 surfaces.[9]

Immersion: Depth of penetration (sinking) into a support surface.[9]

Offload: To remove pressure from any area.[2]

Pressure redistribution: The ability of a support surface on which an individual is placed to distribute the load over the contact areas of the human body, thereby reducing the load on areas in contact with the support surface.[2]

Profiling bed: Motor-driven turning and tilting bed that either aids manual repositioning of the patient or repositions the patient; also known as a kinetic or turning bed.[4]

Repositioning: Involving 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.[2]

Shear: The force per unit area exerted parallel to the plane of interest.[9]

Stage (of AP devices): Referring to the inflation and deflation cycle of the air cells in a support surface with an alternating pressure feature. Single-stage inflation cycles have a relatively steep

transition during inflation and deflation of air cells, whereas the transition is more gradual with multi-stage inflation cycles.[13]

Standard mattress: A mattress not intended to prevent or treat pressure ulcers (Task Force definition).

Suspected deep-tissue injury (sDTI): Purple or maroon localized area of discolored 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. DTI may be difficult to detect in individuals with dark skin tones. Evolution may include a thin blister over a dark ulcer bed. The wound may further evolve and become covered by thin eschar. Evolution may be rapid, exposing additional layers of tissue even with treatment.[2]

Turning: The act of changing position; a component of "turning and repositioning. "[2]

Turning surface: Surface of the body onto which an individual may be turned. Individuals are presumed to have 4 turning surfaces on which to lie (ie, prone, supine, right side, and left side), unless documented otherwise.

BOX B

Draft Consensus Statements

Definition
A CLP support surface is one that is not active (ie, it will move or change load-distribution properties only in response to an applied load).
General Recommendations for Support Surfaces
1. When choosing a support surface, consider current patient characteristics and risk factors, including weight and weight distribution; fall and entrapment risk; risk for developing new pressure ulcers; and number, severity, and location of existing pressure ulcers; as well as previous support surface usage. 2. Persons with Braden mobility subscale scores of 2 or below and Braden moisture subscale scores of 3 or higher should be placed on a CLP or AP support surface.[a] 3. Persons with Braden moisture subscale scores of 2 or below should be placed on an LAL support surface. 4. Persons with Braden moisture subscale scores of 2 or below and who weigh greater than 300 lbs. should be placed on a bariatric LAL support surface. 5. The person who exceeds the weight limit or whose weight distribution exceeds his or her current support surface should be moved to the appropriate Bariatric support surface. 6. For persons who are candidates for progressive mobility, consider a support surface that facilitates egress for ambulation. 7. Persons with fall risk who have, or are at risk for developing, a pressure ulcer should be placed on a low bed with a pressure-redistribution support surface.

8. Persons with pressure ulcers affecting multiple turning surfaces and patients with medical contraindications for turning should be placed on an LAL or AF support surface.
9. Persons experiencing intractable pain should be placed on an LAL or AF support surface.
10. Persons with a myocutaneous flap should be placed on an LAL or AF support surface.

Use of Support Surfaces to Prevent Pressure Ulcers

1. There is no difference between CLP and AP devices for pressure ulcer prevention.
2. Persons with Braden mobility subscale scores of 2 or below who are at risk for the development of pressure ulcers should be placed on a CLP or AP support surface.
3. In the critical care setting, use of an LAL mattress with microclimate management results in a lower incidence of new pressure ulcers than use of an AP mattress.

Use of Support Surfaces in the Treatment of Pressure Ulcers

1. There is no difference between CLP and AP devices for pressure ulcer treatment.
2. Persons with Braden mobility subscale scores of 3 or higher, existing pressure ulcers on the trunk or pelvis, and 2 unaffected turning surfaces should be placed on a high-specification foam support surface.
3. Persons with Braden mobility subscale scores of 2 or below and existing pressure ulcers on the trunk or pelvis, and 2 unaffected turning surfaces should be placed on a CLP or AP support surface.
4. Persons with Braden mobility subscale scores of 2 or below, existing pressure ulcers on the trunk or pelvis, and a moisture subscale score of 1 should be placed on an LAL or AF support surface.
5. Patients with multiple Stage II, or large or multiple Stage III or Stage IV pressure ulcers on the trunk and pelvis involving more than one turning surface should be placed on an LAL or

AF support surface.

6. Persons without significant moisture or mobility issues (ie, Braden mobility and moisture subscale scores of 3 or more) who have multiple ulcers (Stages II-IV) on 2 or more turning surfaces should be placed on a CLP, AP, LAL, or AF support surface.
7. Persons with Braden mobility subscale scores of 2 or below and moisture subscale scores of 3 or more who have multiple ulcers (Stages II- IV) on 2 or more turning surfaces should be placed on an LAL or AF support surface.
8. In the critical care setting, use of an LAL mattress with microclimate management results in a lower likelihood of pressure ulcer progression than use of an AP mattress.
9. In cases of suspected deep-tissue injury (sDTI), early use of an AF mattress reduces the magnitude of tissue loss and prevents full-thickness pressure ulceration.
10. Persons with pressure ulcers on the head, elbows, or lower extremities should be off-loaded per facility protocol and may not require a change in current support surface.
11. If while on an LAL or AF support surface, a patient's condition improves such that the patient no longer has a pressure ulcer or no longer is at risk for the development of a pressure ulcer, the patient should be placed on a CLP, AP, or high-specification foam support surface.

Abbreviations: AF, air fluidized; AP, alternating pressure; CLP, constant low pressure; LAL, low air loss.

[a] Braden moisture subscale scores are as follows: 1 = constantly moist; 2 = very moist; 3 = occasionally moist; 4 = rarely moist. Braden mobility subscale scores are as follows: 1 = completely immobile; 2 = very limited; 3 = slightly limited; 4 = no limitation.[23] Refer to Appendix 1 for complete Braden scale descriptors.

APPENDIX 1

Braden Scale for Predicting Pressure Sore Risk[23]

BRADEN SCALE FOR PREDICTING PRESSURE SORE RISK

Patient's Name _____ Evaluator's Name_____ Date of Assessment

SENSORY PERCEPTION ability to respond meaningfully to pressure-related discomfort	**1. Completely Limited** Unresponsive (does not moan, flinch, or grasp) to painful stimuli, due to diminished level of consciousness or sedation. OR limited ability to feel pain over most of body	**2. Very Limited** Responds only to painful stimuli. Cannot communicate discomfort except by moaning or restlessness OR has a sensory impairment which limits the ability to feel pain or discomfort over ½ of body.	**3. Slightly Limited** Responds to verbal commands, but cannot always communicate discomfort or the need to be turned. OR has some sensory impairment which limits ability to feel pain or discomfort in 1 or 2 extremities.	**4. No Impairment** Responds to verbal commands. Has no sensory deficit which would limit ability to feel or voice pain or discomfort..				
MOISTURE degree to which skin is exposed to moisture	**1. Constantly Moist** Skin is kept moist almost constantly by perspiration, urine, etc. Dampness is detected every time patient is moved or turned.	**2. Very Moist** Skin is often, but not always moist. Linen must be changed at least once a shift.	**3. Occasionally Moist:** Skin is occasionally moist, requiring an extra linen change approximately once a day.	**4. Rarely Moist** Skin is usually dry, linen only requires changing at routine intervals.				
ACTIVITY degree of physical activity	**1. Bedfast** Confined to bed.	**2. Chairfast** Ability to walk severely limited or non-existent. Cannot bear own weight and/or must be assisted into chair or wheelchair.	**3. Walks Occasionally** Walks occasionally during day, but for very short distances, with or without assistance. Spends majority of each shift in bed or chair	**4. Walks Frequently** Walks outside room at least twice a day and inside room at least once every two hours during waking hours				
MOBILITY ability to change and control body position	**1. Completely Immobile** Does not make even slight changes in body or extremity position without assistance	**2. Very Limited** Makes occasional slight changes in body or extremity position but unable to make frequent or significant changes independently.	**3. Slightly Limited** Makes frequent though slight changes in body or extremity position independently.	**4. No Limitation** Makes major and frequent changes in position without assistance.				
NUTRITION usual food intake pattern	**1. Very Poor** Never eats a complete meal. Rarely eats more than ⅓ of any food offered. Eats 2 servings or less of protein (meat or dairy products) per day. Takes fluids poorly. Does not take a liquid dietary supplement OR is NPO and/or maintained on clear liquids or IV's for more than 5 days.	**2. Probably Inadequate** Rarely eats a complete meal and generally eats only about ½ of any food offered. Protein intake includes only 3 servings of meat or dairy products per day. Occasionally will take a dietary supplement. OR receives less than optimum amount of liquid diet or tube feeding	**3. Adequate** Eats over half of most meals. Eats a total of 4 servings of protein (meat, dairy products per day. Occasionally will refuse a meal, but will usually take a supplement when offered OR is on a tube feeding or TPN regimen which probably meets most of nutritional needs	**4. Excellent** Eats most of every meal. Never refuses a meal. Usually eats a total of 4 or more servings of meat and dairy products. Occasionally eats between meals. Does not require supplementation.				
FRICTION & SHEAR	**1. Problem** Requires moderate to maximum assistance in moving. Complete lifting without sliding against sheets is impossible. Frequently slides down in bed or chair, requiring frequent repositioning with maximum assistance. Spasticity, contractures or agitation leads to almost constant friction	**2. Potential Problem** Moves feebly or requires minimum assistance. During a move skin probably slides to some extent against sheets, chair, restraints or other devices. Maintains relatively good position in chair or bed most of the time but occasionally slides down.	**3. No Apparent Problem** Moves in bed and in chair independently and has sufficient muscle strength to lift up completely during move. Maintains good position in bed or chair.					
				Total Score				

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