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WOUND CARE

Identifying the Right Surface for the Right Patient at the Right Time: Generation and Content Validation of an Algorithm for Support Surface Selection

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■ ABSTRACT

Support surfaces are an integral component of pressure ulcer prevention and treatment, but there is insufficient evidence to guide clinical decision making in this area. In an effort to provide clinical guidance for selecting support surfaces based on individual patient needs, the Wound, Ostomy and Continence Nurses Society (WOCN®) set out to develop an evidence- and consensus-based algorithm. A Task Force of clinical experts was identified who: 1) reviewed the literature and identified evidence for support surface use in the prevention and treatment of pressure ulcers; 2) developed supporting statements for essential components for the algorithm, 3) developed a draft algorithm for support surface selection; and 4) determined its face validity. A consensus panel of 20 key opinion leaders was then convened that: 1.) reviewed the draft algorithm and supporting statements, 2.) reached consensus on statements lacking robust supporting evidence, 3.) modified the draft algorithm and evaluated its content validity. The Content Validity Index (CVI) for the algorithm was strong (0.95 out of 1.0) with an overall mean score of 3.72 (out of 1 to 4), suggesting that the steps were appropriate to the purpose of the algorithm. To our knowledge, this is the first evidence and consensus based algorithm for support surface selection that has undergone content validation.

KEY WORDS: Algorithm, Pressure ulcer, Pressure injury, Prevention, Support surface, Treatment

■ 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 nearly all evidence-based clinical practice guidelines as a component of comprehensive pressure ulcer prevention programs and treatment recommendations.[1–5] Although a number of support surfaces have been shown to reduce the incidence of pressure ulcers or facilitate wound healing when compared to standard mattresses, there is insufficient evidence to guide support surface selection to match individual patient needs in many situations. Findings from clinical studies are often of limited use due to inconsistencies in how support surfaces are classified, limitations in research design, and advances in technology since studies were published. Results of 4 high-quality systematic reviews[6–9] reveal insufficient evidence to conclude superiority of one type of support surface over another. Evidence concerning optimal selection of a particular support surface for treatment

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of pressure ulcers is even more limited. Further details of the Study Group findings are available as Supplemental Digital Content (see Supplemental Digital Content 1, http://links.lww.com/JWOCN/A27 and Supplemental Digital Content 2, http://links.lww.com/JWOCN/A28).

In an effort to provide clinical guidance for selecting a support surface based on individual patient needs, the WOCN elected to develop an evidence- and consensus-based algorithm. Society leaders assembled a Task Force of key opinion leaders to: 1) identify and rank levels of evidence for the use of support surfaces for prevention and treatment of pressure ulcers; 2) develop evidence-based statements needed to support the algorithm; 3) develop consensus statements needed to support decisions and pathways not supported by higher level evidence; and 4) determine the face validity of the first draft of the support surface algorithm. Subsequently, a group of 20 key opinion leaders was convened to 1) review the draft algorithm and supporting statements, 2) reach consensus on statements lacking robust supporting evidence, 3) modify the draft algorithm where indicated, and 4) establish its content validity (Box 1).

Task Force

Three WOCN members with clinical expertise in pressure ulcer prevention and treatment were invited to act as a Task Force for generation and validation of a support surface algorithm (CW, DM, LM). They identified search terms for a comprehensive literature search, reviewed the literature and identified key publications, categorized levels of evidence for the use of support surfaces for the prevention and treatment of pressure ulcers, formulated a draft algorithm and evaluated its face validity. Based on recommendation from the Task Force, an experienced moderator (MG) was invited to act in an advisory role to the Task Force and serve as moderator for a consensus conference. The moderator 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. The Task force also sought assistance from an expert in algorithm development (JB) who also has extensive knowledge of support surface selection for prevention and treatment of pressure ulcers. An independent third party (Magellan Medical Technology Consultants, Inc. Minneapolis, MN) was contracted to plan and facilitate the developmental process and consensus conference.

Comprehensive Literature Review

A comprehensive literature search was conducted from December 2013 through April 2014. The following electronic databases were searched: MEDLINE, CINAHL, Agency for Healthcare Research and Quality (AHRQ), Evidence Reports and Technology Assessments, and the Cochrane Database of Systematic Reviews. Additional sources included AHRQ publications and the Blue Cross and Blue Shield Center for Clinical Effectiveness (formerly

BOX 1.

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the Technology Evaluation Center). Search terms identified by the Task Force and Boolean functions were incorporated to capture all pertinent literature. 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." All articles with an English language abstract that were published from 1993 to 2014 were included in the search. An additional search was conducted for relevant clinical practice guidelines or procedures not previously identified. Ancestry searches of key articles were also completed.

The initial search retrieved 1309 citations; they included systematic and integrative reviews, original research reports, preclinical studies (*in vitro* and *in vivo* research), technical articles, letters to the editor, and product-related articles. A title review narrowed the search to 342 citations; redundant publications, individual case reports or case series, letters to the editor, single-product evaluations, and publications deemed not relevant to the topic were eliminated.

Because the purpose of this review was generation of an algorithm rather than creation of a systematic review, the Task Force completed an abstract review of the remaining 342 citations and identified 4 high-quality systematic reviews with meta-analysis; 2 from the Cochrane Collaboration Library of Systematic Reviews[6,7] and 2 from the AHRQ.[8,9] Because the Cochrane Library for Systematic Reviews and US Agency for Health Care Quality are widely accepted as authoritative sources for systematic reviews and meta-analysis, 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. In addition, key publications were identified to aid in algorithm development and provide relevant background; they included integrative and comprehensive review articles not discussed in the 4 systematic reviews and clinical research articles not covered in these authoritative resources. Each article was ranked as "keep" or "discard" by Task Force members. Seventy-two key publications were ranked as "keep" by 3 of 3 members and an additional 70 publications were ranked as "keep" by 2 of 3 members.

Supporting Statements for the Algorithm

The task force then generated statements from the 4 systematic reviews and key publications described above that supported elements of the algorithm including clinical decision points and various pathways within the algorithm. The strength of evidence from these statements were ranked using a 3-point ordinal scale adapted from the Level of Evidence Rating found in the WOCN Clinical Practice Guideline for Prevention and Management of Pressure Ulcers and the Strength of Recommendations Taxonomy (SORT) from the American Academy of Family Physicians[10,11] (Table 1). Statements supported by A- or B-level evidence were deemed "evidence-based" and were used to support elements of the algorithm (Box 2). In contrast, statements supported by C-level evidence were deemed "consensus statements"; they were further subjected to formal consensus among a panel of 20 experts before incorporation into the algorithm (Box 3). The Task Force further acknowledged that skin and pressure ulcer risk assessments and consideration of other risk factors would be incorporated into the algorithm (Table 2). General principles supporting use of these instruments were derived from existing clinical practice guidelines from the WOCN, National Pressure Ulcer Advisory Panel (NPUAP), and Association for the Advancement of Wound Care.[2,3]

Inconsistencies in support surface terminology were detected during the comprehensive literature review, potentially leading to confusion in use of the algorithm in the clinical setting. Therefore, the Task Force identified and used uniform terms and definitions related to support surfaces developed by the NPUAP Support Surface Standards Initiative (S3I) in 2007 to enhance consistency with existing nomenclature (Table 3).[22] Additional terms essential for

TABLE 1.

Levels of Evidence Taxonomy for Supporting Statements

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

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BOX 2.

Evidence-based Statements

1.0 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]

2.0 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]

3.0 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 identify the rationale for intervention with a support surface; it is used for pressure redistribution away from bony prominences to reduce the magnitude of tissue load, as compared to turning and repositioning, which are completed to reduce the duration of tissue load.[12] 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 LAL or 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]

4.0 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,[7,8] in a pooled analysis of 5 trials with groups of unequal size and varying risk,[7] and in a pooled analysis of 4 trials conducted in the United Kingdom.[8] 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.[13]

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 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.[7]

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[14] 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 CLP devices).[7,8]

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.[7,8]

4.5 **Active support surfaces with an 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).[8] 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).[7]

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BOX 2.

Evidence-based Statements (*Continued*)

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[15] cited in two systematic reviews. [7,8]

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.[14] In one large RCT, mattresses with multi- and single-stage AP features were shown to be equally effective in preventing pressure ulcers.[16] 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[17] showed that fewer pressure ulcers and severe pressure ulcers developed on mattresses with a multi-stage AP feature compared with the overlays with an AP feature when controlling for Braden score and age.[18]

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[16,17] showed no difference in time to ulcer development and incidence of superficial pressure ulcers between mattresses and overlays with a single-stage AP feature.[18]

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.[19] 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.

5.0 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.[6,9]

BOX 3.

Consensus Statements

1.0 General Recommendations for Support Surfaces

1.1 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; number, severity, and location of existing pressure ulcers; as well as previous support surface usage and patient preference.

1.2 A person who exceeds the weight limit or whose body dimensions exceed his or her current support surface should be moved to an appropriate bariatric support surface.

1.3 For persons who are candidates for progressive mobility, consider a support surface that facilitates getting out of bed.

1.4 Persons who meet facility protocol for a low bed frame and who have a pressure ulcer, or are at risk for developing a pressure ulcer, should also receive an appropriate support surface.

1.5 Persons who have medical contraindications for turning should be considered for an appropriate support surface and repositioning with frequent small shifts.

1.6 For persons experiencing intractable pain, consider providing an appropriate alternative to the current support surface.

1.7 Persons with a new myocutaneous flap on the posterior or lateral trunk or pelvis should be provided with an appropriate support surface per facility protocol. Minimize the number and type of layers between the patient and the support surface.

2.0 Use of Support Surfaces to Prevent Pressure Ulcers

2.1 There is no difference between reactive/CLP support surfaces and active support surfaces with an AP feature with regard to efficacy in pressure ulcer prevention.

2.2 Persons with Braden mobility subscale scores of 2 or 1 and Braden moisture subscale scores of 4 or 3 should be placed on a reactive/CLP support surface or an active support surface with an AP feature.

3.0 Use of Support Surfaces for Treatment of Pressure Ulcers

(*continues*)

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BOX 3.

Consensus Statements (*Continued*)

3.1 Current evidence suggests there is no difference between reactive/CLP support surfaces and active support surfaces with an AP feature for pressure ulcer treatment.

3.2 Persons with Braden mobility subscale scores of 4 or 3, existing pressure ulcers on the trunk or pelvis, and 2 available turning surfaces should be placed on a reactive/CLP (air, foam, gel, or viscous fluid) support surface.

3.3 Persons with Braden mobility subscale scores of 2 or 1 and Braden moisture subscale scores of 4 or 3 should be placed on a reactive/CLP support surface or an active support surface with an AP feature.

3.4 Persons with Braden mobility subscale scores of 2 or 1, existing pressure ulcers on the trunk or pelvis, and 2 available turning surfaces should be placed on a reactive/CLP support surface or an active support surface with an AP feature.

3.5 Persons with Braden mobility subscale scores of 2 or 1, a Braden moisture subscale score of 1 with moisture that cannot be managed by other means, along with existing pressure ulcers on the trunk or pelvis, should be placed on a reactive/CLP support surface with an LAL or AF feature.

3.6 Persons with multiple Stage II, or large (of sufficient size to compromise a turning surface) or multiple Stage III or Stage IV pressure ulcers on the trunk or pelvis involving more than 1 available turning surface, should be placed on a reactive support surface with an LAL or AF feature.

3.7 Persons who have ulcers (Stages II-IV) on 2 or more turning surfaces, or have 1 or no available turning surfaces, should be placed on an active support surface with an AP feature or a reactive support surface with an LAL or AF feature.

3.8 In cases of suspected deep-tissue injury (sDTI) located on the trunk or pelvis, intervention should include strategies that facilitate tissue temperature reduction between the patient and the support surface (eg, implementation of a turning regimen and use of a support surface that facilitates temperature reduction, eg, one with a gel surface or an AP, LAL, or AF feature).

3.9 Persons with pressure ulcers on the head or upper or lower extremities should be offloaded and may not require a change in the current support surface.

3.10 If, while on a reactive/CLP support surface with an LAL or AF feature, a person's condition improves such that the person no longer has a pressure ulcer or no longer is at high risk for the development of a pressure ulcer, the person should be placed on a reactive/CLP support surface or an active support surface with an AP feature.

development of the algorithm are defined in a glossary that serves as supplemental information for the algorithm (Box 4).

Development of Draft Algorithm

The Task Force then developed a draft algorithm via a series of web-based conference calls and a single face to face meeting. Members of the Task Force evaluated the face validity of the draft algorithm at multiple points during 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, interim

TABLE 2.

Intrinsic and Extrinsic Risk Factors for Pressure Ulcer Development[1–3,20,21]

Intrinsic Factors	Extrinsic Factors
• Advanced age	• Pressure
• Reduced mobility or activity levels	• Shear
• Presence of fever	• Friction
• Poor dietary intake of protein/impaired nutritional status	• Heat
• Diastolic pressure <60 mmHg	• Moisture (ie, sweat, urine, feces, wound drainage, etc.)
• Anemia	• Recent surgery, particularly operative procedures lasting >3 hours
• 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	

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TABLE 3.

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	Non-permeable 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.[22] Includes elastic (non-memory) and viscoelastic (memory) foam, types of porous polymer materials that conform in proportion to the applied weight[23]
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[24]
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/Constant low pressure (CLP) support surface	*Consensus definition:* A powered or nonpowered support surface that provides pressure redistribution in response to an applied load (patient) through immersion and envelopment. 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[c,6]
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.[22]

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

[c]Due to the distinct properties and limited availability of Australian Medical-grade sheepskin overlays, these devices are discussed separately from other CLP products.

and end results (eg, recommendations for use of a particular type of support surface, a change in support surface) were comprehensive, feasible, and appropriate.

Following extensive discussion, the Task Force decided that the algorithm was to be designed for selection of specific categories 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 the algorithm includes nurses, specialty and advanced practice nurses, physicians, physician assistants, physical therapists and occupational therapists. The algorithm was designed for adult patients (including morbidly obese individuals) in acute care facilities (critical care units, medical-surgical, orthopedic, rehabilitation, units and the emergency department), long-term acute care facilities, long-term care/skilled nursing homes, and home care settings. The algorithm was not designed for use in patients <16 years of age, or selected settings such as the operating room and interventional diagnostic suite where the length of stay is less than 24 hours. Selection 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, were not incorporated into the algorithm.

■ Consensus Conference

The Task Force identified potential consensus panel members based on their expertise in support surface technologies

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BOX 4.

Glossary

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.[14]

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.[22]

Immersion: Depth of penetration (sinking) into a support surface.[22]

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.[22]

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.[19]

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.

and their clinical applications. Additional criteria for participation included membership in relevant professional organizations, geographic location, and practice settings (acute care, long-term acute care, long-term care, and home care). Many potential invitees were responsible for support surface selection and value-based purchasing (VBP) decisions in their respective clinical setting. The panel comprised 20 experts; 9 (45%) were advanced practice nurses, 6 (30%) were registered nurses, 2 (10%) were physical therapists, 1 was an engineer, 2 were researchers, and 1 was a certified expert in prosthetics. The majority (80%) were certified in wound care. More than half (59%) encountered 10 or more patients per week who are at risk for or have a pressure ulcer. Three panel members were researchers; they reported 6 to 25 years experience conducting research in the area of support surface technology.

The 2-day conference began with a presentation summarizing preconference activities and a state-of-the-science presentation on support surface selection. This was followed by a discussion of evidence-based statements; several statements were clarified based on panel member input. For example, panel members recommended adding the comorbid conditions of advanced age, fever, poor dietary intake of protein, diastolic pressure <60 mm Hg, hemodynamic instability, anemia, and generalized edema to intrinsic and extrinsic risk factors for pressure ulcer development. Comments and recommendations related specifically to support surfaces are summarized in Table 4.

Statements supported by level C evidence were then subjected to a formalized process of consensus validation. An interactive software program and wireless response system (IML ViewPoint Express and IML Click, IML, Minneapolis, MN) allowed anonymous interactive voting by the panel members and Task Force. Consensus on each statement was obtained based on general principles outlined by Murphy and colleagues,[26] using 80% agreement as the criterion for consensus. If consensus was not achieved on the first vote, the statement was edited based on panel member input and second, and sometimes third, votes were taken. If consensus could not be reached after 3 rounds of discussion, or the statement deemed irrelevant to algorithm development, consensus regarding deletion of the statement was obtained. The draft algorithm was then reviewed in detail by the panel and modified based on evidence-based and consensus statements and additional discussion.

■ Support Surface Algorithm

Users enter the algorithm at the point of the initial skin assessment, followed by pressure ulcer risk assessment (Figure 1).

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TABLE 4.

Evidence-based Statements: Panel Comments and Recommendations

Statement	Comments and Recommendations
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]	Panel members concur with existing guidelines and the need to use support surfaces along with these recommended components.
3.2. Support surfaces do not eliminate the need for turning and repositioning.[1,2]	Panel members noted that "turning" is often incorrectly used in place of the proper term "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]	Panel members noted that, if an individual requires use of a support surface, he or she should also be considered for use of an appropriate pressure redistribution seating surface or cushion.
3.4. Consider product lifespan when choosing a support surface.[2]	Recommendations in this document are based on the assumption that a support surface has been maintained according to manufacturer specifications. Staff who have ongoing exposure to support surfaces during bedding or room changes should practice a continual awareness and opportunity-based observation of support surface lifespan indicators, with the surface referred to engineering or maintenance for testing or evaluation for continued use if observed, irrespective of stated product lifespan.
3.5. When choosing a support surface, consider contraindications for use of specific support surfaces as specified by the manufacturer.	Refer to Figure 1, Table B for select considerations and contraindications for various types of support surfaces.
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]	Although it may sound obvious to state that a support surface must be functioning properly, panel members noted cases in the field where active support surfaces with an AP feature were nonfunctional.
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.[7,23]	
4.2. There is no evidence of the superiority of any one high-specification foam mattress over an alternative high-specification foam mattress.[7]	
4.3. Sheepskin overlays (Australian Medical-grade) are effective in reducing the incidence of pressure ulcers compared to standard care.[7,8]	The panel considers Australian Medical-grade sheepskin to be an appropriate choice for pressure ulcer prevention in patients without significant mobility and moisture issues (Braden mobility and moisture subscale scores of 4 or 3). However, the panel noted that this product is not readily available in the United States other than through online suppliers and is not considered as a standard of care for that reason.
4.4. There is insufficient evidence to determine comparative effectiveness of various reactive/constant low pressure (CLP) support surfaces.[7,8]	
4.5. Active support surfaces with an alternating pressure (AP) feature are more effective than standard hospital mattresses in the prevention of pressure ulcers.[7,8]	
4.6. Overlays and mattresses with AP features demonstrate similar efficacy in reducing pressure ulcer incidence.7,8	
4.7. Mattresses with a multi-stage AP feature are more effective than overlays with an AP feature in preventing full thickness pressure ulcers.[16–18]	

(*continues*)

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TABLE 4.

Evidence-based Statements: Panel Comments and Recommendations (*Continued*)

Statement	Comments and Recommendations
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.[16–18]	
4.9. Postoperative use of a support surface reduces the incidence of surgery-related pressure ulcers.[25]	Panel members noted that additional research is needed to determine the impact of postoperative support surface use on the evolution of suspected deep-tissue injury (sDTI).
Use of Support Surfaces to Treat Pressure Ulcers	
5.1. There is insufficient evidence to suggest that there are differences among the efficacies of reactive/CLP devices, AP devices, low air loss (LAL) therapy, profiling beds, or Australian Medical-grade sheepskin for the treatment of existing pressure ulcers.[6,9]	

Based on the risk for development of pressure ulcers (Braden score cut-off of 18)[27] or presence of pressure ulcers, users follow pathways that guide clinical decision making for support surface use for pressure ulcer prevention or treatment. 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 the need for a change in or removal from a support surface, and support surface considerations and contraindications. Task Force and Consensus Panel members acknowledge the need for individual facilities to adapt the algorithm for their own use by including the specific products used at their facility, along with appropriate staff education.

Content Validation

Content validation was based on procedures originally proposed by Lynn[28] and Waltz & Bausell[29] and modified by Grant & Davis.[30] A data collection form was developed to evaluate content validity of the algorithm. The form contained 18 questions regarding panel demographic and pertinent professional credential data including gender, age, educational background, wound care certification, years of experience, and practice setting. Twenty nine items representing each pathways and decision points in the algorithm were developed. Following revision of the algorithm during the consensus conference, panel members were asked to rank individual items on scale of 1 to 4 where: 1 = not relevant/appropriate; 2 = unable to assess relevance without revision, 3 = relevant but needs minor alteration, or 4 = very relevant and appropriate. Panel members were also asked to provide qualitative feedback (written comments and suggestions) on the comprehensiveness of the algorithm, omissions of essential content, and suggest changes to improve clarity, parsimony, and relevance. All panel members agreed to participate.

Data analysis was conducted using Excel® version 2013 (Microsoft, Seattle, WA). Data were coded and entered into a database, analyzed by the data coordinator, and reviewed by the authors. Descriptive statistics were used to summarize demographic and pertinent professional credential data. Ratings of 29 algorithm decision statements/steps were entered and mean scores were calculated. A Content Validity Index (CVI) was calculated using processes described by Polit and Beck.[31] Qualitative comments regarding decision statements/steps were transcribed and thematically analyzed using qualitative data reduction techniques.

Quantitative Analysis

Table 5 summarizes changes incorporated into the final algorithm, mean scores, and the CVI for decision points and pathways in the algorithm. The overall mean score was 3.72 ± 0.48 out of 4 (mean ± SD), indicating components of the algorithm were ranked as "very relevant and appropriate" or "relevant and needed only minor alteration." The CVI for the entire algorithm was 0.95, well above the minimum (0.70 or 0.80) considered acceptable.[28,31,32] All decision statements/pathways were above this minimum except for Treatment of Pressure Ulcers, Step 6, "For intact/closed skin not at risk for development of pressure ulcers (Braden >18), reassess need for support surface." The CVI for this item was 0.65 out of 1.00. Review of qualitative data revealed that the lower CVI on this item reflected disagreement with language included in the draft algorithm; it was subsequently clarified.

Qualitative Analysis

All comments entered into the data collection form were collated and reviewed by the Task Force. Respondents' comments reflected concern about: 1) exclusive use of the

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Braden Scale for pressure ulcer risk assessment and the limited number of comorbid conditions listed for consideration; 2) the need to provide definitions for each of the categories of support surfaces, particularly Australian Medical-grade sheepskin, as well as a desire for inclusion of examples of support surfaces in each category; 3) the desire to provide more specific guidance with regard to support surface recommendations; 4) possible inclusion of patient preference as a consideration for support surface selection; and 5) a desire to compress the algorithm presented during the conference for efficiency and ease of use. In a few instances, respondents felt that instructions for the user to "consider" use of a support surface were too soft and should be replaced with "should." Modifications to were made to the algorithm's wording to improve clarity or appropriateness based on this qualitative feedback.

Discussion

An evidence- and consensus-based algorithm for support surface selection was created and its content validity analyzed. The CVI for the algorithm was strong (0.95 out of 1.0), with an overall mean score of 3.72 (out of 1 to 4), suggesting that the steps were appropriate to the purpose of the algorithm. Only one validation score was below 3.0, and this statement was revised. Consensus panel member comments reflected concern about exclusive use of the Braden Scale for Pressure Sore Risk Assessment, but they also acknowledged the instrument is widely used in North America and has undergone extensive validation. Panel members also noted the limited number of comorbid conditions listed for consideration. Other issues discussed were the need to provide definitions for categories of support surfaces, a desire for inclusion of examples, a desire to provide more specific guidance with regard to support surface recommendations, and a desire to compress the algorithm for efficiency and ease of use.

Support surface terminology generated considerable discussion when drafting the algorithm and during the Consensus Conference. Agreement was reached to use the convention of a respective support surface category with added features as applicable. Definitions of these terms were provided for algorithm users. The use of this convention is adaptable to addition of new support surface features or combinations in the future. Despite higher level clinical evidence supporting the effectiveness of Australian Medical-grade sheepskin for prevention of pressure ulcers, inclusion of these support surfaces generated considerable discussion due to their limited availability and usage in the United States. Since this product is now available through online suppliers, this category of support surface was included in the algorithm as a suggested option for pressure ulcer prevention, although it was considered separately from other reactive/CLP products.

Unique to this algorithm is the use of 2 Braden subscale scores, mobility and moisture, to guide support surface selection. While research is limited, Task Force members believed that these subscale scores are indicative of clinically relevant risk for development of pressure ulcers, even when the overall risk score indicates minimal risk. The cumulative Braden Scale score is a valid and reliable predictor of pressure ulcer risk, but its application does not reduce the risk of pressure ulcers to zero.[27,34,35] As a result, there has been increasing interest in investigating whether patient outcomes may be improved by tailoring pressure ulcer prevention strategies based on individual subscale scores in addition to a cumulative score.[36–39] Bergquist[40] analyzed risk factors for pressure ulcer development in older adults receiving home health care and found that mobility and moisture subscale scores predicted pressure ulcer development, but they also noted that the cumulative Braden Scale score was more strongly related to pressure ulcer development than were these subscale scores. Tescher and colleagues[41] reported findings from a large, retrospective study (N = 12,566) that examined risk factors associated for pressure ulcer development in patients cared for in intensive and progressive care units. They found that low scores on the friction/shear, moisture, sensory perception, and mobility subscales were more predictive than the cumulative Braden score alone. Results of a comprehensive literature review on pressure ulcer risk assessment in the critical care population suggests that sensory perception, mobility, moisture, and friction/shear subscale scores are predictive of pressure ulcer development.[42] A study examining the relationship of individual Braden subscale scores to pressure ulcer prevalence in obese and non-obese hospitalized patients found high-risk total Braden and Braden subscale scores, except for moisture, to be significantly related to the occurrence of pressure ulcers in both groups.[43] However, high-risk total Braden score and mobility and friction/shear subscale scores were much more strongly related to ulcer occurrence in obese patients. Results of a retrospective review of hospitalized Brazilian patients deemed at risk of pressure ulcers (cumulative Braden Scale score ≤13) suggests that score stratification by subscale may extend and specify the total Braden score to better direct interventions to prevent pressure ulcers.[37] Gadd[39] reported results of a retrospective review of 20 patients with hospital-acquired pressure ulcers identified patients deemed at low risk of pressure ulcer development based on cumulative Braden score. Analysis of these cases revealed that these patients may have benefitted from interventions based on suboptimal Braden score on the sensory perception, activity, and mobility subscales.

The relative contributions of the cumulative Braden scale score, subscale scores, clinical judgment and experience in clinical decision-making are not known. Magnan & Maklebust[44] evaluated relationships between Braden subscale scores and nurses' selection of 10 commonly used pressure ulcer preventive interventions. Findings suggest that subscale scores influence nurses' endorsement of

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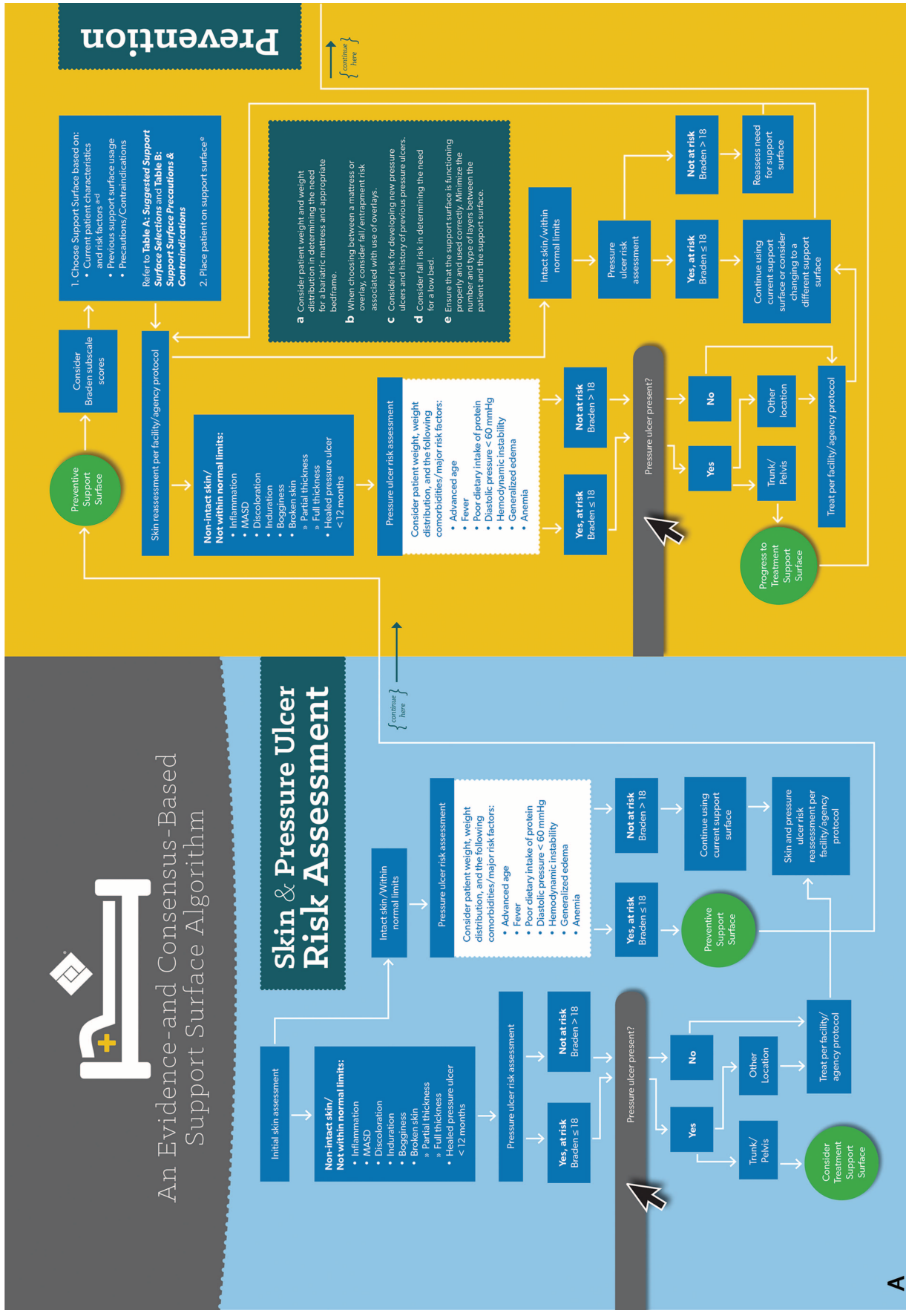

FIGURE 1. Algorithm for support surface selection.

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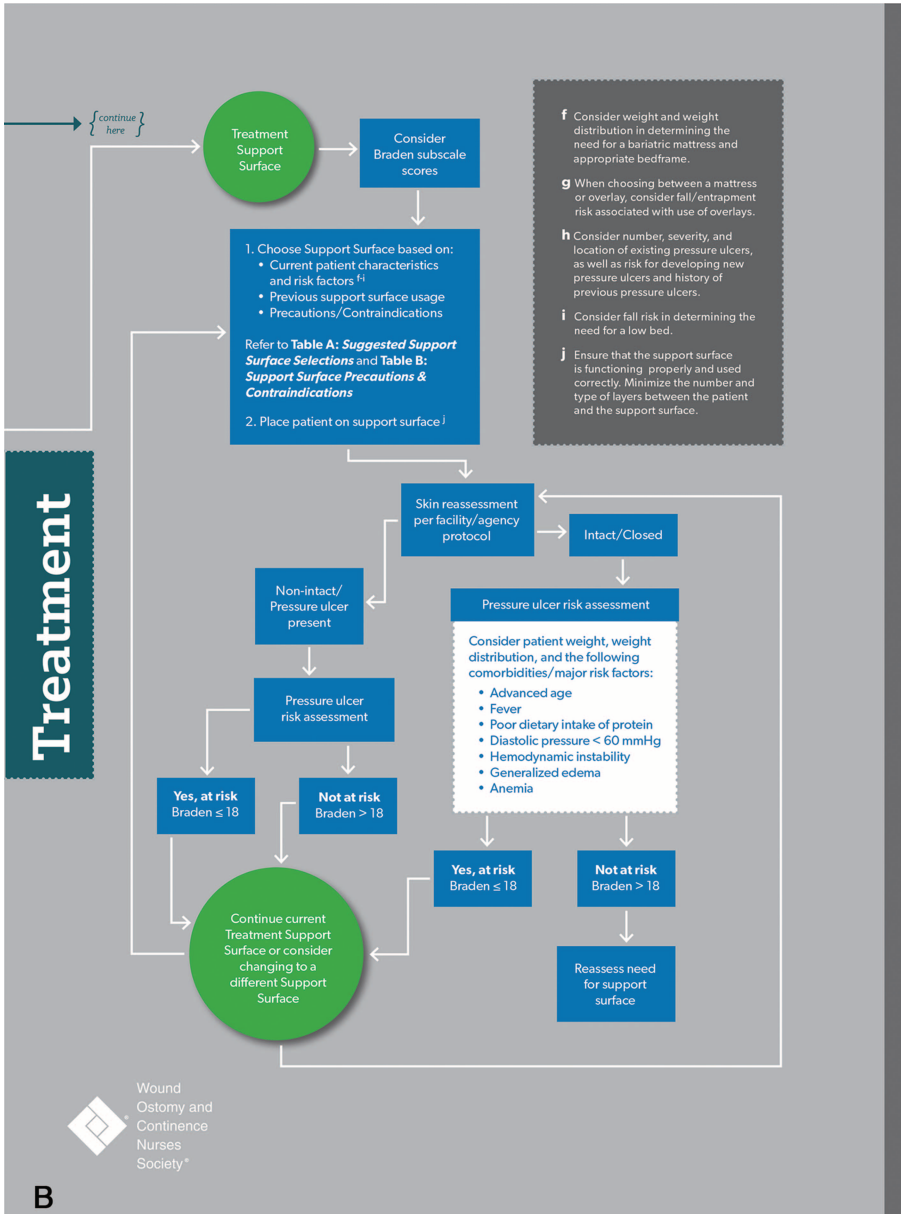

TABLE A:

Suggested Support Surface Overlay or Mattress Selections for Pressure Ulcer Prevention & Treatment Based on Braden Mobility & Moisture Subscores

a Braden B, Bergstrom N. http://bradenscale.com/images/bradenscale.pdf. Copyright 1988. Accessed August 8, 2014.

b In this table, Reactive/CLP refers to all types of Support Surfaces in this category with the exception of AMG sheep skin overlays, which are noted separately.

c AMG sheepskin is available for purchase through online suppliers.

Note: Persons with multiple Stage II, or large (of sufficient size to compromise a turning surface) or multiple Stage III or Stage IV pressure ulcers on the trunk or pelvis involving more than one available turning surface should be placed on a support surface with a low air loss or an air fluidized feature.

	BRADEN MOBILITY SUBSCALE SCORES[a]	
BRADEN MOISTURE SUBSCALE SCORES	**4 or 3** No limitation or slightly limited	**2 or 1** Very limited or completely immobile
4 or 3 Rarely or occasionally moist	• Reactive/CLP[b] (air, foam, gel, fiber, or viscous fluid, or combinations) • AMG sheepskin overlay (Prevention only) [c]	• Reactive/CLP • Active with AP feature
2 Very moist	• Reactive/CLP • Reactive/CLP with LAL feature	• Reactive/CLP with LAL feature
1 Constantly moist	• Reactive/CLP • Reactive/CLP with LAL feature	• Reactive/CLP with LAL feature • Reactive/CLP with AF feature (Treatment only)

AF = air fluidized; AMG = Australian Medical grade; AP = alternating pressure; CLP = constant low pressure; LAL = low air loss.

a Refer to manufacturer specifications, including product lifespan. Staff who have ongoing exposure to support surfaces during bedding or room changes should practice a continual awareness and opportunity-based observation of support surface lifespan indicators, including reduced height or thickness; discoloration; altered integrity of cover, seams, zipper/ zipper cover flap, or backing; degradation of internal components, or presence of odor. If any of these are observed, it is recommended that the surface be referred to engineering/ maintenance for testing or evaluation for continued use, irrespective of stated product lifespan.

b High risk for moisture penetration with potential for infection.

TABLE B:

Select Support Surface Precautions & Contraindications[a]

SUPPORT SURFACE	PRECAUTIONS	CONTRAINDICATIONS
High-specification foam	• Braden moisture subscale score of 2 or 1[b]	• Weight limitations for surface–may require another product in this category with higher weight limit
Reactive/CLP	• NA	• Unstable cervical, thoracic or lumbar spine • Cervical or skeletal traction • Weight limitations for surface– may require another product in this category with higher weight limit
Active with AP feature	• NA	
Reactive/CLP with LAL feature	• Combative/restless/agitated state	
Reactive/CLP with AF feature	• Combative/restless/agitated state • Need for aggressive pulmonary toilet • Need for frequent head elevation • Need for mobilization • Claustrophobia	• Unstable cervical, thoracic or lumbar spine • Cervical or skeletal traction • Weight limitations for surface– may require another product in this category with higher weight limit • Trendelenburg positioning

AF = air fluidized; AP = alternating pressure; CLP = constant low pressure; LAL = low air loss.

FIGURE 1. (*Continued*)

TABLE 5.

Changes Incorporated into Final Algorithm and Quantitative Analysis

Steps in Draft Algorithm	Steps in Revised Algorithm with Associated Mean and Content Validity Index (CVI) Results	Mean Score (SD) (Range, 2.95–4.00)	CVI (Range, 0.65–1.0)	Median (IQR)
	SKIN AND PRESSURE ULCER RISK ASSESSMENT			
1. Assess and document a complete skin assessment for intact/nonintact skin.	Assess and document a complete skin assessment for intact skin/within normal limits (WNL) and nonintact skin/not WNL. **Nonintact skin/not WNL includes:** inflammation; moisture-associated skin damage (MASD); discoloration; induration; bogginess; broken skin: partial thickness, full thickness; healed pressure ulcer <12 months.	3.85 (0.37)	1.00	4
2. Assess and document a pressure ulcer risk assessment using the Braden scale.	Assess and document a pressure ulcer risk assessment using Braden scale. Consider patient weight, weight distribution, and the following comorbidities/major risk factors: advanced age, fever, poor dietary intake of protein, diastolic pressure below 60 mmHg, hemodynamic instability, generalized edema, anemia.	3.80 (0.62)	1.00	4
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.	Following risk assessment, if patient is not at risk for development of pressure ulcers (Braden >18) and with intact skin: Continue using current support surface, pending skin reassessment as per care setting protocol.	3.70 (0.66)	0.90	4
4. Following risk assessment, if patient at risk for development of pressure ulcers (Braden ≤18) and has intact skin, use support surface (preventative). Following risk assessment of a patient with nonintact skin:	Following risk assessment, if patient is at risk for development of pressure ulcers (Braden ≤18) and with intact skin/WNL: Use support surface (preventative).	4.00 (0.00)	1.00	4
5. Determine presence and location of pressure ulcers.	Determine presence and location of pressure ulcers.	3.95 (0.23)	1.00	
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.	If no pressure ulcer(s) present, and not at risk for development of pressure ulcers (Braden >18), treat per facility/department protocol, continuing skin and pressure ulcer risk reassessment per care setting protocol.	3.90 (0.31)	1.00	4
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.	If no pressure ulcer(s) present, but at risk for development of pressure ulcers (Braden ≤18), treat per facility/department protocol, continuing skin and pressure ulcer risk reassessment per care setting protocol.	3.70 (0.57)	0.95	4
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).	If not at risk (Braden ≤18) or at risk for development of pressure ulcers (Braden >18) and if pressure ulcer(s) are present but not on the trunk/pelvis, treat per facility/department protocol, continuing skin and pressure ulcer risk reassessment per care setting protocol.	3.55 (0.83)	0.90	4
9. If pressure ulcer(s) are present and on the trunk, consider use of a support surface (treatment).	If not at risk (Braden ≤18) or at risk for development of pressure ulcers (Braden >18) and if pressure ulcer(s) are present and on the trunk/pelvis, consider support surface (treatment).	3.90 (0.31)	1.00	4
	PREVENTION OF PRESSURE ULCERS			
1. Consider Braden subscale scores for moisture and mobility (≥3 or ≤2).[a]	Consider Braden subscale scores.	4.00 (0.00)	1.00	4

(*continues*)

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TABLE 5.

Changes Incorporated into Final Algorithm and Quantitative Analysis (*Continued*)

Steps in Draft Algorithm	Steps in Revised Algorithm with Associated Mean and Content Validity Index (CVI) Results	Mean Score (SD) (Range, 2.95–4.00)	CVI (Range, 0.65–1.0)	Median (IQR)
2. **Support surface options**: high-specification foam or Australian Medical-grade sheepskin, constant low pressure (CLP), alternating pressure (AP), or low air loss (LAL).	**Support surface options listed in Table A**: Australian Medical-grade sheepskin, Reactive/CLP +/- LAL feature, Active with AP feature.	3.42 (0.90)	0.84	4
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.	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; precautions/ contraindications. **Suggested options in Table A:** Reactive/CLP +/- LAL feature, Active with AP feature; choice dependent on specific scores.	3.80 (0.41)	1.00	4
4. If Braden moisture and mobility subscale scores are both ≥3, select high-specification foam or Australian Medical-grade sheepskin.	If Braden moisture and mobility subscale scores are both ≥3, 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; precautions/ contraindications. Suggested options in Table A: Reactive/CLP or Australian Medical-grade sheepskin overlay.	3.47 (0.61)	0.94	4
5. Skin reassessment as per care setting.	Skin reassessment as per care setting protocol.	3.95 (0.22)	1.00	4
6. Pressure ulcer risk assessment (consider patient weight and weight distribution as well as comorbidities and other contextual factors).	Pressure ulcer risk assessment (consider patient weight, weight distribution, and the following comorbidities/ major risk factors: advanced age, fever, poor dietary intake of protein, diastolic pressure below 60 mmHg, hemodynamic instability, generalized edema, anemia).	3.85 (0.37)	1.00	4
7. For intact skin not at risk for development of pressure ulcers (Braden >18), off support surface.	For intact skin/WNL not at risk for development of pressure ulcers (Braden >18), reassess need for support surface, continuing skin and pressure ulcer risk reassessment per care setting protocol.	3.20 (0.95)	0.85	3
8. For intact skin at risk for development of pressure ulcers (Braden ≤18), continue using current support surface.	For intact skin/WNL at risk for development of pressure ulcers (Braden ≤18), continue current preventive support surface or consider changing to a different support surface, continuing skin and pressure ulcer risk reassessment per care setting protocol.	3.60 (0.68)	0.90	4
	For nonintact skin/not WNL, determine if pressure ulcer(s) are present.			4
9. For nonintact skin not at risk for development of pressure ulcers (Braden >18), continue using current support surface.	For nonintact skin/not WNL not at risk for development of pressure ulcers (Braden >18) and no pressure ulcer(s) present, treat per facility/department policy, continue current preventive support surface or consider changing to a different support surface, and continue skin and pressure ulcer risk reassessment per care setting protocol.	3.35 (0.81)	0.80	4
	For nonintact skin/not WNL not at risk for development of pressure ulcers (Braden >18) and pressure ulcer(s) present outside of the trunk/pelvis, treat per facility department policy, continue current preventive support surface or consider changing to a different support surface, and continue skin and pressure ulcer risk reassessment per care setting protocol.			

(*continues*)

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TABLE 5.

Changes Incorporated into Final Algorithm and Quantitative Analysis (*Continued*)

Steps in Draft Algorithm	Steps in Revised Algorithm with Associated Mean and Content Validity Index (CVI) Results	Mean Score (SD) (Range, 2.95–4.00)	CVI (Range, 0.65–1.0)	Median (IQR)
	For nonintact skin/not WNL not at risk for development of pressure ulcers (Braden >18) and pressure ulcer(s) present on the trunk/pelvis, progress to Treatment Support Surface.			
10. For nonintact skin at risk for development of pressure ulcers (Braden ≤18), switch to support surface (treatment).	For nonintact skin/not WNL at risk for development of pressure ulcers (Braden ≤18) and no pressure ulcer(s) present, treat per facility/department protocol, continue current preventive support surface or consider changing to a different support surface, and continue skin and pressure ulcer risk reassessment per care setting protocol.	3.85 (0.37)	1.00	4
	For nonintact skin/not WNL at risk for development of pressure ulcers (Braden ≤18) and pressure ulcer present outside of the trunk/pelvis, treat per facility/department policy, continue current preventive support surface or consider changing to a different support surface, and continue skin and pressure ulcer risk reassessment per care setting protocol.			
	For nonintact skin/not WNL at risk for development of pressure ulcers (Braden ≤18) and pressure ulcer(s) present on the trunk/pelvis, progress to Treatment Support Surface.			
	TREATMENT OF PRESSURE ULCERS			
1. Consider Braden moisture and mobility subscores (≥3 or ≤2).[a]	Consider Braden subscale scores.	3.95 (0.22)	1.00	4
Treatment support surface options: high-specification foam, CLP, AP, LAL, or air-fluidized (AF).	Support surface options listed in Table A for Treatment: Reactive/CLP +/- LAL or AF feature, Active with AP feature.			
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.	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; precautions/ contraindications. **Suggested options in Table A:** Reactive/CLP +/- LAL or AF feature, Active with AP feature; choice dependent on specific scores.	3.55 (0.60)	0.95	4
3. If Braden moisture and mobility subscale scores are both ≥3, select high-specification foam.	If Braden moisture and mobility subscale scores are both ≥3, 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; precautions/ contraindications. **Suggested options in Table A:** Reactive/CLP.	3.75 (0.55)	0.95	
4. Skin reassessment as per care setting.	Skin reassessment as per care setting protocol.	4.00 (0.00)	1.00	4
5. Pressure ulcer risk assessment (consider patient weight and weight distribution as well as comorbidities and other contextual factors).	Pressure ulcer risk assessment (consider patient weight, weight distribution, and the following comorbidities/ major risk factors: advanced age, fever, poor dietary intake of protein, diastolic pressure below 60 mmHg, hemodynamic instability, generalized edema, anemia).	3.80 (0.41)	1.00	4

(*continues*)

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TABLE 5.

Changes Incorporated into Final Algorithm and Quantitative Analysis (*Continued*)

Steps in Draft Algorithm	Steps in Revised Algorithm with Associated Mean and Content Validity Index (CVI) Results	Mean Score (SD) (Range, 2.95–4.00)	CVI (Range, 0.65–1.0)	Median (IQR)
6. For intact skin not at risk for development of pressure ulcers (Braden >18), use preventive support surface.	For intact/closed skin not at risk for development of pressure ulcers (Braden >18), reassess need for support surface.	2.95 (1.23)	0.65	3.5
7. For intact skin at risk for development of pressure ulcers (Braden ≤18), use preventive support surface.	For intact/closed skin at risk for development of pressure ulcers (Braden ≤18), continue current treatment support surface or consider changing to a different support surface.	3.80 (0.41)	1.00	4
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.	For nonintact skin/pressure ulcer(s) present, not at risk for development of pressure ulcers (Braden >18), continue current treatment support surface or consider changing to a different support surface.	3.60 (0.68)	0.90	4
9. For nonintact skin at risk for development of pressure ulcers, (Braden ≤18), modify treatment support surface.	For nonintact skin/pressure ulcer(s) present, at risk for development of pressure ulcers (Braden ≤18), continue current treatment support surface or consider changing to a different support surface.	3.65 (0.67)	0.90	4
10. Skin reassessment as per care setting.	Skin reassessment as per care setting protocol.	4.00 (0.00)	1.00	4

Abbrevation: IQR = Interquartile range.

[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.[33]

various preventive interventions in 2 ways; participants used unique combinations of subscale scores to assess risk, and they were more likely to implement preventive interventions as these scores decreased and risk increased. Additional research is needed to determine the efficacy of preventive strategies based on Braden Scale subscores alone or in combination.

Limitations

The support surface selection algorithm was designed for use in adult and bariatric patients in care settings with a length of stay > 24 hours. It does not address use of seating surfaces and cushions, continuous lateral rotation mattresses, and other special purpose beds or surfaces. 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. Clinical evidence regarding the 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. In each of these cases, decisions supported in the algorithm relied on lower level evidence (consensus among members of an expert panel). In some instances, consensus on more specific recommendations for support surface selection could not be achieved, suggesting that multiple support surface options may be appropriate under specific circumstances.

Conclusions

Support surfaces are one of a bundle of interventions used for pressure ulcer prevention and treatment. Nevertheless, their role is critical. Multiple factors come into play when selecting a support surface, but limited guidance supported by high-level evidence for choice of a specific type of support surface over another is available. This content validated support surface selection algorithm and the accompanying consensus statements were developed in response to the critical need for this type of information for use in clinical practice. To our knowledge, this is the first support surface selection algorithm based on a comprehensive literature review that has been content validated. In the algorithm, support surface selection is largely driven by Braden mobility and moisture subscale scores. Facilities are encouraged to adapt this algorithm for their own use by including the specific products used at their facility and incorporate appropriate staff education for optimal implementation.

KEY POINTS

✔ In an effort to provide clinical guidance for selecting support surfaces to match individual patient needs, an evidence- and consensus-based algorithm for support surface selection that largely utilizes Braden mobility and moisture subscale scores to drive selection was developed and content validated.

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✔ Consensus was obtained for statements supporting decision points in the draft algorithm not supported by high-level evidence and/or providing ancillary information.

✔ Health care facilities may adapt this algorithm for their own use by including the specific products used at their institutions.

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