Support Surfaces: Tissue Integrity, Terms, Principles, and Choice

Cynthia Ann Fleck, RN, BSN, MBA, APN/CNS, ET/WOCN, CWS, CFCN, DNC; Stephen Sprigle, PhD, PT

Introduction

In the pursuit of prevention and management of skin and tissue breakdown, support surface selection remains an important decision for the clinician. Pressure ulcers are caused by a myriad of intrinsic and extrinsic factors. Support surfaces can have significant influence over extrinsic factors, such as pressure, shear, friction, moisture, and temperature. These factors directly impact deformation of the soft tissue, blood flow, tissue ischemia and necrosis, and pressure ulcer development, especially in the immobile patient. The manner by which support surfaces manage these extrinsic factors can be used by clinicians as they select support surfaces for their patients.

By definition, pressure ulcers are caused by localized pressure, which deforms soft tissue and occludes capillaries causing ischemia, which can lead to cell and tissue death. Clinicians typically use the term “pressure” to reflect normal pressure or interface pressure—the force-per-unit area that acts perpendicular to the tissue. The forces that result in normal pressure on the tissues are typically due to gravity: body weight is resting on the supporting surface. With respect to support surfaces, this normal loading may be the most significant but not the only force that impacts tissue integrity.

While commonly used together, shear and frictional forces are not the same thing, but both can contribute to pressure ulcer development. Friction is a force that opposes the movement of 2 bodies in contact, such as the sliding of the buttocks on a bed surface. The term “shear”...
can refer to either shear stress—the force acting tangentially on an area of an object—or shear strain—the deformation of an object in response to shear stresses. With respect to support surfaces, shear strain results from all the forces that cause the deformation of the body’s tissues, including normal, shear, and frictional forces. Shear stress on tissue has been documented as adversely affecting tissue integrity.  

Moisture and temperature can also increase the risk of skin breakdown. The ability of a support surface to dissipate heat affects the temperature and moisture of the buttock tissues. Moisture and temperature are often linked because an increase in temperature typically results in moist skin through sweating. Obviously, many other sources of moisture and wetness can put skin at risk. Increasing evidence suggests that an increase in tissue temperature increases tissue’s susceptibility to pressure ulcers. Furthermore, any increase of moisture, whether from sweating or another source, will increase the coefficient of friction of the skin. Excessive moisture can also macerate tissue, resulting in a reduced ability to withstand external forces.

Various clinical strategies exist to manage these extrinsic factors, especially for patients exhibiting the 2 greatest risk factors for pressure ulcers: lack of mobility and lack of sensation. Turning and repositioning are the most effective ways to counteract impaired mobility. However, the accepted protocol of turning and repositioning a patient every 2 hours may not be enough. An individualized care plan must be developed that includes support surfaces as integral components to prevention and management of pressure ulcers.

The purposes and indications for use of a support surface are to prevent skin breakdown in the immobile and high-risk patient, to prevent further breakdown, to promote healing and granulation in the patient with an existing wound, and to address pain management and comfort issues in patients experiencing chronic pain (e.g., end-stage cancer). Fortunately, a wide variety of surfaces are available. While clinicians cannot be expected to know everything about every product, an understanding of how to judge support surface performance and of the different options will result in a more informed selection.

**Considerations When Selecting Support Surfaces**

In 1995, Krouskop and van Rijswijk gathered pressure ulcer experts to determine and identify important features that reflect support surface performance and usability. The list included:

- Redistribution of pressure
- Moisture control
- Temperature control
- Patient and product friction control
- Infection control
- Flammability
- Life expectancy
- Fail safety
- Product service requirements.

One can readily see the extrinsic risk factors along with other important and practical criteria. This chapter will discuss many of these criteria in hopes of defining the various tradeoffs in performance that are inherent to the selection of support surfaces.

**Redistribution of Pressure**

The damaging effects of pressure on the body depend on both the magnitude and duration of that pressure. The body can withstand higher pressures for shorter amounts of time. This relationship drives the design of active support surfaces as well as clinical turning schedules.

Many researchers have attempted to determine the pressures at which tissue ischemia occurs with widely varying results. Some studies related measures of blood pressure to blood flow occlusion and others documented differences in occlusion pressures in the presence and absence of shear forces. Taking these results together, one can deduce that the pressures needed to cause ischemia differ from person to person and from body site to body site. If one accepts this conclusion, pressure ulcer prevention strategies must become more individualistic and reflect the current understanding of clinical and physiological situations that influence the load-bearing integrity of tissues.

Envelopment is the ability of a support surface to conform around the contours of the body to redistribute pressure. The ability of a support surface to envelop the body can be adversely impacted by the surface tension of the material or cover. A low surface tension environment will al-
low the surface to deform and the engaging body to sink in, accommodating bony prominences and displacing body weight. The surface should deform, not the body and soft tissues. Surface tension can be increased by tight bed linens or support surface cover.

Determining if a support surface offers adequate pressure distribution is difficult. Regular monitoring of localized, post-ischemic erythema is always required. The measurement of interface pressures is one approach that is gaining in popularity. This is a simple, noninvasive method of comparing and determining the force-per-unit area that acts between the body and the support surface. The approach typically uses an array of pressure sensors between the subject and the support surface. While a detailed description of interface pressure measurement is beyond the scope of this chapter, a few important issues should be remembered.

Clinicians should concentrate on the interface pressures under bony prominences that are more at-risk for pressure ulcer development. One must remember, however, that pressures are dependent on the position in bed, so the measurements should ideally be repeated in supine and side lying as well as in other positions commonly adopted by the patient. Finally, since these devices measure interface pressure, the interface between the person and surface must reflect clinical use. If a person typically lies upon a towel, incontinence pad or “chux,” or multiple fabrics, these should be in place during measurement as they, most likely, will affect the pressures on the body.

Patient and product friction control. As previously mentioned, the presence of shear impacts the tissue’s ability to withstand pressures. However, because friction cannot be avoided, clinicians must assess the impact on the specific patient. Some support surfaces and covers are manufactured with material that is inherently low in friction, which may prove beneficial to the person. However, some patients may be adversely impacted by very low friction surfaces if they hinder sitting up in bed, transferring, or bed mobility.

Temperature and moisture control. Excessive skin moisture and temperature are contributors to tissue damage. Temperature and moisture are often linked because an increase in body surface temperature leads to sweating, which elevates moisture. Maintaining normal skin temperature and moisture may be important in certain patients to preserve skin integrity.

Support surfaces dissipate heat and moisture with varying abilities. Surfaces made from foam tend to elevate temperatures more than those topped with gel or a viscous fluid. Air cushions are hard to judge since their impermeable cover has a huge impact on temperature. Some support surfaces are designed to exchange air, which permit more temperature and moisture control. A person’s activity on a cushion also impacts temperature. Regular movement helps dissipate heat from the body-support surface interface. A judicious clinical guideline follows: if a person regularly sweats on a particular surface, others should be investigated.

As stated, moisture can result from sweating and many other sources. Support surface covers have a huge impact on how this moisture is managed. Cushions that permit airflow via a breathable cover and cushioning material are better able to dissipate moisture than cushions that do not. Some “incontinence” covers are breathable: they are made from fabric that prevents water passage but allows airflow. These have advantages over covers that block both air and water flow but at a higher cost.

Support Surface Categories

The many designs of support surfaces complicate simple groupings or categorization. By definition, all support surfaces must meet a medical need, as do all types of durable medical equipment. One simple manner to divide support surfaces is active and reactive surfaces.

Reactive support surfaces redistribute pressures by deflecting or deforming in response to the load from the body. The goal of these surfaces is to allow the body to immerse, thereby accommodating the bony prominences by increasing the contact area between the body and support surface. By definition, increasing contact area will reduce overall pressure given a constant body weight. The different materials used in support surfaces redistribute pressures a little differently as will be discussed later in the chapter. Reactive surfaces can be powered or non-powered.

Active support surfaces purposely offload or re-direct forces away from the areas of the body.
Typically, these surfaces are comprised of compartments, which alternatively reduce loading on one or more areas thereby supporting the body on the remaining compartments. These are powered systems that have pumps, blowers, or some other electro-mechanical system.

Support surfaces may or may not be combined with a bed frame and associated hardware. Overlays are designed to be placed directly on top of an existing mattress. Mattress replacements are designed to be placed on the bed frame. Different features can be incorporated into overlays, replacements, and full bed systems that define their use and performance. Some of the more common features include low air loss, alternating pressure, air fluidized, and lateral rotation. The National Pressure Ulcer Advisory Panel offers the following definitions of each feature.18

Low air-loss systems provide airflow to assist in managing the microclimate (moisture and heat) of the skin. Support surfaces with alternating pressure provide pressure redistribution via cyclic changes in loading and unloading as characterized by frequency, duration, amplitude, and rate of change parameter. Air fluidized systems provide pressure redistribution by means of a fluid-like medium created by forcing air through beads as characterized by immersion and envelopment. Lateral rotation systems provide rotation about a longitudinal axis as characterized by degree of patient turn, duration, and frequency.

The use of support surfaces can be organized into 2 distinct purposes with respect to pressure ulcers: prevention and treatment. Overall, surfaces designed for prevention tend to be of a simpler design. Prevention surfaces can be reactive or active. Some are single material surfaces, but a few incorporate combinations of materials. Surfaces designed for patients with pressure ulcers, most often, severe ulcers, can also be active or reactive but exhibit more complex designs to provide advanced performance.

Overlays. Overlays are placed directly on top of existing hospital or home care mattresses and are available in foam, air, gel, viscous fluid, water, or some combination of these materials. They range in height, usually up to 4 inches.

Foam overlays. Several characteristics of foam are important for effective pressure redistribution, such as base height, density, and indentation force deflection.19 Base height refers to the height of the foam from the base to where the convolutions begin. Density is the weight per cubic foot (the amount of foam in a product) and reflects the foam’s ability to support a subject’s weight. Indentation force deflection (IFD) is a measurement of stiffness and is determined by the number of pounds required to indent a sample of foam with a circular plate to a depth of 25% of the thickness of the foam. Indentation force deflection reflects foam’s ability to deflect and conform to distribute the subject’s body weight.
Adequate height for a foam overlay is 3 to 4 inches with a 25% IFD of about 30 lb. Recommended minimum density of a foam overlay is 1.3 lb to 1.6 lb per cubic foot. Foam products, including overlays and mattress replacements, can be comprised of various types of foam. In a general sense, foam can be divided into elastic or viscoelastic. Elastic foam acts like a spring. It deflects in proportion to the load applied to it. As previously mentioned, the amount of deflection per unit force defines the stiffness of foam. Like a spring, elastic foam has resilience, so it will recover once the load is removed. Viscoelastic foam has time-dependent qualities, so it deflects in relation to both the load applied and the rate of that loading (Figure 1). Viscoelastic foam exhibits creep and stress relaxation and thus has much less resilience than elastic foam. In other words, it relaxes after being compressed, so it does not push back against the skin. However, this advantageous feature has a tradeoff. The creep characteristics of viscoelastic foam also make it susceptible to bottoming out. Many foam products use a combination of elastic and viscoelastic foam to take advantage of the respective benefits of each.

The manufacturer’s guidelines should state the body weight limit and the estimated length of use for a foam overlay. It may be advantageous to pressure map new foam products. This process of pressure mapping should continue at regular intervals to determine their ability to offer effective pressure reduction. This offers a practical means to determine whether the product meets performance claims throughout the warranty period.

Advantages of foam overlays include cost effectiveness (one time patient charge), no set-up cost, low maintenance, portability, light weight, availability in many sizes, and ability to be customized (Figure 2).

Disadvantages of foam overlays include limited life span; absorption of fluids from incontinence, perspiration, and exudate; infection control issues (if not covered by plastic protective covers); weight limit; disposal problems, which create environmental concerns (is there the ability to recycle?); single patient use; and lack of effectiveness.

Air overlays. Air overlays can be described as non-powered and powered. Non-powered overlays are designed so that air is enclosed in interconnected air cells, a single bladder, or latitudinal or longitudinal tubes (Figure 3 and 4). These systems can be comprised of multitude zones to address different bony prominences (ie, occiput, scapulae, sacrum, and heels) or as a single bladder system that is more likely to cause peak pressures. The more resolution a product has, the more likely it will reduce and evenly distribute pressures. In addition, pressure and pain reduction is contingent upon adequate immersion of the body into such a product.

Powered alternating pressure (AP) overlays...
consist of columns or chambers of air that are alternately inflated and deflated by an air pump. The air pressure fluctuates as one column or chamber inflates and another deflates, creating areas of low and high pressure. These systems work on the theory that while one area of the body might be experiencing a high peak pressure, another area has a very low pressure. As these areas inflate and deflate at specific intervals, this creates an environment for reactive hyperemia. Published studies on the efficacy of AP overlays report conflicting results; some show effectiveness, while others do not.24–26

Advantages of air overlays include ease of cleaning, durability, ease of repair, portability and light weight, cost effectiveness, low maintenance, ability to adjust to individual patient, ability to synthesize fluid without the weight, provision of custom environment for each bony prominence by zoned products, and provision of distribution of pressures by products with greater resolution.

Disadvantage of air overlays include requirement of electricity for powered products; limited use of dynamic/battery-powered products during power failures; high risk of damage by sharp objects; necessity of set up and monitoring to determine proper inflation and adjustment; environmental concerns caused by disposal problems (is there the ability to recycle?).

Water overlays. Water-filled overlays are polyvinyl bladders that are filled with water. The theory behind water beds and overlays is that of Pascal's law, which states, "The weight of a body floating on a fluid system is evenly distributed over the entire supporting system."27 However, by encasing water in a bladder, the patient does not realize total immersion and could suffer from high pressure forces due to hammocking and uneven distribution of pressure. The engaging body should displace the water without bottoming out.

Advantages of water overlays include cost effectiveness, ease of cleaning, and coolness in temperature.

Disadvantages of water overlays include heavy weight; inability to raise the head of the bed unless the mattress has separate compartments; potential to be over- or under-filled; water temperature becoming too cold without a heater; motion of fluid may be undesirable to patients and unstable for procedures, such as CPR; potential to be punctured, which may also present a safety hazard; and possible hammock effect.

Mattress replacements. These products are designed to take the place of standard hospital mattresses while providing more pressure reduction compared to standard mattresses. They are placed directly on the existing bed frame. Mattress replacements vary in design and medium. Most are constructed of foam, gel, air, water, or some combination of these materials. Those comprised of foam may have layers and combinations of different densities of foam for various areas of the body.

The base height of a foam mattress replacement should be 5 inches or greater.28 The density of a mattress replacement is between 1.35 lb and 1.8 lb per cubic foot.29 A 25% IFD between 25 lb and 35 lb is recommended.28 Mattress replacements are usually covered with durable, waterproof, bacteriostatic covers similar to standard hospital mattresses.

For all mattress replacements, the manufacturer's guidelines should be consulted for maximum weight of the engaging patient as well as the lifespan of the product. Most mattress replacements hold a warranty that is between 2 and 5 years. Some warranties are as long as 5 to 10 years or lifetime warranties. It may be advantageous to date each mattress (with an indelible marker) and pressure map new foam products upon delivery. Pressure mapping should continue at regular intervals as the mattress replacement ages to determine the product's ability to offer effective pressure reduction throughout its life. This procedure will also offer a practical way to determine whether the product meets its stated warranty/guarantee and, in the long run, save the facility money.

Some mattress replacements need to be turned and flipped over periodically while others should not be turned or flipped due to their compositions. To keep the warranty intact, it is important to know and understand the manufacturer's requirements.

Purchasing of mattress replacements typically requires a large capital expenditure by the institution. Some people hypothesize that renting support surfaces reduces costs and utilization, but some studies refute that belief. One randomized, controlled clinical trial with economic evaluation by Inman and colleagues concluded that purchase-
Support Surfaces: Tissue Integrity, Terms, Principles, and Choice

Advantages of mattress replacements include low maintenance requirements, theoretical reduction in the use of pressure reduction overlays, multiple patient use, and provision of automatic pressure reduction.

Disadvantages of mattress replacements include high initial expense to purchase, potential for delay in obtaining more appropriate level of support surface, possibility of not performing as desired throughout the life expectancy of the product, and potential disposal issues.

Figure 5 shows an example of a multidensity foam mattress replacement.

Reactive, non-powered advanced systems. These support surfaces typically rely on a combination of materials to better redistribute pressures. Both overlays and mattress replacements may fall under this category. These advanced systems do not require electricity to operate, and some designs exhibit a low surface tension, allowing the surface to conform to any shape; thereby, the product deforms to accommodate bony prominences (Figure 6). This allows for maximum surface contact and equalization of pressure. Additionally, these systems are designed to provide low friction and shear due to the consistency of their medium.

Non-powered, air-filled surfaces offer zoned, adjustable environments that can be customized to the body shape and bony prominences of the subject. Unlike a single bladder support surface, this zoned approach minimizes the chance of bottoming out and allows pressure to be adjusted for each body segment. These products may be rented or purchased.

Advantages of reactive, non-powered, advanced support surfaces include no need for electricity; convenient rental agreement secures set-up, service, and pickup; less expensive than most other therapeutic systems; easy set-up, use, cleaning, and maintenance; durability and ease of repair; air-filled products are adjustable, zoned, and can be customized to each individual patient and body segment; assimilate well into care environment, with no noise that may agitate patients; no need for storage or disposal of existing mattresses if an overlay is used; multiple patient use is possible; and air-filled products are light weight and portable. With air-filled products, individual sections can be replaced without replacing the entire support surface, and customization is possible by adding an air-flow module for moisture and temperature control or a bariatric kit for obese patients.

Disadvantages of non-powered viscous fluid or gel beds include heaviness and necessity for periodic kneading to address movement of gel and bottom-out potential. With air-filled products, regular monitoring to determine proper adjustment is required and the risk of puncture necessitates caution in use; regular assessment to prevent bottoming out is necessary. Other disadvantages include the necessity to store the existing mattress if a mattress replacement is used and potential daily rental fees, which can increase overall costs in addition to the possibility of the gel becoming hardened and causing pressure in a cold environment or storage situation.
Advanced Features of Powered Support Surfaces

Low air-loss therapy. These support surfaces enhance air circulation or flow for improved moisture and temperature control (microclimate) in addition to providing low interface pressures. They should provide diffuse airflow through the top and across the entire support surface, which directly or indirectly interfaces with the patient. One study defines “true” low air loss as an air flotation support surface capable of dissipating a minimum of 200 g of moisture per 24 hours from the patient-bed boundary via a continuous flow of fresh air in sufficient proximity and volume so that the body can regulate skin temperature through heat evaporation.31 The National Pressure Ulcer Advisory Panel’s (NPUAP) Support Surface Initiative has criteria for low air-loss and moisture dissipation. The widest variety of support surface products falls into this category, so extra care should be taken in product selection, and attention to design and performance is suggested.

Low air-loss products are comprised of connected air pillows that are supplied with a predetermined amount of continuous airflow that is supplied by a pump. This airflow can be controlled to provide low interface pressure as well as moisture and temperature control. The clinician should consider whether the product is comprised of a single bladder or a zoned environment.

Low air-loss support surfaces are available as overlays, mattress replacements, and full bed systems (Figure 7). They may be rented or purchased.

Advantages of low-air loss include provision of moisture and temperature control; possible customization for each individual patient depending on number of zones and adjustment features in pump/blower; potential convenience of rental agreement, which secures set-up, service, and pickup; disposal or storage of an existing mattress is not necessary, if mattress overlay is used; and durability and ease of repair.

Disadvantages of low air-loss include use of electricity, which is a hidden expense;32 limited use of dynamic/battery-powered products during power failures; noisy motors; daily rental fees, which can increase overall costs; inability to accommodate very obese patients in some circumstances; larger-than-standard sizes are not always available; storage of an existing mattress may be necessary; and full-bed (specialty bed) systems are the most costly of low air-loss support surfaces.

Evidence indicates that low air-loss surfaces have been shown to improve prevention and treatment outcomes compared to conventional treatment and non-powered foam alternatives.25,33

Powered flotation and alternating pressure. These are powered mattress replacement products characterized by air pumps or blowers, which provide either sequential inflation and deflation of the air cells or a low interface pressure throughout the mattress (Figure 8).

Powered flotation systems vary in the height of the air chambers and proximity of the air cham-
bers to one another, and air pressure provides adequate patient lift, reduces pressure, and prevents bottoming out.

Alternating pressure mattresses vary widely in design and performance. The number of cells, their inflated and deflated height, and the frequency of air cycling can impact performance. This wide variation may explain the conflicting results of research into AP technology.25,33

Fleurence used a modeling approach to assess cost effectiveness of alternating pressure mattresses and overlays and showed that they were more cost effective for the treatment of superficial and severe pressure ulcers and prevention of pressure ulcers, respectively, than standard hospital mattresses.26

Advantages of powered flotation and alternating pressure include convenience of rental agreements, which secure set-up, service, and pickup; ability to use with multiple patients; and durability and ease of repair.

Disadvantages of powered flotation and alternating pressure include use of electricity, which is a hidden expense; noisy motors; limited use of dynamic/battery-powered products during power failures; daily rental fees (if leased), which can increase overall costs; inability to accommodate very obese patients in some cases; larger-than-standard sizes are not available; and storage of an existing mattress may be necessary.

Air-fluidized or high air-loss systems. These products employ the circulation of filtered air through silicone-coated ceramic beads creating the characteristics of fluid (Figure 9).18,34 This technology is comprised of small silicone-coated beads in a tank-like environment that is covered by a permeable sheet. The ceramic beads become dynamic when a high rate of airflow is forced through them, allowing the patient to float on the sheet with two-thirds of the body immersed and enveloped in the beads.35

Air-fluidized systems are utilized to manage large amounts of excessive skin and wound moisture as well as burns and provide a low friction and shear environment. High airflow against the skin and tissue can dry moist wound dressings and desiccate the wound bed. An occlusive wound dressing or non-permeable under pad may be utilized or another form of therapeutic support surface may need to be investigated if these challenges exist. Air-fluidized beds are the heaviest and most costly of the therapeutic support surfaces.

High air-loss bed systems circulate and warm the room air, which may cause heat accumulation and increased room temperature. Air-fluidized beds are not recommended for patients with pulmonary disease or with unstable spines due to the inability to raise the head of the bed and the relative instability of the surface.

Although some evidence indicates that high air-loss beds enhance pressure ulcer healing rates,36 occipital and calcaneal skin resting surface interface pressure may remain sufficient to occlude capillary perfusion. Occipital and calcaneal ulcers have been reported to develop in patients while on the high air-loss surfaces.37 These systems have traditionally been recommended as a last resort, if all else fails, and for patients with burns, tissue grafts and flaps, or multiple Stage III and Stage IV pressure ulcers; however, recent research suggests that less costly pressure-relieving support surfaces (ie, non-powered pressure reducing systems and low air-loss systems) can be used with an equal therapeutic benefit.38,39

Advantages of air-fluidized beds include ability to manage high volumes of excessive skin and wound moisture; maintenance of low friction and shear environment; convenience of rental agreement, which secures set-up, service, and pickup; and ability to provide pain reduction in some patients.
Disadvantages of air-fluidized beds include expensive rental or purchasing fees; potential dehydration of patients by the continuous warm, dry air circulation; difficulty of transfers and bedside care due to tank’s edge; inability to raise head of bed, which may require the use of foam wedges, which in turn may interrupt therapy; difficulty moving product due to size and weight (1,600 lb or more), which may not be appropriate for certain environments (ie, home care); potential expense of electricity; and potential adverse side effects, such as corneal abrasions.

Alternative hybrid air-fluidized and low air-loss combination products have been developed to decrease the disadvantages of air-fluidized therapy, making it more acceptable to both the patient and the clinician.

Hybrid support surfaces. Hybrid support surfaces offer combinations of low air-loss and kinetic or percussion therapies, alternating pressure, or air-fluidized and low air-loss therapies.

The combination of low air-loss and air-fluidized therapies offers the ability to effectively raise and lower the head of the bed while maintaining air-fluidized therapy, as the upper one-third of the system is comprised of low air-loss therapy and the lower two-thirds of air-fluidized therapy.

Lateral rotation. Lateral rotation offers rotation from side to side about a longitudinal axis as characterized by degree of patient turn, duration, and frequency (Figure 10). It is believed to provide passive pulmonary secretion mobilization thus decreasing complications of immobility, such as atelectasis and pneumonia; preventing deep vein thrombosis and pulmonary emboli due to venous stasis; and reducing urinary tract infections by preventing urinary stasis. Lateral rotation does not take the place of turning and repositioning the patient. It can be intrusive and unpleasant to the patient due to the continual movement.

Bariatric support surfaces. Obese patients, defined as those having a larger than average body mass index (>40 body mass index [BMI]), may need a bariatric support surface to provide safety and protection. These special bed frames and surfaces are generally wider, utilize a reinforced frame, have side rails that tilt outward, feature a built-in scale, and offer a chair feature that allows the head of the bed to be put at a 45-degree angle and the foot of the bed to be positioned directly down.

Special non-powered or low air-loss therapeutic overlays or mattress replacements can be added to address the obese patient’s pressure, shear, friction, and moisture issues (Figure 11). An important caveat for all support surfaces is ascertaining the patient weight limit of that particular product. This is particularly true for bariatric systems.

Continuity of Care

Support surface needs should be considered along the continuum of care. Pressure reduction in the seated position, whether in a wheelchair, geriatric chair, easy chair, or automobile, is sometimes even more important since the seated posture dramatically decreases the surface area over which the engaging body is in contact. In the
seated position, approximately 70% of the body’s weight is distributed over a small area of space. Three bony prominences, the sacrum, coccyx, and bilateral ischial tuberosities (ITs), further increase the likelihood of pressure ulcer development in the seated position. Approximately 47% of pressure ulcers occur on these 3 areas.40 If the patient sits upright, the care plan should reflect the need for a pressure reduction seat cushion comprised of air, foam, gel, or a combination of these mediums (Figure 12). Likewise, a plan for weight shifts should be incorporated, allowing blood flow to reach the occluded area.

Other areas of pressure-reduction concern include stretchers, gurneys, operating room and exam tables, as well as managing tissue loads at the heel. The pressure ulcer incidence of intraoperatively acquired pressure ulcers has been reported to be as low as 12% and as high as 66%.41 By utilizing an effective pressure-reduction device in the operating room, pressure ulcer incidence can be decreased to 3%–8%.28 A patient who is at risk for pressure ulcers can develop breakdown as a result of pressure, shear, and friction from these surfaces, depending on the duration of use and procedure being done.

Heels provide a particular dilemma in that they not only present a penetrating bony prominence and a thin layer of subcutaneous fat tissue,42 they can additionally present with compromised circulation, further complicating their risk for breakdown.

Unacceptable products that should be avoided for pressure redistribution include those comprised of sheepskin (genuine or synthetic), 2-inch foam “egg crate” type overlays or cushions, and invalid rings or “donut-type” cushions. These measures constitute comfort measures only.

Practice Setting, Clinician, Cost, and Patient Considerations

Practice environment criteria. Choosing support surfaces for facilities, agencies, and home care settings should involve an interprofessional team approach. Although team members may vary depending on the setting, team members should generally include all interested and knowledgeable participants in the patient’s plan of care. Headed up by a specialist with expertise in wound management and skin care, the committee should include, but not be limited to, staff nurses from various clinical areas, a materials management and/or purchasing member, an infection control professional, a seating and positioning professional (ie, physical and/or occupational therapist), a member of the financial management staff or administrator, and a case manager or discharge planner.

No single support surface has the ability to address all of the institution’s requirements. Rather, a range of categories should be available to speak to both preventative and therapeutic needs. The following questions should be considered when selecting support surfaces for an agency:

- What are the collective needs of the patient population?
- Does the institution or department deal with high-acuity, high-risk, critically ill patients?
- Do patients exhibit any unique needs?
- What size are the patients?
- What extrinsic risk factors are causing the breakdown?
- What is the pressure ulcer prevalence rate?
- What is the nosocomial pressure ulcer incidence rate?

Prevalence and incidence rates will help isolate areas of high risk and provide a big-picture view of patient and institutional need. An institution with a wide variety of patients will require several support surfaces.

Other concerns within the institution and home involve questions regarding who will set up and operate the devices. Are company personnel available 24 hours a day, 7 days a week? Are the products simple to use? How is the product maintained or disposed? Is the support surface durable and repairable? Is it easy to clean? Who will clean it? How about infection control issues? Are special linens necessary?

Cost is another matter to consider. Questions, such as, “How much does the product cost?” and “Are there additional associated costs, such as
electrical power consumption?” are of supreme importance. Another item to deal with is how a power failure will be addressed. Some support surfaces are available for rental and others for purchase. Factors, such as clinician’s time and ease of repair and service, are of extreme significance. A rental agreement addresses the indirect cost of staff time to set-up, maintain, periodically check, and discontinue support surfaces. The cost of rental and purchase should be factored. Many preventative support surfaces are a one-time purchase item. This can be of particular importance to a large facility that may need to consider capital budget concerns.

Manufacturer and provider information should be collected from the companies supplying the support surfaces. The company’s reputation for service, set-up time, delivery, and availability should be further investigated. Ask for a list of independent clinicians who are willing to discuss their experiences with the product considered. Other important questions include: Is service adequate? What is the corresponding warranty/guarantee? What type of clinical education support is provided? Is there independent clinical research available to determine product effectiveness and interface pressure measurement? An evaluation plan should be developed that includes a trial period.

Patient-needs criteria. After the practice environment issues have been addressed, selection of those specific support surfaces for individual patients must be made. Development of an institution or facility protocol for both prevention and treatment of pressure ulcers and use of specific support surfaces should then be developed. Bergstom and her colleagues reported that support surface choice established by classifying patients using a pressure ulcer risk assessment, such as the Braden Scale, created both successful and cost-effective outcomes. Risk-based prescription of support surfaces has also been shown cost effective by others. Algorithms, decision trees, and decision guidelines are often useful. First and foremost, goals need to be established for each patient. The goals for treatment of a pressure ulcer of a young, newly injured, quadriplegic patient may be different from our goals for treatment of a pressure ulcer of an end-stage lung cancer patient.

Several factors should be investigated when considering support surfaces specific to patient need. The patient’s risk assessment, overall condition, and disease process should be taken into account as well as his or her mobility, sensory perception, and pain the patient experience. Does the disease process or current therapy dictate the necessity to place the patient in certain positions? The ability to customize the support surface, no matter what position the patient takes, is important, as is the ability to adjust to each individual body segment. In what types of activities does the patient participate? Are there activities of daily living that could be contributing to the pressure, shear, friction, and moisture factors that encourage pressure ulcers? What about the patient’s support surface needs? Are they short term or long term? Is this a product that the patient might need for a chronic condition or for the rest of his life? In the case of a home care patient, is the home environment suited for the space, size, and structural needs of the support surface?

A therapeutic support surface can additionally be used as an adjunct to pain management. Redistributing pressure from the body’s frame, as well as managing heat and moisture, offer comfort and relief to patients experiencing chronic pain. Conformation to the body’s contours helps to equalize soft tissue pressure, diminish ischemia, promote healthy blood flow, and can decrease the experience of pain. Dallum and her associates showed that pain was significantly lower in patients using support surfaces for pressure reduction.

The patient’s reimbursement source is of paramount importance when choosing a support surface. For example, Medicare Part B has distinctive medical policy coverage and payment rules, which dictate coverage criteria for specific support surfaces. Documentation is therefore critical. Does the support surface meet the criteria for the patient’s insurance, reimbursement, or private pay? Can the patient afford a co-pay in the case of Medicare B and some private insurance? Will the support surface be available in the next healthcare
Setting? In other words, is it portable? How about any hidden costs, such as electricity, the patient will incur?

Important matters to consider when using support surfaces include pressure and time, so turning and repositioning the patient continues to be paramount. Despite support surface use, patients still need to be turned and repositioned according to protocol, or at a minimum of every 1 to 2 hours, no matter how effective the surface. Kosiak postulated that turning and repositioning take place at 1- to 2-hour intervals based on his study of healthy subjects.45 Keep in mind, the elderly with less resilient skin may not be able to tolerate a single position for 2 hours without damage. This protocol should therefore be customized to each patient. Range of motion and prevention of contractures and other problems is not accomplished by any surface, so good care must prevail.

A minimum of linen and incontinence pad use is recommended with every support surface. The closer the patient body is to the therapy (the support surface), the better the product will be able to prevent and heal ulcers. Layering of multiple or tight linens and incontinent pads is not suggested. Finally, checking for “bottoming out” or “hitting bottom” on a support surface should be ascertained on a regular basis. The patient’s body must be immersed, yet float or be suspended in the surface. If not, a part of his or her body (usually the trunk and/or pelvis) can sink to the bottom of the product with no medium between the body and the surface. A simple hand check can be done by placing one’s hand between the patient’s bony prominences and the surface, making certain there is “wiggle room,” or enough depth to support the patient’s body.

Conclusion

Support surface selection will continue to challenge the healthcare provider until we develop a ubiquitous master plan of criteria that consistently demonstrates excellent outcomes. This is currently in the works as the NPUAP Support Surface Initiative; a group of interested parties (clinical personnel, manufacturers, scientists, and researchers) are currently developing consistent language, terminology and definitions, and life span and tissue integrity management criteria. The state of the science for determining support surface product effectiveness is growing with the addition of high-tech interface pressure mapping, laser Doppler blood velocimetry, and transcutaneous oxygen tension measurement. The process of support surface selection continues to be refined and clarified as more is discovered about gauging effectiveness. Further outcome-focused research on the relative effectiveness of specific support surfaces is needed.

It is important to consider that support surfaces are only one component of a comprehensive pressure ulcer treatment plan. If the ulcer(s) does not show progress toward healing, the entire care plan should be reevaluated before the support surface is changed. Accordingly, it is important for the clinician to be aware of support surface categories and decision-making factors in order to make an informed and effective choice.

Take-Home Messages for Practice

- Support surfaces are specialized devices for pressure redistribution designed for management of tissue loads, microclimate, and/or other therapeutic functions.
- External pressure, especially over the bony prominences, has been identified as the major etiology in pressure ulcer development. Additional associated origins consist of the degree of shear and friction forces and the further effects of temperature and moisture. All of these factors can be affected by, and are correlated to, the characteristics of the support surface selected for an individual.
- Support surface selection is one of many important decisions the clinician and team must assess, plan, implement, evaluate, and discuss.
Self-Assessment Questions:

1. A support surface can affect all of the following EXCEPT:
   A. Pressure
   B. Shear
   C. Albumin level
   D. Moisture

2. Support surfaces include:
   A. Beds and mattresses
   B. Seat cushions
   C. Operating room tables
   D. All of the above

3. An immobile patient at high risk for pressure ulcers who requires good microclimate control would be best treated on which type of support surface:
   A. Low air-loss mattress or bed
   B. Water mattress
   C. Non-powered, air-filled support surface
   D. None of the above

Answers: 1-C, 2-D, 3-A

References

13. Same as 1


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


