Heat, moisture, and the skin interface:
The importance of microclimate management

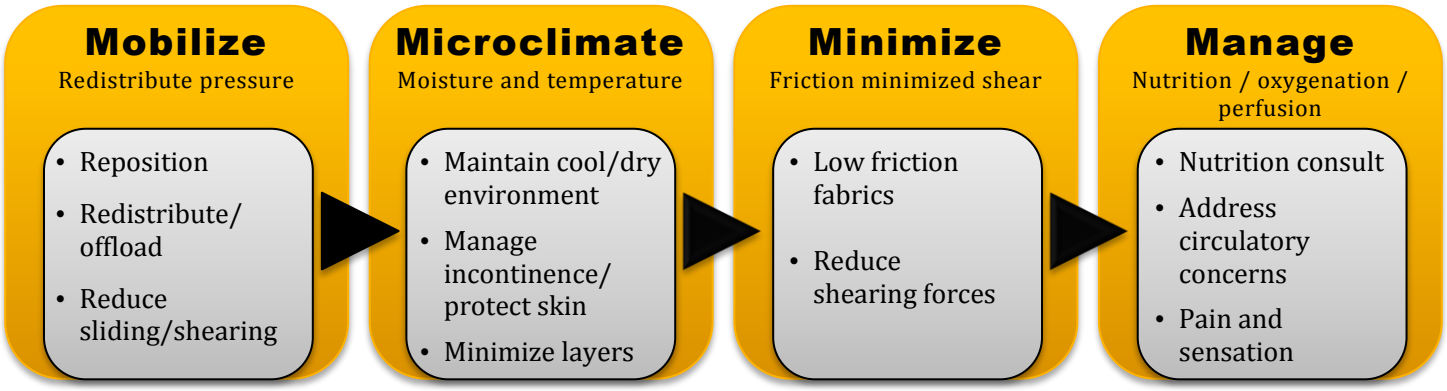
Content

Background

The National Pressure Ulcer Advisory Panel (NPUAP) was formed in 1986 to serve as an independent, not-for-profit, professional organization whose mission is to advance the field of prevention and management of pressure injuries. The NPUAP is comprised of leading experts from various healthcare disciplines and serves as a resource around the world to healthcare professionals, government, and public healthcare. The NPUAP has collaborated with experts around the world to establish regional organizations, such as the European Pressure Ulcer Advisory Panel (EPUAP) and the Japanese Society of Pressure Ulcers.

As part of their ongoing mission to improve prevention and care of pressure injuries, the NPUAP has created many professional and educational resources to assist healthcare professionals in establishing best practices. A subcommittee of the NPUAP, the Support Surfaces Standardization Initiative (S3I), was formed to provide guidance to the manufacturers of support surfaces to improve the understanding of the role of support surfaces in prevention and treatment of pressure injuries. In 2007, the S3I published a list of standardized terms and definitions related to support surfaces to provide a common language among manufacturers and healthcare providers.

The NPUAP has published recommendations for pressure injury prevention strategies.[1] The recommendations center around interventions to address the major risk factors associated with pressure injury development. The recommendations are summarized simply below:



The role of moisture in the development of pressure injury

As defined by the NPUAP, the term microclimate refers to the heat and humidity at the intersection of the patient's skin/body and the surface on which the patient is laying.[2] Moisture, which can accumulate due to a variety of factors, weakens the skin and increases the effect of friction and shear. The increased impact is due to increased tissue deformation and weakening of the tissue due to maceration of the skin.

Another factor impacting microclimate is the position in which the patient is laying. Skin temperatures can be impacted by changes in position, which can alter superficial blood flow and contact areas of the skin. Physiologically, as the patient's temperature rises, metabolic demand increases. A 1°C rise in temperature equates to a 13% increase in metabolic demand.[2] As temperature increases, the risk of ischemia and moisture production (perspiration) increases as well. As moisture increases, so does the risk of tissue weakening, which further decreases the tolerance for physical forces such as pressure, shear, and friction. The mechanism by which weakening of the skin occurs due to excessive moisture is by a softening of the stratum corneum (outermost layer of skin cells).[2]

Moisture also causes increased permeability of the skin, making it more susceptible to irritants.[2] Increases in temperature also impact the presence of reactive hyperemia. Reactive hyperemia is the excess blood flow to an area that occurs when blood flow is restored after an occlusion.

Reddening (erythema) that occurs to the skin may dissipate once pressure is removed and blood flow is normalized. In some cases, the erythema will not dissipate (non-blanchable) and is indicative of an injury to the tissue.

Types of moisture

Moisture refers to any liquid to which the patient's skin is subjected. In some cases, the moisture comes from an external source, such as fluids and other liquids necessary for treatment of a condition. An example of a fluid-rich environment would be the operating room or labor and delivery.

In most cases, moisture is a by-product of bodily functions. Intrinsic moisture can occur from perspiration, drainage from wounds or body cavities, incontinence, and other insensible fluid loss.

Incontinence

About 25-45% of women report some form of urinary leakage,[3] while up to 34% of males experience urinary incontinence.[4] Much focus has been paid recently to the prevention of catheter-associated urinary tract infection. As such, the appropriate use of indwelling catheters is being examined and justified.

Prevention and management of moisture

Prevention

For the large number of patients that are incontinent of urine and/or stool, the major preventative intervention will be frequent toileting and offering assistance to the bathroom or the bedpan/urinal. There are many external urinary collection device options available to address male incontinence. Minimal viable options exist, for females. Sage Products has introduced the PrimaFit™ Female External Urinary Collection system to help manage urinary incontinence in female patients. Whatever the strategy, the goal should be to prevent incontinence when possible and to provide rapid cleansing and drying once an incontinence episode has occurred.

Management

It is important that staff receive appropriate education on the differentiation between a pressure injury and moisture-associated skin damage (MASD). Incontinence-associated dermatitis (IAD) is a form of MASD that is caused by exposure of the skin to urine or feces. There are many differentiating factors between pressure injury and IAD (Table 1).

The evidence-based recommendations for prevention and treatment of IAD are early assessment, diagnosis, treatment, and prevention by way of cleansing, protecting, and moisturizing the skin. This can be accomplished by utilizing the appropriate pH-balanced cleansers and barrier products to protect the skin.

TABLE 1.

Differentiation of IAD Versus Stage I and II Pressure Ulcers

Factors	IAD	Stage I Pressure Ulcers	Stage II Pressure Ulcers
History of condition	Exposure to urine or stool	Exposure to pressure, shear, and/or microclimate from immobility or inactivity	Exposure to pressure, shear, and/or microclimate from immobility or inactivity
Location of affected skin	Skin folds in areas where urine or stool can accumulate	Skin usually over bony prominences or exposed to other external pressure (eg, medical device)	Skin usually over bony prominences or exposed to other external pressure (eg, medical device)
Color of wound bed	Shiny, red, glistening, no slough in wound bed	Nonblanchable erythema of intact skin	Shiny, pink, or red open wound, no slough in wound bed
Color of periwound tissue	Red, irritated, edematous	Normal for race/ethnicity, edema may be palpable	Normal for race/ethnicity, edema may be palpable
Characteristics of involved area	Blotchy, not uniform in appearance	Tend to be single areas of erythema	Tend to be single ulcers with distinct ulcer wound margin
Pain	Burning, itching, and tingling	Sharp pain, usually no itching; pain may intensify when patient is initially moved off of injured areas	Sharp pain, usually no itching; pain may intensify when patient is initially moved off of injured areas
Odor	Urine, fecal odor	None	None unless infected and then may have odor of infecting organism
Other	Candidiasis common (seen as satellite lesions)	Redness tends to resolve with offloading or repositioning of device	Ulcer bed is shallow and heals through epithelialization

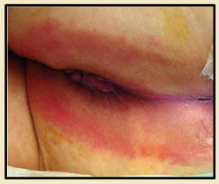
Abbreviation: IAD, incontinence-associated dermatitis.

Incontinence-Associated Dermatitis Intervention Tool (IADIT)

Skin Care for Incontinent Persons

The #1 priority is to address the cause of incontinence. Use this tool until incontinence is resolved.

1. **Cleanse incontinence ASAP and apply barrier.**
2. **Document condition of skin at least once every shift in nurse's notes or per organization's policy for documenting skin breakdown.**
3. **Notify primary care provider when skin injury occurs and collaborate on the plan of care.**
4. **Consider use of external catheter or fecal collector.**
5. **Consider short term use of urinary catheter only in cases of IAD complicated by secondary infection.**

	Definition	Intervention
HIGH-RISK	Skin is not erythematous or warmer than nearby skin but may show scars or color changes from previous IAD episodes and/or healed pressure ulcer(s). Person not able to adequately care for self or communicate need and is incontinent of liquid stool at least 3 times in 24 hours.[1]	1. Use a disposable barrier cloth containing cleanser, moisturizer, and protectant.[2,3] 2. If barrier cloths not available, use acidic cleanser (6.5 or lower), **not soap** (soap is too alkaline); cleanse gently (soak for a minute or two – **no scrubbing**); and apply a protectant (ie: dimethicone, liquid skin barrier or petrolatum). 3. If briefs or underpads are used, allow skin to be exposed to air. Use containment briefs only for sitting in chair or ambulating – not while in bed. 4. Manage the cause of incontinence: a) Determine why the person is incontinent. Check for urinary tract infection, b) Consider timed toileting or a bladder or bowel program, c) Refer to incontinence specialist if no success.[4]
EARLY IAD 	Skin exposed to stool and/or urine is dry, intact, and not blistered, but is pink or red with diffuse (not sharply defined), often irregular borders. In darker skin tones, it might be more difficult to visualize color changes (white, yellow, very dark red/purple) and palpation may be more useful. Palpation may reveal a warmer temperature compared to skin not exposed. People with adequate sensation and the ability to communicate may complain of burning, stinging, or other pain.	
MODERATE IAD 	Affected skin is bright or angry red – in darker skin tones, it may appear white, yellow, or very dark red/purple. Skin usually appears shiny and moist with weeping or pinpoint areas of bleeding. Raised areas or small blisters may be noted. Small areas of skin loss (dime size) if any. This is painful whether or not the person can communicate the pain.	↑ ***Include treatments from box above plus:*** 5. Consider applying a zinc oxide-based product for weepy or bleeding areas 3 times a day and whenever stooling occurs. 6. Apply the ointment to a non-adherent dressing (such as anorectal dressing for cleft, Telfa for flat areas, or ABD pad for larger areas) and gently place on injured skin to avoid rubbing. Do not use tape or other adhesive dressings. 7. If using zinc oxide paste, **do not scrub the paste completely off** with the next cleaning. Gently soak stool off top then apply new paste covered dressing to area. 8. If denuded areas remain to be healed after inflammation is reduced, consider BTC ointment (balsam of peru, trypsin, castor oil) but remember balsam of peru is pro-inflammatory. 9. Consult WOCN if available.
SEVERE IAD 	Affected skin is red with areas of denudement (partial-thickness skin loss) and oozing/bleeding. In dark-skinned persons, the skin tones may be white, yellow, or very dark red/purple. Skin layers may be stripped off as the oozing protein is sticky and adheres to any dry surface.	↑ ***Include treatments from box above plus:*** 10. Position the person semiprone BID to expose affected skin to air. 11. Consider treatments that reduce moisture: low air loss mattress/overlay, more frequent turning, astringents such as Domeboro soaks. 12. Consider the air flow type underpads (without plastic backing).
FUNGAL-APPEARING RASH 	This may occur in addition to any level of IAD skin injury. Usually spots are noted near edges of red areas (white, yellow, or very dark red/purple areas in dark-skinned patients) that may appear as pimples or just flat red (white or yellow) spots. Person may report itching which may be intense.	Ask primary care provider to order an anti-fungal powder or ointment. Avoid creams in the case of IAD because they add moisture to a moisture damaged area (main ingredient is water). In order to avoid resistant fungus, use zinc oxide and exposure to air as the first intervention for fungal-appearing rashes. If this is not successful after a few days, or if the person is severely immunocompromised, then proceed with the following: 1. If using powder, lightly dust powder to affected areas. Seal with ointment or liquid skin barrier to prevent caking. 2. Continue the treatments based on the level of IAD. 3. Assess for thrush (oral fungal infection) and ask for treatment if present. 4. For women with fungal rash, ask health care provider to evaluate for vaginal fungal infection and ask for treatment if needed. 5. Assess skin folds, including under breasts, under pannus, and in groin. 6. If no improvement, culture area for possible bacterial infection.

1. Bliss DZ, Zehrer C, Savik K, et al. Incontinence-associated skin injury in nursing home residents: a secondary analysis of a prospective, multicenter study. Ostomy Wound Manage. 2006; 52: 46-55. Institute for Healthcare Improvement. Prevent Pressure Ulcers: How-To Guide. May 2007. Available at: http://www.ihi.org/nr/rdonlyres/5ababb51-93b3-4d88-ae19-be88b7d96858/0/pressureulcerhowtoguide.doc, accessed 10/21/07. Gray M, Bliss DB, Ermer-Seltun J, et al. Incontinence-associated dermatitis: a consensus. J Wound Ostomy Continence Nurs. 2007; 34: 45-54. Junkin J, Selekof JL. Prevalence of incontinence and associated skin injury in the acute care patient. J Wound Ostomy Continence Nurs. 2007; 34: 260-269.

Linens

Most healthcare linens in use today are 100% cotton or a polyester/cotton blend with no special properties.[5] It is important to know that when cotton linens become wet, their coefficient of friction increases significantly. This is especially impactful for patients at risk of pressure injury development. Specialty fabrics are beginning to make their way into healthcare linen supply. Due to cost constraints and lack of clinical evidence, however, the use of these fabrics has not become widespread. These synthetic linens have silk-like properties that allow for moisture wicking and drying.[5]

Amount

Aside from the type of linen used, another component to consider is the amount of linen used. Many times, the configuration of bed linens is based on nursing or unit-based preferences. With a lack of other patient handling equipment, hospital staff must rely on the linens to assist with the movement of the patient. This practice requires either very sturdy material or multiple layers of standard linens. In some cases the configuration of a fitted sheet, a quilted incontinence pad, and a flannel blanket comprise one configuration that is repeated multiple times. This practice is helpful to staff in the case of an incontinent patient, as it minimizes the time required to change a full bed of linen.

Williamson, et al. conducted laboratory testing to determine the impact of various configurations of linen on the pressure and low air loss properties of support surfaces. They found that in all types of surfaces, the performance for pressure and low air loss properties were best with only a fitted sheet. Both peak interface pressures and total heat withdrawal and evaporative capacity were greatly impacted by multiple layers of linen. [6]

Purpose

Linens serve many purposes: protection of the hospital mattress, infection control, patient comfort, and patient handling. In terms of pressure injury prevention, linens should be made of low friction fabric, provide vapor permeability, and should be loose and flowing to lessen the effect of shear and friction. Practically, loose fitting sheets may appear messy and unappealing to staff and family members. Fitted sheets are therefore used to present a tidy appearance.

A staple of nursing education was learning how to make hospital corners and to be able to bounce a coin off the surface of a made bed. Tight linens, however, increase the impact of friction and shear because they do not move with the patient, but instead, against the patient's skin. Fabrics that are silky and low friction may make it easier for patients to migrate in the bed. This may cause patients to slip down to the foot of bed more easily, which will require frequent repositioning by the staff, thereby increasing the potential for injury.

Linens that are 'waterproof' may seem necessary for incontinent patients. This feature of the linen, however, is made possible by materials that are mostly non-vapor permeable. This means that the linen will not allow for the passage of air through the fabric and will

hold moisture against the patient's skin, increasing the potential for skin injury.

With the advancements in knowledge and practice around safe patient handling, more hospitals are investing in specialized lift equipment to protect their staff from work-related injuries. Many of these devices require the use of a sling under the patient. Much debate has occurred about whether these slings are safe to leave under the patient. The argument is that placing the sling for every patient handling task will likely result in decreased utilization of the equipment and therefore an increase in staff injury. On the other hand, following the 'less is best' model for linen usage under the patient, the sling adds an additional layer and may not be made of a suitable fabric to meet individual patient care needs.

According to Brienza, et. al, because of a lack of evidence, "the decision regarding placement/removal of SPHM equipment between uses must balance the putative risk (decreased efficacy of a therapeutic support surface) and potential benefit (easier repositioning increasing frequency and/or efficacy) on pressure injury prevention." [7]

Support surfaces

Air flow

Low air loss is a property of certain support surfaces that, by definition, provides a flow of air to assist in the management of the microclimate (heat and humidity) of the patient's skin.

Support surfaces may provide this flow of air in a variety of formats, including supplying air via hoses within the surface cushions or by channeling air through layers of a mattress covering. The purpose of the low air loss surface is to help prevent increases in skin temperature that may lead to perspiration and accumulation of moisture. There is currently no evidence for optimal levels of skin temperature and moisture.[5]

Covering

The NPUAP recommends a vapor permeable surface cover.[5] This recommendation is based on the ability of the covering to draw moisture and heat away from the patient. Vapor permeability refers to the ability of gas to pass through the fabric. This is more commonly referred to as 'breathability.'

Testing related to microclimate

Routine repositioning of the patient is a standard of care in the prevention of pressure injury. While optimal frequency has not been determined, every patient needs to be repositioned to provide pressure redistribution to the various bony prominences along the surface of the body. By positioning the patient laterally, the sacrum, coccyx, and sometimes the heel can be offloaded. Repositioning the patient will expose the patient's skin to shear and friction by nature of the maneuver. In a study to model the effects of moisture on the skin during repositioning tasks, Shaked and Gefen stress the importance of preventing moisture accumulation and keeping the skin-surface interface dry (free from sweat and urine) prior to repositioning that patient.[8]

"For immobile and bed-bound patients, the tolerance of the skin is constantly challenged by factors affecting from the outside in (frictional forces at the skin surface) that changes due to microclimate conditions, clothing and bedsheet material, interface pressures, relative motion and sliding velocity, as well as, moist or wet skin."[8]

Repositioning and transferring

Sage Products markets products to assist with the repositioning and transfer needs of the hospitalized patient. The Prevalon® Turn and Position (TAP) system provides a safe way to reposition patients. Unlike lift slings and plastic slide sheets, the system stays under the patient throughout their hospital stay and is therefore always ready to use. The system also incorporates two anatomically designed wedges to assist caregivers in providing a lateral position consistent with the NPUAP guidelines of 30° tilt for effective offloading of the sacrum. The AirTAP system provides the addition of air assisted technology to further decrease the potential risk of injury to the nurse. This helps staff to safely achieve compliance to turning protocols while reducing strain and potential for injury to themselves. A unique feature of the TAP and AirTAP system is the provision of a specialized microclimate body pad that permits air flow and wicks away moisture from patients, keeping them dry.

The Prevalon® Mobile Air Transport System (MATS) is an air-assisted lateral transfer device system designed for areas in which frequent transfers are anticipated. MATS is designed to be cleanable for those fluid-rich areas, such as the operating and emergency rooms.

Testing methods

Hospitals that have invested in support surface technology should and do question whether ancillary products will impact the performance of their equipment. More specifically, the question is how these products will impact the microclimate properties of their support surfaces.

The American Society for Testing and Materials recommends different types of testing via validated methods. Many consumer products such as clothing, packaging for food or medicine, and building materials must meet certain standards for barrier properties. In most cases, the test is intended to measure how well the material blocks moisture vapor transmission (keeping air out). With support surfaces, the desired characteristic of the material is to allow air/vapor to flow through (breathability). The ASTM E96 tests only one layer of material. The output metric is expressed as moisture/water vapor transfer rate (MVTR/WVTR). It is important to note that MVTR is impacted by heat and relative humidity. ASTM E96 outlines the Cup Method for testing water vapor transmission. It can be conducted in two ways:

- The desiccant method, in which a material is sealed over a cup of water and then placed in an environmentally controlled atmosphere. The sealing of the material over the cup creates a low vapor pressure environment, which then allows moisture vapor to pass through the material. As the pressure inside the cup is lower than the surrounding atmosphere, more water will accumulate in the cup as moisture vapor molecules pass from the

atmosphere into the cup through the material. This is known as the dry cup method.

- The water method (or wet cup method) creates a high vapor pressure environment inside the cup. Because the pressure is higher inside the cup than outside the cup, the moisture vapor molecules will tend to pass through the material into the atmosphere (there will be less water in the cup at the end of the test).

Testing standards

Because the need for microclimate management is essential to prevention of pressure injuries in hospitalized patients, special work groups have been formed to develop testing standards that relate specifically to materials used in support surfaces.

The National Pressure Ulcer Advisory Panel (NPUAP) Support Surface Standards Initiative is comprised of consumers, clinicians, researchers, scientists, healthcare providers, manufacturers, and policy makers. The group was formed in 2001 and since that time has joined forces with American National Standards Institute (ANSI) and Rehabilitation Engineering Society of North America (RESNA) to become the official standards body for testing specifically related to support surfaces.

RESNA/ANSI/S3I recommended testing methods to determine MVTR are:

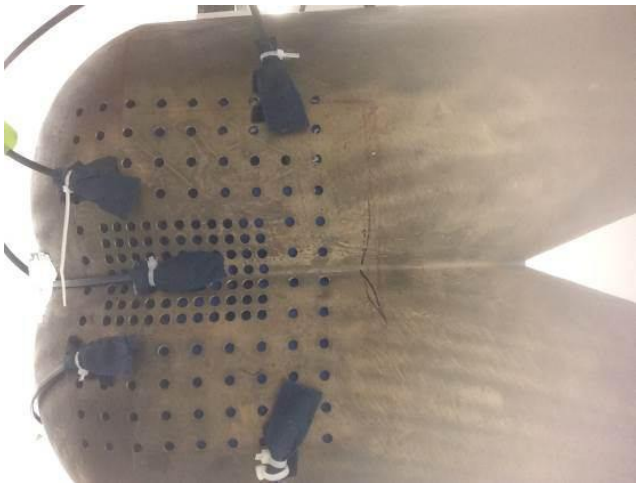
Sweating guarded hot plate method: simulates the transfer of heat and moisture from the body through clothing/material into the environment. This test is used to measure comfortability of garments.

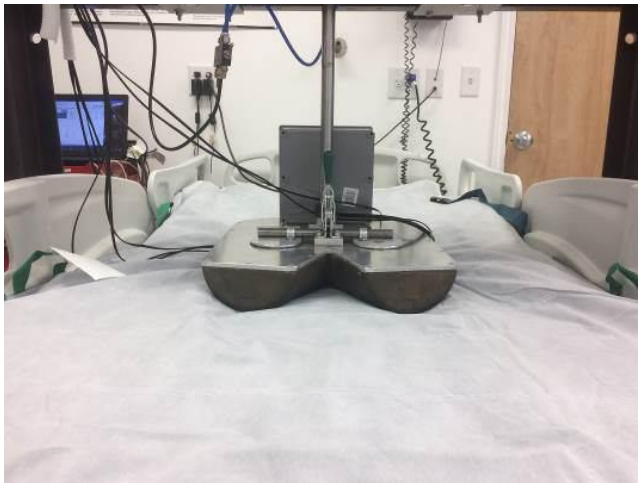
Body Analog Test: the NPUAP approved standard test methodology for assessing temperature and humidity at the skin surface interface. This test is performed in controlled conditions with specialized equipment. This test uses a metal thermodynamic rigid cushion loading indenter (TRCLI) to deliver temperature, load, and moisture, in the form of water vapor, to the support surface. This test meets the current US standard for microclimate testing of full body support surfaces that specifies the use of a TRCLI to load a support surface while delivering heat and moisture. The test output metric is temperature (heat) and relative humidity, which matches the NPUAP definition of microclimate.

The indenter provides consistent microclimate delivery and a geometric shape analogous to the buttocks to simulate in vivo conditions. The indenter-support surface interface conditions are monitored by temperature and humidity sensors. This testing methodology is thought to more closely mimic the patient-support surface interface.[9]

The question of compatibility of transfer and positioning devices frequently arises in relation to low air loss surfaces. Sage Products enlisted the services of EC Service, Inc. to investigate the impact of the Prevalon family of products on the microclimate of the patient-surface interface on low air loss mattresses.

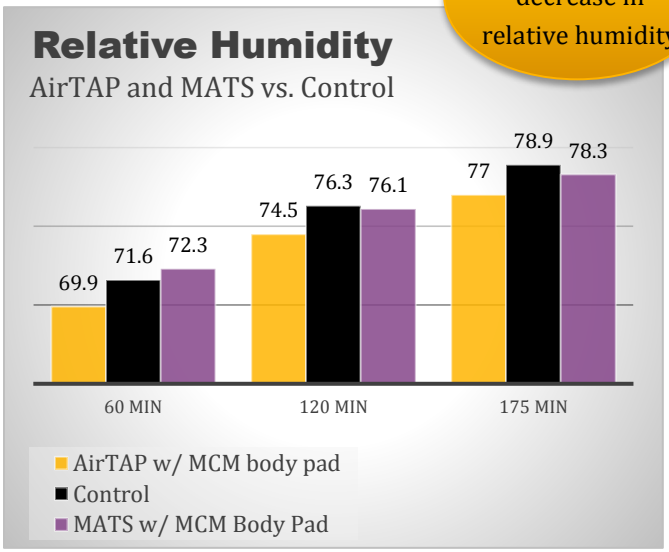
Multiple testing scenarios were conducted with each product and surface combination (repeated with each product placed on Stryker InTouch bed with Isolibrium and Isoflex with low air loss (LAL) feature on) and compared to a control (surface with fitted sheet only).[10] In each testing scenario, the air pump for the AirTAP and MATS was not active.





Results showed that average temperatures were comparable for all configurations, ranging from 33.4°C to 33.9°C.[10] Maximum relative humidity averages for configurations with a microclimate body pad were between 77.1% and 78.9%.[10]

As high as 2% decrease in relative humidity



Clinical application

Good clinical practice requires interventions geared toward minimizing the impact of pressure, shear, friction, and moisture on the patient's skin. Each patient presents with unique challenges and risk factors that impact the care required. Many risk factors that impact the microclimate of the skin are uncontrollable (fever, perspiration, fluid loss); however, there are interventions that enable the caregiver to minimize the risk.

Turning and positioning the patient, utilizing as few layers as possible under the patient, keeping the patient cool and dry, preventing incontinence, providing rapid clean-up when soiled, and utilizing fabrics that reduce friction and shear will help to protect the at-risk patient. With products such as the Prevalon AirTAP System, it is no longer necessary for caregivers to choose between providing quality pressure injury prevention and risking injury themselves.

Appendix

1. Definitions
2. NPUAP Physical Forces Associated with Pressure Injury Development
3. References

1a. Definitions: Support Surface Components

Term	Definition
Friction	The resistance to motion in a parallel direction relative to the common boundary of two surfaces.
Coefficient of Friction	A measurement of the amount of friction existing between two surfaces.
Envelopment	The ability of a support surface to conform, so to fit or mold around irregularities in the body.
Fatigue	The reduced capacity of a surface or its components to perform as specified. This change may be the result of intended or unintended use and or prolonged exposure to chemical, thermal or physical forces.
Force	A push-pull vector with magnitude (quantity) and direction (pressure, shear) that is capable of maintaining or altering the position of the body.
Immersion	Depth of penetration (sinking) into a support surface.
Life Expectancy	The defined period of time during which a product is able to effectively fulfill its designated purpose.
Mechanical Load	Force distribution acting on a surface.
Pressure	The force per unit area exerted perpendicular to the plane of interest.
Pressure Redistribution	The ability of a support surface to distribute load over the contact areas of the human body. This term replaces prior terminology of pressure reduction and pressure relief surfaces.
Shear	The force per unit area exerted parallel to the plane of interest.
Shear Strain	Distortion or deformation of tissue as a result of shear stress.

1b. Definitions: Support Surface

Term	Definition
Air	A low density fluid with minimal resistance to flow.
Cell/ Bladder	A means of encapsulating a support medium.
Viscoelastic Foam	A type of porous polymer material that conforms in proportion to the applied weight. The air exits and enters the foam cells slowly which allows the material to respond slower than a standard elastic foam (memory foam).
Elastic Foam	A type of porous polymer material that conforms in proportion to the applied weight. Air enters and exits the foam cells more rapidly, due to greater density (non-memory).

Closed Cell Foam	A non-permeable structure in which there is a barrier between cells, preventing gases or liquids from passing through foam.
Open Cell Foam	A permeable structure in which there is no barrier between cells and gases or liquids can pass through the foam.
Gel	A semisolid system consisting of a network of solid aggregates, colloidal dispersions or polymers which may exhibit elastic properties (can range from hard to soft gel).
Pad	A cushion-like mass of soft material used for comfort, protection or positioning.
Viscous Fluid	A fluid with a relatively high resistance to flow of the fluid.
Elastomer	Any material that can be repeatedly stretched to at least twice its original length; upon release the stretch will return to approximately it original length.
Solid	A substance that does not flow perceptibly under stress. Under ordinary conditions retains its size and shape.
Water	A moderate density fluid with moderate resistance to flow.

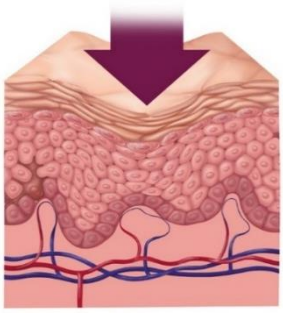
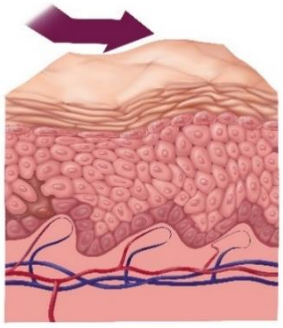
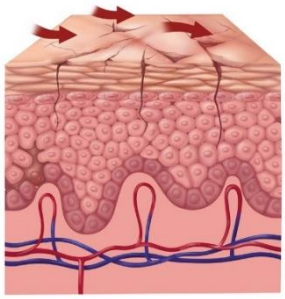
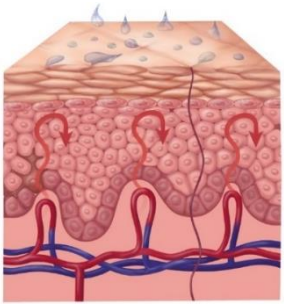
1c. Definitions: Features of Support

Term	Definition
Air Fluidized	A feature of a support surface that provides pressure redistribution via a fluid-like medium created by forcing air through beads as characterized by immersion and envelopment.
Alternation Pressure	A feature of a support surface that provides pressure redistribution via cyclic changes in loading and unloading as characterized by frequency, duration, amplitude and rate of change parameters.
Lateral Rotation	A feature of a support surface that provides rotation about a longitudinal axis as characterized by a degree of patient turn, duration and frequency.
Low Air Loss	A feature of a support surface that provides a flow of air to assist in managing the heat and humidity (microclimate) of the skin.
Zone	A segment with a single pressure redistribution capability.
Multi-zoned Surface	A surface in which different segments can have difference pressure redistribution capabilities.

1d. Definitions: Categories of Support

Term	Definition
Reactive Support Surface	A powered or non-powered support surface with the capability to change its load distribution properties only in response to applied load.
Active Support System	A bed frame and support surface that are combined into a single unit whereby the surface in unable to function separately.
Non-Powered	Any support surface not requiring or using external sources of energy for operation. (Energy = D/C or A/C)
Powered	Any support surface requiring or using external sources of energy to operate. (Energy = D/C or A/C).
Overlay	An additional support surface designed to be placed directly on top of an existing surface.
Mattress	A support surface designed to be placed directly on the existing bed frame.

2. NPUAP Physical Forces Associated with Pressure Injury

Term	Definition	
Pressure	The force per unit area exerted perpendicular to the plane of interest.[11] In laymen's terms, pressure is the amount of the patient's body weight that is being exerted upon a given body surface area. When a patient is laying on a hard surface that does not conform (envelop) the bony prominences of the body, then a larger proportion of the patient's weight is supported on that one area. The result of the pressure is the compromise of blood flow to the skin. In a compromised patient, this can cause ischemia which deprives the tissue of oxygen and nutrients, thus resulting in skin injury.	
Shear	The force per unit area exerted parallel to the plane of interest.[11] The underlying problem with shear stress is that the capillary loops feeding the skin become kinked and distortion of the tissues occurs. The end result is ischemia and damage to the tissue to due to lack of blood flow. Shear stress can occur due to normal gravitational forces, such as sliding down in the bed or chair.	
Friction	The resistance to motion in a parallel direction relative to the common boundary of two surfaces. [11] Friction can occur from abrasive linens, pads or mattress coverings. The continual rubbing from the abrasive fabric can create a mechanical injury to the skin.	
Moisture	A small amount of a liquid (such as water) that makes something wet or moist; liquid diffused or condensed in relatively small quantity.[12] Moisture can occur from incontinence, perspiration or from fluids used for patient care. Sustained exposure to urine or feces can cause chemical injury to the skin and further weakens the skin to be more vulnerable to the forces of pressure, shear and friction. The gas exchange that normally takes place at the dermis cannot occur due to the saturation of skin cells.	

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