Support Surfaces and the Prevention of Pressure Ulcers
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1 Introduction

Pressure ulcers (also called decubitus ulcers or “bed sores”) are common in elderly persons and those with physical impairments who spend extended periods of time in bed. These sores are an indicator of poor prognosis, and may contribute to patient mortality (Reddy et al, 2006). The condition is often avoidable using pressure ulcer prevention strategies which reduce the magnitude and/or duration of pressure at the interface of a patient and his/her support surface (mattress). This may be achieved by physically repositioning the patient (either manually or using turning beds), or using pressure-relieving support surfaces such as cushions, mattress overlays, specialty mattresses or specialty beds.

A standard hospital mattress has an interface pressure of 100 mmHg which can result in pressure ulcers unless repositioning occurs at regular intervals (Coats-Bennett 2002). In addition to reducing the pressure at the patient/mattress interface, maintaining the general health of the patient’s skin is also essential to prevent pressure ulcers. Moisture accumulation on the skin is an important physical factor predisposing a patient to the occurrence of pressure ulcers and tissue breakdown (Reger et al, 2001). Furthermore, skin moisture buildup dilutes the skin acidity, thereby reducing the antibacterial properties of the epidermal layers and increasing the risk of infection (Reger et al, 2001). An ideal support surface prevents pressure ulcers by providing pressure redistribution and maintaining a healthy skin microenvironment.

Prevention of pressure ulcers in the acute care setting is critical, especially given recent regulations removing additional payment to facilities for treatment of hospital-acquired conditions, including pressure ulcers (Centers for Medicare and Medicaid Services, 2007). Selection of a support surface plays a major role in preventing this condition. Many specialized beds appear to be effective in reducing the development of pressure ulcers when compared with standard mattresses (Agostini et al, 2001). Well over 100 different pressure-relieving support surfaces are marketed, making it confusing for clinicians to determine which option is best for their patients.

This document provides an overview of the terminology of pressure relieving devices, summarizes the current options for pressure relieving devices, reviews the benefits of air therapy surfaces, and explains the importance of underpad selection when used in conjunction with certain air therapy surfaces.
2 Terminology

The following terms appear in this document or the referenced articles:

**Air permeability**: The rate of air flow passing perpendicularly through a known area under a prescribed air pressure differential between the two surfaces of a material. This provides a measure of the breathability of a material.

**Bias**: May result from flaws in the design of a study or in the analysis of results; may result in an underestimate or overestimate of the effect of an intervention.

**Blanching erythema**: Skin whitening that occurs when pressure is applied; indicates that microcirculation is intact.

**Clinical effectiveness**: The extent to which an intervention such as a device or treatment produces health benefits.

**Comorbidity**: Coexistence of a disease or diseases in a study population in addition to the condition that is the subject of study.

**Controlled clinical study**: The term for a study or clinical trial that compares an experimental product to a comparison (control) group. The control group may be either placebo or an active control, such as standard-of-care.

**Cost effectiveness**: The cost per unit of benefit of an intervention.

**Effectiveness**: The extent to which interventions achieve health improvements in a clinical setting.

**Efficacy**: The extent to which interventions achieve health improvements under ideal circumstances such as in a clinical trial.

**Erythema**: Non-specific redness of the skin, either localized or general, which may be associated with cellulitis, infection, prolonged pressure or reactive hyperaemia.

**Extrinsic**: Factors that are external to the individual. (Opposite of ‘intrinsic’)

**Friction**: The resistance to motion in a parallel direction relative to the common boundary of 2 surfaces. Coefficient of Friction is the term for the amount of friction measured between 2 surfaces.

**Gold standard**: A method, procedure or measurement that is widely accepted as being the best available.

**High-tech devices**: Dynamic pressure-relieving devices that include alternating pressure devices, low air loss devices and others (Cullum et al, 2004).

**Incidence**: The number of new cases of illness commencing, or individuals falling ill during a specified time period in a given population.

**Immersion**: Depth of sinking into a support surface.

**Intrinsic**: Factors present within the individual.

**Low-tech devices**: A non-powered, conforming support surface that distributes the body weight over a large area (Cullum et al, 2004).

**Meta-analysis**: A statistical method of summarizing the results from a group of similar studies.

**Moisture Vapor Transmission Rate (MVTR)**: Also called “water vapor transmission rate” (WVTR); a measure of the passage of water vapor through a substance.

**Non-blanching erythema**: No skin color change when light finger pressure is applied.

**Overlay**: Surfaces placed on top of a standard mattress or operating table.

**P value**: As seen in the results section of journal articles, i.e. p=0.03. The P value is a probability, with a value ranging from zero to one. It answers the question: If the populations’ results really are the same, what is the probability that random sampling would lead to a difference between sample means as large as you observed? A P value of 0.05 means that 5 out of 100 times you would obtain the results by chance. A P value of 0.05 is the arbitrary cut-off for clinical significance in most trials.
2 Terminology

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

**Pressure redistribution**: The ability of the support surface to distribute load over contact areas of the body; more updated term for pressure reduction or pressure relieving.

**Pressure-relieving**: Both pressure-reducing and pressure-distributing devices that either remove pressure from different areas of the body at regular intervals, or contours around the body, spreading the load and relieving pressure over bony prominences. Pressure redistribution is the more updated term.

**Prevalence**: The proportion of persons with a particular disease within a given population at a given time.

**Profiling bed (kinetic or turning bed)**: Motor-driven turning and tilting beds that either assist with manual repositioning of the patient or reposition the patient automatically.

**Prospective study**: A study in which the subjects are identified and then followed forward in time (in contrast to a ‘Retrospective study’).

**Randomized controlled trial**: A clinical trial in which treatments are randomly assigned to subjects. The random allocation eliminates bias in the assignment of treatment to patients and establishes the basis for the statistical analysis.

**Reactive hyperaemia**: Bright flush of the skin associated with an increased volume of blood flow following the release of an obstruction to the circulation, or a vascular flush following the release of an occlusion of the circulation (for example following release of a tourniquet, in direct response to incoming arterial blood).

**Relative risk**: An estimate of the magnitude of an association between exposure and disease that also indicates the likelihood of developing the disease among persons who are exposed relative to those who are not. The ratio of incidence of disease in the exposed group, divided by the corresponding incidence in the non-exposed group.

**Retrospective study**: A retrospective study is a study that looks backwards in time, for example a retrospective chart review.

**Shear**: A force created when the skin of a patient stays in one place as the deep fascia and skeletal muscle slide down with gravity. This can also cause the pinching off of blood vessels which may lead to ischemia and tissue necrosis.

**Skin microenvironment**: The term describing the heat and moisture level (humidity) at the skin surface.

**Standard mattress or standard hospital mattress**: Not uniformly defined in the literature, a standard mattress may be described as a hospital-issue, usually foam-based mattress found in a typical hospital room. The lack of agreement on the definition of standard mattress makes it difficult to interpret studies conducted in different settings where the standard mattress may differ.

**Systematic review**: A way of finding, assessing and using evidence from studies, usually randomized controlled trials, to obtain a reliable overview and consistent treatment guideline.

**Validity**: The extent to which a variable or intervention measures what it is supposed to measure or accomplish. The internal validity of a study refers to the integrity of the design; the external validity of a study refers to the appropriateness by which its results can be applied to non-study patients or populations. External validity may also be called “generalizability.”
The interface between the patient and the mattress can lead to impaired circulation and ulcer formation (Cullum et al, 2004). Depending on the patient's physical condition and risk factors, low-tech and high-tech options exist. Support surfaces are categorized as:

- **Group 1** (static overlays and replacement mattresses)
- **Group 2** (low-air-loss beds, alternating pressure, and powered/non-powered overlays/mattresses)
- **Group 3** (air-fluidized beds).

### 3.1 Low-tech surfaces

**i.e. static support surfaces**

The low-tech, or non-powered options reduce the pressure of the patient's body weight on the skin and tissues. These static surfaces are recommended if a patient can assume varying positions without bearing weight on a pressure ulcer. They are used for prevention of ulcers or for those with Stage 1 ulcers. Static options include the following:

- Standard foam mattresses
- Air filled mattresses or overlays
- Alternative foam mattresses or overlays
  (e.g. conformable foam, zoned foam)
- Fiber-filled mattresses or overlays
- Gel-filled mattresses or overlays
- Water-filled mattresses or overlays
- Bead filled mattresses or overlays
- Sheepskins

Seat cushion options of the above are also available for patients in a wheelchair.

Standard hospital mattresses have been consistently outperformed by low-tech support surfaces, although the best type of support surface is unclear based on current research (Cullum et al, 2004; Collier 1996; Santy et al, 1994). Foam surfaces have been shown to be effective and durable during several years of use in one hospital (Gray & Campbell 1994).

The choice of support surface should be left to the discretion of the clinician. The studies below are some of the best research in support of low-tech surfaces compared to standard hospital mattresses.

#### 3.1.1 Clinical Evidence Supporting Low-tech Surfaces


This prospective, randomized, controlled, 7-month clinical trial of 1729 patients admitted to medical and surgical departments compared a foam mattress with a standard hospital mattress. The two groups were monitored for pressure sores. The median time for the occurrence of pressure sores was 31 days (range 6-87) with the foam mattress and 18 days (range 2 to 38) with the standard mattress (p < 0.001). The occurrence of pressure sores was not reduced but was delayed when patients used a foam, pressure-decreasing mattress.


A prospective, randomized, controlled clinical trial tested a pressure relieving cube foam mattress against the standard hospital mattress in 44 patients with femoral-neck fracture and high pressure-sore risk scores. At 1 week, 25% of the patients on the cube foam mattress and 64% of the patients on the standard mattress had clinically relevant pressure sores (grade 2 or more). At 2 weeks the figures were 24% and 68%, respectively. The maximum score over the several body regions of the pressure-sore grading, measured on a 5-point scale, was significantly in favor of the cube foam mattress at 1 week (p = 0.0043) and 2 weeks (p = 0.0067) postoperatively. The occurrence of pressure sores and their severity can be significantly reduced when patients at risk receive an interface-pressure decreasing mattress.

This study randomized 446 surgery patients to either standard operating tables or a specialized foam overlay on the operating table. The main endpoint failure rate (a pressure sore) was 11% (22/205) for patients allocated to the specialized foam (a dry visco-elastic polymer pad), and 20% (43/211) for patients allocated to the standard operating table mattress. The results demonstrated that foam overlays on operating tables reduced the incidence of postoperative pressure ulcers.


The goal of this unblinded, randomized, prospective trial was to determine whether a visco-elastic polymer (energy absorbing) foam mattress was superior to a standard hospital mattress for pressure ulcer prevention. Elderly acute care, rehabilitation, and orthopedic wards at 3 hospitals in the United Kingdom were studied. 1168 patients at risk of developing pressure ulcers with a median age of 83 years were allocated to either the experimental equipment (foam mattress/cushion combination) or a standard mattress/cushion combination. All received standard nursing care. A significant decrease in the incidence of blanching erythema (26.3% to 19.9%; p = .004) and a nonsignificant decrease in the incidence of non-blanching erythema occurred in participants allocated to the experimental equipment. Regardless of prevention routine, pressure ulcers occur in high risk patients. In this study, the foam mattress showed statistical significance over standard equipment for prevention of blanching erythema. Statistical significance was not achieved for nonblanching erythema.

3.2 High-tech surfaces
(i.e. dynamic support surfaces)
These options provide relief from pressure using technology to create dynamic surfaces. Dynamic surfaces are required if the patient cannot change positions without bearing weight on the pressure ulcer, or if the patient fully compresses the static support surface. They may also be used if pressure ulcers are not healing. Options include the following:

3.2.1 Turning Beds/Kinetic Beds
• Lateral Rotation Mattress: Constantly rotates the patient from side to side to change pressure points. Lateral rotation may be used in combination with air therapy, but often the goal of this is not for pressure ulcers but for other reasons such as to promote chest drainage.

There is insufficient evidence to draw conclusions on the value of kinetic turning tables as pressure ulcer prevention devices (McInnes 2004).

3.2.2 Air Therapy
• Alternating pressure mattresses/overlays: Patient lies on air-filled sacs which sequentially inflate and deflate. The alternating high and low pressure between the patient and mattress results in pressure at different parts of the body for short periods of time, therefore diminishing the period of high pressure on any one anatomic area (Andersen et al, 1982). These mattresses may incorporate a pressure sensor to respond/adjust to a patient's movement in the bed.

• Low air loss beds (LAL): A specialty bed on which patients are supported on a series of air sacs through which warmed air passes. The actual temperature of the air can be adjusted to warm or cool the patient as needed. The amount of pressure in each pillow can be adjusted to provide maximum pressure redistribution for the individual patient. In addition to providing support, the LAL bed provides a continuous flow of air across the surface of the mattress which prevents moisture build-up on the patient's skin.

Low air loss refers to a system consisting of a mattress casing, a vapor permeable coverlet with...
or without cushioning material, and an air delivery system to move air under the coverlet, and in some cases, through the coverlet (Figliola 2003). The term low air loss, now sometimes referred to as true low air loss, dates back to the original patent which allowed the air to leak out of the mattress through the coverlet and onto the patient’s skin.

- **Air Fluidized Therapy (AFT) bed**: A specialty bed in which warmed air is circulated through fine silicon-coated or ceramic beads covered by a permeable sheet. The beads in the bed behave like a liquid when air is pumped through them. On this type of bed, the body is immersed in the warm, dry fluidized beads which act similar to being immersed in water, and provides support over a large contact area. When the bed is turned off, the beads settle to the bottom and mold around the patient’s body to provide support. Temperature regulation is an important factor when using these beds since dehydration and overheating can occur if the temperature of the air is not set properly. These are generally the most expensive type of dynamic support surface and is indicated for advanced stage pressure ulcers in conjunction with pain. Sometimes called “high air loss” beds or “fluidized bead beds”.

These technologies may be combined in one mattress (i.e. an alternating pressure/LAL bed; or LAL/AFT bed). Dynamic support surfaces are available for hospital use as well as home use, and are typically rented by facilities.

The next portion of this document will focus on LAL and AFT beds since they both rely upon a porous top sheet which permits air to circulate to the patient’s skin.
In the early 1960’s, Dr. John Scales of England conducted studies on burn patients who had received skin grafts. He proposed using high volumes of air to prevent the patient from dislodging the skin graft due to shear on the graft area. High air loss rendered the patient completely supported on a high volume of air similar to the principle of a hovercraft. This type of device became known as the “levitation bed”. The bed was perfected in subsequent versions which could completely support the patient. However, use of these beds remained impractical due to the high cost of heating and humidifying the large volume of air. The idea was abandoned around 1970.

The low air loss (LAL) bed was patented by Leslie Hopkins and further perfected by Dr. John Scales in the late 1960’s and early 1970’s. After working on the levitation bed together, both men had determined that the concept was feasible and clinically successful. This new concept of LAL called for lower volumes of air which would not completely suspend a patient, but still minimized the pressure exerted by the body on the mattress. The bed consisted of cells filled with air to support the patient, and allowed air to escape through a porous outer covering and flow over the patient’s back. These beds also permitted easier changes of dressings and movement of the patient since pressure can be lowered in one section of the mattress, allowing a clinician to position hands under the patient without applying friction.

A 1972 article in the Proceedings of the Royal Society of Medicine described the LAL system as porous air cells which provide patient support by a continuous flow of temperature-controlled air at pressures which do not cause vascular changes to the skin and deep tissues. The article stated that 13 burn patients had been treated on these beds without a single development of a pressure ulcer requiring treatment.

Although LAL beds were developed for patients with burns, the technology has applications to other immobile patients. The LAL prevents pressure ulcers by:

- Improving the skin micro-climate by maintaining a normal moisture level at the interface between the skin and the support surface
- Regulating skin temperature by cooling the skin via air flowing from the surface and over the patient’s skin
- Reducing the pressure exerted by the body on the support surface

Multiple changes have been made to the LAL bed since its original invention. One major change was the addition of a micro-porous cover sheet that would allow air to come through the sheet and reach the patient, but would prevent contamination from direct contact with the patient’s bodily fluids. Some LAL manufacturers have developed proprietary top “sheets” which allow air to come out of the mattress to provide air therapy, but prevent bodily fluid from contacting the mattress directly.

Concurrent to the development of the LAL bed, the concept of the air fluidized therapy (AFT) bed or “bead bed” was patented by Thomas Hargest. A geologist by training, Mr. Hargest developed this bed while working as a clinical engineer at a burn hospital in Galveston, TX. Also developed to reduce shear, the air fluidized bed uses granular material to support a patient on a porous covering sheet. This not only distributes pressure over a large portion of the body, but also aerates the skin.

Although they consist of different technologies, LAL and AFT have several factors in common:

- Both are expensive treatments.
- Both distribute pressure over a large surface area to reduce pressure points.
• Both are designed to conform to body contours.
• Both eliminate shear and friction and decrease skin moisture.
• Despite the ability to decrease skin moisture, neither LAL nor AFT can manage the quantity of moisture resulting from incontinence (Figliola 2003).
• Both are more effective at limiting skin warming compared to a gel mattress (Lachenbruch 2005).
• Both rely on porous top sheets which circulate air over the patient’s skin to promote healing and prevent skin breakdown.
• Both should be used in conjunction with breathable underpads for patients who require use of an absorbable pad.

Because of the high cost of LAL and AFT, other low-tech solutions have been developed to address the problem of pressure ulcers (e.g. alternating pressure mattresses/overlays, foam overlays, gel surfaces). These options have also shown clinical advantages, but LAL and AFT remain popular for the highest risk patients and burn victims, and are the only support surfaces with a “breathable” top sheet and air circulation directly to the patient’s skin. Clinical trials and cost-effectiveness analyses have been undertaken to demonstrate the advantages of air therapy. The next section focuses on the clinical data supporting the use of LAL and AFT.
5.1 Low Air Loss (LAL) Therapy


In a randomized, controlled study of 98 patients, Inman et al. (1993) found that LAL beds were more cost-effective at decreasing the incidence of pressure ulcers than standard hospital mattresses. Patients in the study were adults in the intensive care unit who were randomized to standard ICU beds (with rotation every 2 hours) or LAL beds. The outcome measure was the incidence of pressure ulcers. In the LAL group, 12% of patients developed grade 2 or greater pressure ulcers, compared to 51% in the standard ICU bed group.


This prospective, randomized, clinical trial was conducted to assess the effectiveness of LAL beds for the treatment of pressure ulcers in nursing home residents. Patients with pressure ulcers were randomly assigned to a LAL bed (n=43) or a 10-cm corrugated foam mattress (n = 41). The outcome measure was wound severity and surface area. Patients with deep as well as superficial ulcers experienced a threefold improvement in median rate of healing in LAL beds compared with foam mattresses. The authors conclude that LAL beds provide substantial improvement compared with foam mattresses.


The study was conducted on ten healthy volunteers in the supine position for three hours in warm ambient room conditions. The purpose was to research the LAL technology and its effect on skin. Skin temperature was measured continuously and the moisture level of the skin was determined using direct and indirect indicators. The results showed that the skin temperature on the LAL system was an average of 1.2°F lower than that on the standard hospital mattress (p=0.0001). With the Moisture Vapor Transmission Rate skin moisture indicator, the moisture gain above normal with the LAL system was 87 percent lower than that with the standard hospital mattress (p=0.01). The conductance skin moisture indicator found that the conductance increase above normal with the LAL system was 96 percent lower than that with the standard hospital mattress (p=0.01). These results demonstrated the ability of the LAL system to maintain normal skin temperature and moisture content and aid in the protection against skin damage.

5.2 Air Fluidized Therapy (AFT)


Nine patients on a plastic surgery ward were treated on an air-fluidized bed during their recovery period. Skin-bed interface pressures were significantly lower on the AFT bed than on a conventional hospital bed, particularly over the areas of the highest pressure. The AFT bed also simplified nursing and improved patient comfort, especially in burn cases. Using the AFT bed, no new pressure sores developed and established sores did not become worse in this high-risk group.


This randomized trial was conducted to compare the effectiveness and adverse effects of air-fluidized beds and conventional therapy for patients with pressure sores in a hospital facility. Sixty-five subjects were randomized to receive either an AFT bed (N=31), or conventional therapy (N=34) using an alternating air-mattress covered by a foam pad on a regular hospital bed with repositioning every 2 hours and elbow or
heel pads as needed. Pressure sores showed a median decrease in total surface area on air-fluidized beds, and showed a median increase on conventional therapy. No significant increase in adverse effects occurred with air-fluidized beds. The authors conclude that air-fluidized beds were more effective than conventional therapy, particularly for patients with large pressure sores.


One hundred twelve patients with 3rd or 4th stage pressure sores were randomly assigned to 36-weeks of either home AFT or conventional therapy. Patients who used AFT beds spent significantly fewer days in the hospital and used fewer inpatient resources which was reflected in the lower cost of caring for these patients despite the higher cost of AFT beds. Total inpatient and outpatient resources were lower for patients treated with AFT beds, but the difference was not statistically significant. The study determined that AFT beds are safe, reduce hospitalizations, and are ultimately no more costly than alternative therapy for home use.

**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.**

A retrospective analysis of pressure ulcer prevention and treatment was undertaken. Despite limitations inherent in retrospective studies, ulcers treated with AFT had statistically significant faster healing rates (particularly for Stage 3 and 4 ulcers) with significantly fewer hospitalizations and emergency room visits. Air-fluidized support surfaces demonstrated great healing potential.
Pressure ulcers and incontinence are common, costly, and often co-existent conditions (Fader et al., 2004). Patients using support surfaces are therefore likely to also be using absorbent underpads. Over the past 20 years, absorbent underpads have become commonplace in hospitals and long-term care facilities. Although the choice of underpad is often dictated by cost, other factors, such as the support surface being used by the patient, should also be considered when selecting the appropriate underpad (Hampton, 2005). The Royal College of Nursing (RCN) guidelines for pressure ulcer risk assessment and prevention (2001) advise practitioners that the use of incontinence aids must not interfere with the patient’s support surface. Multiple studies have been undertaken to evaluate the performance of underpads (Leiby & Shanahan, 1994; Edlich et al., 2006).

Fader, Bain and Cottenden (2004) performed a laboratory evaluation to investigate the effect of underpads on the pressure management mattress. They used pressure mapping to determine the distribution of pressure over the sacral and ischial areas of a dummy patient both with and without an underpad. The study found substantial and significant differences in pressures between the buttocks and the mattress when using an underpad on 3 types of support mattresses. The presence of the underpad raises the peak pressure by approximately 20-25%, a difference which is likely to be of clinical importance.

Given the effect of the underpad on the pressure profile, the selection of the appropriate underpad is important. Shirran and Brazzelli (2000) found that disposable underpads were more effective than non-disposable pads in decreasing the incidence of skin problems. As a word of caution, however, disposable pads traditionally contain a plastic backing which can cause the patient to perspire, and therefore result in compromised skin (Hampton, 2002).

Skin problems resulting from the use of incontinence products are mostly due to warming, chafing, or the accumulation of moisture between the skin and the absorbent pad (Runeman, 2008). Lachenbruch (2005) reviewed published literature in conjunction with graphical techniques and determined that a 5°C reduction in skin temperature had an effect similar to a reduction of interface pressure as provided by currently marketed support surfaces. Estimates using laser blood flow results in rat skin suggest that an 8°C reduction in skin temperature might be equivalent to a 29% reduction in interface pressure. He concludes that temperature management has a critical effect on skin health, although further research is needed to determine how much of the clinical effect of LAL is due to temperature management of the skin versus the drying and supportive effects of LAL.

Prolonged occlusion of the skin also results in higher humidity and pH, and increased microbial growth (Aly et al., 1978). Advances in incontinence products have resulted in breathable materials which reduce the effect of occlusion. Numerous studies have shown the clinical benefit of breathable materials. Schäfer et al (2002) showed that products with breathable back sheets decreased skin maceration. Research on skin humidity confirmed that breathable diapers had significantly less humid conditions than non-breathable diapers in adult and child laboratory simulations (Grove et al., 1998). Breathable materials have also been shown to reduce the survival of Candida, a type of yeast that can cause irritation and infection to the skin or mucous membranes (Schäfer et al., 2002).

LAL and AFT beds rely upon a porous top sheet that permits air to circulate around the patient, drying the skin, and reducing maceration that results from pooling of moisture. Some manufacturers of LAL and AFT beds warn clinicians not to use these surfaces in conjunction with incontinence products due to the obstruction of airflow to the skin (Clarke-O’Neill, 2004). However, if a patient is incontinent, there is little alternative and an underpad is required. When using one of these dynamic support surfaces, it is critical to select the appropriate underpad for use in conjunction with the support surface. In order to obtain the full clinical benefit of LAL and AFT treatment, the underpad must also be breathable to permit air to flow through the underpad and over the patient’s skin.
7 Summary

- Pressure ulcers and incontinence are common, costly, and often co-existent conditions.
- A standard hospital mattress has an interface pressure of 100 mmHg which can result in pressure ulcers unless repositioning occurs at regular intervals.
- Interface pressure can be reduced using support surfaces (either static or dynamic).
- Low air loss (LAL) and air fluidized therapy (AFT) are the major types of dynamic support surfaces for the prevention of pressure ulcers in high-risk patients.
- Moisture accumulation on the skin is an important physical factor predisposing a patient to the occurrence of pressure ulcers and tissue breakdown.
- Skin moisture buildup dilutes the skin acidity, thereby reducing the antibacterial properties of the epidermal layers and increasing the risk of infection.
- Temperature management has a critical effect on skin health.
- The support surface being used by the patient should be considered when selecting the appropriate underpad.
- LAL and AFT rely on porous top sheets which circulate air over the patient’s skin to promote healing and prevent skin breakdown.
- Products with breathable back sheets decrease skin maceration.
- LAL and AFT should be used in conjunction with breathable underpads to get the full benefit of the air therapy in patients requiring an underpad.
References


References


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 Feb; 51(2):38-68.


Santy JE, Butler MK, Whyman JD. A comparison study of 6 types of hospital mattress to determine which most effectively reduces the incidence of pressure sores in elderly patients with hip fractures in a District General Hospital. Report to Northern &Yorkshire Regional Health Authority. 1994.


Appendix A: Low Air Loss Bed Settings

There are no current standards for the performance of a LAL bed. The following are averages available in the literature (Figliola 2003; Flam 1995; Hardin 2000).

<table>
<thead>
<tr>
<th>Patient Indications</th>
<th>Prevention of pressure ulcers in high-risk patients</th>
</tr>
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<tbody>
<tr>
<td>(in general)</td>
<td>Pain management</td>
</tr>
<tr>
<td></td>
<td>Treatment of existing pressure ulcers</td>
</tr>
<tr>
<td></td>
<td>CONTRAINDICATED: Unstable cervical, thoracic, and/or lumbar fracture; cervical traction; skeletal traction in the wound care turn mode</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Airflow Blower</th>
<th>Approx. 1275 Liters per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure levels (adjustable)</td>
<td>Ranges by manufacturer and can be adjusted by user. (approx. 5 to 90 mmHg)</td>
</tr>
<tr>
<td>Tissue Interface Pressure on LAL (value for static fluid mattress)</td>
<td>Sacrum 24.80 mmHg (31.47 mmHg) *</td>
</tr>
<tr>
<td></td>
<td>Trochanter 54.75 mmHg (53.02 mmHg)</td>
</tr>
<tr>
<td></td>
<td>Heel 47.82 mmHg (39.10 mmHg)</td>
</tr>
<tr>
<td></td>
<td>*p&lt;0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Moisture Vapor Transmission Rate (compared to standard hospital mattress)</th>
<th>3.86 g/m2/hr (30.14 g/m2/hr) **</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>**p=0.01</td>
</tr>
</tbody>
</table>

| Air flow to the skin (adjusted for weight of 150 lb person) | Approx. 113 Liters per minute |
## Patient Indications
- Skin grafts and flaps
- Pressure ulcers
- Burns
- Acute exfoliative dermatitis
- Limited mobility
- CONTRAINDICATED: Unstable, acute spinal cord injury

## Tissue Interface Pressure on AFT
- Scapula 11 mmHg
- Sacrum 15 mmHg
- Buttock 24 mmHg
- Heel 70 mmHg

*NOTE: A standard hospital mattress has an interface pressure of 100 mmHg on average.*

## Temperature Setting Range
- Approx. 80° to 102° F
Q1. What kinds of air therapy surfaces would benefit from the use of breathable underpads?
Low air loss and air fluidized therapy both rely on a permeable top sheet to allow air circulation close to the skin. For this reason, the use of a breathable underpad is most critical in patients on these support surfaces to maximize the circulation of air to the skin and prevent maceration by cooling the skin and preventing the build up of moisture.

Q2. What is the difference between Air Permeability and Moisture Vapor Transmission Rate (Water Vapor Transmission Rate)?
Which is important to the selection of an underpad?
Air permeability is the rate of air flow passing perpendicularly through a known area under a prescribed air pressure differential between the two surfaces of a material. It provides a measure of the breathability of a material. This may be tested using the following procedure:
The material in question is held, and through the use of a vacuum, the air pressure is made different on one side of the material. Airflow will occur from the side with higher air pressure, through the material, to the side with the lower air pressure. From this rate of air flow, the air permeability of the material is determined.
Moisture Vapor Transmission Rate also called water vapor transmission rate is a measure of the passage of water vapor through a material.
When using these terms to evaluate an underpad's ability to allow air to pass through, air permeability provides the best measure of the ability of air to pass from the mattress through the breathable underpad.

Q3. How much air passes through a LAL bed per unit time?
Since there is no standard definition of LAL, this varies per manufacturer. An average value is approximately 113 Liters per minute.