CLINICAL EVIDENCE SUMMARY

# Pressure injury prevention solutions

# Our commitment to pressure injury prevention and treatment

As a global leader in pressure injury prevention, we leverage more than 60 years of specialist expertise and design knowledge to bring you best-in-class, technically innovative solutions, which are designed to support mobility and reduce both the incidence and severity of healthcare-acquired pressure injury.

In this clinical evidence review, we explore the key processes behind tissue damage, introduce our solutions and present a wide range of clinical evidence from standardised laboratory tests through to clinical trials and outcome analysis in the highest risk populations. Such 'real world' evidence can be used to support clinical decision-making in an increasingly complex and diverse healthcare environment. Our summary recommendations align to contemporary best practice guidelines[1], drawing upon multi-disciplinary expertise, key opinion leader insights and developmental research from around the world.

To help get the right intervention to the right patient at the right time, we also offer professional education and support for clinicians, while our health economic data can guide the selection of appropriate interventions for your facility.



# Pressure injury in context

Pressure injury affects millions of people each year, causing distress to the individual and their families, as well as demanding significant healthcare resources.[1–3]

As population age, weight and acuity trends upwards, it is likely that more patients will present with complex co-morbidities, increased frailty and, most importantly, immobility: factors associated with an increased risk of pressure injury. However, when the care pathway is optimised, pressure injury is generally considered to be avoidable[4] and there are compelling reasons to act quickly once risk is established.

Successful prevention requires a clear stepwise approach, from initial risk and skin assessment through care delivery to outcome measurement – the goal, to act fast and reduce the incidence and severity of pressure injury. The recent adoption of the SEM assessment technology and state of the art preventative equipment has brought this goal within reach.

> Pressure injuries are a frequently occurring health problem throughout the world. They are a painful, costly and often preventable complication for which many individuals are at risk.[1]

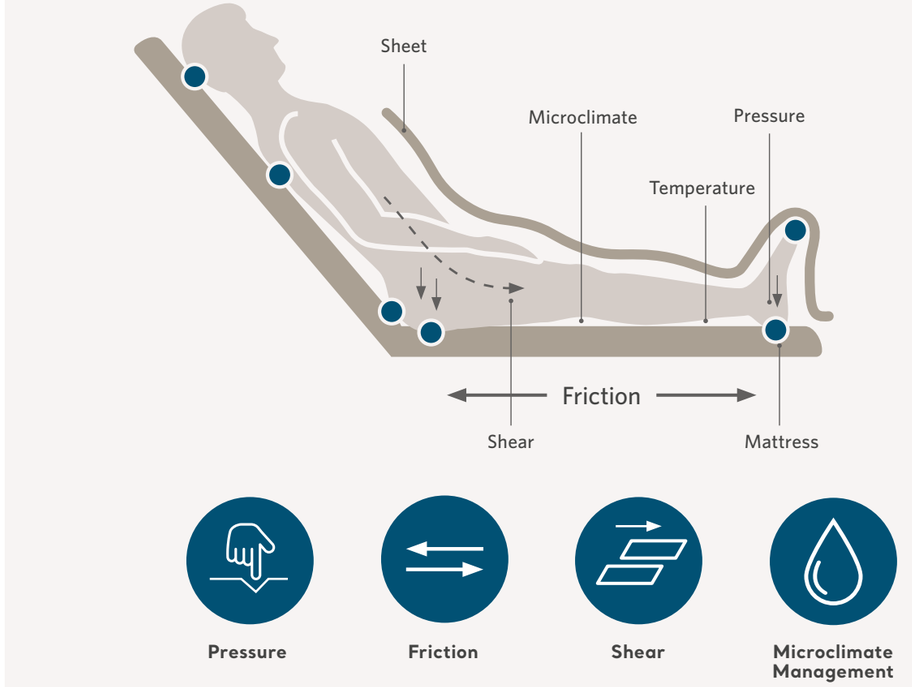



Figure 1: Pressure, shear, friction and microclimate

# Pressure, shear, time & tolerance: a toxic combination

**Pressure injury is defined as localised damage to the skin and/or underlying tissue, as a result of pressure or pressure in combination with shear.**[1] This simple explanation belies the complex chain of events that lead to pressure injury. The pathology can be described as a fine balance between two groups: the type, duration and magnitude of 'load' and the susceptibility and tolerance of the tissue[1, 5] (fig. 2).

Whether injury occurs, largely depends upon two physiological relevant thresholds. A lower threshold associated with vessel occlusion leading to necrosis and a higher threshold leading to direct deformation-induced cell damage.[1]

## Susceptibility and tolerance

Tolerance thresholds are influenced by a diverse set of anatomical, intrinsic and environmental factors, unique to each individual (fig. 2). When immobile and/or insensate these factors determine vulnerability to pressure injury and the speed and severity of tissue damage.[1]

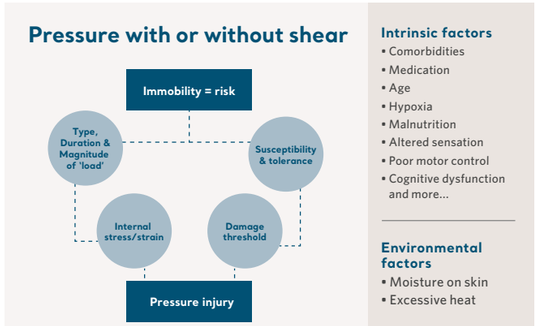



Figure 2: Susceptibility & tolerance

## Pressure threshold

When exposed to pressure, e.g. when lying or sitting, displacement and deformation of the soft tissues hinders perfusion and lymphatic drainage. This underpins the importance of implementing effective strategies to address both pressure and shear, particularly as pressure as low as 6 mmHg is sufficient to interrupt the microcirculation[6, 7] (fig. 3).

When damage occurs, it can do so rapidly at the cellular level, but it may take hours of sustained loading before being clinically visible as a pressure injury.[1]

There is no universally safe pressure-time level for all

## Time threshold

The classic aetiological model (fig. 4) describes an inverse relationship between pressure and time, with tissue generally able to with stand higher pressure for short periods and lower pressure for longer periods.[1]

However, tissue type varies with respect to resilience under load, with muscle being more susceptible to damage than skin.[1] Likewise, intense deformation episodes, for example contact with solid objects such as toilet seats, safety rails and oxygen masks, can cause cell death and tissue damage within a matter of minutes.[1]

In order to reduce the likelihood of pressure injury successful preventative measures focus on reducing exposure to prolonged pressure by regularly off-loading or reducing pressure.

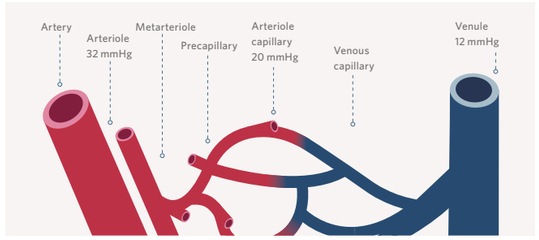



Figure 3: Intravessel pressure in the tissue

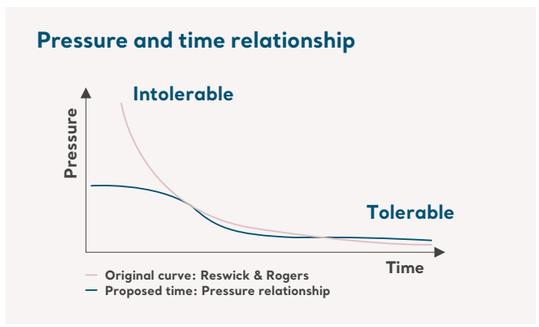



Figure 4: Pressure/time curve

Consider bedfast/chairfast individuals to be at risk of pressure injury, especially when mobility is impaired [1]

## Microclimate: the impact of heat and moisture

Tissue tolerance is further impacted by environmental conditions at the skin, in particular the microclimate. Temperature has been shown to have a profound effect on tissue tolerance by raising metabolic demand at a time when the blood supply may be limited by pressure-related occlusion of the microcirculation; this can be particularly problematic when higher pressures are experienced.[8] Furthermore, pressure alone can trigger a temperature rise.[9]

In association with temperature, increased heat may trigger a natural diaphoretic (sweat) response, creating a continually moist skin environment that leads to maceration and increased vulnerability to damage.[1]

## Pressure injury damage cascade

When tissue tolerance is exceeded, a cascade of events is initiated[1, 10] (fig. 5). Three main stages are described:

**Direct deformation**
Sustained loading can initiate damage to internal cell structures leading to cell death at a microscopic level and provoking an inflammatory response.

**Inflammatory response**
Increased blood flow and cellular porosity result in an accumulation of interstitial fluid below the epidermis (sub-epidermal moisture – SEM).[11, 12] The subsequent rise in interstitial pressure further loads the tissue and is considered a potential contributor to progressive tissue damage.[11, 12]

The presence of SEM in the early stage of pressure injury, whilst pathological, also presents a unique opportunity for the early identification of increasing risk, since inflammatory changes in the skin and underlying tissues may precede skin surface changes by 3 to 10 days[13].

**Ischaemic damage**
The combined effects of deformation caused by bodyweight and, or, other external forces, the intensifying effects of oedema and the associated high interstitial pressure, obstructs the blood vessels and impair tissue perfusion at the damage site.[11] The subsequent reduction in the supply of oxygen and micronutrients, combined with the failure to remove toxic metabolites (lymph obstruction), can lead to tissue ischaemia and irreversible necrotic injury,[1] particularly if prolonged.

Successful pressure injury prevention strategies (repositioning and support surfaces) interrupt this pathway by reducing exposure to sustained tissue deformation (pressure and shear).

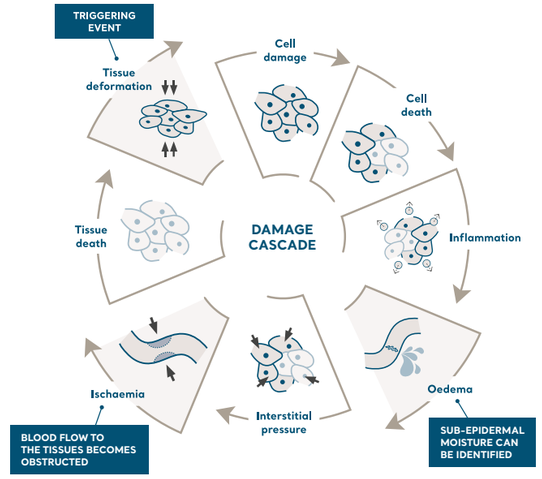



Figure 5: Cycle of pressure injury: adapted from Gefen 2020: The SEM Scanner for Early Pressure Ulcer Detection: A 360-degree Review of the Technology. Wounds International. Vol 11, Issue 3: P22-30." Figure adapted by kind permission of Wounds International Limited.

Exposure to sustained cell and tissue deformation, directly and indirectly causes formation and progression of cell and tissue damage in multiple, interacting and cascading pathways [1]

# Preventing Pressure Injury - Act Fast

Prevention begins with the identification of individuals at risk as early as possible in the care pathway, ideally the point of first contact and regularly thereafter.[1] Two assessment methods are recommended:

### Holistic risk assessment

The use of a validated risk assessment tool, alongside clinical judgement, to estimate vulnerability based upon a range of weighted factors, prioritising conditions that adversely affect independent mobility.

### Skin and Tissue assessment (STA)

Skin and tissue assessment depends upon qualitative visual inspection alongside touch and palpation to detect signs of underlying tissue damage i.e. localised heat, redness, induration/ hardness and oedema. While Category I (non-blanching erythema) identification is typically reliant upon a finger or transparent disc compression method.

### Limitations

Though commonplace, both risk and skin assessment methods are challenged by subjectivity and require a level of clinical expertise that is not always available at the bedside. As a result, important risk indicators may go undetected, delaying the implementation of preventative measures.[1, 11, 14] This is of particular importance for people with darker skin tones, who may develop more extensive tissue injury when visible skin changes are missed.[15, 16]

### Opportunity

As an adjunct to STA[1], a handheld wireless device may be used to identify the presence of sub-epidermal moisture (SEM), which is one of the earliest indications of underlying pressure injury (fig. 5).

### Provizio® SEM Scanner: Skin assessment made easy

The Provizio SEM Scanner is a hand-held, wireless, non-invasive, device with a skin-contact sensor that reads the electrical biocapacitance of the skin: this biophysical marker changes when sub-epidermal moisture is present.[12]

Target anatomical locations (sacrum and heels) are scanned along with adjacent tissue. The SEM assessment technology completes the scan by reporting differences detected across the target and reference zones, known as a SEM delta (Δ). Patients with a SEM delta of <0.6 at an anatomical site may suggest the tissue is at lower risk for PI. A SEM delta of ≥ 0.6 at an anatomical site may suggest that tissue is at increased risk of a PI.[13]

The Provizio SEM Scanner supports clinicians to identify specific anatomical areas at increased risk of PI development on admission and 5 days* earlier than visual skin assessment.[17] This is particularly important for people with darker skin tones.[18]

When used on admission and daily thereafter, as an adjunct to regular STA and risk assessment, the Provizio SEM Scanner can help reduce the incidence of pressure injury by triggering the timely and targeted deployment of preventative measures.[17, 19, 20] The Provizio SEM Scanner has been demonstrated as an effective tool supporting the prevention of pressure injury when used as an adjunct to standard of care with a weighted average reduction in PI incidence of 90.5% in acute care facilities.[21]

More information about the Provizio SEM Scanner can be found in the Science of SEM Clinical Evidence Brochure

Consider individuals with limited mobility, limited activity and a high potential for friction and shear to be at risk of pressure injuries [1]

Consider individuals with a Category/ Stage 1 pressure injury to be at risk of developing a Category/Stage II or greater pressure injury [1]



## The benefit of using the Provizio SEM Scanner:

- Rapid, objective, non-invasive skin assessment at the point of care
- Supports clinicians to identify specific anatomical areas at increased risk of PI development on admission and 5 days* earlier than visual skin assessment[17,20,22]
- Directs anatomically specific preventative interventions to those most likely to benefit
- **Allows assessment across all skin tones**[23, 24]

* Median

## Prioritising protective measures

Act Fast! When an assessment identifies anatomical areas at increased risk of a PI, preventative measures should be initiated or strengthened without delay – time is critical. Even temporary steps to off-load the skin can sufficiently restore blood supply to arrest and reverse tissue damage.[25-27]

**Recommendation 2.6:** Consider using a sub-epidermal moisture/edema device as an adjunct to routine clinical skin assessment [1]

**Recommendation 2.7:** When assessing darkly pigmented skin, consider assessment of skin temperature and sub-epidermal moisture as important adjunct assessment strategies [1]

## Pyramid Of Care

As it is not possible to address all risk factors, and the relative contribution of some are less certain, the first step is to address the known cause of pressure injury - pressure, shear and microclimate.

Priority interventions include: **pressure off-loading; a support surface for bed and chair; assisted repositioning; early mobilisation and heat/moisture control.**

**Secure the base of the pyramid before moving upwards to address the more complex risk factors.**

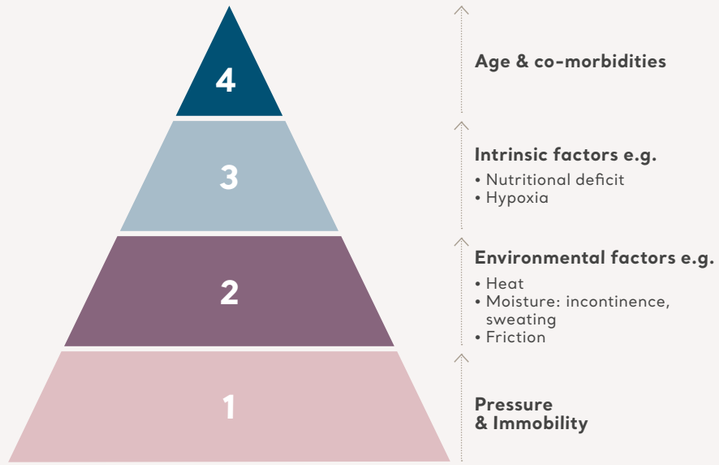



Figure 6: Pyramid Of Care

# Active pressure redistribution

Citadel™ C200

Auralis

Nimbus® Range

Product availability may differ by market. Please check product availability with your local Arjo Representative.

Assess the relative benefits of using an alternating pressure air mattress or overlay for individuals at risk of pressure injury [1]

**Active support surface**

Figure 8: Active pressure redistribution

Any surface that periodically redistributes pressure, irrespective of patient movement, is deemed to be active.[1] The mechanism of off-loading varies by design. Key performance characteristics such as cycle time, cycle duration, amplitude and rate of change, can be measured and compared using standardised methodology.[1, 28]

Such tests show that some surfaces deliver a shallow pulsation wave (fig. 7a), as incorporated in low-air-loss surfaces such as the TheraPulse® mattress. Other mattresses, such as the Nimbus® system and Auralis® mattress replacement range, are designed to hold pressure as low as possible, for as long as possible, by deploying a high amplitude cycle (fig. 7b).

**Low pulsation cycle**

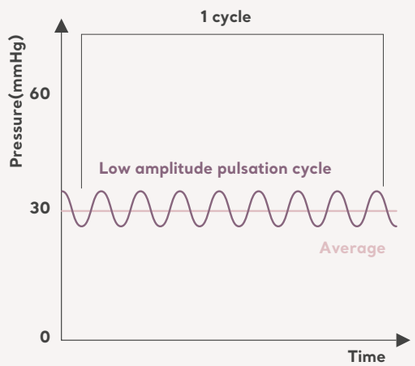



Figure 7a: Active 'pulsation'

**High amplitude alternating cycle**

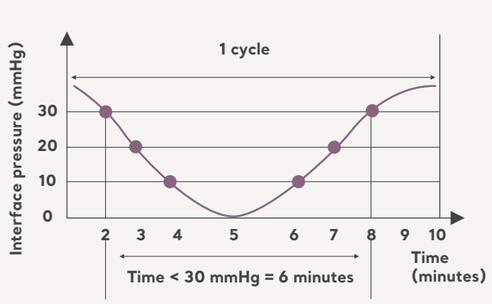



Figure 7b: High aplitude cycle



Active mattress and cushion selection is guided by matching the key performance features to clinical goals and also the wider care environment. These decisions can be informed by studies that describe the off-loading profile of the surface and the effect on the tissue.

To demonstrate, a comparative study compared three mattresses that appeared to be similar in design. Yet one, Mattress B (Auto Logic 200 mattress), achieved much lower interface pressure than the other two and this was associated with significantly greater tissue perfusion: perfusion being critical to tissue integrity.[29] Active surfaces also directly stimulate lymph flow; this is important for reducing extracellular pressure on the microcirculation and removing interstitial waste products that can provoke tissue necrosis.[30–32]

To achieve these key performance goals, sufficient air pressure is required to support the patient clear of the deflating cell. By optimising the cell shape, using a 1-in-2 deflation cycle and high-amplitude profile (fig. 7b), pressure can be held as low as possible for as long as possible, with off-loading up to 50% of the time (fig. 7b). This is an important factor when selecting a surface for patients who cannot be regularly repositioned (fig. 10) and is something that can be measured using standardised tests.

Active surfaces regularly offload pressure, even if the patient doesn't move [1]

Complete or near complete offloading most closely mimics the action of natural spontaneous movement or assisted repositioning

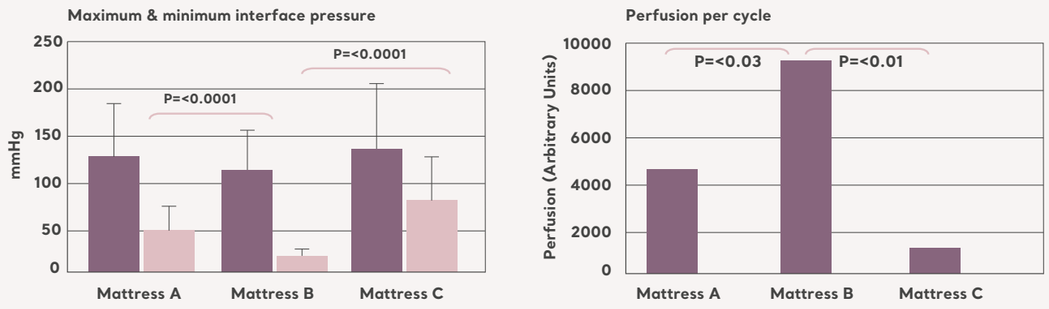
**Active surfaces**

Not all patients can be regularly respositioned or offload an existing pressure injury

- Pressure injury on multiple surfaces
- Limited access to caregivers
- Intensive care
- Traction
- Respiratory
- Pain
- End of life care
- Restless
- Personal preference
- And many more...

Figure 10: Clinical application

**Surfaces differ significantly by design**




**Tissue perfusion**

- 3 very similar mattress replacements (visual)
- 3 highly significant differences in performance (ability to off-load)
- Significant differences in tissue perfusion

Figure 9: Goossens et al.[29]

## Evidence: Active surfaces

Demonstrating clinical outcomes in the most challenging patient groups and across a wide variety of different healthcare environments

| Design | Speciality | Products | Findings |
|---|---|---|---|
| RCT[33] | **ICU** | *Nimbus 3* (active) vs. ROHO® (reactive) mattress | 82% of existing pressure injury (PI) healed in the active group, none healed in the reactive group. |
| RCT[34] | **Reconstructive surgery (USA)** | *Nimbus professional* vs. Air fluidised bed | Surgical repair of PI, many spinal injury patients. Clinical outcomes in both groups were excellent (PI prevention & flap integrity) but **costs were 50% lower in the Nimbus group.** |
| Clinical outcome study[35] | **Acute care** | Alpha *Response* | Sixty high-risk patients: one developed non-blanching erythema. |
| Clinical outcome study[36] | **ICU** | *Auto Logic* 200 | 100 patients: 91% avoided pressure injury with 9 developing non-blanching erythema. 50% of PI present on admission improved or healed. |
| Clinical outcome study[37] | **Eight Medical specialities (UK)** | *Nimbus, Auto Logic 200, Auto Logic 110* | 219 subjects: more than 95% of patients remained PI free despite multiple risk factors; all PI present on admission were improved or healed. |
| Case studies[38, 39] | **Burns** | *Nimbus 3* | Two patients, 30% and 41% burn injury. Positive outcomes and patients and staff preferred the active surface compared to traditional low air loss or air. |

Table 1

## Mattress replacement or mattress overlay?

To demonstrate cost effectiveness, a multi-centre study was undertaken to determine the added clinical value of a mattress replacement. In total, 1,971 patients were randomly assigned to a mattress replacement or a mattress overlay. While the overall incidence of pressure injury was similar, patients in the overlay group developed wounds 10 days sooner, resulting in additional treatment costs. Overlays were also deemed less acceptable in terms of comfort. The evaluation concluded that using a **mattress replacement would be 80% more cost efficient despite a higher initial expenditure.**[40]

Be it residential or intensive care, our active therapy range has been developed with your patient in mind. Complex software algorithms, based on laboratory data, automatically set the correct cell pressure. Several surfaces have integrated features that reduce the risk of 'bottoming out', including the Auto Mat™ sensor pad (Nimbus range) and Self Set Technology™ (Auto Logic & Auralis Range). The latter also has the option of battery backup to protect patients in the case of facility power failure.

A mattress replacement is likely to be more cost effective than a mattress overlay [40]

Economic studies suggest that active mattresses are both cost-effective[40, 41] and associated with the greatest risk reduction [42]

Alternating pressure may aid tissue perfusion in full thickness pressure injury [1]

Appearances can deceive[29] and cost is no guide.[34, 40] For informed product prescription, you need reliable information

## Performance tests

All Arjo surfaces undergo rigorous in-house bench testing to ensure they deliver the desired pressure redistribution under clinically relevant conditions (e.g. different weight, body mass distribution and nursing position). Surfaces are also tested in independent laboratories to national and international standards e.g. ANSI/RESNA (USA).

Two primary methods are used: Pressure Relief Index (PRI) for active surfaces[43] and Pressure Area Index (PAI) for reactive surfaces. Both methods produce data that describe offloading characteristics and how these align to clinically important thresholds. Furthermore, perfusion studies are used to define and compare physiological response.

For example, a comparison of Auto Logic with the new Auralis mattress replacement, the latter with specialised 'Power Down Heel Zone', showed that both systems effectively off-load the heels to below 30 mmHg; with the Auralis powered down heel section augmenting the off-loading performance.[44] The physiological relevance can be demonstrated in volunteer studies, which indicate that neither device compromised heel perfusion.[44]

Consideration should be given to where the support surface/bed will be placed.

Contingency plans for power failures should be in place [1]

# Reactive pressure redistribution

Citadel™ C200

AtmosAir

PentaFlex

Product availability may differ by market. Please check product availability with your local Arjo Representative.

Consider using reactive mattress or overlay for individuals assessed as being at risk for developing pressure injuries [1]

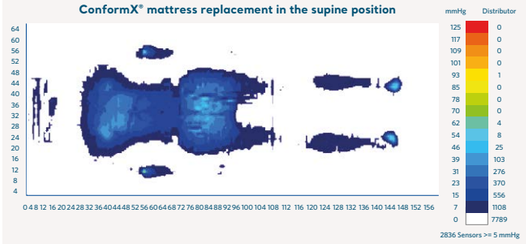



Figure 12: Pressure mapping

Reactive surfaces[1] provide an alternative, yet equally efficient, method of pressure redistribution. As opposed to periodic inflation and deflation of air cells, the entire surface of a reactive mattress or cushion yields to the patient's weight, allowing the body to immerse into, and be enveloped by, the supporting medium: air (powered or non-powered), gel or foam (fig. 11).

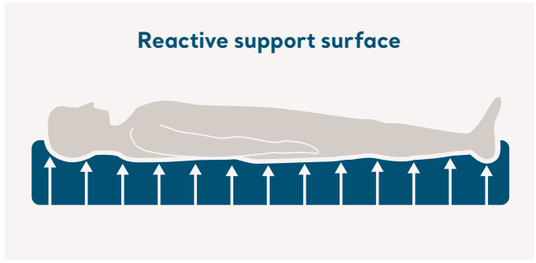



Figure 11: Reactive support surfaces

**By increasing the surface area in contact with the body, pressure is widely distributed and lowered**. The benefits can be visualised using specialised pressure mapping (fig. 12), which visually assess the degree of immersion provided by different support systems. Some therapeutic surfaces combine many of the aforementioned features and are therefore particularly suited to the care of high risk patients, including those with complex clinical needs such as burn injuries.[45]

For example, Therakair® Visio systems (fig. 13) offer a high level of pressure redistribution and microclimate control, with the added benefit of a 'pulsation' mode.[31, 32]

Figure 13:
Therakair® Visio

Many reactive surfaces contain a single supporting medium such as foam. Others, such as the AtmosAir® 9000, have a combination of air and foam regulated by Self Adjusting Technology (SAT™) (fig. 14) to optimise pressure redistribution, comfort and support without the need of a pump unit.

Figure 14: AtmosAir 9000

Reactive surfaces, such as the AtmosAir range, have also delivered proven efficacy in a number of field evaluations and trials.[48-49] This has enabled facilities to both reduce the incidence of facility-acquired pressure injuries and reduce the cost of dynamic overlay rental.[50]

### Hybrid foam-air surfaces

Powered hybrid mattresses combine foam support with integrated alternating air cells. As a result, the off-loading profile provides gentle modulation rather than achieving the lowest pressure during deflation.

For the highest risk patients who cannot be repositioned as well as other vulnerable patients, we recommend surfaces capable of achieving and sustaining the lowest pressures during the alternating cycle, as this has been proven to significantly enhance perfusion.[29]

Pulsating low-air-loss therapy may be of great clinical and financial benefit, decreasing the intensive care unit length of stay and potentially contributing to reduced charges to payers [45]

### Evidence: Reactive surfaces

Evaluation and implementation studies demonstrate cost savings and improved health outcomes when replacing pressure redistributing foam mattresses with specialised surfaces.

| Design | Speciality | Products | Findings |
|---|---|---|---|
| RCT[33] | **ICU** | *TheraPulse* (pulsating LAL) vs. KinAir® III Non pulsating LAL system | Average ICU length of stay was less in pulsation than in non-pulsation group, 40 days vs. 64 days. Use of a pulsating low air loss surface resulted in reduction of ICU LOS and a significant reduction in cost for patients who survive severe burns. |
| Lab Study[32] | **Surgery (USA)** | *TheraPulse* | Pulsating air suspension beds directly stimulate lymphatic circulation. The pulsation cycle acts to augment flow by a pumping action similar to normal limb and torso movement. |
| Evaluation[49] | **2000 bed Acute Trust (Ireland)** | *AtmosAir* | 50% decrease in the number of inpatients who have developed avoidable deep pressure damage over a 3 year period. Treatment costs reduced by £502k and a 76% reduction in powered mattress usage was reported. |
| Evaluation & implementation study | **District Hospital: 2 Acute Medical Unit (UK)[47]** | *50 AtmosAir* mattresses | Historic comparison showed a reduction in PI by 65% (unit 1) and 50% (unit 2) and a 75% reduction in the use of powered mattresses. |
| | **General Medical Center (USA)[50]** | *198 AtmosAir* mattresses | Reduced incident of PI and reduced cost through less spend on dynamic mattress rental. |
| | **146 bed Community Center, Missoula, Montana (USA)[51]** | *80 AtmosAir* mattresses | Facility-acquired PI dropped from 31% to 0%.<br>77% reduction in overlay rental = substantial cost saving |
| | **70 bed rehabilitation unit (USA)[52]** | *70 AtmosAir* mattresses | Incidence of PI running at 0.5% (86% reduction) with a 74% reduction in cost associated with heel off-loading devices. |
| | **Med/surg, ICU, rehabilitation. (USA)[53]** | *300 AtmosAir* mattresses | After one year: 53% reduction in facility-acquired PI<br>95% reduction in powered mattress rentals. |

Table 2

# Microclimate management

**Microclimate:** Refers to increased skin temperature and skin surface moisture[1]

Sub-epidermal moisture refers to oedema in the interstitial tissues beneath the surface of the skin.

The 2 terms are not interchangable.

Individuals with damp skin (e.g. perspiration, moisture trapping, fever and incontinence) may benefit from microclimate features [1]

There are numerous ways to normalise the local skin microclimate, the simplest being to reposition the patient. However, this is not always possible and many patients require additional intervention.

Figure 15: *Skin IQ* MCM

Unlike powered surfaces, non-powered mattresses, such as foam or static air, do not have the ability to proactively regulate tissue microclimate. An effective addition to the surface is *Skin IQ* MCM (fig. 15), a powered coverlet designed to fit over an existing active or reactive mattress without compromising the pressure redistribution properties.[54, 55]

*Skin IQ* MCM was easy to use and effective on a variety of mattresses [56]

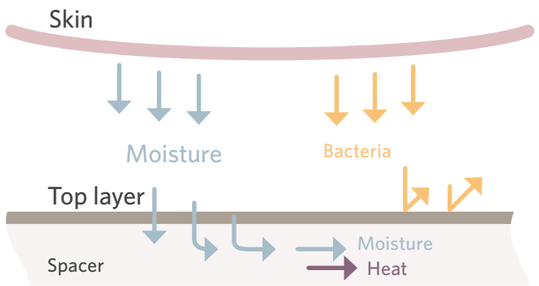



Figure 16: *Skin IQ* MCM mode of action

The *Skin IQ* MCM applies negative airflow to draw temperature and moisture through a spacer fabric and away from the skin (fig. 16).

Following a range of comparative bench tests and field trials, *Skin IQ* MCM has proven beneficial in normalising microclimate, reducing odour and promoting an environment conducive to healing.[56–59]

*Skin IQ* in ICU patients produced "a rapid, sustained and significant decrease in skin humidity [60]

## Low-Air-Loss surfaces

Surfaces, such as the *Therakair Visio* mattress (fig. 17), use positive airflow to create a thermal-moisture gradient beneath a vapour permeable cover (fig. 18). This serves to regulate microclimate, keeping the skin cool and dry.



### Evidence: Microclimate management

| Design | Objective | Findings |
|---|---|---|
| Independent lab tests[54] | To determine if the underlying therapeutic surface would be altered in terms of immersion with the addition of a *Skin IQ* MCM coverlet. | *Skin IQ* MCM can be used with a variety of therapeutic surfaces without negatively affecting the immersion properties whilst providing an augmented microclimate feature. |
| Bench tests[56] | Control of moisture, odour and microbial growth compared to a standard bed sheet. | *Skin IQ* MCM demonstrated superior moisture vapour transfer rate, a larger reduction in skin temperature, better odour control and lower bacterial counts compared to the bed sheet. |
| Case studies[59] | Evaluate the performance of *Skin IQ* MCM when used with three challenging patients. | In all cases the skin condition improved faster than expected; although subjective the patients were assessed by skilled clinicians. |
| Field evaluation and case studies[57] | Evaluate *Skin IQ* MCM when used on a range of mattresses for the management of excessive moisture; n=43 subjects. | No subject developed pressure injury indicating that *Skin IQ* MCM did not conflict with the underlying mattress and most reported the coverlet to be comfortable. Nursing staff found it easy to use. |
| | Series of 8 case studies using *Skin IQ* MCM in different applications. | Clear demonstration of excessive moisture control and creating an environment conducive to healing. |
| Cohort study[60] | 34 ICU patients were evaluated using surface skin impedance (humidity) and infrared thermometer (temperature). | Skin humidity showed significant reduction across all measured sites other than the occiput and temperature reduction beneath both scapulae; no side effects were noted. Clinicians considered the device easy to use and efficient. |

Table 3

Figure 17: *TheraKair Visio* low-air-loss surface

Active surfaces, such as the *Auto Logic* 200, have been shown to both regulate heat and moisture during the alternating cycle.[61] However, the preferred modality for patients requiring proactive microclimate management is a mattress or coverlet with an inbuilt microclimate management capability.

### Mode of action of low air loss surfaces

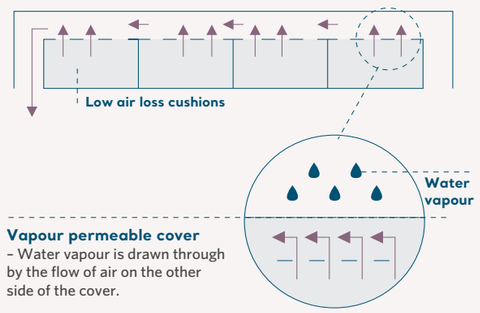



Figure 18: Mode of action of low air loss surfaces

# Heel floatation and wound off-loading

The Provizio SEM Scanner supports clinicians to identify specific anatomical areas at increased risk of PI development such as the heels. This provides an opportunity for early targeted interventions to support PI prevention strategies at the heel.

To protect the heel area, which is especially vulnerable to pressure injury, many products have specialised heel sections and/or slopes that further reduce the pressure applied. Even though support surfaces may reduce or eliminate pressure at the heels area, complete and permanent off-loading may be recommended.[1]

In the context of reconstructive surgery, *Nimbus Professional* was 50% lower cost than air fluidised therapy [34]

Ensure the heels are free from the surface of the bed [1]

Complete and permanent off-loading may be recommended [1]

Figure 20: *Nimbus Professional* showing a side on shot of the Wound Valve Technology

Heels can be permanently off-loaded using Wound Valve Technology™, a feature of both the *Nimbus* 4 and Nimbus Professional™ mattresses, that isolates and permanently deflates air cells in the foot section of the mattress (fig. 19). Additional deflation cells across the surface of the *Nimbus Professional* mattress protect vulnerable tissue across the body, providing a cost-effective[34] solution for complex clinical needs (fig. 20).

Figure 19: *Nimbus 4 Wound Valve Technology*

Reducing the incidence of heel pressure injuries in the intensive care unit should be an achievable goal, as off-loading the patient's heel is usually possible, even for the most unstable patient [62]



### Evidence: Active surfaces

Demonstrating clinical outcomes in the most challenging patient groups and across a wide variety of different healthcare environments

| Design | Speciality | Products | Findings |
|---|---|---|---|
| RCT[34] | **Reconstructive surgery (USA)** | *Nimbus Professional* vs. Air fluidised bed | Surgical repair of PI, many spinal injury patients. Clinical outcomes in both groups were excellent (PI prevention & flap integrity) **but costs were 50% lower in the Nimbus group**. |
| Clinical outcome Study[62] | **Acute care ICU (UK)** | *Nimbus 4* | 10 week evaluation involving 82 patients – 24 level 3 patients and 58 level 2. None of the patients on the Nimbus 4 mattress developed a PI during the evaluation period. Nimbus 4 offers an integrated system of pressure redistribution for the body surface whilst also providing an innovative method for off-loading heel pressure. |
| Laboratory Study[63] | Pressure & perfusion study | *Nimbus 4* mattress | Perfusion over the heel using Wound Valve Technology is similar to complete off-loading when side lying and there is not detrimental effect on neighbouring tissue under load. |

Table 4

# Seating

As limited sit time is not always feasible or desirable, a range of active and reactive pressure-redistribution cushions are available to complement the bed surface (fig. 21).

Cushions are indicated for individuals at risk of pressure injury who sit for prolonged periods, particularly if they are unable to relieve pressure through movement. While an active surface (alternating pressure) may be appropriate for patients with existing tissue injury.[1]


Figure 21: Seat cushion solutions

### Evidence: Seating

| Design | Products | Methods | Findings |
|---|---|---|---|
| Volunteer laboratory Study[64] | *AURA* cushion *ROHO*® air filled Prima® Gel | One hour sit time on each cushion. Aura cushion: no repositioning Static cushions: 'lift offs' every 20 mins. | Active cushion reduced pressure to less than 30 mmHg for 16 min/hr; with significant differences in both pressure and tissue perfusion compared to the static cushions. |
| Clinical outcome Study[65] | *Airtech*™ static air cushion | Field evaluation: comfort and prevention in 30 at risk patients | No patient developed pressure injury, and most rated the cushion as comfortable. |

Table 5

Cushions are indicated for individuals at risk of pressure injury who sit for prolonged periods [1]

Assess the relative benefits of an alternating pressure air cushion for supporting healing... [1]

# Posture and repositioning

## Avoid slouched positions that can increase pressure and shear on the sacrum and coccyx [1]

Our range of bed frames are designed with an auto-regression mattress platform that moves the backrest towards the headboard as it rises.

This feature, together with the simultaneous knee raise, helps to maintain your patient's position during bed articulation reducing the risk from sliding down in bed.


Figure 22: *Enterprise 9000*

## Bed frame design has a tangible and clinically important impact on interface pressure [66]

A study compared the Minuet® Community bed with Pro-Contour to three similar beds without this feature.

In all cases, the *Minuet* bed delivered significantly lower interface pressure; a benefit that goes beyond postural support.[66]

A 30° maximum backrest elevation is also recommended if not medically contraindicated.[1] Beds in our range have a 'pause' feature to alert the caregiver when this level is reached.

Repositioning is key to pressure injury prevention.

## Reposition all individuals... unless contraindicated [1]

While a pressure redistribution mattress may enable the repositioning regimen to be individualised, regular postural change is still important but not without risk to the patient or caregiver.

## Increase activity as rapidly as tolerated [1]

Figure 23: MaxiSlide Flite™

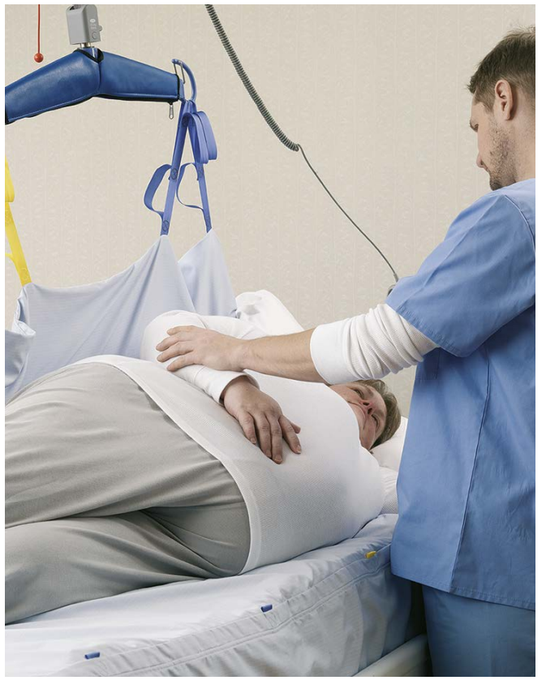


Figure 24: *Maxi Transfer* Sheet

A number of tools are available to promote and maintain physical activity, a discussion of which is beyond the scope of this document. However, one device is of particular relevance. Unlike most lift sheets, the MaxiTransfer™ Sheet (fig. 24) is designed to remain in situ beneath the patient without compromising mattress performance.

## Do not leave moving and handling equipment under the individual after use, unless the equipment is specifically designed for this purpose [1]

*MaxiTransfer* Sheet delivers higher breathability and moisture wicking than a standard hospital sheet. It also features lower heat retention properties and a lower coefficient of friction, the latter giving rise to superior pressure redistribution when draped over an active (alternating) mattress.[67]

## Regular repositioning, the cornerstone of prevention, is most likely to occur when clinicians have immediate access to lifting equipment [67]

Besides supplementary repositioning aids, beds such as the *Citadel* C200 (fig. 25) have integrated 'patient turn' features to complement the manual repositioning of patients for periodic care procedures, while reducing the physical burden for the caregiver. The Citadel Patient care system also provides a continuous patient turn function which can complement or supplement routine repositioning while allowing the patient to rest.

Figure 25: *Citadel* C200 with 'patient turn'

## Slow gradual turns allow sufficient time for haemodynamic stabilisation [68]

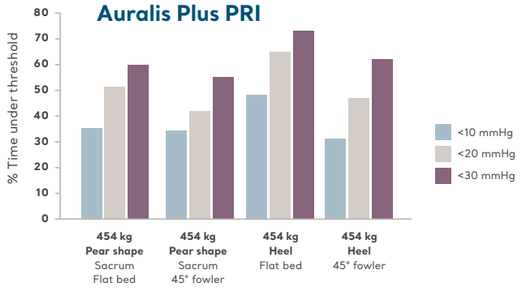
# Specialist populations

Plus-sized and critical care patients are particularly vulnerable to pressure injury as mobility may be physically challenging, with repositioning hindered by competing medical priorities. These patients require specialised equipment so that they may be cared for safely and with dignity.

It is important to recognise that plus-size patients have a body mass distribution, often described as 'pear' or 'apple' shaped. To reflect these characteristics, our products are tested to the upper weight range and with subjects supported in both supine and clinically relevant, semi recumbent, positions.[69]

To illustrate, the Auralis Plus mattress consistently off-loaded pressure for at least 40% of each active (alternating) cycle, achieving 55% over the heels. While there were no areas of high pressure or high-pressure gradient evident in reactive mode (fig. 26a).[69]

Beds should be wide enough to allow for repositioning and the support surface should provide enhanced pressure redistribution, shear reduction and microclimate control.[1] We offer a range of solutions to help you meet these needs, including beds that offer automated lateral rotation.



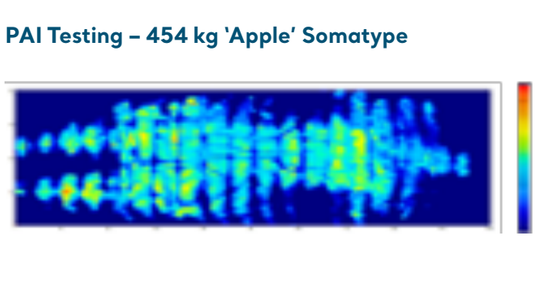




Figure 26a and 26b: Auralis Plus – Testing active and reactive pressure redistribution with different weights, position and body shape 454 kg

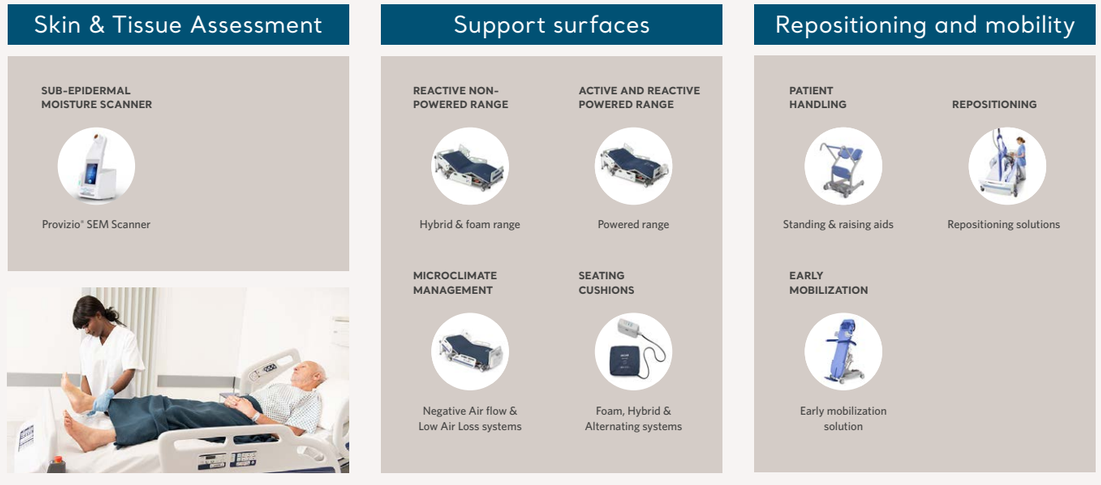


# A full PIP Solution – Early and Targeted Intervention Kit

Arjo empowers you with the ability to elevate the pressure injury prevention pathway in your care environment, equipping you with the knowledge, skills and tools to act on a new standard of clinical excellence and deliver measurable outcomes in early identification, prevention and management of pressure injuries.

We can help you:

- Drive sustainable clinical excellence and optimized outcomes
- Ensure early, objective and anatomically specific risk assessment
- Deliver tailored, comprehensive and clinically proven intervention



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At Arjo, we believe that empowering movement within healthcare environments is essential to quality care. Our products and solutions are designed to promote a safe and dignified experience through patient handling, medical beds, personal hygiene, disinfection, diagnostics, and the prevention of pressure injuries and venous thromboembolism. With over 6000 people worldwide and 60 years caring for patients and healthcare professionals, we are committed to driving healthier outcomes for people facing mobility challenges.

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