AtmosAir Velaris® Adaptable Alternating Pressure System

Immersion, Envelopment, Horizontal Stiffness and Microclimate Testing

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Introduction & clinical context

Pressure injuries develop over time and are a consequence of a sequential and gradual deterioration of cell structures which are subjected to bodyweight or external forces[1,2]. Although the underlying cause and formation of pressure injuries is complex and multifaceted, generally they cannot form without loading or pressure on the tissues[3].

Given that prolonged or unrelieved pressure is the primary causative factor[3], the most appropriate interventions must be those designed to mitigate risk by reducing the exposure to the degree and duration of pressure. Interventions such as assisted repositioning regimens help to reduce risk and are most effective when used in combination with pressure redistributing support surfaces.

Support surface technologies reduce the interface pressure between the body and the support surface. The international pressure injury prevention and treatment guidelines[4] view support surfaces as an important component in pressure injury prevention and treatment protocols, since they can help to prevent the effects of damaging tissue deformation and provide an environment that enhances perfusion of at-risk or injured tissues[5]. They further recommend that the key characteristics to consider when selecting a support surface are those features that affect **pressure redistribution, friction, shear force management and microclimate**[4].

These key characteristics however will vary substantially between the different support surface technologies available, which can often make appropriate surface selection in the clinical setting challenging. Standard test methods that quantify performance characteristics have been developed with the aim of matching users' needs to support surface capabilities[6].

All Arjo support surfaces undergo rigorous bench testing to ensure they deliver the desired pressure redistribution under clinically relevant conditions. Our surfaces are also tested in independent laboratories to meet the US national standard for support surfaces: ANSI/RESNA SS-1:2019[7].

This document will provide a summary of the results of immersion, envelopment, horizontal stiffness (shear) and microclimate testing performed to this standard with the AtmosAir Velaris® Adaptable Alternating Pressure system (Figure 1) both with and without the addition of the Arjo Skin IQ® microclimate manager coverlet[8] (Figure 2).

Surface Tested: AtmosAir Velaris Adaptable Alternating Pressure System

The AtmosAir Velaris (Figure 1) is designed to meet the time critical challenges of pressure injury prevention. When used as a reactive surface, the Velaris uses ARM® (Air Redistribution Module) technology to constantly maintain a predefined level of pressure throughout the mattress. With the pump attached, it uses AltoVac® vacuum technology to deliver alternating pressure that is capable of full pressure offloading, including from the vulnerable heel and sacral areas.

Skin IQ is an adjunctive therapeutic mattress cover, which adds microclimate control to a pressure redistributing surface used with patients presenting with complex skin care issues, including full thickness tissue injury.

Figure 1: AtmosAir Velaris Adaptable Alternating Pressure System

Figure 2: Skin IQ advanced microclimate coverlet, designed for compatibility with pressure redistribution mattresses on the market today

Immersion & envelopment testing – Hemispherical indenter: SS-1:2019: Section 6[7]

Test Overview:

Immersion Testing: provides one measure of the pressure redistribution properties of a surface, by measuring how far a load sinks into a surface. Increased immersion can lead to an increase in envelopment.

Envelopment Testing: is designed to assess/measure how well a support surface conforms around the irregularities of the body to redistribute pressure and immersion.

Method: Testing was performed to ANSI/RESNA SS-1:2019 section 6[7]. A half sphere indenter containing pressure sensors, was applied to the surface (Figure 3a), to measure the immersion and envelopment properties of the AtmosAir Velaris both with and without the addition of Skin IQ coverlet to the surface.

Immersion levels were measured by the distance the indenter sunk into the Velaris surface, whilst envelopment was measured to establish how well the surface conforms around the indentor (Figure 3b).

Clinical Relevance of Immersion & Envelopment Testing: Higher levels of immersion and envelopment equate to lower interface pressure and more potential for pressure redistribution[6].

Figure 3a: Hemispherical Indenter used for test SS-1:2019 Section 6. Not actual test rig used – image for illustration purposes only.

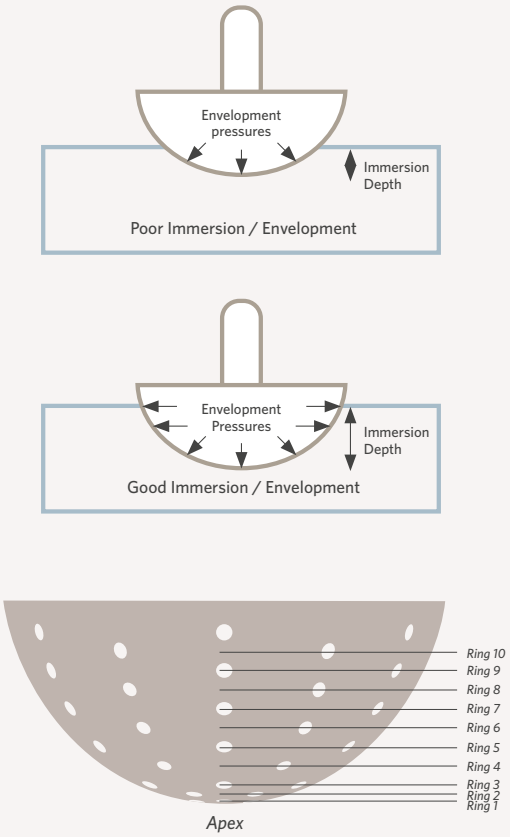

Figure 3b

Immersion is measured as the total distance the indenter travelled through the top of the mattress

Contact Depth is measured by counting the 'active' rings on the indenter. A ring is considered 'active' if the average pressure of sensors across that ring exceeds 1 mmHg. The aim is to activate as many rings as possible.

Envelopment is calculated as a percentage of contact depth divided by immersion.

Immersion & Envelopment Results for AtmosAir Velaris

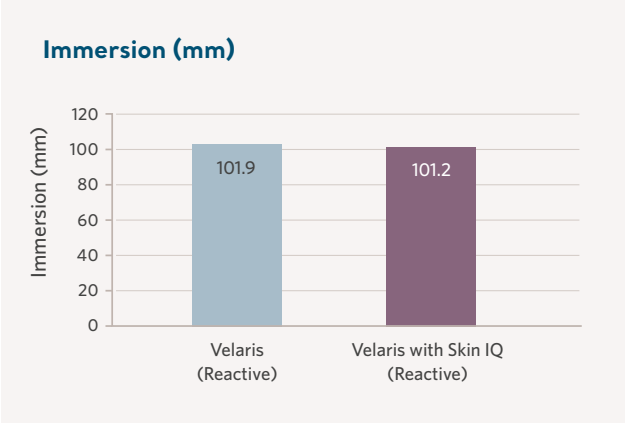

Figure 4a: AtmosAir Velaris Immersion Test data in Reactive mode

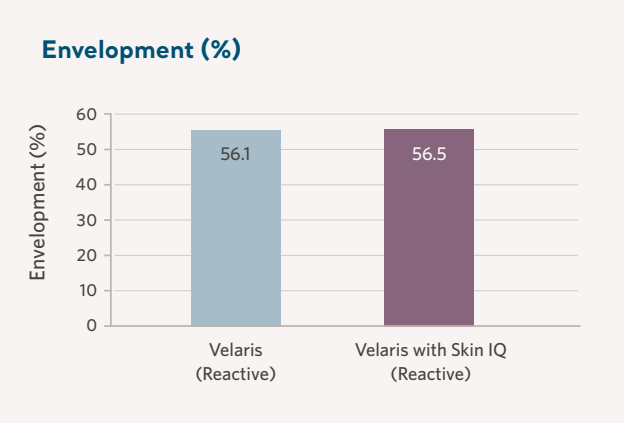

Figure 4b: AtmosAir Velaris Envelopment Test data in Reactive mode

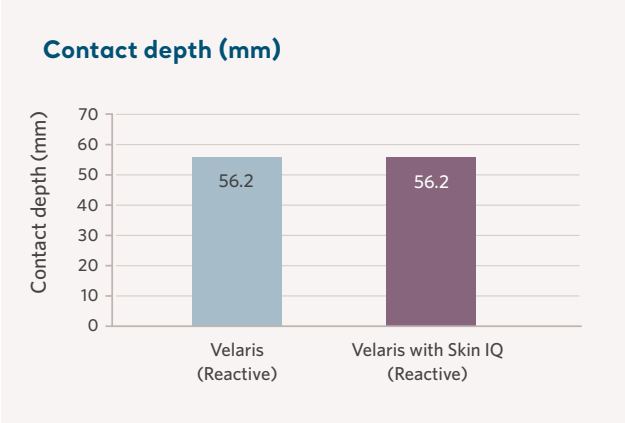

Figure 4c: AtmosAir Velaris Contact Depth Pressure Test data in Reactive mode

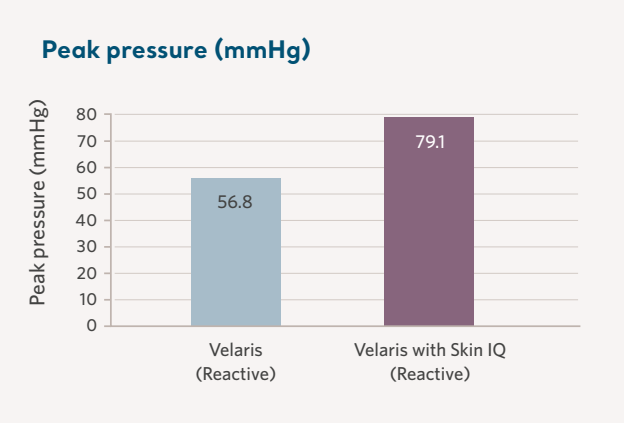

Figure 4d: AtmosAir Velaris Peak Contact Pressure Test data in Reactive mode

Results Interpretation:

In terms of immersion and envelopment the AtmosAir Velaris demonstrated very consistent (less than 1% difference) performance in every test run. This indicates that the surface is very stable in reactive mode and so can provide particular benefits to patients requiring this type of support surface.

Immersion, envelopment and contact depth remained consistent with the addition of the Skin IQ to the surface.

There was a slight increase in peak pressures observed with the addition of the Skin IQ coverlet to the Velaris. This increase in pressure is a temporary effect during the offload cycle to the other cells and ensures patient support.

Horizontal Stiffness (Shear) Testing SS-1:2019 Section 5[7]

Test Overview: The purpose of this test is to simulate shear forces that occur with support surfaces when patient movement occurs on the surface. The test can be used to allow for comparison between different support surfaces of the shear forces that are present with a simulated patient.

Method: A pelvic indenter representing the trunk and pelvic area of a 50th percentile male is pulled horizontally across a support surface toward the foot end, simulating patient movement. Comparison tests were performed with the AtmosAir Velaris in active and reactive modes of operation, both with and without the addition of a Skin IQ coverlet.

Clinical Relevance: Mechanical loading and tissue compression from external forces deform the skin, creating stress within the tissues. While pressure may be applied to the skin and deeper tissues, the effects of pressure are frequently exacerbated by lateral shear forces. This causes deep horizontal stress by stretching and distorting tissues and blood vessels, minimising the effects of shear is an important element in pressure injury prevention and support surface design.

Horizontal Stiffness Results for AtmosAir Velaris

A graphical summary representation of the average shear forces over time for the AtmosAir Velaris in active and reactive modes both with and without the addition of the Skin IQ coverlet is represented in Figure 5 below.

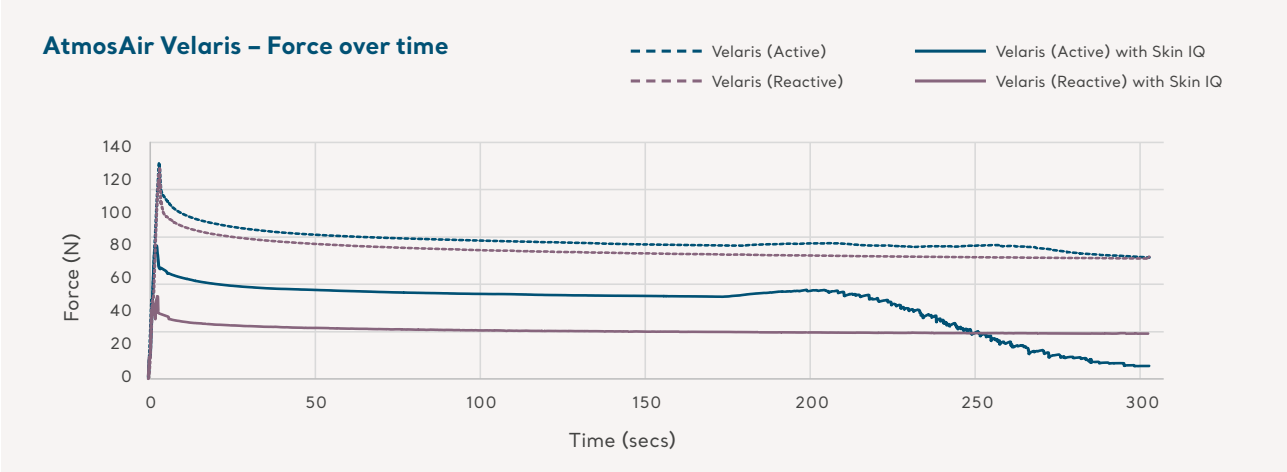

Figure 5: Horizontal Stiffness Testing: Velaris Shear Force over Time

Results Interpretation:

In the reactive mode, during the pull of the indenter, the reduction in force was consistent during the test. In active mode the alternating characteristic of the Velaris system showed a minor variation in force (figure 5), however it did not increase the shear force between the indenter and the support surface. This suggests that the alternating action of the cells does not pose an increased risk of shear on the skin and tissues.

With the addition of the Skin IQ coverlet to the surface shear forces were reduced by 40–60% for Velaris in the reactive mode of operation. The addition of Skin IQ during testing in active mode reduced shear forces by 40%. After 5 minutes of alternation, the shear force had on average been reduced by 90%. The Skin IQ significantly reduces shear forces in active mode. This reduced force is an indication that patients will experience reduced shear and therefore is a positive factor in the prevention of pressure injuries.

Microclimate Management

An increasing body of evidence suggests that microclimate between the skin and the support surface plays a role in the development of pressure injuries. The term microclimate refers to the temperature and humidity next to the skin. Managing microclimate helps to improve tissue tolerance to pressure, friction and shear.

Heat & water dissipation characteristics for full body support surfaces: Sweating guarded hotplate (SGHP) method: SS-1:2019 Section 4[7]

Test overview: The purpose of this test is to identify the ability of the support surface to remove heat and moisture from the patient interface.

Method: A heated moist indenter measures the flow of heat and humidity through a support surface simulating the interface between the skin and the support surface. For the purpose of this evaluation, testing was performed with the addition of the Skin IQ microclimate coverlet to the surface, which the Velaris mattress was designed to be functionally integrated with. Testing was performed in both active and reactive modes of operation.

Clinical relevance: There is a growing appreciation of the role of microclimate management in helping to improve tissue tolerance to aid in pressure injury prevention and management, particularly in the presence of excessive moisture and elevated temperature at the skin surface interface. Any surface that is in contact with the skin has the potential to affect the microclimate. The overall affect is dependent on the nature of the support surface and the cover material.

Sweating Guarded Hotplate results for AtmosAir Velaris

The results are presented graphically in Figures 6 to 8 and summarized in the box below.

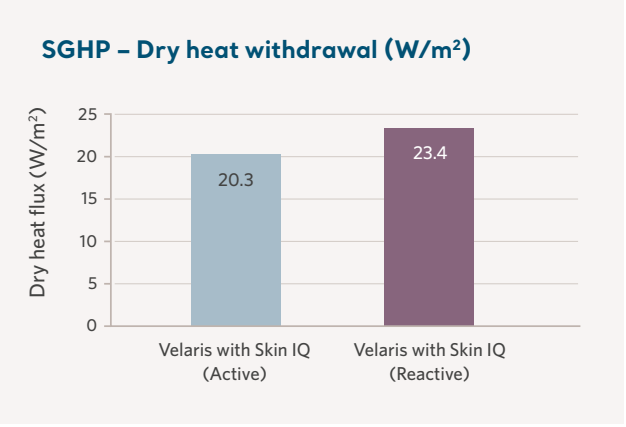

Figure 6: AtmosAir Velaris with Skin IQ: Dry Heat Flux (Q_{dry}) Performance

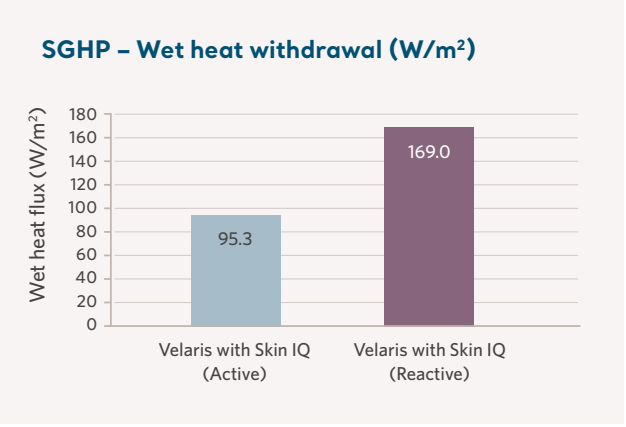

Figure 7: AtmosAir Velaris Wet Heat Flux (Q_{wet}) Performance

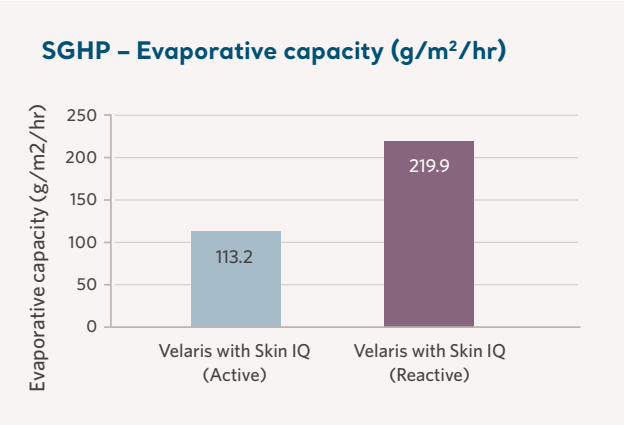

Figure 8: AtmosAir Velaris Evaporative Capacity (EvapCap) Performance

Results Interpretation:

The improvement in the microclimate of the AtmosAir Velaris in both active and reactive modes with the addition of the Skin IQ to the surface is significant. The combination of AtmosAir Velaris and SkinIQ provides an effective solution for the needs of the patient, addressing a range of microclimate considerations.

When Velaris is in active (alternating) mode there is a decrease in microclimate performance, when compared to the reactive mode of operation. This is more pronounced in the wet heat flux (Q-wet) condition.

Overall however the Skin IQ still gives significant microclimate performance in the active mode. In active (alternating) mode the AtmosAir Velaris has reduced engagement with the test device (patient) due to its enhanced offloading features. As a result, the measured microclimate performance is less than in reactive mode.

However the SkinIQ still provides significant performance compared to that of other microclimate technologies or support surfaces.

Body Analogue Method: SS-1:2019 Section 3[7]

Test Overview: This method measures the heat and moisture dissipation properties of the support surface by creating a condition comparable to the human body lying on a mattress. This test also includes a simulated repositioning event (shown at 180 minutes) to assess the ability of the surface to return to its original state prior to loading.

Method: A Thermodynamic Rigid Cushion Loading Indenter (TRCL) is used to generate, control, and measure the environmental conditions of temperature and relative humidity (%RH) at the patient interface.

Clinical Relevance: Humidity can have an adverse effect on tissue viability and often results in moisture being condensed and trapped under the patient's body. Products that provide less resistance to heat flow and more breathability will demonstrate RH values closer to 50% with lower temperature.

Body Analogue results for AtmosAir Velaris

Graphical representation of the surface performance in terms of temperature and relative humidity are shown in Figure 9 and Figure 10.

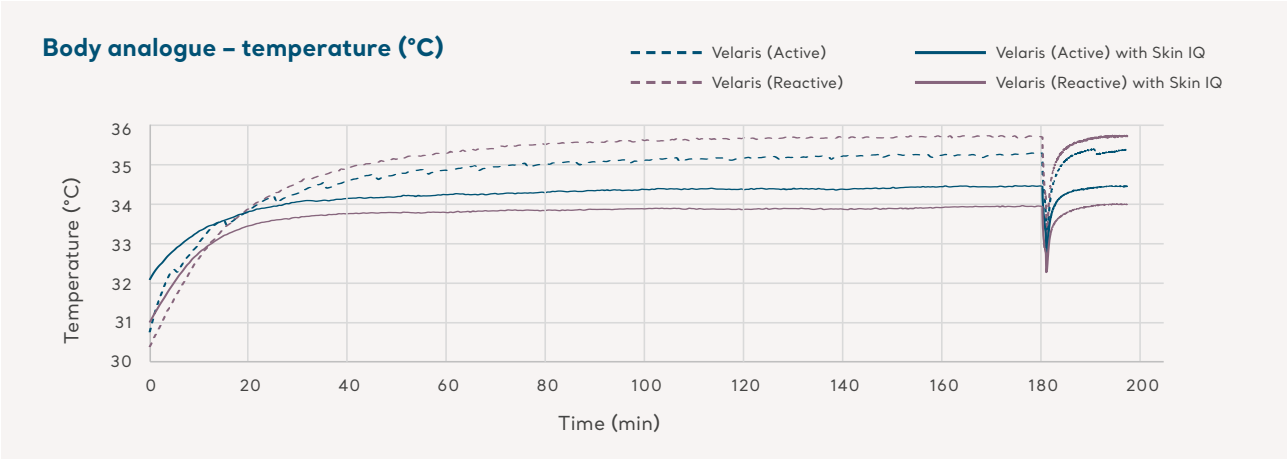

Figure 9: Average Temperature: AtmosAir Velaris with and without Skin IQ in both active and reactive modes

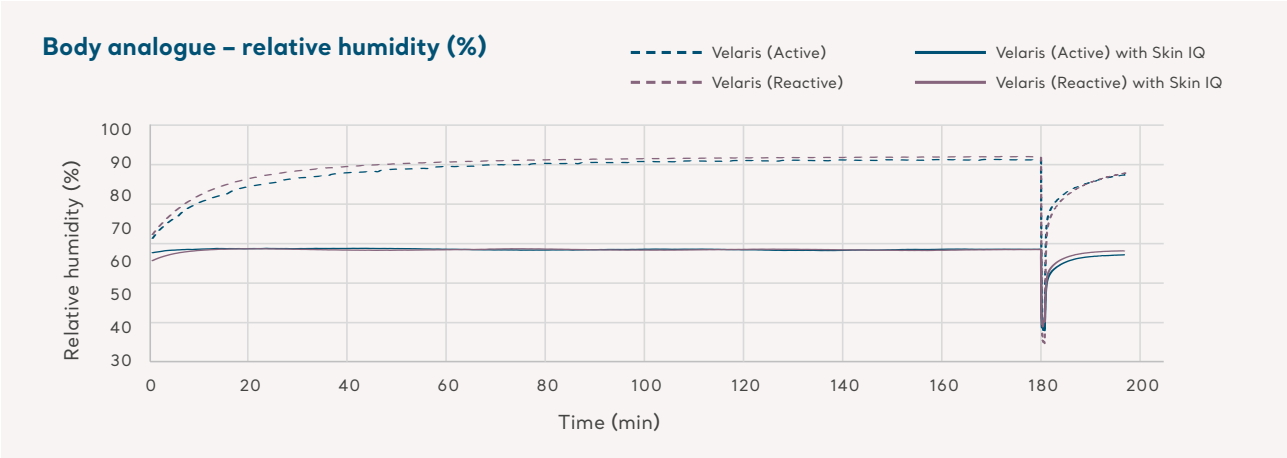

Figure 10: % Relative Humidity for AtmosAir Velaris with and without Skin IQ in both active and reactive modes

Results Interpretation:

Similar performance between Velaris in active and reactive mode, in terms of both temperature and relative humidity.

The addition of a Skin IQ coverlet to the AtmosAir Velaris surface reduces average temperatures by 0.8–1.8 °C, and also decreases relative humidity at the surface interface by 25%. These reductions are significant in terms of microclimate control and in keeping the patient cool and dry.

With no Skin IQ fitted, the Velaris in active mode gave lower temperature and humidity values than in reactive mode, with this resulting from the alternation of the air cells which allows air to flow more freely underneath the test the test indentor (patient).

Summary & conclusion

These tests are designed to measure and assess support surface performance characteristics to provide clinically meaningful metrics for comparison, they are not intended to assess the impact directly on individual patients.

The results of this independent testing demonstrate that:

- The addition of a Skin IQ coverlet to the device makes no significant difference to the surface performance in terms of immersion and envelopment characteristics. In terms of immersion and envelopment, the Velaris demonstrated very consistent performance in every position tested.
- No significant difference in shear force when the Velaris is in the active (alternating) or reactive modes of operation. The addition of the Skin IQ reduces the shear forces significantly.
- The performance improvement of the AtmosAir Velaris in terms of heat and water dissipation characteristics in both active and reactive mode with the addition of the Skin IQ coverlet to the surface is significant.
- The addition of the Skin IQ to the AtmosAir Velaris surface, reduces average temperatures by >1 °C and relative humidity at the surface interface by 25%.

These results can help to inform clinical decision making and surface selection at the bedside. However, the test results only form part of an individual patient risk assessment, which should be carried out by the responsible clinician.

When selecting an appropriate support surface the following factors should also be taken into consideration:

- The individual clinical condition and needs of the patient
- The efficacy of the existing surface they have been allocated
- Level of mobility
- The need for repositioning
- Other factors influencing the risk of pressure injury e.g. temperature and microclimate

References

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