Repositioning Slings

Immersion, envelopment, pressure mapping, microclimate & horizontal stiffness tests

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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 support surface. The International pressure injury prevention and treatment guideline views support surfaces as an important component in pressure injury prevention and treatment protocols, since they can help prevent the effects of damaging tissue deformation and provide an environment that enhances perfusion of at risk or injured tissues.[4] 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, and this 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[5].

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 the US national standard for support surfaces: ANSI/RESNA SS-1:2019[6]. This whitepaper uses this independent testing to demonstrate the compatibility of Arjo's Repositioning Slings from the perspective of support surfaces[7].

Clinical relevance of testing support surfaces in combination with Arjo Repositioning Slings.

Arjo Repositioning Slings and Maxi Transfer Sheet (collectively referred to as Repositioning Slings) are used to reposition patients within the bed and for lateral transfer to another horizontal surface such as a gurney, trolley or stretcher. The patient often remains on these devices for longer periods of time, to reduce the amount of manual handling by caregivers and improve working efficiencies. The international pressure injury prevention and treatment

guideline[4] recommends not to leave patient handling devices underneath the patient unless specifically designed to do so. It is therefore important to ensure that leaving Repositioning Slings in place underneath the patient does not adversely impact the performance of the support surface.

This document will provide a summary of the results of the tests performed for immersion, envelopment, horizontal stiffness and microclimate testing (performed to the ANSI/RESNA SS-1:2019 standard) on the identified support surfaces with and without the addition of Repositioning Slings.

Surfaces tested:

The two surfaces selected for testing are examples of differently operating but relatively widely used support surfaces. Both of these surfaces are high end surfaces typically seen in acute care and prescribed for immobile patients or patients with microclimate issues.

Citadel® C200 Mattress Replacement System in reactive or active mode with Skin IQ® Microclimate Management System and bed sheet

MaxxAir ETS™ Low Air Loss (LAL) Mattress Replacement System with bed sheet

Repositioning Slings tested:

- Disposable Repositioning Sling
- Washable Repositioning Sling
- Bariatric Disposable Repositioning Sling
- Maxi Transfer Sheet

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

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 irregularities of the body to redistribute pressure and immersion.

Method: Testing was performed to RESNA SS-1: 2019 section 6[6]. The average immersion levels of both the Citadel C200 in reactive mode plus Skin IQ and the MaxxAir ETS with and without the addition of Repositioning Slings were compared to evaluate the effect of leaving Repositioning Slings on the support surfaces.

Clinical relevance: Higher levels of immersion and envelopment equates to lower interface pressure.[5]

Results: Figure 1 and 2 show that the envelopment percentage is fractionally reduced with the addition of the Repositioning Slings on both surfaces which is expected due to the addition of an extra layer on the surfaces.

A variation in envelopment percentage has been observed across the slings, for each surface, when compared to the no-sling condition. Figures 3 and 4 demonstrate that the difference of values in immersion is low between the no sling conditions and between the various slings on both surfaces. The results demonstrate that the impact of slings is neglible in terms of their effect on the surface.

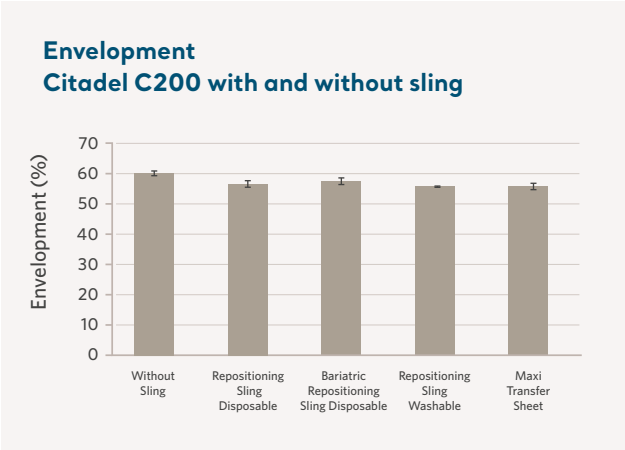

Figure 1: Envelopment; Citadel C200 with Skin IQ with and without sling

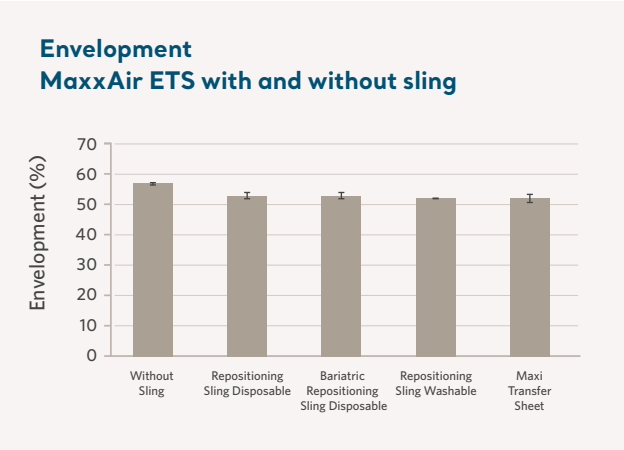

Figure 2: Envelopment; MaxxAir ETS with and without sling

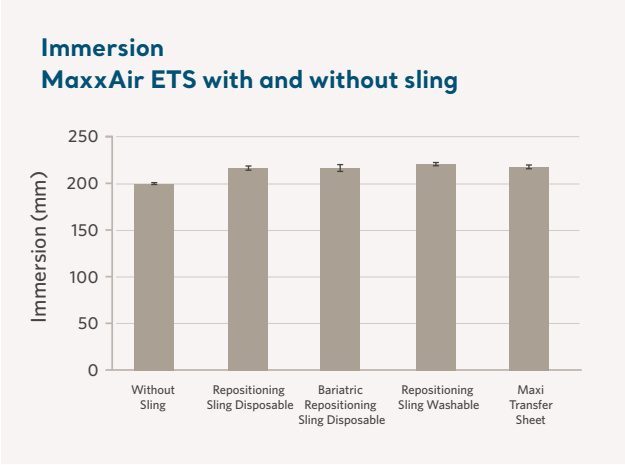

Figure 3: Immersion MaxxAir ETS with and without sling

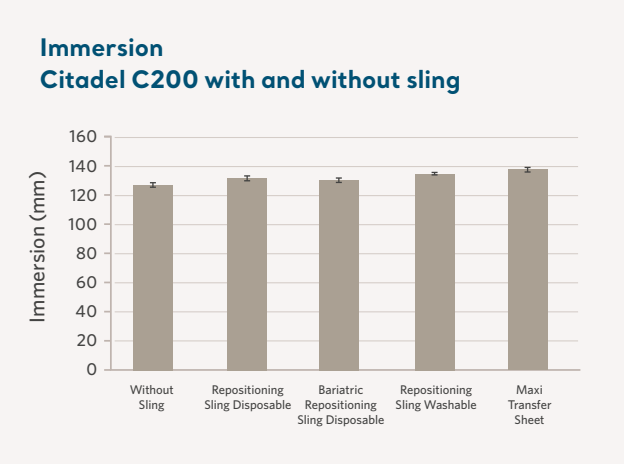

Figure 4: Immersion Citadel C200 with Skin IQ with and without sling

Interpretation

The results demonstrate that the Repositioning Slings don't interfere with the performance of the support surfaces, MaxxAir ETS and Citadel C200 Mattress Replacement Systems, in a way that creates additional harm for the patient.

Pressure mapping

Test overview: This test is performed to measure the interface pressure of a support surface to aid in the evaluation of the ability of a surface to redistribute pressure applied by a human subject.

Method: An Xsensor pressure mapping system was employed for conducting the evaluation. For the purpose of this test, a rigid mannequin was used as the test subject (175 cm, 81.8 kg ± 1 kg). Tests were performed in active and reactive mode.

Clinical Relevance: Pressure redistribution plays an important role in preventing pressure injuries on patients while bed-ridden or in transport. Redistributing pressure around pressure points on the human body is an important factor to preventing or reducing the risk of pressure injuries. Pressure mapping can be an effective tool in determining the ability of a surface to redistribute pressure applied by a human subject.

Results: Figures 5, 6 and 7 show that there is no visible difference in pressure redistribution with the addition of Repositioning Slings, demonstrating that the active pressure redistribution is not affected by the presence of the sling.

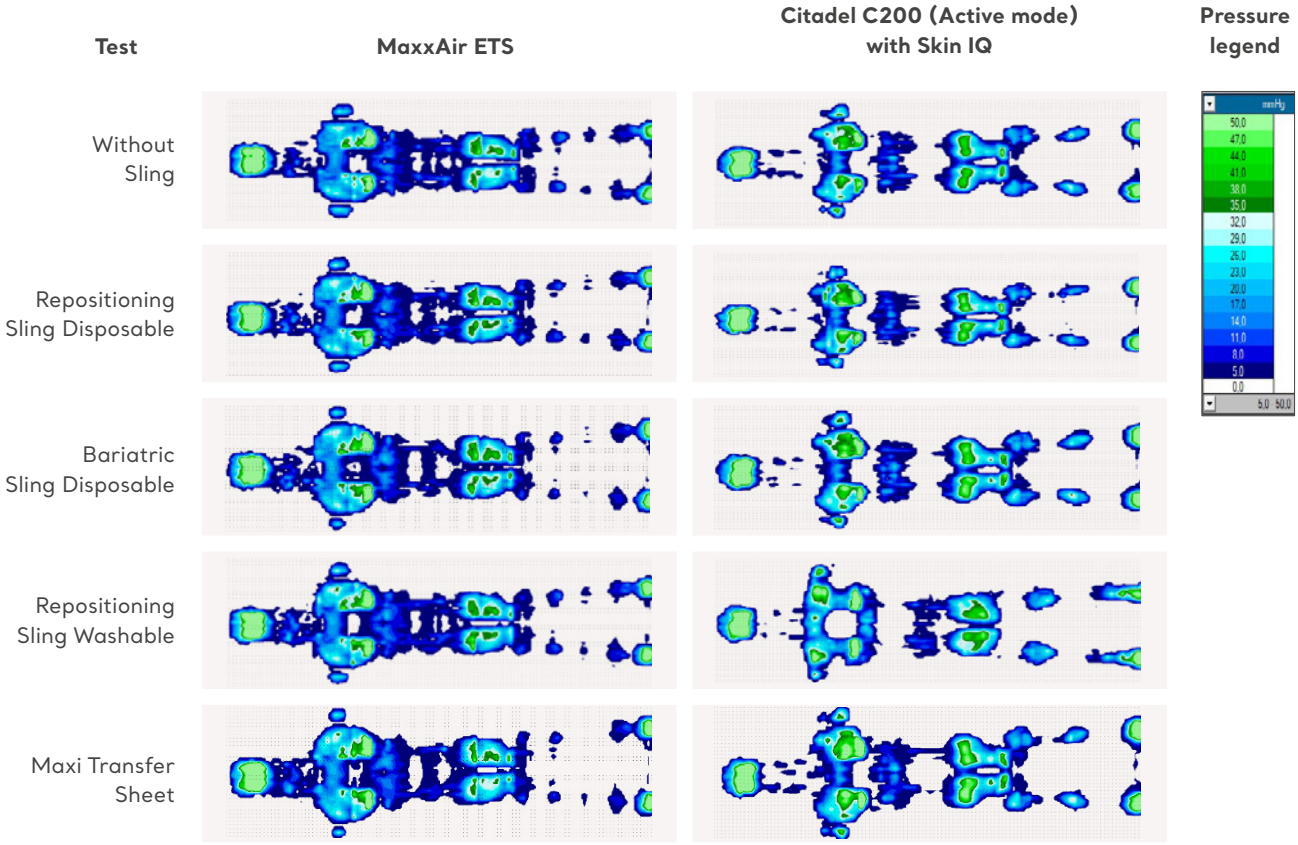

Figure 5: Pressure maps of MaxxAir ETS and Citadel C200 with Skin IQ

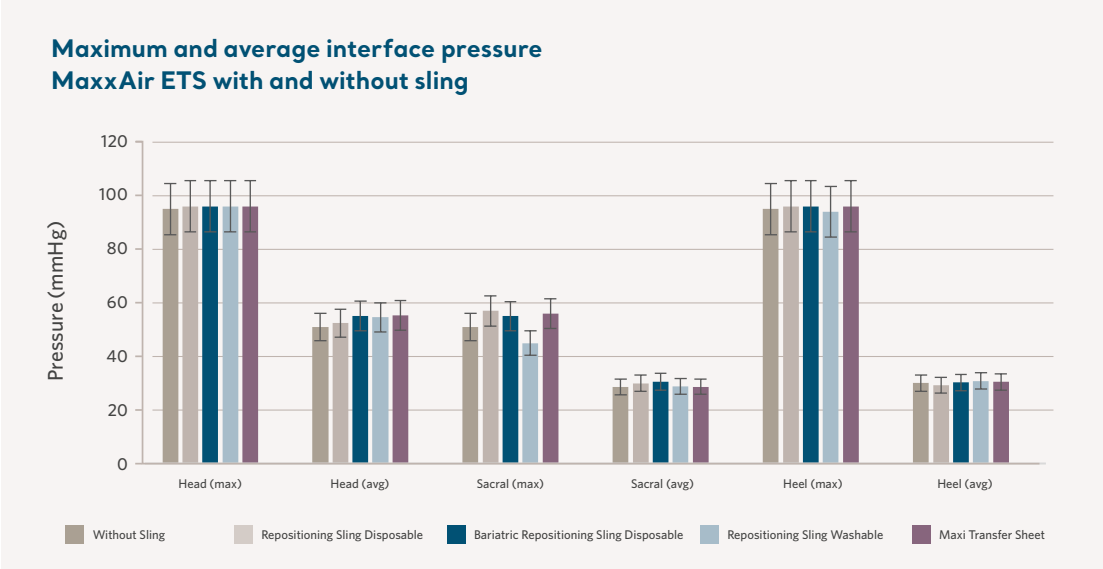

Figure 6: Maximum and average interface pressure on MaxxAir ETS with and without sling

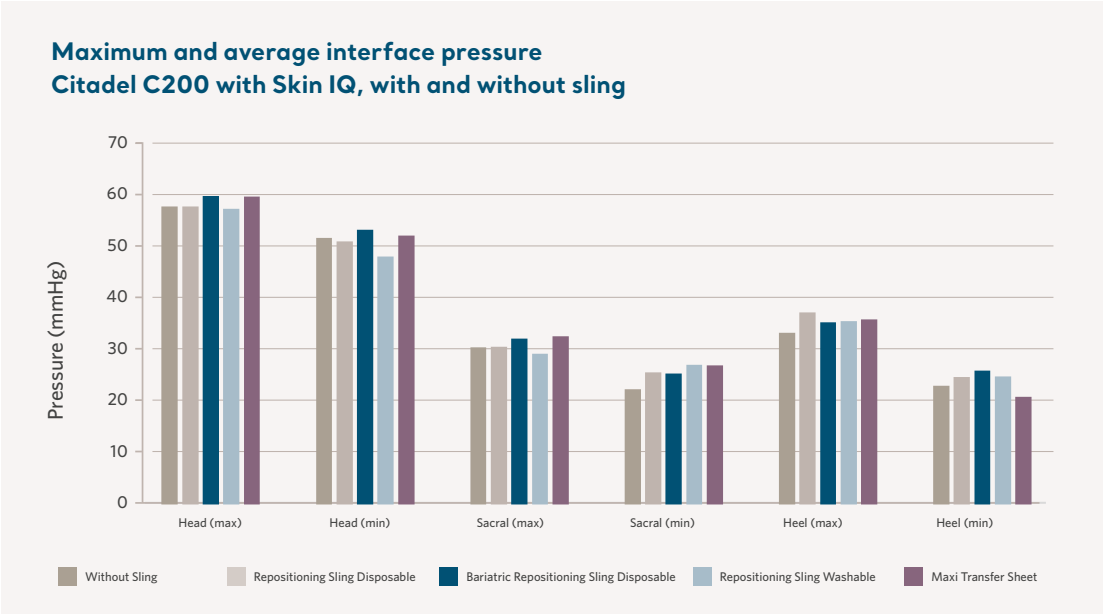

Figure 7: Maximum and average pressure on Citadel C200 in reactive mode with Skin IQ with and without sling

Interpretation

There is no effectual difference in pressure redistribution of Citadel C200 with Skin IQ or MaxxAir ETS, with the addition of the Repositioning Slings. The addition of the Repositioning Slings did not affect the support provided by the underlying support surface as demonstrated by the differential pressures remaining across the anatomical areas of the support surfaces.

Horizontal stiffness (Shear) Test: SS-1 2019: Section 5

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 on a support surface toward the foot end, simulating patient movement. Comparison tests were performed between the Citadel C200 in reactive mode with Skin IQ and MaxxAir ETS, both with and without the addition of slings to evaluate how slings affects the shear forces at the interface with the support surface.

Clinical relevance: Mechanical loading and tissue compression from external forces deform the skin, creating stress and strain forces 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.

Results:

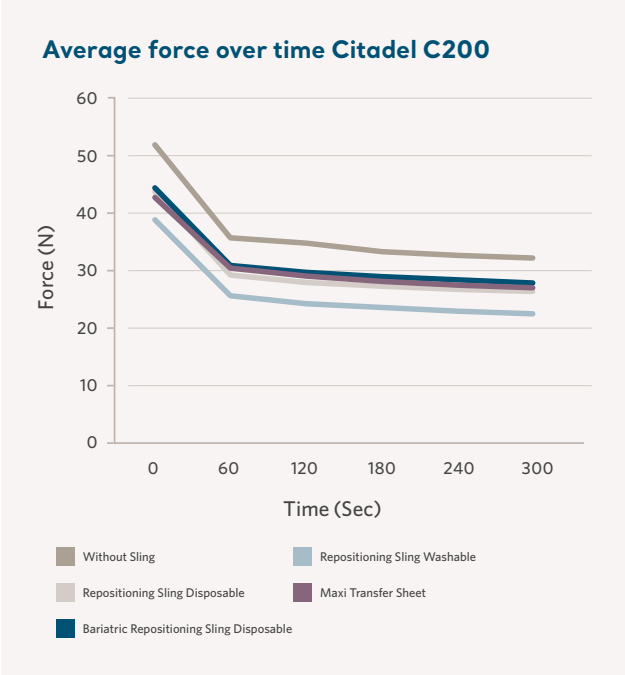

Figure 8a: Average force over time for Citadel C200 with Skin IQ, with and without slings

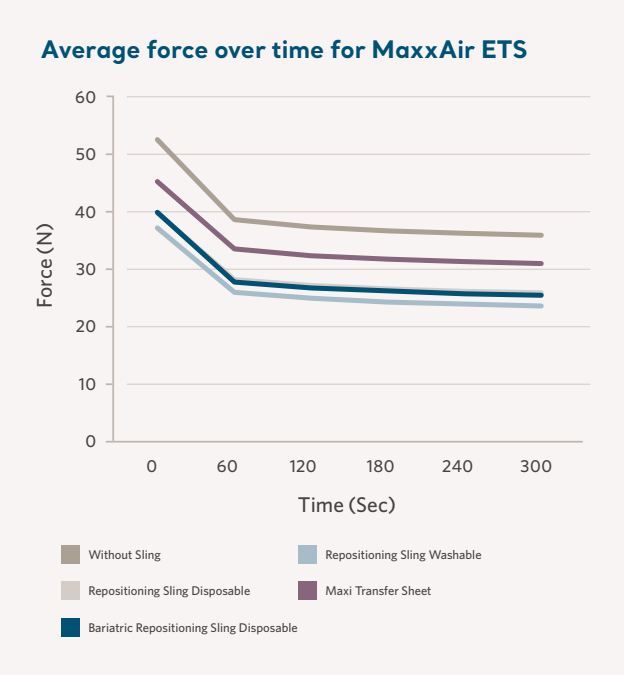

Figure 8b: Average force over time for MaxxAir ETS with and without sling

Figures 8a and 8b show the slings reduce the force, both initially and then during the pull, and demonstrate the benefit of having them present and left under the patient. The slings reduce the pulling force on both surfaces.

Interpretation

For both Citadel C200 with Skin IQ and MaxxAir ETS the average pulling force is reduced with the addition of the Repositioning Slings. The interface between simulated patient and the support surfaces is enhanced by the addition of the Repositioning Slings through the reduced friction force. This reduced force is an analog for reduced shear and 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, humidity and airflow next to the skin. Managing microclimate helps improve tissue tolerance to pressure, friction and shear.

Heat & water dissipation characteristics for full body support surfaces

Sweating guarded hot plate (SGHP) method: SS-1 (2019): Section 4[6]

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. Comparison tests were performed between the Citadel C200 in active mode with Skin IQ and MaxxAir ETS, both with and without the addition of slings to evaluate how slings affect the microclimate at the interface with the support surface.

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 effect is dependent upon the nature of the support surface and the cover material. The layering effect of multiple components located above a support surface, such as a Repositioning Sling left in situ, can potentially affect the microclimate performance of a support surface. The testing clearly demonstrates that this does not occur with the products tested and a suitably high or enhanced microclimate performance is available with the presence of the sling.

Skin IQ Microclimate Management coverlet on a Citadel C200

Results:

Evaporative capacity Citadel C200 with Skin IQ, with and without sling

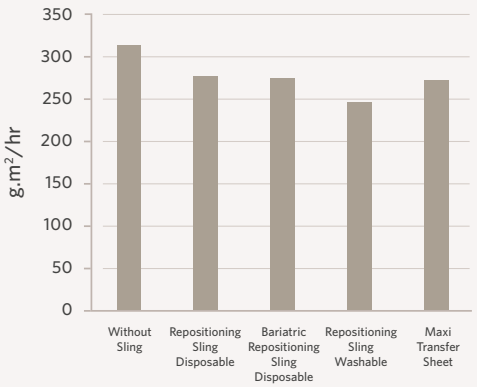

Figure 9: Evaporative Capacity on Citadel C200 with Skin IQ, with and without sling

Evaporative capacity MaxxAir ETS with and without sling

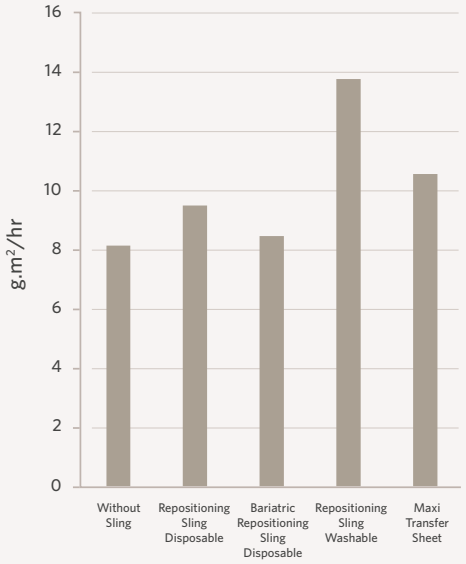

Figure 10: Evaporative Capacity of MaxxAir ETS with and without sling

Interpretation

The addition of Repositioning Slings on the Citadel C200 with Skin IQ did reduce the evaporative capacity but it's performace was still excellent and remained at an extremely high level.

For MaxxAir ETS evaporative capacity increased with the addition of Repositioning Slings.

Body analogue method: SS-1 (2019): Section 3[6]

Test overview: This test method measures the heat and moisture dissipation properties of the support surface by creating a comparable environment to the human body lying on a mattress. This test also includes a simulated repositioning event (shown at time = 180 minutes in Figures 9–12) to assess the ability of a 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 have RH closer to 50% with lower temperature.

Citadel C200 with Skin IQ Microclimate Management coverlet

Results:

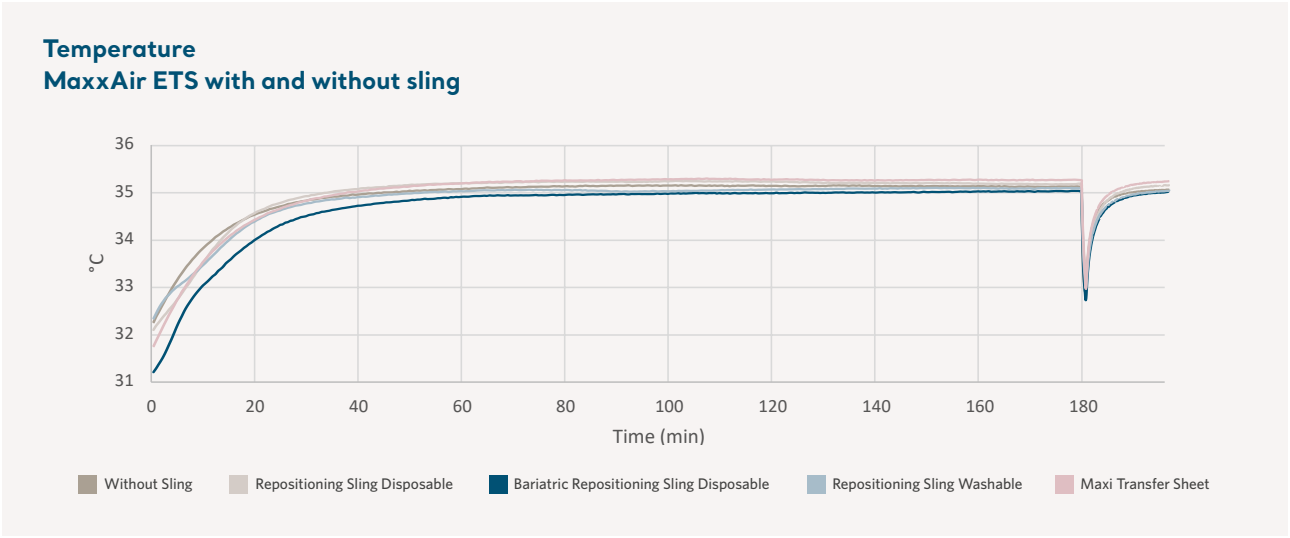

Figure 11: Temperature of MaxxAir ETS with and without sling

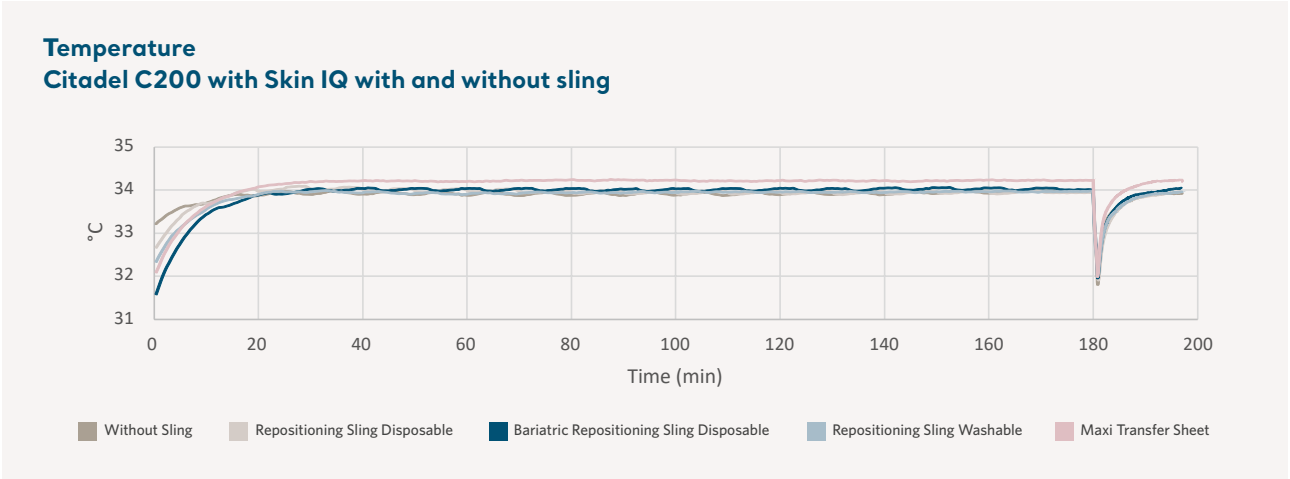

Figure 12: Temperature of Citadel C200 with Skin IQ with and without sling

Relative humidity
MaxxAir ETS with and without sling

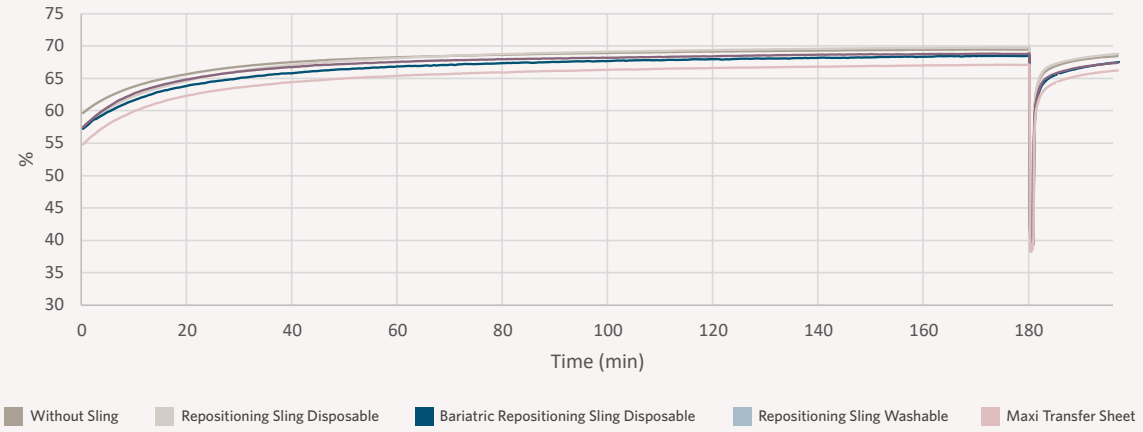

Figure 13: Relative humidity of MaxxAir ETS with and without sling

Relative humidity
Citadel C200 with Skin IQ with and without sling

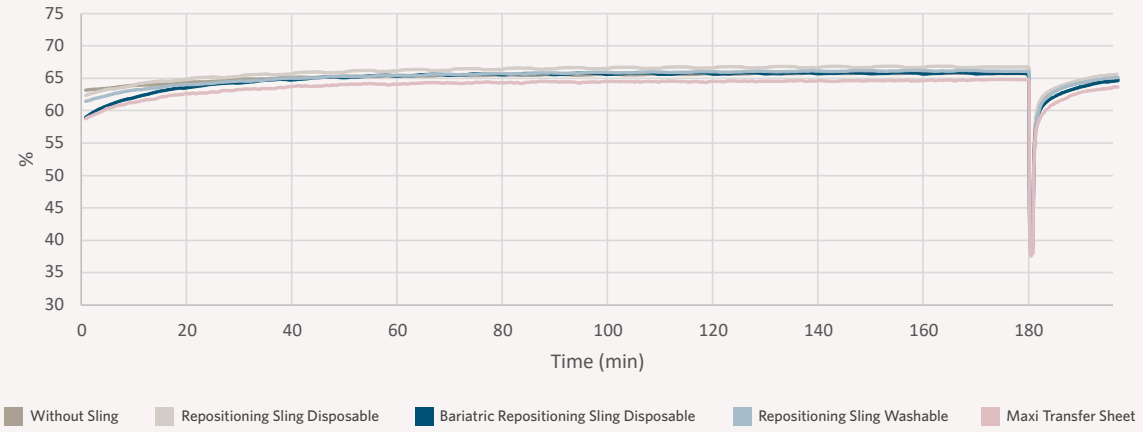

Figure 14: Relative humidity of Citadel C200 with Skin IQ with and without sling

Interpretation

Temperature:
There is no discernable difference in terms of heat dissipation properties of MaxxAir ETS and Citadel C200 (with Skin IQ) with the addition of the Repositioning Slings.

Relative Humidity:
No impact on the amount of moisture being trapped (relative humidity) has been observed with the addition of the Repositioning Slings.

Conclusion

These tests are designed to demonstrate the impact on the support surface performance characteristics (when leaving the Repositioning Slings in place underneath the patient) – not the impact of these directly on individual patients.

The results demonstrate that the Repositioning Slings do not interfere with the performance of two typically used support surfaces, MaxxAir ETS and Citadel C200 (with Skin IQ) Mattress Replacement Systems.

This can support clinical decision making when assessing the risk of leaving Repositioning Slings underneath patients for a period of time between transfers.

Therefore these tests give an indication that the Repositioning Slings tested may be suitable for leaving underneath a patient. However, the test results only form part of an individual patient risk assessment, which should be carried out by the responsible clinician when considering leaving these Repositioning Slings underneath a patient for a period of time between transfers. This should include consideration of the following factors:

- Individual clinical conditions and needs of the patient
- The efficacy of the support surface they are positioned on
- Repositioning and patient handling practices
- Other factors influencing the risk of pressure injury development e.g. temperature and microclimate related needs

Ongoing monitoring of the patient is essential when deciding to leave Repositioning Slings in place on the support surface, underneath the patient.

References

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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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