# Maxi Air® Air-Assisted Lateral Patient Transfer device

## Immersion, Envelopment, Pressure Mapping, Microclimate & Horizontal Stiffness Testing

### 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 Maxi Air from the perspective of support surfaces[7].

### Clinical relevance of testing support surfaces in combination with Maxi Air Air-Assisted Lateral Patient Transfer device

The Maxi Air Air-Assisted Lateral Patient Transfer device is 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 this device in its deflated mode for longer periods of time, to reduce the amount of manual handling by caregivers and improve working efficiencies. It may also remain in place for the duration of clinical procedures such as medical imaging or surgical interventions.

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 Maxi Air Air-Assisted Lateral Patient Transfer device deflated 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 Maxi Air Air-Assisted Lateral Patient Transfer device.

## Surface 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 mode) with Skin IQ® Microclimate Management (MCM) system and bed sheet

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

Maxi Air Air-Assisted Lateral Patient Transfer device (tested in deflated mode)

## 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 plus Skin IQ and the MaxxAir ETS with and without the addition of Maxi Air were compared to evaluate the effect of leaving Maxi Air deflated on the support surfaces.

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

**Results:**

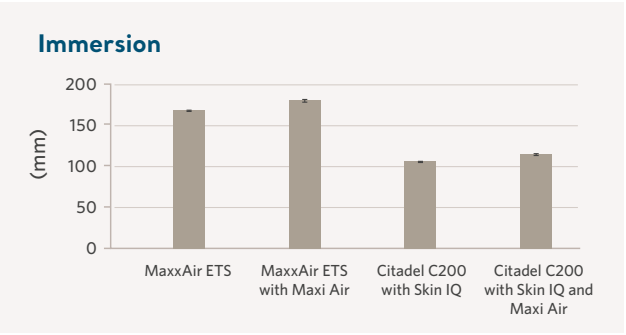



**Figure 1.** Immersion test data

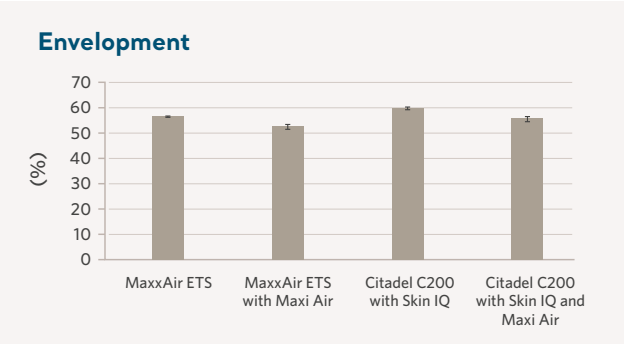



**Figure 2.** Envelopment test data

### Interpretation

Citadel C200 with Skin IQ and MaxxAir ETS keep their ability to conform around irregularities when Maxi Air is added onto the surface.

There was no discernible effect on immersion and envelopment properties of Citadel C200 with Skin IQ or MaxxAir ETS with and without the addition of Maxi Air.

## 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:** A healthy subject of 87 kg and height 170.5 cm was positioned in supine on the support surface. A pillow was placed at the top of the support surface to be used under the subject's head to simulate normal use. Pressure map values were recorded for 360 seconds. This procedure was repeated for Citadel C200 with Skin IQ and for MaxxAir ETS, both with and without the addition of Maxi Air.

**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:**
The test results show the average pressures measured (where the pressure is 10 mm Hg).

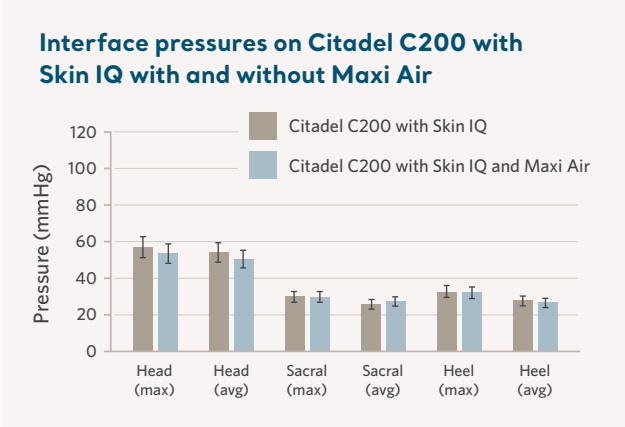



**Figure 3.** Interface pressures on Citadel C200 with Skin IQ, with and without the addition of Maxi Air

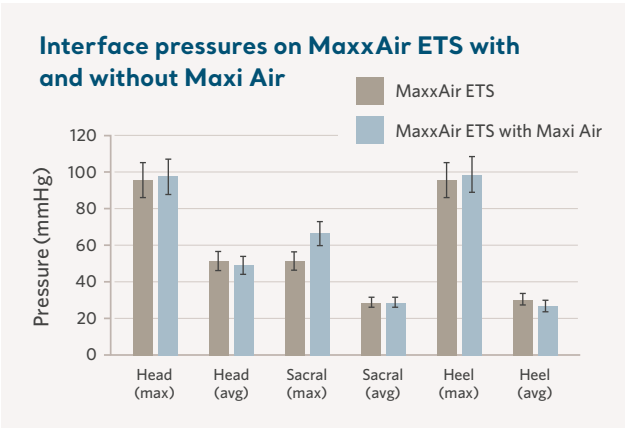
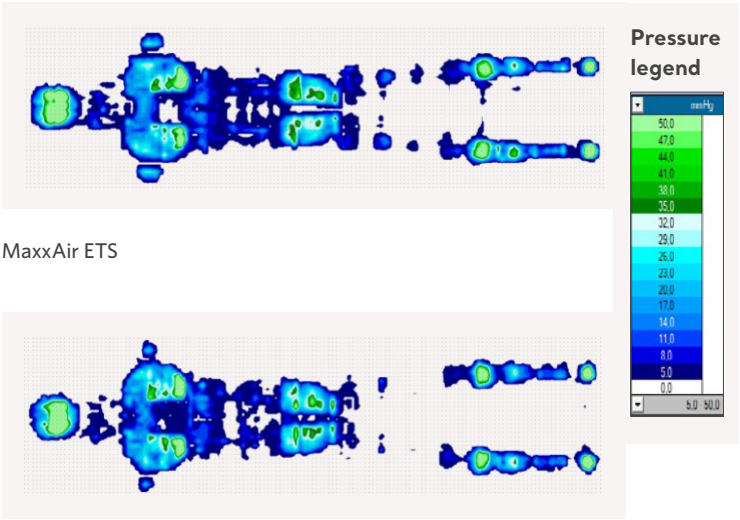



**Figure 4.** Interface pressures on MaxxAir ETS with and without the addition of Maxi Air

### Interpretation

There is no discernible difference in pressure redistribution of Citadel C200 with Skin IQ or MaxxAir ETS, both with the addition of Maxi Air.




MaxxAir ETS

MaxxAir ETS with MaxiAir

Citadel C200 with Skin IQ

Citadel C200 with Skin IQ and Maxi Air

## 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 with Skin IQ and MaxxAir ETS, both with and without the addition of Maxi Air to evaluate how it 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:**

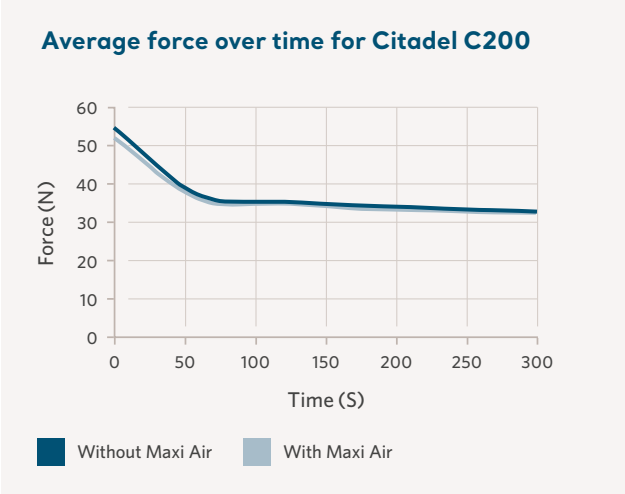



**Figure 5.** Force Over Time for Citadel C200 with Skin IQ, with and without the addition of Maxi Air

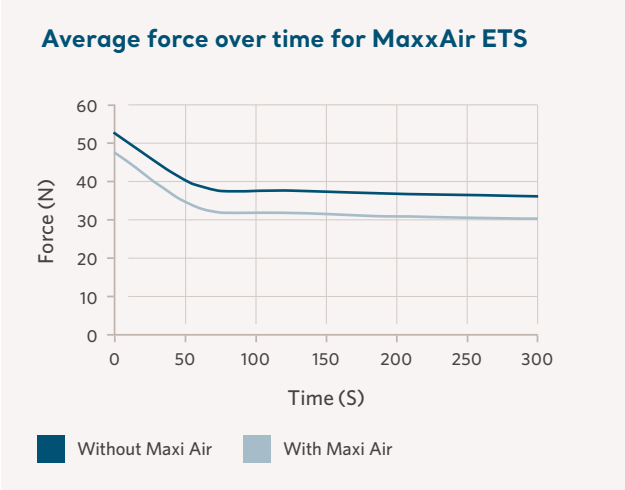



**Figure 6.** Force Over Time for MaxxAir ETS with and without the addition of Maxi Air

### Interpretation

For MaxxAir ETS and Citadel C200, the average force is lower with Maxi Air than without. The interface between simulated patient and the support surfaces is enhanced by the addition of Maxi Air through the reduced 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.

**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.

**Results:**

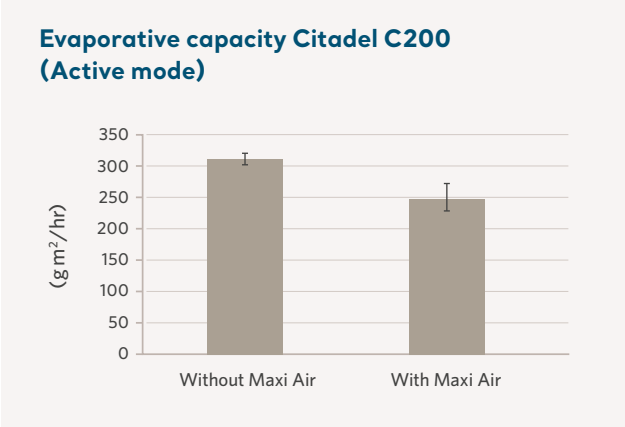



**Figure 7.** Evaporative Capacity on Citadel C200 with Skin IQ, with and without the addition of Maxi Air.

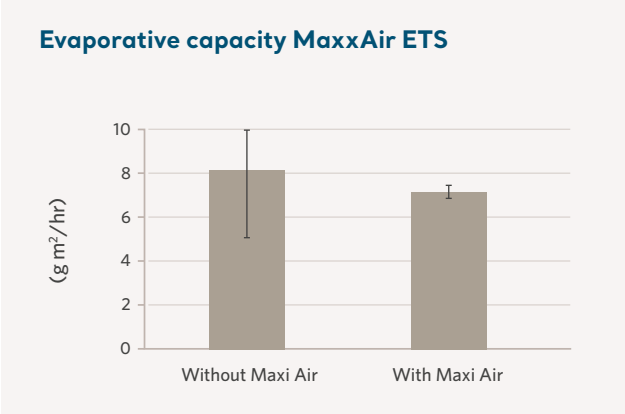



**Figure 8.** Evaporative Capacity of MaxxAir ETS with and without the addition of Maxi Air

### Interpretation

The addition of Maxi Air on the Citadel C200 with Skin IQ did reduce the evaporative capacity but it still remained at an extremely high level. (Figure 7)

For MaxxAir ETS there were no discernible difference in evaporative capacity with and without Maxi Air. (Figure 8)

## 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.

**Results:**

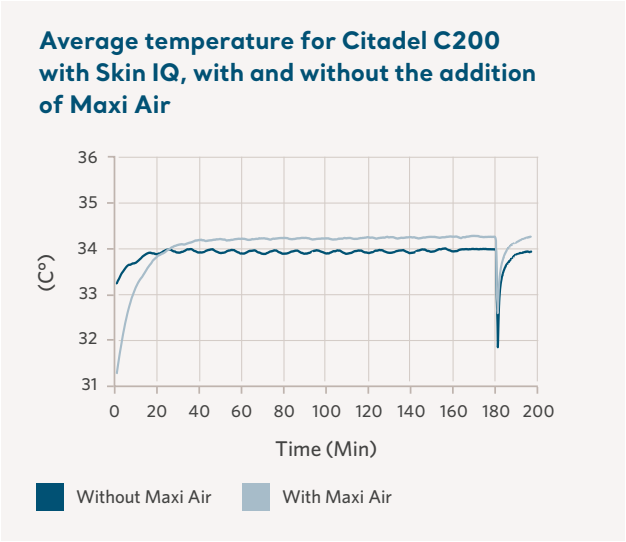



**Figure 9.** Average Temperature throughout testing for Citadel C200 with Skin IQ with and without the addition of Maxi Air

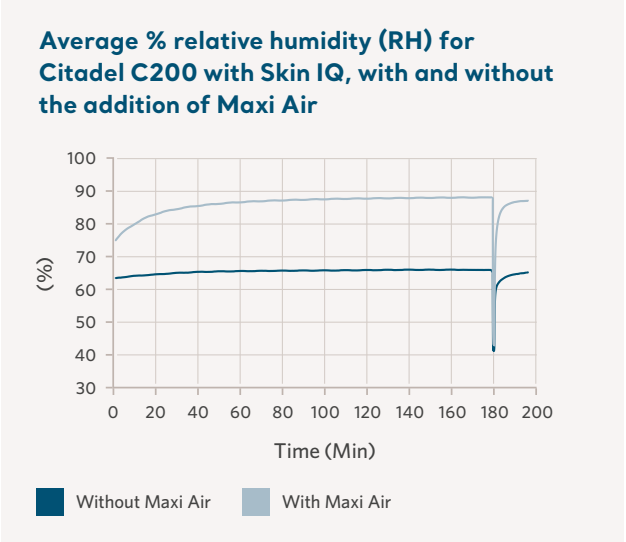



**Figure 10.** Average % RH throughout testing for Citadel C200 with Skin IQ with and without the addition of Maxi Air

### Average temperatures for MaxxAir ETS with and without the addition of Maxi Air

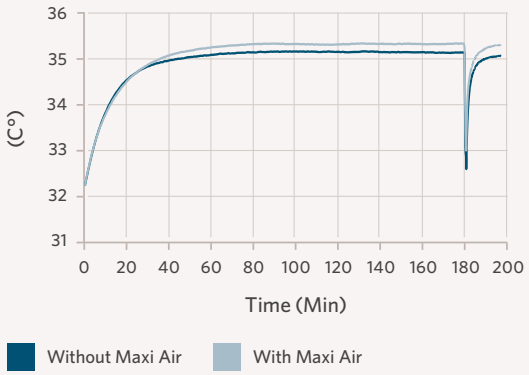



**Figure 11.** Average Temperature throughout testing for MaxxAir ETS with and without the addition of Maxi Air

### Average % relative humidity (RH) for MaxxAir ETS with and without the addition of MaxiAir

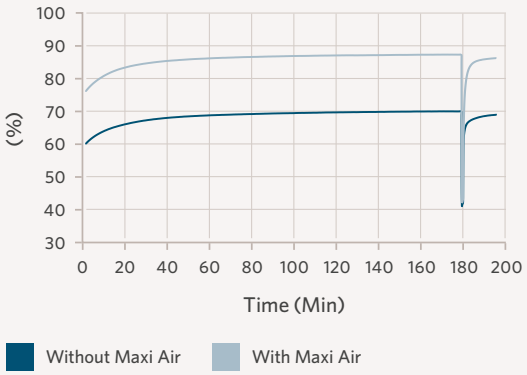



**Figure 12.** Average % RH throughout testing for MaxxAir ETS with and without the addition of Maxi Air

## Interpretation

The heat dissipation properties of the two surfaces; Citadel C200 with Skin IQ and the MaxxAir ETS, both with the addition of Maxi Air shows relatively no difference compared to the control surface testing. The test results showed no heat trapping which helps to keep the patient at normal sweat levels. Although a raise in humidity was observed during the test with the addition of Maxi Air, the evaporative capacity remained at an extremely high level for Citadel C200 with Skin IQ and an unchanged level with MaxxAir ETS.

## Conclusion

These tests are designed to demonstrate the impact on the support surface performance characteristics (when leaving Maxi Air (deflated) in place underneath the patient) – not the impact of this directly on individual patients. The results demonstrate that Maxi Air did not interfere with the performance of the support surfaces tested. This can support clinical decision making when assessing the risk of leaving Maxi Air (deflated) underneath patients for a period of time between transfers. Therefore these tests give an indication that Maxi Air (deflated) 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 Maxi Air (deflated) 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 Maxi Air (deflated) in place on the support surface, underneath the patient.

## References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2. Gefen A, Weihs D. Cytoskeleton and plasma-membrane damage resulting from exposure to sustained deformations: A review of the mechanobiology of chronic wounds. Med Eng Phys, 2016; 38(9): 828-833.
3. European Pressure Ulcer Advisory Panel, National Pressure Injury Advisory Panel & Pan Pacific Pressure Injury Alliance. Prevention and Treatment of Pressure Ulcers/Injuries: The International Guideline 2019. Emily Haesler (Ed). EPUAP/NPIAP/PPPIA, 2019. Section 8: Introduction to Repositioning and Early Mobilisation. Page 115.
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7. Arjo data on File, ref 100122546 and 100122547.




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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