arjo

Comparison of support surface performance characteristics

Immersion, envelopment, microclimate & horizontal stiffness

Citadel® C200 Integrated mattress replacement system

Authors: **Sara Tackson** PT, MPT, CWS, Eur Ing **Dave Newton** MEng, CEng, MIET, MIEEE, **Carroll Gillespie** MS, BSN, RN, WOCN, **Jonathan Busby** MSc, BSc (Hons) RN, **Debbie Rozario** RN

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 between the body and sustained pressure from a 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 prevent the effects of damaging tissue deformation and provide an environment that enhances perfusion of at risk or injured tissues. 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 user's 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 new US based ANSI/RESNA SS-1:2019 standard[6].

This document will provide a summary of the results of immersion, envelopment, horizontal stiffness and microclimate testing performed to this standard with the Citadel® C200 and Skin IQ® Microclimate Management (MCM) System in comparison to the legacy KinAir MedSurg Pulse™.

Immersion & envelopment: SS1:2019 Section 6[6]

Test overview:

Immersion testing: provides one measure of the pressure redistribution properties of a surface. The test measures the depth of 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.

Method: Testing was performed to RESNA SS-1: 2019 section 6[6]. The average immersion level provided by the Citadel C200 plus Skin IQ for each operating mode was compared to the KinAir MedSurg Pulse™ in its High Pulsation Mode (Figure 1).

Clinical relevance: Higher levels of immersion and envelopment support increased pressure redistribution

Results:

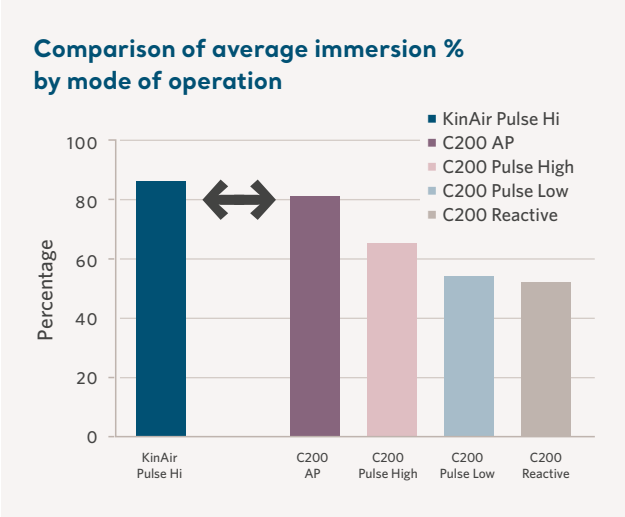

Figure 1: Immersion Test Data[7]

Interpretation

- Despite the two products differing significantly in height, construction and operation, it is possible to compare them in terms of their immersion and envelopment characteristics
- Figure 1 shows how the Citadel C200 in alternating pressure (AP) mode provides a broadly equivalent percentage depth of immersion to the KinAir MedSurg Pulse

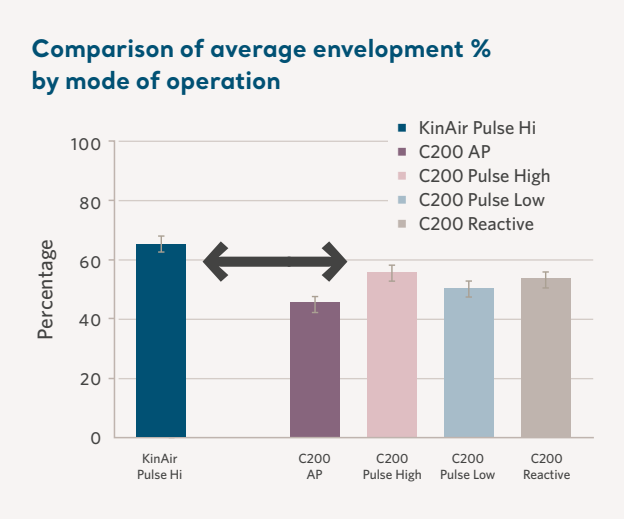

Figure 2: Average Envelopment data comparing KinAir MedSurg Pulse (High Pulse Mode) to Citadel C200[7]

Interpretation

- In Figure 2, The range of envelopment percentage of the KinAir MedSurg is higher than the Citadel C200, however the performance can be most closely matched through the use of Citadel C200 + Skin IQ in Pulsation High Mode

Horizontal stiffness (shear) test: SS-1 2019: Section 5[6]

Test overview: The purpose of this test is to simulate shearing forces that support surfaces impart when patient movement occurs on the surface. The test is designed to allow for comparison between different support surfaces of the shear forces applied to a bed bound patient.

Method: A mannequin representing a 50th percentile male is pulled down a support surface simulating patient migration. Comparison tests were performed between the KinAir MedSurg legacy product and the Citadel C200 plus Skin IQ MCM.

Clinical relevance: Loaded tissues distort and deform which result in extrinsic 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:

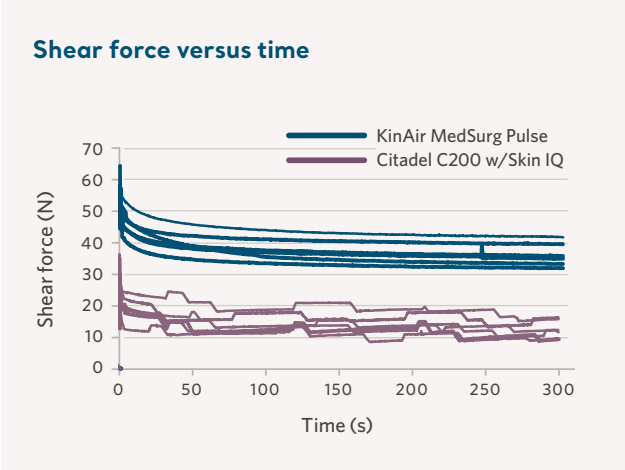

Figure 3: Comparison of horizontal stiffness results for the KinAir MedSurg Pulse compared to the C200 + Skin IQ[7]

Interpretation

- The C200 and Skin IQ MCM has a lower horizontal stiffness and so offers less resistance to patient motion on the surface
- The lower initial static and dynamic forces measured with the C200 and Skin IQ MCM can be expected to reduce the shear effect and tissue strain on the patient when repositioned
- The C200 and Skin IQ MCM shows a considerable improvement to the horizontal stiffness performance compared to the legacy product

Temperature & 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 skin in contact 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.

Results:

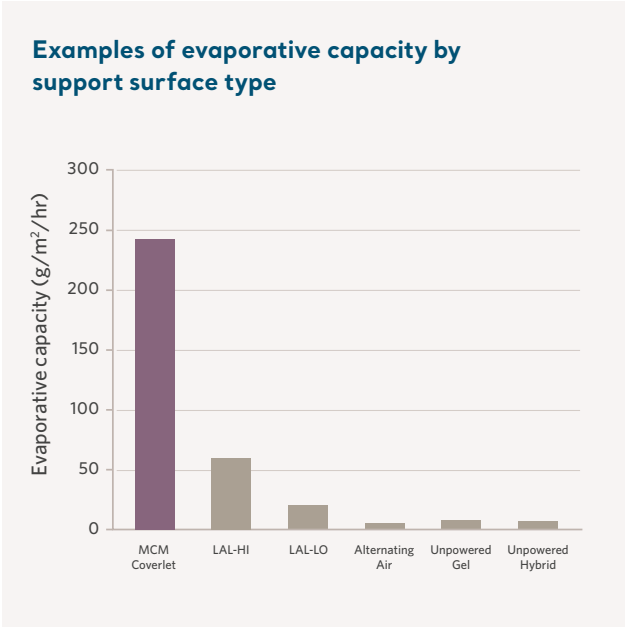

Figure 4: Comparative test results using the body analogue Method[7]

Interpretation

- The C200 was compared with examples of other commonly used support surfaces readily available in the US market and is shown graphically in Figure 4

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 figure 5) 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:

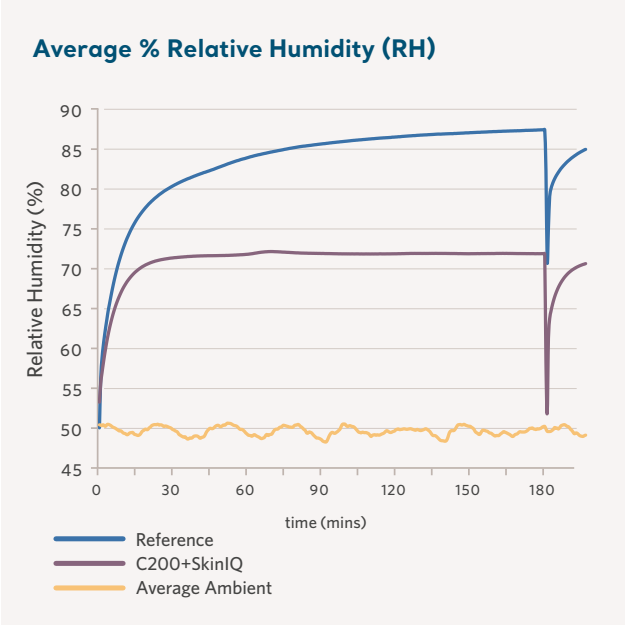

Figure 5: Test results using the Body Analog Method[7]

Interpretation

- Figure 5 shows the % relative humidity (RH) at the interface of the indenter to the surface was kept at a steady state. This demonstrates that the C200 and Skin IQ was able to quickly stabilize and remove a significant amount of the humidity introduced by the test environment
- The flat nature of the curve shows that the C200 & Skin IQ is able to control and limit the increase in moisture at the simulated skin interface compared to a reference surface
- This demonstrates the beneficial microclimate effect that may be present in a real life clinical situation

Conclusion

Many product features within the design, construction, and operation differ between the KinAir MedSurg Pulse and the Citadel C200 + Skin IQ. However in terms of key measurable parameters, the user can configure the C200 system at the bedside to provide a broadly comparable level of surface performance.

Based on these measurable parameters, the utilisation of the C200 could provide an acceptable alternative to air fluidised therapy (AFT) or low air loss (LAL) support surfaces.

References

1. Gefen (2018) The future of pressure ulcer prevention is here: detecting and targeting inflammation early. EWMA Journal 19 (2)
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.
4. 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.
5. National Pressure Injury Advisory Panel (NPIAP). Guidance on Interpretation of Performance Standards for Support Surfaces. https://npiap.com/page/S3i.
6. RESNA SS-1:2019 Requirements and Test Methods for Full Body Support Surfaces.
7. Arjo Test Data on File

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.

Arjo AB • Hans Michelsensgatan 10 • 211 20 Malmö • Sweden • +46 10 335 4500

www.arjo.com

Arjo.A00492.1.0.INT.EN