Surface Performance Comparison: Envella™ bed vs. Dolphin® Surface

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Abstract

Clinitron® Air Fluidized Therapy (AFT) surfaces have been shown in clinical studies to be extremely effective in both the prevention and treatment of pressure injuries. One particular study concluded that Group III surfaces according to the CMS categorization (which includes only AFT) were able to heal pressure injuries four times as quickly as Group II (powered air) mattresses. Other products have occasionally capitalized on these findings. One such product, which the manufacturer has described as a "Fluid Immersion Simulation" surface, is the Dolphin surface. No such category has been recognized by the NPUAP / S3I committee nor by CMS, which simply designates it as a Group II product. The performance differences between the products can be demonstrated conclusively using the NPUAP/S3I tests that have been validated by experts: Shear: Dolphin: 22.3 N vs. Envella: 1.8 N (92% better shear performance); Peak Sacral Interface Pressure: Dolphin: 39.5 mm Hg vs. Envella: 26.4 mm Hg (33% better pressure redistribution); and Evaporative Capacity: Dolphin: 17.4 g/m^2-hr vs. Envella: 1080 g/m^2-hr (6100% or 61x's greater). Although the Dolphin surface is frequently presented as a substitute for AFT, the objective data strongly suggest that this is not the case.

Introduction

The therapeutic effectiveness of Air-fluidized therapy (AFT) products such as Hill-Rom's new Envella bed is widely recognized in the clinical community. Wound healing has been shown to occur four times as rapidly on AFT as on Group II (Powered Air) support surfaces.[1] In addition, the same fluid support properties have also been shown to provide significant benefits for pressure injury prevention. In a clinical study of AFT products on high risk cardiovascular patients vs. the existing standard of care (typically powered air), pressure injury rates were reduced by 97.7%.[2] A relatively small study also suggests that AFT may be highly effective in a niche that is rapidly growing in importance: the resolution of Deep Tissue Injury.[3] It is not surprising that other products want to promote similarities compared to AFT.

A recent example is the Dolphin "Fluid Immersion Simulation" surface or FIS product. From the website:

"By emulating the effects of a body " floating" in a fluid medium, Dolphin FIS provides an environment that promotes tissue perfusion and prevents injury related to compromised blood flow. In multiple clinical situations such as surgical procedures, spinal cord injuries and obesity, Dolphin FIS minimizes soft tissue deformation."[4]

It is important to note that the National Pressure Ulcer Advisory Panel's Support Surface Standards Initiative (NPUAP/S3I) which is tasked with developing standard industry categories and terms, has not recognized a Fluid Immersion Simulation category. Similarly, despite the FIS name, it falls not in the group III (Fluid Support) category but within the standard group II category (powered air products).

Envelopment and Peak Interface Pressure

An essential characteristic of fluid support is the ability to conform to the irregularities of the body. This is known as Envelopment.[5] Fluid support is characteristic

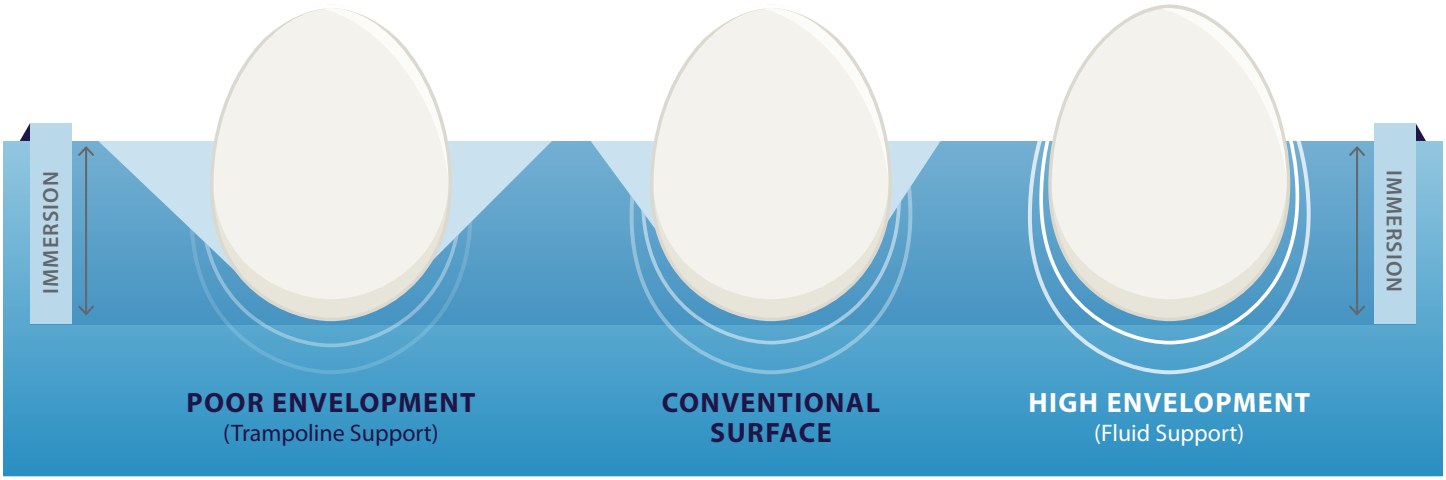

Figure 1: Identical Levels of Immersion (penetration depth into the surface) but different levels of Envelopment (conformability and contact area). LEFT: Trampoline-like support (Poor Envelopment) such that pressure is concentrated at the apex, increasing Peak Interface Pressure. RIGHT: Fluid support (High envelopment); pressure is broadly distributed across the contact area and peak pressure is minimized.

of the highest levels of envelopment **(Figure 1)** resulting in less pressure on the tissue.

The greater the envelopment for a given level of immersion the higher the contact area and the lower the interface pressure **(Figure 1).** Peak sacral interface pressures on Dolphin® surface and Envella™ bed are shown in **Figure 2** for 180 lb. patient loading at 30° head of bed angle. The result is the mean of 10 measurements. The peak pressure on the Envella Bed (26.4 mm Hg) was nearly 33% lower than on the Dolphin surface (39.5 mm Hg). The difference was again highly significant ($P < 0.001$).

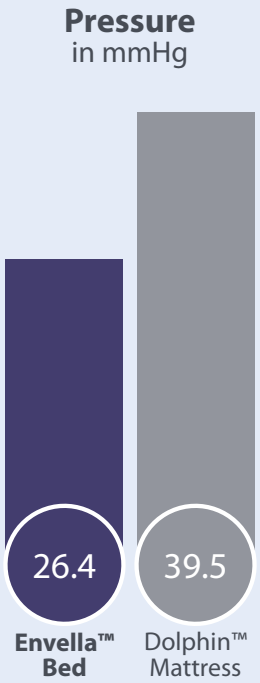

Figure 2: 33% better pressure redistribution.

The result highlights the superior cradling properties of true fluid support and calls into question the Dolphin surface claim that the product minimizes tissue deformation.[4] If the primary determinant of tissue deformation for a given patient is peak interface pressure and the peak pressure is nearly 33% lower on the Envella Bed, can the deformation truly be minimized on the Dolphin surface?

Shear or "Pushback Force" on the Body

Another fundamental aspect of fluid support is the shear or "pushback" force on the tissue when the body is moved across the surface. Conventional solid support surfaces behave like a lattice of springs. Any motion across the surface increases the compression of these springs and the resulting "pushback force" they exert on the tissue. In a fluid; the "pushback force" is negligible. The clinical implications are obvious for wounds, flaps, grafts, and even prevention of injury in healthy tissue.

The NPUAP / S3I committee has recently validated and approved a method of measuring this shear or "pushback force" on the body that occurs as a result of movement. In the Horizontal Stiffness Test, a pelvic-shaped device is weighted to match the pressure of 180 lb. patient and carefully pulled 10 mm toward the foot of the bed. The shear force tending to drive the device back towards its initial position is measured and recorded for a total of five minutes.

Sustained shear stress was measured on the Envella bed and Dolphin surface using this method **(Figure 3).** The result — the Envella bed resulted in 92% better shear performance against the Dolphin surface. This illustrates the degree to which the two products differ in their approximation of fluid support.

The Dolphin® surface is composed of conventional air bladders that behave as one would expect when deformed: they push back. The bead bath of the Envella™ bed is truly fluidized in that the fine beads are supported by the air that flows between them. When the body is moved through the fluid bath, there is little push-back as the fluid is free to simply flow out of the way to accommodate the body's new position. And, as measured, the pushback force is negligible.

Microclimate Management: Heat and Humidity on the Skin

The primary additional factors shown to impact skin integrity are the heat and humidity of the skin, also known as the microclimate.[6] The ability of these two products to manage the skin microclimate was also compared using a standard NPUAP/S3I validated and approved test known as the Sweating Guarded Hot Plate method.[5]

The evaporative capacities of the two products are shown in **Figure 4.** The evaporative capacity of the Envella bed (1080 g/m^2*hr) vs. that of Dolphin surface (17.4 g/m^2*hr) reflects a 6100% (61x's) greater evaporative capacity to remove urine, sweat, exudate, and other damaging fluids from the skin.

The dry heat withdrawal comparison is shown in **Figure 5.** With the bead bath temperature set at 91° the Envella bed (Dolphin surface has no temperature setting), the Envella bed is able to dissipate heat more freely with 120 W/m^2 vs. 53 W/m^2 for Dolphin surface. Higher values are generally preferable as they reduce the possibility for heat build-up, and cooler skin needs less nutrients and is less likely to suffer ischemia when blood flow is reduced by pressure.[6-7] Obviously, the optimal level of heat withdrawal is subject to the personal comfort preferences of the patient. This is why the Envella bed, unlike Dolphin surface, allows the caregiver to adjust the temperature to optimize both temperature and comfort simultaneously.

Summary

The Dolphin surface is frequently being presented as a suitable substitute for Air-Fluidized Therapy surfaces. Using tests that have been developed and validated by objective, third-party experts to assess risk factor management capabilities, the results suggest that this is not the case.

*With bead bath temperature at 91°

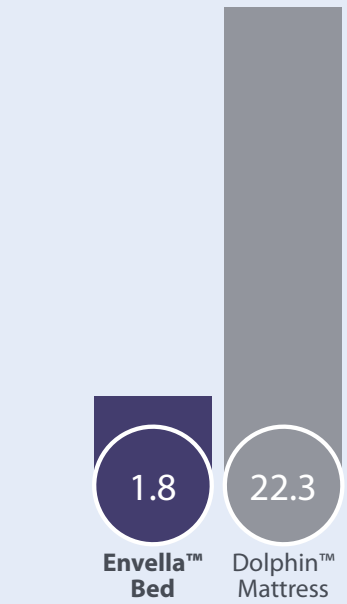

Figure 3: 92% better shear performance.

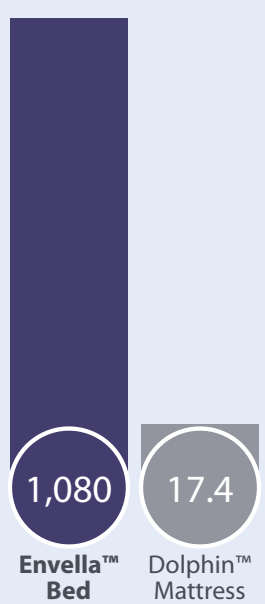

Figure 4: 6100% (61x's) greater evaporative capacity.*

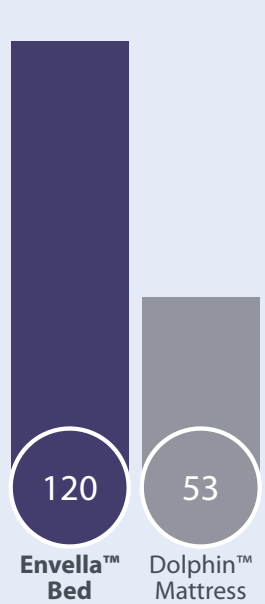

Figure 5: 126% greater heat withdrawal.*

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