WHITE PAPER

Not all Hybrids are Created Equally:
Demonstrating the Therapeutic Differences Between Foam-in-Air and Foam-over-Air Powered Hybrid Support Surfaces

Clinical Context

Global demographics, such as our increasingly aging population and an associated rising prevalence in long-term health conditions, are contributing to a population that is more susceptible to high incidences of pressure ulcers. The significant economical strain that this places on healthcare systems is well documented, as is the impact on the quality of life for those who develop a pressure ulcer.

Pressure ulcer prevention support surfaces are medical devices designed to impact, and reduce, the factors that lead to the formation of pressure ulcers. This may be in one of the following ways:

- **Redistributing pressure**, through the principles of immersion and envelopment, to provide lower peak interface pressures, particularly on the bony prominences. Examples of such surfaces include static foam mattresses, or powered constant low pressure. These support surfaces are typically, but not always, used to prevent pressure ulcers.

- **Relieving pressure** by offloading tissue. This is typically seen in dynamic alternating systems whereby individual, or groups of, cells are alternately inflated and deflated to provides areas of tissue loading and offload. These support surfaces are typically, but not always, used to treat pressure ulcers.

Hybrid support surfaces have been available for over 10 years, and seek to combine foam and air material in order to maximise the benefits of both static and alternating surfaces. Though broadly there are two types of hybrid surfaces, non-powered and powered, this white paper will focus on powered hybrid support surfaces.

DHG's **Dyna-Form® Mercury Advance** is one such powered hybrid support surface and has been clinically demonstrated to provide a number of benefits, including a significant reduction in pressure ulcer incidence rates[1,2], a reduction in the cost to treat pressure ulcers[2], a reduction in the cost of equipment associated with preventing and treating pressure ulcers[1], and the mechanism by which to heal pressure ulcers[3].

The construction of powered hybrid support surfaces varies by system, typically falling into one of two categories, which we have labelled as:

Foam-in-Air

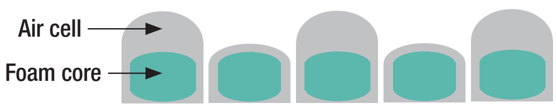

Figure 1. Foam-in-air powered hybrid mattress construction.

Constructed with foam encased within an air cell. In the non-powered mode this system will provide pressure redistribution as per a static foam mattress. In the powered mode this mattress will provide alternating pressure relief.[4]

Foam-over-Air

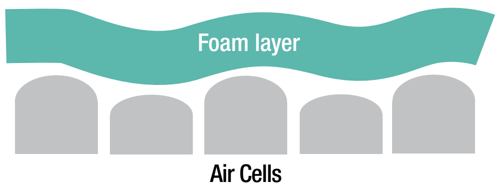

Figure 2. Foam-over-air powered hybrid mattress construction.

Constructed with a layer of foam over the top of air cells. In the non-powered mode, this system will provide pressure redistribution as per a static foam mattress. In the powered mode this mattress will provide constant low pressure.[4]

When selecting a powered hybrid support system, it is important to consider the action of therapy that it delivers. Hybrid systems where there is a layer of foam on top of the air cells will provide a form of active redistribution as the presence of the foam on top of the air cells restricts their capacity to offload tissue. Where foam is placed within a cell, the cells are not constricted by the presence of foam on top, and are therefore able to provide additional pressure relief.[4]

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This white paper study looked to demonstrate the therapeutic differences between foam-in-air and foam-over-air powered hybrid support surfaces, utilising pressure mapping to visualise the differences in therapeutic approach.

Methodology

Two different pressure ulcer prevention support surfaces were utilised in this study. Their construction is as follows:

Foam-in-Air Surface

The foam-in-air surface is DHG's Dyna-Form® Mercury Advance. This mattress is constructed of 14 castellated foam-in-air cells and a static foam head section, the mattress is zoned, with specific castellations for the head and calf/heel regions, and for the main torso, sacrum and thigh region. This is then placed inside a higher nominal hardness foam U-core which prevents the patient bottoming out and provides a firm outer perimeter. The mattress is then placed inside a multi-stretch, waterproof, vapour permeable polyurethane cover with a 3-sided zip. The control unit delivers a 10 minute, 1-in-2 cell cycle and has a high/low comfort control setting. The surface has a maximum SWL of 254kg.

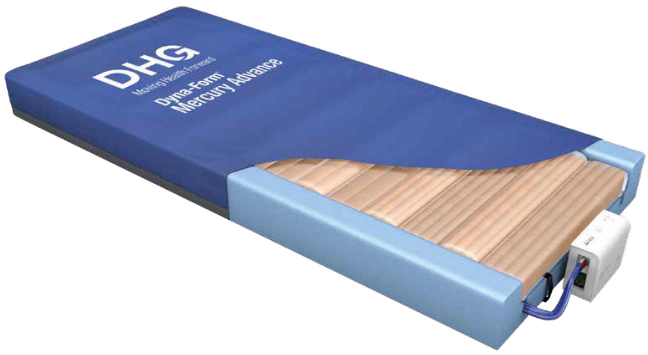

Figure 3. The Dyna-Form® Mercury Advance foam-in-air powered hybrid.

Foam-over-Air Surface

The foam-over-air surface is constructed of 12cm (5") high air cells, with a 2.5cm (1") viscoelastic foam topper. The mattress has a full height viscoelastic foam perimeter. This is then placed inside a flame retardent fire sock, and a 4-sided zipped polyurethane cover. The control unit states three modes: continuous low pressure, 1-in-2 alternation and auto firm. The system has variable cycle times of 5, 10, 15 or 20 minutes and 3 comfort settings of Soft, Medium and Firm. The surface has a maximum SWL of 227kg.

The same healthy, male volunteer (weight 65kg, height 175cm) was used for both systems, recorded on the same day. The following protocol was followed for each mattress:

1. The volunteer laid on the mattress in the non-powered mode. The pressure mapping was recorded for a period of 5 minutes to allow the system sufficient time to adjust. The non-powered pressure map was taken at the 5 minute mark. This process was followed for both mattresses.

2. The system was set to its alternating mode. Initially a total length of 5 minutes was allowed to ensure that the mattress was fully inflated. This process was followed for both mattresses.

3. The systems were then tested as follows:

   Foam-over-air
   The system was placed into the soft mode. Once the system had come up to pressure, therefore beginning the cell cycle, pressure mapping was recorded for 5 minutes to enable the system sufficient time to adjust. The pressure map was taken at the 5 minute mark of cell cycle one. Following the beginning of cell cycle 2, pressure mapping was recorded for 5 minutes. The pressure map was taken at the 5 minute mark of cell cycle two.
   This process was repeated for the Medium and Firm mode. The cell cycle time was set to 10 minutes on all modes.

   Foam-in-Air
   The system was placed into the low mode. Once the system had come up to pressure, therefore beginning the cell cycle, pressure mapping was recorded for 5 minutes to enable the system sufficient time to adjust. The pressure map was taken at the 5 minute mark of cell cycle one. Following the beginning of cell cycle 2, pressure mapping was recorded for 5 minutes. The pressure map was taken at the 5 minute mark of cell cycle two.
   This process was repeated for the High mode. The cell cycle time is automatically set to 10 minutes on all modes.

The pressure mapping system used was the FSA Mat 5E (102cm (L) x 86cm (W) with 5E interface module.

Results

Non-Powered Mode

Both systems provided pressure redistribution within the non-powered mode, although to differing degrees. The maximum interface pressure exerted on the body when using the foam-over-air mattress in the non-powered mode was 66.90mmHg, whilst on the foam-in-air hybrid mattress the maximum interface pressure exerted on the body was 62.81mmHg. The pressure mapping of each system can be visualised below.

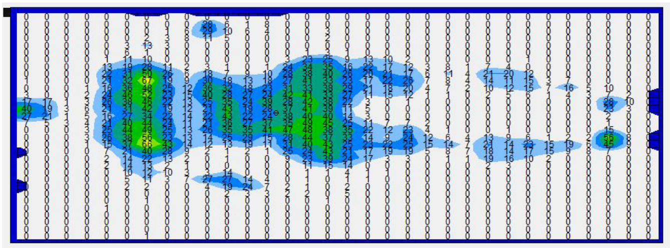

Figure 4. Pressure mapping of the foam-over-air system in the non-powered mode.

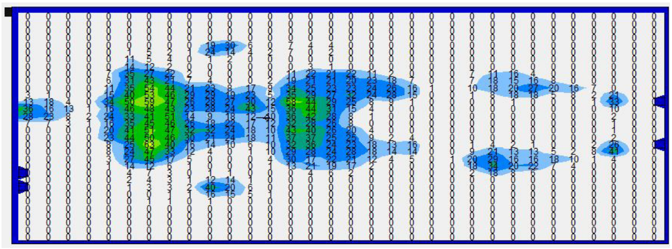

Figure 5. Pressure mapping of the foam-in-air system in the non-powered mode.

Pressure mapping demonstrates a greater redistribution of pressure within the foam-in-air system versus the foam-over-air system, particularly within the sacral region and the lower/mid back. This is likely due to the castellations of the foam-in-air system creating a greater level of immersion and envelopment and increasing the surface area in contact with the body. This is in comparison to the foam-over-air system that was constructed of a flat 2.5cm high viscoelastic foam topper over air cells.

Powered Mode

Pressure mapping of the foam-over-air system across its three comfort settings, and the foam-in-air system across its two comfort settings, within their powered modes can be seen below. Comparatively, the foam-in-air system provided clearer offloading of tissue whilst also demonstrating lower peak interface pressures across both cycles and in comparative comfort control settings. Maximum interface pressures are as follows:

Foam-over-Air System
Soft (cycle 1) - 67.91mmHg
Soft (cycle 2) - 68.94mmHg
Medium (cycle 1) - 74.44mmHg
Medium (cycle 2) - 81.84mmHg
Firm (cycle 1) - 100.00mmHg (maximum the system shows)
Firm (cycle 2) - 100.00mmHg (maximum the system shows)

Foam-in-Air System
Low (cycle 1) - 71.59mmHg
Low (cycle 2) - 73.05mmHg
High (cycle 1) - 71.71mmHg
High (cycle 2) - 79.97mmHg

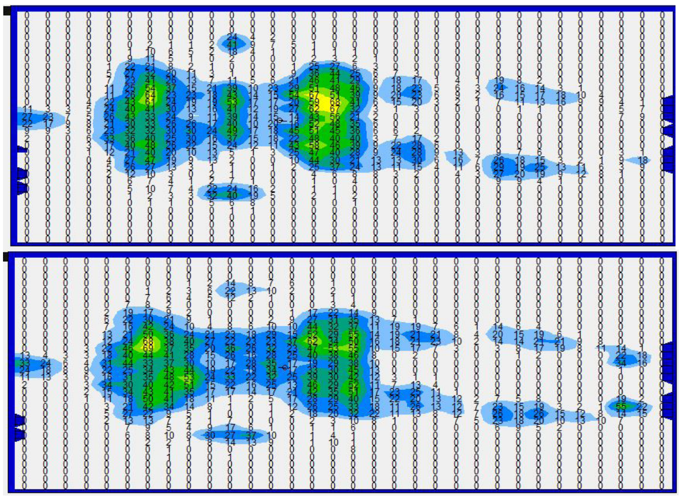

Figure 6. Pressure mapping of the foam-over-air system in soft mode across cycle 1 (top) and cycle 2 (bottom).

Pressure mapping of the foam-over-air system, in the soft mode, demonstrates that, whilst there is a change in the gradient of pressure as the cells alternating, tissue still clearly remains loaded, particularly across the shoulders, back, sacrum and legs.

Both systems were compared in the Low/Medium mode, as these modes provided comparative cell pressures (figures 7 and 8). A more consistent offloading pattern can be seen within the foam-in-air system, in comparison to the foam-over-air system where tissue remains loaded. Starkest contrast between the two systems can be seen in the High/Firm mode comparison (figures 9 and 10). Within this mode, we see no tissue offloading occurring within the foam-over-air mattress, whilst also exerted very high peak interface pressures. There have been numerous studies that demonstrate the relationship between higher peak interface pressures and higher incidence of pressure ulcers.[5] In comparison, the foam-in-air surface continues to provide a level of offloading, whilst also retaining lower peak interface pressures. This is as a result of the mechanism of action of the foam-in-air hybrid support surface, whereby the air cells can operate independently from the foam when utilised in the powered mode. In comparison, the foam topper create a constant layer of contact on the skin-surface interface, preventing tissue off-loading from occurring, even when the pressure gradient between the inflated and deflated cells are at their greatest.

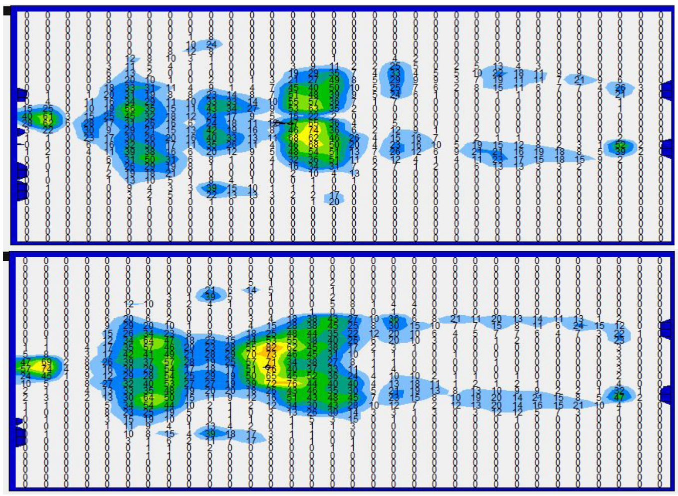

Figure 7. Pressure mapping of the foam-over-air system in medium mode across cycle 1 (top) and cycle 2 (bottom).

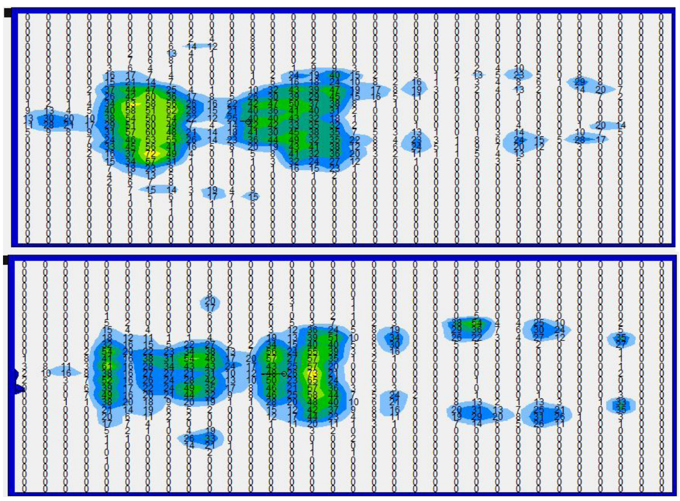

Figure 8. Pressure mapping of the foam-in-air system in low mode across cycle 1 (top) and cycle 2 (bottom).

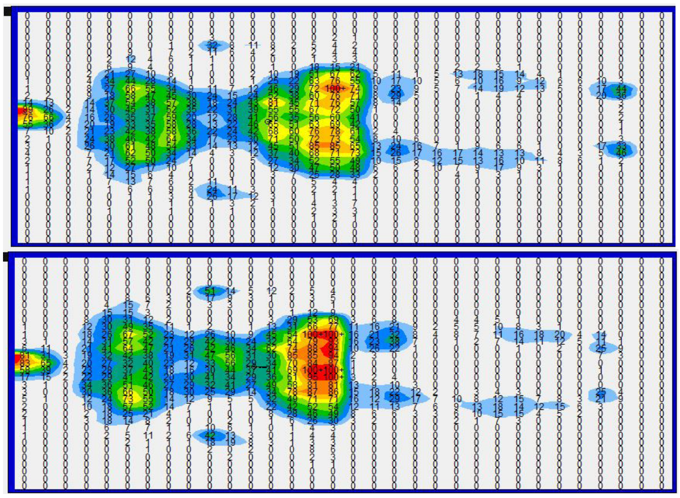

Figure 9. Pressure mapping of the foam-over-air system in firm mode across cycle 1 (top) and cycle 2 (bottom).

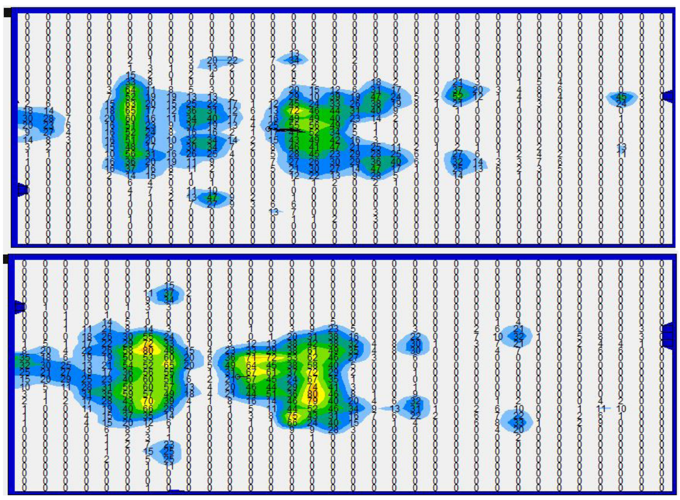

Figure 10. Pressure mapping of the foam-in-air system in high mode across cycle 1 (top) and cycle 2 (bottom).

Discussion

This study demonstrates the primary differences in therapeutic action of a foam-in-air powered hybrid system versus a foam-over-air powered hybrid system. As is demonstrated across these pressure maps, a foam-in-air system delivers pressure redistribution within the non-powered mode, and active pressure relief when in the powered mode. Whilst a foam-over-air mattress provides pressure redistribution in the non-powered mode, and active pressure redistribution in the powered mode.

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2. Jones, L. & Fletcher, J. (2014). Improved patient experience and outcomes using the Dyna-Form® Mercury Advance mattress. *Wounds UK.* 10(4):88-91.
3. Newcomb, S. & Warner, V. (2018). Audit of pressure ulcer healing rates in an acute hospital. *Wounds UK.* 14(3):26-28.
4. Fletcher, J. *et al.* (2015). Hybrid support surfaces made easy. *Wounds International.* 1-6.
5. Reenalda, J. *et al.* (2009). Clinical use of interface pressure to predict pressure ulcer development: a systematic review. *Assist Technol.* 21(2):76-85.