The Effectiveness of Two Heel Pressure Reduction Devices for Heel Pressure Ulcer Prevention

Anne Aquila MSN, RN, CS
Deborah Ferretti MS, RN, CS
Hospital of Saint Raphael, New Haven, Connecticut

Abstract
A descriptive study design using a convenience sample of thirty-four acute care patients was conducted to comparatively evaluate the effectiveness of the EHOB Foot WAFFLE® Air Cushion and the Stryker® Air-Shu Boot at relieving tissue interface pressure at the heel. Subjects were studied for a maximum period of seven days, with tissue interface pressure readings taken on day one, three, and seven. During the study, subjects wore the Foot WAFFLE® Air Cushion on the right foot and the Stryker® Air-Shu Boot on the left foot. General skin condition, product application, and subjective data were collected. Analysis of the data using one-tailed T-test demonstrated that the EHOB Foot WAFFLE® Air Cushion was more effective at relieving heel interface pressure with the subject positioned both supine (p=.00005) and supine with 30 degrees of head elevation (p=.00005). There was no significant difference between the two products at reducing pressure at the Achilles of calf. Subjective responses from subjects demonstrated a preference for the Foot WAFFLE® Air Cushion.

Purpose
The purpose of this study was to compare the effectiveness of the Stryker® Air-Shu Boot and the Foot WAFFLE® Air Cushion in reducing tissue interface pressures at the heel and in the prevention of heel pressure ulcers. The redistribution of pressure to other surfaces of the leg was also examined.

Introduction
Heel pressure ulcers constitute 30% of all pressure ulcers in hospitalized patients (Dekeyser, Dejarger, Meyst, and Evers, 1994). While many treatments are available to heel pressure ulcers, prevention remains the best method of treatment.

Currently there are several devices available for heel pressure relief. There is, however, little data comparing the effectiveness of them. An effective pressure relieving device should decrease pressure concentration over the bony prominence by dispersing that pressure over a greater support surface area and should control the shear force generated on the skin surface. Pressure in the soft tissue should be reduced to 32 mm HG or lower as this is the approximate pressure exerted by the capillaries (Landis, 1930)

When choosing a pressure relieving device, additional factors must be considered. These include patient comfort, ease of application, and the ability to easily evaluate the effectiveness of the device at relieving pressure. The heel is susceptible to pressure ulcer development because it is thinly covered with fat and thus offers little protection from pressure exerted by the weight of the foot. In addition, the relatively large width of the calcaneus bone in relation to the small skin surface of the heel compounds the problem (Gray 1977).

Objective
This study was undertaken to evaluate the products comparatively and to enable us to make a research based decision as to which product to offer our patients.
The research questions were:
- Which product is more effective at reducing tissue interface pressure at the heel with the patient in the supine flat position and when supine with 30 degrees of head elevation?
- Which product is more effective overall for heel pressure relief, patient comfort, ease of use, and lack of complications?

Methodology
A control group pilot study was conducted on a convenience sample of 20 healthy volunteers. Each volunteer was placed supine in a hospital bed with the head of the bed fully reclined. The Stryker® Air-Shu Boot was placed on the left foot and the Foot WAFFE Air Cushions was placed on the right. Three pressure readings were obtained at the heel, achilles, and calf using the Gaymar Pressure Sensor Gauge. The average of these three readings for each location was used for data analysis. This procedure was then repeated with the head of the bed elevated 30 degrees (See Table 1).

The setting for the study was a 500 bed teaching hospital in New England. This study was conducted on one surgical unit and one critical care unit. These units admit patients with a variety of medical, cardiac, and surgical problems.

The actual patient population consisted of a convenience sample. Thirty four adult patients were selected. Patients were screened for inclusion using the following criteria:
- Immobility of the lower extremities (including paralysis and weakness).
- Vascular impairment of the lower extremities in a bedbound patient.
- Sensory impairment of the lower extremities in a bedbound patient.
- Impaired ability to change body position, especially lower extremities, in a bedbound patient.
- Score of 6 or more on the Skin Integrity Risk Assessment Tool (Modified Norton Scale).
- Lack of existing heel breakdown or below the knee amputation.

Once screened for inclusion, informed consent was obtained. Subjects had the Stryker® Air-Shu Boot placed on the left foot and the Foot WAFFE® Air Cushion placed on the right. Pressure readings were taken on day one with subjects supine and supine with 30 degree of head elevation (See Table 2). On days three and seven, readings were replaced in the position the patient was in when the nurse researcher walked into the room.

Pressure Readings
Table 1: Control group average interface pressure readings.

<table>
<thead>
<tr>
<th>Supine Position HOB Flat N=20</th>
<th>Heel</th>
<th>Achilles</th>
<th>Calf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot WAFFE® Air Cushion</td>
<td>0.5 mm HG*</td>
<td>25.31 mm HG</td>
<td>15.58 mm HG</td>
</tr>
<tr>
<td>Air-Shu</td>
<td>24.57 mm HG</td>
<td>11.23 mm HG</td>
<td>12.96 mm HG</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supine Position HOB 30 Degrees N=20</th>
<th>Heel</th>
<th>Achilles</th>
<th>Calf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot WAFFE® Air Cushion</td>
<td>0.3 mm HG*</td>
<td>33.0 mm HG</td>
<td>16.7 mm HG</td>
</tr>
<tr>
<td>Air-Shu</td>
<td>28.17 mm HG</td>
<td>11.7 mm HG</td>
<td>12.4 mm HG</td>
</tr>
</tbody>
</table>

* One subject had an odd shaped heel and complete heel elevation could not be achieved with properly sized and properly inflated product.

Table 2: Actual patient group average interface pressure readings on day one.

<table>
<thead>
<tr>
<th>Supine Position HOB Flat N=18</th>
<th>Heel</th>
<th>Achilles</th>
<th>Calf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot WAFFE® Air Cushion</td>
<td>0 mm HG*</td>
<td>26.0 mm HG</td>
<td>11.4 mm HG</td>
</tr>
<tr>
<td>Air-Shu</td>
<td>26.7 mm HG</td>
<td>18.5 mm HG</td>
<td>8.6 mm HG</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supine Position HOB 30 Degrees N=17</th>
<th>Heel</th>
<th>Achilles</th>
<th>Calf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foot WAFFE® Air Cushion</td>
<td>0.37 mm HG*</td>
<td>26.6 mm HG</td>
<td>14.1 mm HG</td>
</tr>
<tr>
<td>Air-Shu</td>
<td>23.9 mm HG</td>
<td>16.4 mm HG</td>
<td>9.5 mm HG</td>
</tr>
</tbody>
</table>
Subjective Data

Patient Input

<table>
<thead>
<tr>
<th>Item</th>
<th>WAFFLE®</th>
<th>Air-Shu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was the device comfortable?</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Did the device stay in place?</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Did the device reduce pressure?</td>
<td>8</td>
<td>7</td>
</tr>
<tr>
<td>Would you recommend this device?</td>
<td>8</td>
<td>4</td>
</tr>
</tbody>
</table>

Patient Comments:
- “WAFFLE® was more comfortable.”
- “Don’t like Air-Shu.”
- “They both get hot.”
- “Didn’t like either one of them.”
- “WAFFLE® rubbed on toes.”
- “Air-Shu didn’t stay on.”
- “Air-Shu very heavy, hotter than WAFFLE®.”
- “Both kick off when move in the bed.”
- “Air-Shu more comfortable.”
- “Liked the WAFFLE® better.”
- “WAFFLE® better but both comfortable.”
- “Prefer WAFFLE®.”
- “WAFFLE® better but too hot. Would prefer if it was shorter.”
- “WAFFLE® more comfortable but hot.”
- “WAFFLE® hot but better than Air-Shu.”
- “Both hot, liked WAFFLE® better.”

Nursing Input

<table>
<thead>
<tr>
<th>Item</th>
<th>WAFFLE®</th>
<th>Air-Shu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was the device easy to use?</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Did the device stay in place?</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>Would you recommend the device?</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>

Nurse Comments:
- “Air-Shu more difficult to maintain.”
- “Patient can move better with the WAFFLE®.”
- “Like the Air-Shu better - more rugged.”
- “Air-Shu tends to rotate.”
- “Like the WAFFLE®.”
- “WAFFLE® keeps heel off the bed, open to air, easier to visualize.”
- “Air-Shu better, other one rubs if the patient is not in it just right.”
- “Unable to secure WAFFLE® to venodynes.”
- “Like the WAFFLE® better but patients complain it is hot.”

Results

The results demonstrated superior pressure relief at the heel with the Foot WAFFLE® Air Cushion (p=.00005) on day one in both positions, and day three in the elevated position. There was no evidence of superior pressure relief at the Achilles or the calf. While subjects and nurses identified concerns with both products, response to the Foot WAFFLE® Air Cushion were more favorable.

Cost Analysis

When calculating the cost of the products, one must consider the savings realized if pressure ulcers are prevented that may have otherwise occurred. The average cost to treat a pressure ulcers ranges from $5,000 to $40,000. Nursing care costs can increase as much as 50% for patients with pressure ulcers. The cost of the Foot WAFFLE® Air Cushion was comparable to the cost of the Stryker® Air-Shu Boot (shell with liner.) In settings which clean and reuse the Air-Shu shell, the product cost would be lower. However, the study showed more effective pressure relief and more positive patient responses to the Foot WAFFLE® Air Cushion which could lead to better prevention of pressure ulcers on the heel.
Conclusions

The EHOB Foot WAFFLE® Air Cushion was more effective at reducing tissue interface pressure on the heel on day one of the study with the subjects supine (p=.00005), and with 30 degree of head elevation (p=.00005). The EHOB Foot WAFFLE® Air Cushion was more effective at reducing tissue interface pressure on the heel on day three only with the subjects supine with 30 degrees of head elevation. No significant difference was found between the products on day seven in either position. There was no significant difference between the products at reducing tissue interface pressure at the Achilles or the calf. Subjective responses of the subjects and staff demonstrated a preference for the EHOB Foot WAFFLE® Air Cushion.

Collaborative Efforts Between the Clinicians and the Manufacturer:

Upon completion of the study, Dr. Spahn reviewed the data at EHOB. He noticed a few readings in the Achilles area were slightly above 32 mm Hg. He proposed a change in the heel flap to help lower the Achilles pressure. Twelve of the newly designed prototypes were given to the clinicians to evaluate using the same criteria as the control group.

Although the interface pressure readings improved at the Achilles level, it was harder to obtain adequate heel elevation with the revised product. The research in this study did not show any statistical significance between the Achilles pressures of the Air-Shu Boot and the Foot WAFFLE® Air Cushion. The clinicians that performed this research did not have any issues with Achilles breakdown in this study or in their current practice with using the Foot WAFFLE® Air Cushion. It was the clinicians recommendation that the product not be changed.