TRELLEBORG

# Support Surface Cover and Core: Working Together In Sweet Harmony

A study into how different types of polyurethane-coated covers impact the pressure redistribution and microclimate properties of medical support surfaces.

dartex Endurance

dartex MicroClimate

dartex Performance

dartex Care

# Aim

This study shows that not all fabrics are the same by demonstrating how properties of the support surface can be influenced when the fabric and core operate together.

## BACKGROUND

Pressure redistribution has often been reported in relation to medical support surfaces. As far back as 1993, mattress covers were shown to have an impact[1]. To date, however, the attention surrounding mattress performance has focused almost exclusively on the mattress contents, such as the properties of foam, the type of air system utilized, etc. with minimal attention being paid to the cover, except in regards to cleaning and care[2]. Likewise, it is well documented that managing skin temperature and moisture levels is important for maintaining skin integrity; for example, Fisher, Szymke and Apte (1978) report that a 1°C increase in skin temperature leads to a 13% increase in metabolic demand[3]. Relative humidity also affects the strength of the stratum corneum: at a relative humidity of 100% the stratum corneum is 25 times weaker than at 50% relative humidity[4]. However, there appears to be little research in bringing these factors together to establish the cumulative impact they have when considering the properties of a medical support surface as a whole.

# Clinical Relevance

### PRESSURE REDISTRIBUTION

Demonstrating how the mattress cover can have an impact on the redistribution of pressure, depending on the properties of the fabric[1].

### IMMERSION & ENVELOPMENT

Demonstrating how the mattress cover fabric can have an impact on the extent of patient immersion and envelopment.

### MICROCLIMATE CHARACTERISTICS

Demonstrating how different fabrics can influence the level of humidity in the area between skin and fabric.





# Method

Three different tests were carried out on a range of support surface covers and cores in a laboratory setting: Pressure Mapping, Immersion & Envelopment and Temperature & Humidity

| DARTEX® RANGE | | PROPERTY OF COVER |
|---|---|---|
| **PRESSURE REDISTRIBUTION** | | |
| | CAR676 | LOW STRETCH |
| | PER200 | 2 WAY STRETCH (High Stretch, Low Modulus) |
| | PER 406 | 4 WAY STRETCH (High Modulus) |
| | END409 | 4 WAY STRETCH (High Stretch, High Modulus) |

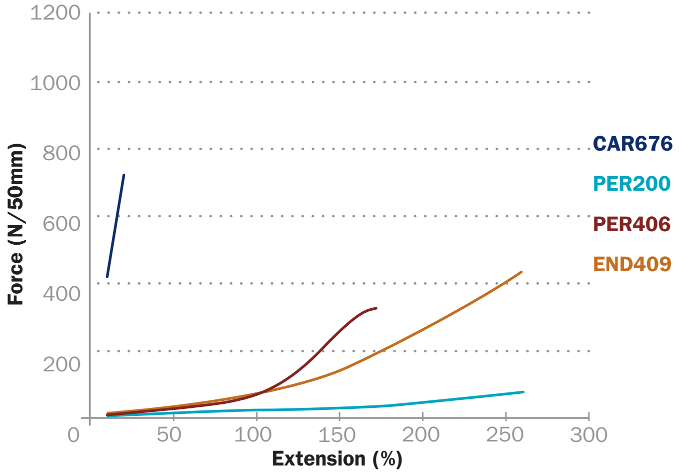
| DARTEX® RANGE | | PROPERTY OF COVER |
|---|---|---|
| **MICROCLIMATE CHARACTERISTICS** | | |
| | MIC200 | HIGH BREATHABILITY 1000g/24hr/m², ASTM D1653 (g/m²/24h) |
| | PER200 Typical Polyurethane - coated fabric | STANDARD BREATHABILITY 500g/24hr/m², ASTM D1653 (g/m²/24h) |

## FORCE/EXTENSION

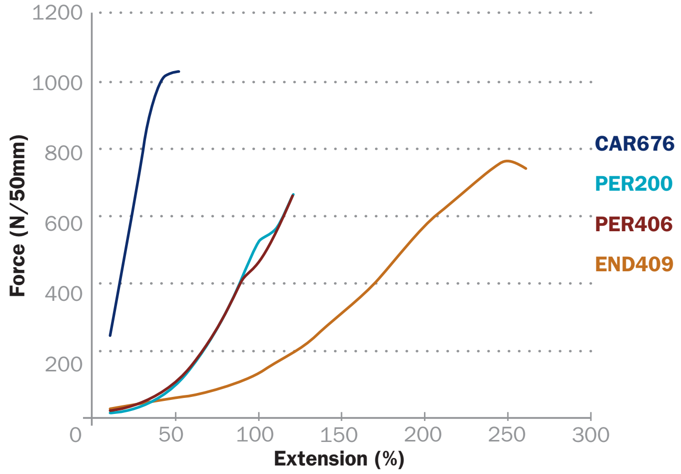
The fabrics chosen have very different stretch properties, as can be seen on the Force/Extension graphs below:

These graphs demonstrate how much each fabric stretches when force is applied. On a support surface, the fabric needs to stretch to envelop the patient, and allow them to be immersed into the mattress.

**FORCE/EXTENSION CURVES – WIDTH**




**FORCE/EXTENSION CURVES – LENGTH**




For each mattress, two covers were made from each fabric: a tight cover and a loose cover.

Three different mattresses were specified for the experiment:

**Mattress 1** High specification foam mattress

**Mattress 2** Castellated high specification foam mattress

**Mattress 3** Foam and gel hybrid mattress

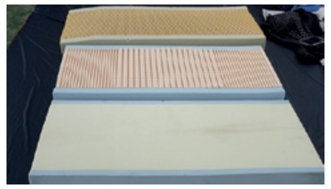
Covers for the mattresses were made using four fabrics from the Dartex Healthcare range:

**CAR676** Low stretch fabric
**PER200** 2 way stretch fabric (high stretch, low modulus)
**PER406** 4 way stretch (high modulus)
**END409** 4 way stretch (high stretch, high modulus)

## Pressure Redistribution

### PRESSURE MAPPING

A loose cover and a tight cover was made in each of the four fabric types. The covers were then applied to each of the three different mattresses and pressure mapped using an XSENSOR ForeSite SS Pressure Mapping system, with a 73kg adult male subject. The standard cover supplied with each mattress was also tested.



### IMMERSION TEST

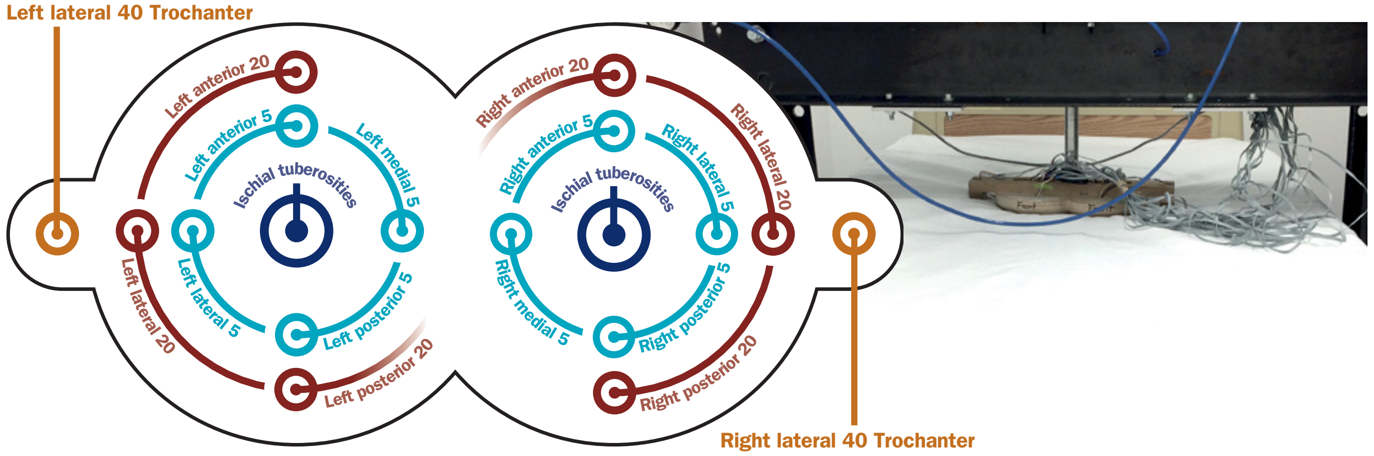
Using a system of weights and pulleys, a wooden mannequin weighing 178lbs was lowered onto the mattress. Percent immersion was calculated based on the mannequin thickness. The mannequin was raised from the support surface for a recovery of 300 seconds ± 15 seconds between each trial. Three measurements were taken each time and the average recorded.

### ENVELOPMENT TEST

The test uses a bulbous indenter, designed to replicate the shape of the buttocks. The indenter is embedded with pressure sensors, and the results are reported across four zones – **ZONE 1** shown here in dark blue, **ZONE 2** in light blue, **ZONE 3** in maroon and **ZONE 4** in orange.

A load of 22 ± 1lbs (representing the pelvic load of a 50th percentile male) was applied to the test support surface for 60 seconds and pressure readings taken. The more even the pressure distribution across the four zones, the better the envelopment.

The test environment had an ambient temperature of 23 +/-2 °C and relative humidity 50% +/- 5% which is specified in ISO 554–1976(E).




## Microclimate Characteristics

### TEMPERATURE & HUMIDITY TEST

Using temperature and humidity sensors, the microclimate of a 73kg seated volunteer was monitored to see how the use of seating fabrics with different moisture vapour permeability (MVP) levels affected the temperature and humidity experienced. Sensors were placed underneath the thighs and buttocks of the volunteer, above and below the cover fabric. The cover was designed with MIC200 on one side (blue) and PER200 on the other (black). Data was collected using a Body View system supplied by Inside Climate. The test was run for 1 hour.



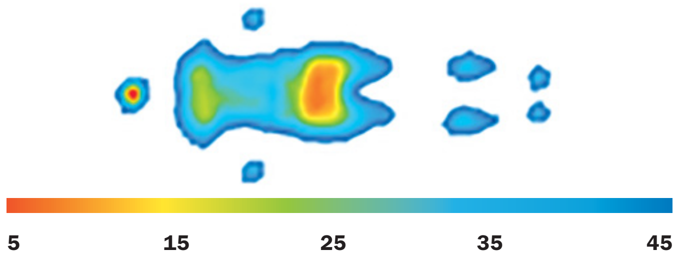


# Results

### PRESSURE MAPPING

Real differences were seen between the tested fabrics. The difference between best and worst fabrics was greater for the more "technical" mattress. The "best" combination was different for each mattress. For the low stretch fabrics, loose covers gave lower peak pressure and lower average pressure. For the high-stretch fabrics, the results were very similar. The average pressure was largely independent of fabric.

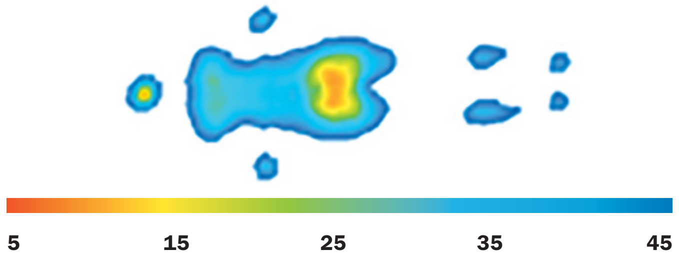
**WORST COVER - STANDARD**




**The same mattress core provided the best and worst results.**

| | |
|---|---|
| Coefficient of variation | 162.22 |
| Average (mmHg) | 21.11 |
| Peak (mmHg) | 45.42 |
| Area (cm²) | 3377.01 |

**BEST COVER – PER 200 TIGHT**



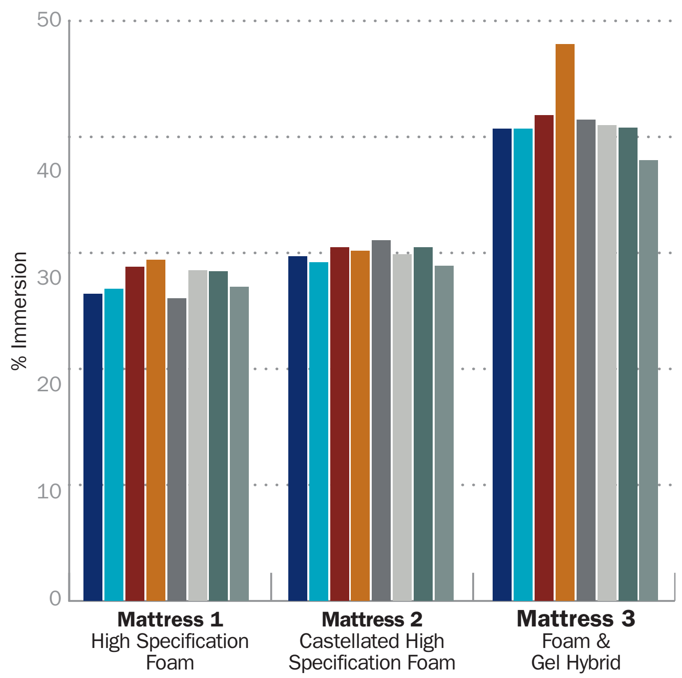

| | |
|---|---|
| Coefficient of variation | 130.47 |
| Average (mmHg) | 19.22 |
| Peak (mmHg) | 38.64 |
| Area (cm²) | 3044.35 |

### IMMERSION

The absolute level of **immersion** achieved is primarily determined by the mattress core, but for a given core, the maximum immersion can be increased by choosing the right cover fabric and the right tension i.e. tight or loose cover.

For each mattress, changing the cover fabric influences both the maximum pressures recorded and the distribution of pressure across the indenter. The stretch properties of the fabric have a large influence on the way the support surface is able to **envelop**:

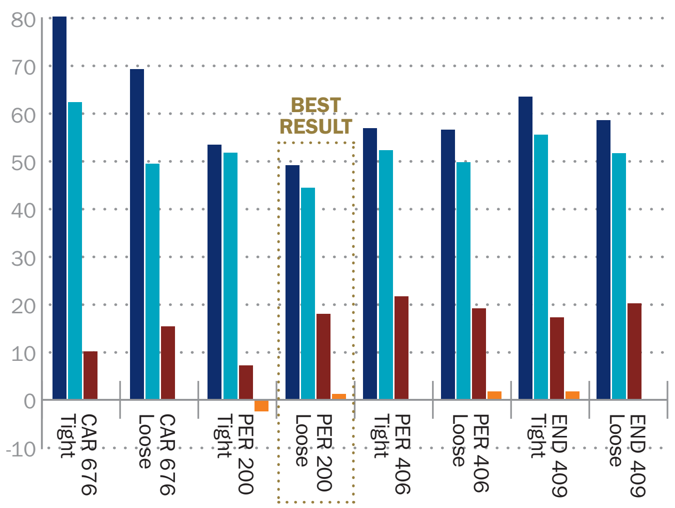
**KEY:** CAR676 Tight/CAR676 Loose/PER200 Tight/PER200 Tight/PER409 Tight/PER409 Loose/END409 TIGHT/PER409 Loose




| Sample | Mattress 1 % Immersion | Mattress 2 % Immersion | Mattress 3 % Immersion |
|---|---|---|---|
| CAR676 Tight | 26.40 | 29.70 | 40.70 |
| CAR676 Loose | 26.80 | 29.20 | 40.70 |
| PER200 Tight | 28.70 | 30.50 | 41.90 |
| PER200 Loose | 29.30 | 30.20 | 48.00 |
| PER406 Tight | 26.00 | 31.10 | 41.50 |
| PER406 Loose | 28.40 | 29.90 | 41.00 |
| END409 Tight | 28.30 | 30.50 | 40.80 |
| END409 Loose | 27.00 | 28.90 | 38.00 |

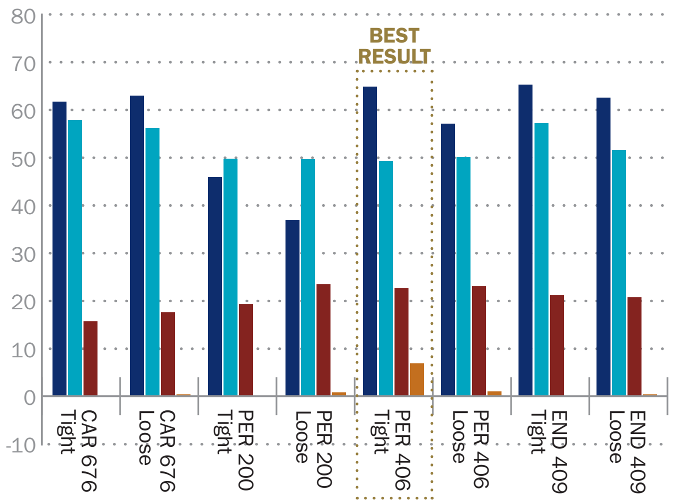
## ENVELOPMENT

### MATTRESS 1 ZONE 1/ZONE 2/ZONE 3/ZONE 4



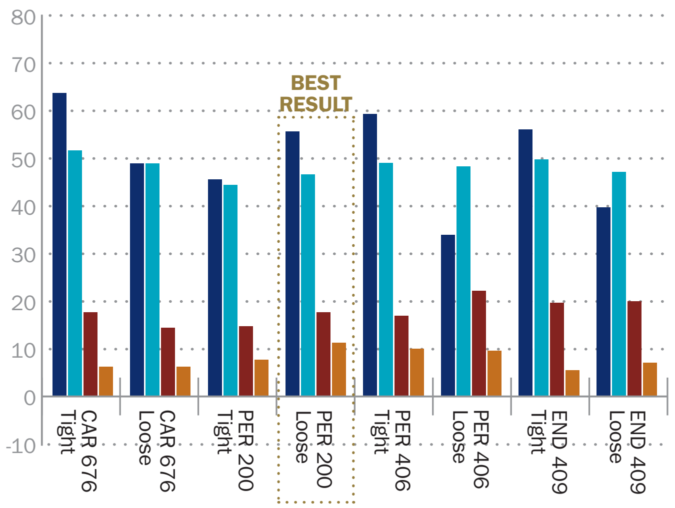

| Cover | Zone 1 (mmHg) | Zone 2 (mmHg) | Zone 3 (mmHg) | Zone 4 (mmHg) |
|---|---|---|---|---|
| CAR676 Tight | 80.39 | 62.45 | 10.08 | 0.16 |
| CAR676 Loose | 69.43 | 49.56 | 15.36 | -0.21 |
| PER200 Tight | 53.57 | 51.80 | 7.19 | -2.50 |
| PER200 Loose | 49.24 | 44.44 | 17.98 | 1.16 |
| PER406 Tight | 57.00 | 52.36 | 21.68 | 0.12 |
| PER406 Loose | 56.64 | 49.85 | 19.20 | 1.72 |
| END409 Tight | 63.58 | 55.61 | 17.23 | 1.70 |
| END409 Tight | 58.71 | 51.77 | 20.22 | 0.11 |

### MATTRESS 2 ZONE 1/ZONE 2/ZONE 3/ZONE 4




| Cover | Zone 1 (mmHg) | Zone 2 (mmHg) | Zone 3 (mmHg) | Zone 4 (mmHg) |
|---|---|---|---|---|
| CAR676 Tight | 61.62 | 57.74 | 15.61 | -0.02 |
| CAR676 Loose | 62.90 | 56.07 | 17.48 | 0.35 |
| PER200 Tight | 45.75 | 49.65 | 19.26 | 0.06 |
| PER200 Loose | 36.76 | 49.60 | 23.36 | 0.77 |
| PER406 Tight | 64.70 | 49.10 | 22.59 | 6.84 |
| PER406 Loose | 56.59 | 49.95 | 23.07 | 0.98 |
| END406 Tight | 65.19 | 57.08 | 21.14 | 0.10 |
| END406 Loose | 62.39 | 51.40 | 20.61 | 0.36 |

### MATTRESS 3 ZONE 1/ZONE 2/ZONE 3/ZONE 4




| Cover | Zone 1 (mmHg) | Zone 2 (mmHg) | Zone 3 (mmHg) | Zone 4 (mmHg) |
|---|---|---|---|---|
| CAR6 76 Tight | 63.73 | 51.62 | 17.70 | 6.19 |
| CAR676 Loose | 48.92 | 48.89 | 14.37 | 6.21 |
| PER200 Tight | 45.58 | 44.47 | 14.75 | 7.73 |
| PER200 Loose | 55.60 | 46.66 | 17.69 | 11.26 |
| PER406 Tight | 59.31 | 49.02 | 16.95 | 10.02 |
| PER406 Loose | 33.91 | 48.31 | 22.20 | 9.57 |
| END406 Tight | 56.10 | 49.79 | 19.67 | 5.48 |
| END406 Loose | 39.75 | 47.20 | 20.00 | 7.07 |

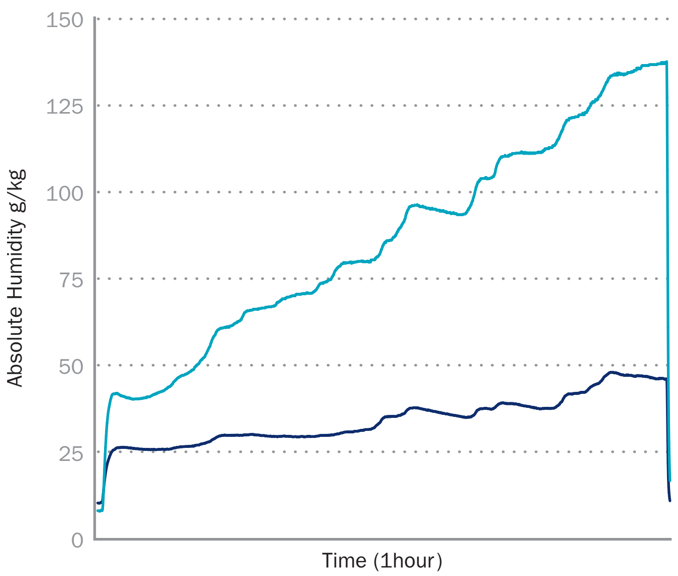


TRELLEBORG ENGINEERED COATED FABRICS

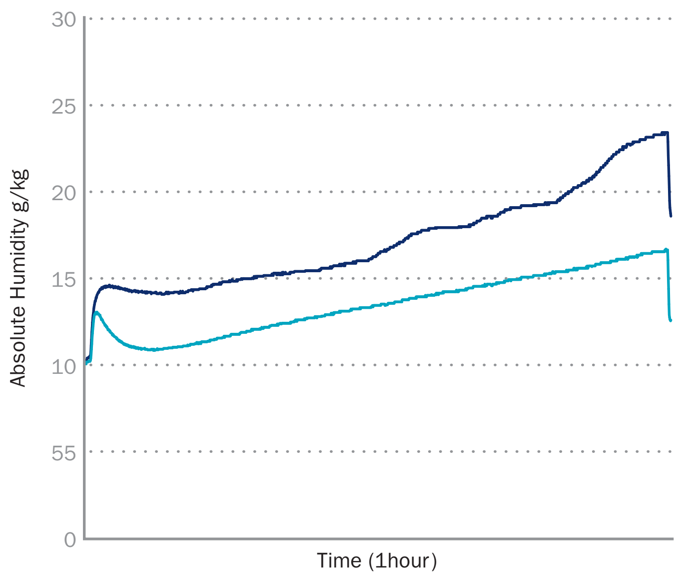
## MICROCLIMATE CHARACTERISTICS

The temperature profile was consistent, but the humidity levels in between skin and fabric (below) were significantly lower for the Microclimate fabric. When measuring absolute humidity below the fabric, a greater increase in humidity was recorded for the Microclimate fabric; demonstrating the increased movement of moisture vapour.

**ABSOLUTE HUMIDITY** MIC200/PER200
(Above - between skin and cushion)




**ABSOLUTE HUMIDITY** MIC200/PER200
(Below - Under the cover)




# Conclusion

## The results infer that in the best medical devices, the support cover and core work harmoniously for the best patient outcome.

Moreover, the performance of the support surface core will depend on its compatibility with the cover. Where these separate parts are designed together, the support surface will perform to its full potential. Therefore, it is important that a like-for-like cover replacement (material, fit and moisture handling properties) takes place if needed during its operational life to ensure the integrity of the support surface system is retained.. Choosing a fabric with high MVP can slow the humidity rise over time, keeping the patient feeling cooler and drier for longer. Further research is required to demonstrate the positive effects of the core and cover working together.

The research for this paper was undertaken by:
**Richard Haxby, Katie Pearce, Ian Scott, Clare Tittershill, Tessa Turton & Claire Williams.**
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National Pressure Ulcer Advisory Panel (NPUAP) Annual Conference in St. Louis, MO, USA (March 2019)

**References:**
**1** PS1 Foam Mattresses: A comparative evaluation special issue (1993) Medical Services Directorate.
**2** British Healthcare Trades Association. (2012). BHTA guidance on the care, cleaning and inspection of healthcare mattresses. Available: http://www.bhta.net/sites/default/files/document-upload/Protect%2C%20Rinse%2C%20Dry%20v2.pdf. Last accessed 12th Aug 2016.
**3** Fisher SV, Szymke TE, Apte SY, Kosiak M. Wheelchair cushion effect on skin temperature. Arch Phys Med Rehabil 1978; 59(2): 68-72.
**4** Brienza DM, Geyer MJ. Using support surfaces to manage tissue integrity. Adv Skin Wound Care 2005; 18: 151-57.

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