The Impact of Dressing Pad Design For Pressure Injury Prevention: A Finite Element Study

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Introduction

- Pressure ulcers pose significant healthcare challenges, causing morbidity, prolonged hospitalisation, and high costs. Multi-layer soft silicone dressing have demonstrated efficacy in managing hard-to-heal wounds and are recommended as part of current guidelines relating to the prevention of pressure injuries.
- Recent work has highlighted material composition and interlayer mechanics can influence their protective properties[1]

Study Aim

- This work brings together multiple FE modelling studies examining how material selection and design influence the ability of dressings to dissipate soft tissue strain through frictional energy dissipation. We compare an unbonded multilayer dressing (UD*) with sliding layers, a bonded dressing (BD†), and a single-layer hydrogel dressing (HD‡) to a No dressing (ND) condition.

Methodology

- Three commercially available dressings were selected for assessment, an unbonded multilayer dressing (UD*), a bonded dressing (BD†), and a single-layer hydrogel dressing (HD‡). Additionally, a no dressing (ND) condition was modelled as a base-line comparation.
- Each dressing was mechanically characterised under moisture exposure, to mimic perspiration during use. Once conditioned with moisture exposure the following parameters were assigned:
  - The compressive elastic moduli (UD*=individual layers, BD† + HD‡ bulk)
  - Coefficients of friction between the individual UD layers.
  - Poisson's ration (UD*- individual layers, BD† + HD‡ - bulk)
  - To construct the FE Model of the heel, segmentation was generated from a cadaveric lower limb. The FE model included skin, adipose tissue, Achilles tendon and the calcaneus. A support surface and dressing layers were also modelled.

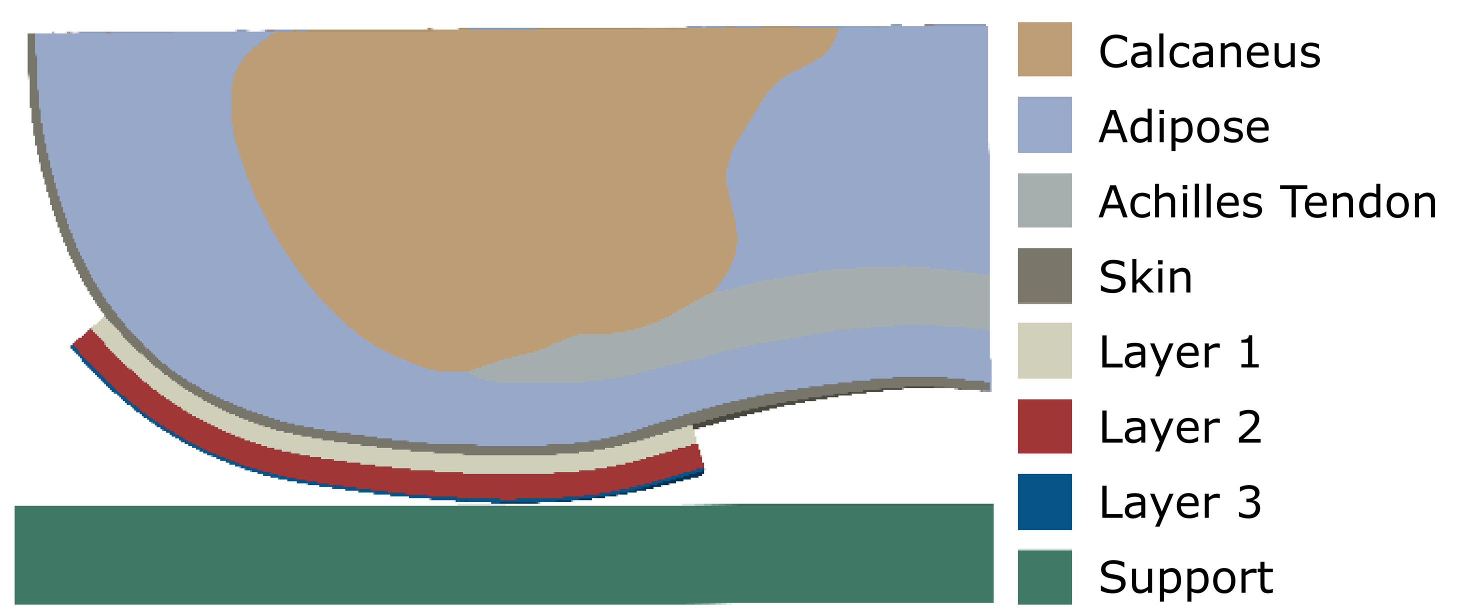

Figure 1. 3D digital heel geometry. Four tissue specific segmentations were generated using a mix of automatic and manual segmentation methods to generate the skin, adipose tissue, calcaneus and Achilles tendon. Dressing layers representative of UD*.

Methodology cont.

- FE simulation of a patient experiencing compressive and shear forces exerted on the foot when the head of the bed is raised or during patient repositioning, as indicated in **Figure 2a**.
- A region of interest (ROI) was established as the area directly under where the dressing would be placed on the heel to evaluate the strain reduction experienced in this region when comparing a dressing vs no dressing, as shown in **Figure 2b**.

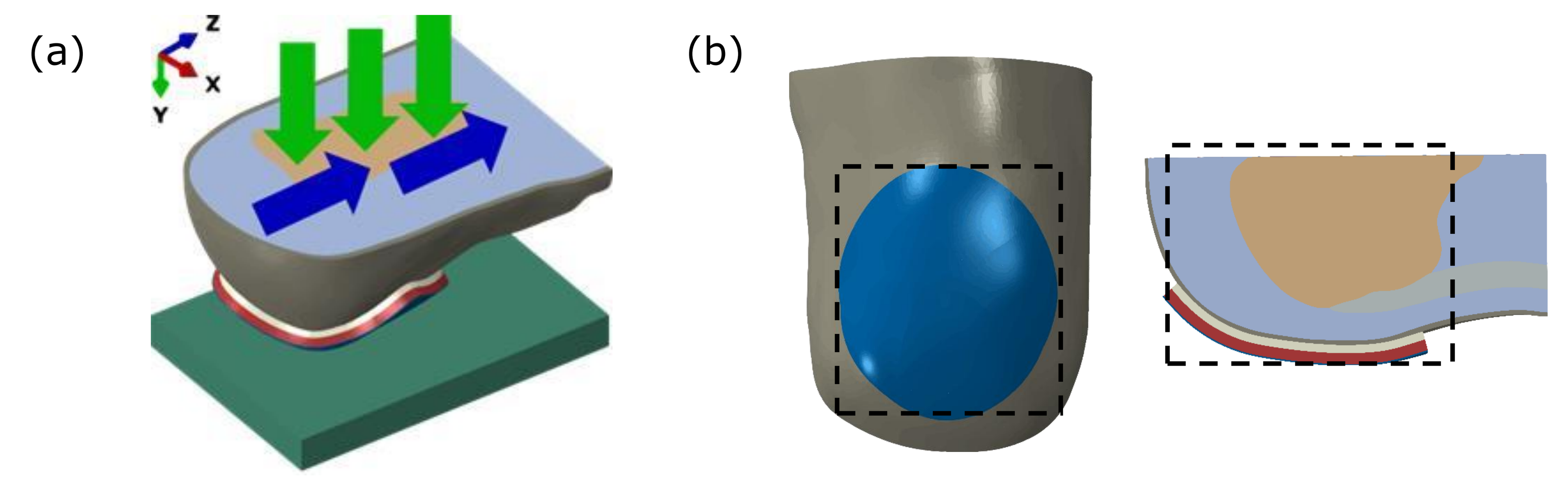

Figure 2. (a) Compression and shear forces simulated in model. Green arrows show direction of compression, blue arrows show direction of shearing motion (b) Region of interest marked out in FE Model.

Results

- FE modelling was used to assess the biomechanical performance of each dressing in relation to tissue strain reduction.

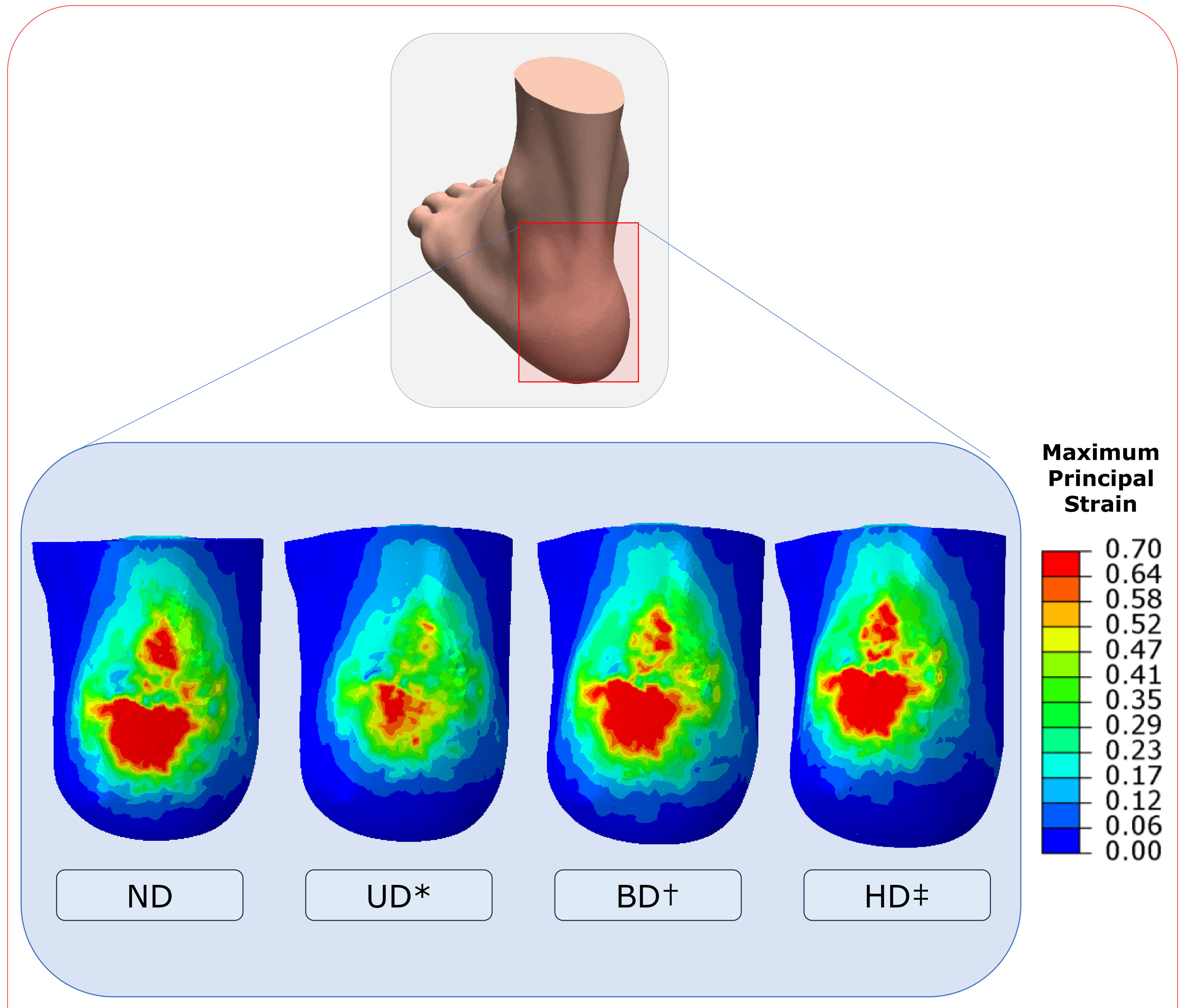

Figure 3. Contour plots demonstrating the maximum principal strain in the adipose tissue shown in the posterior heel view of no dressing condition and each dressing. Red is indicative of high strain regions.

Results cont.

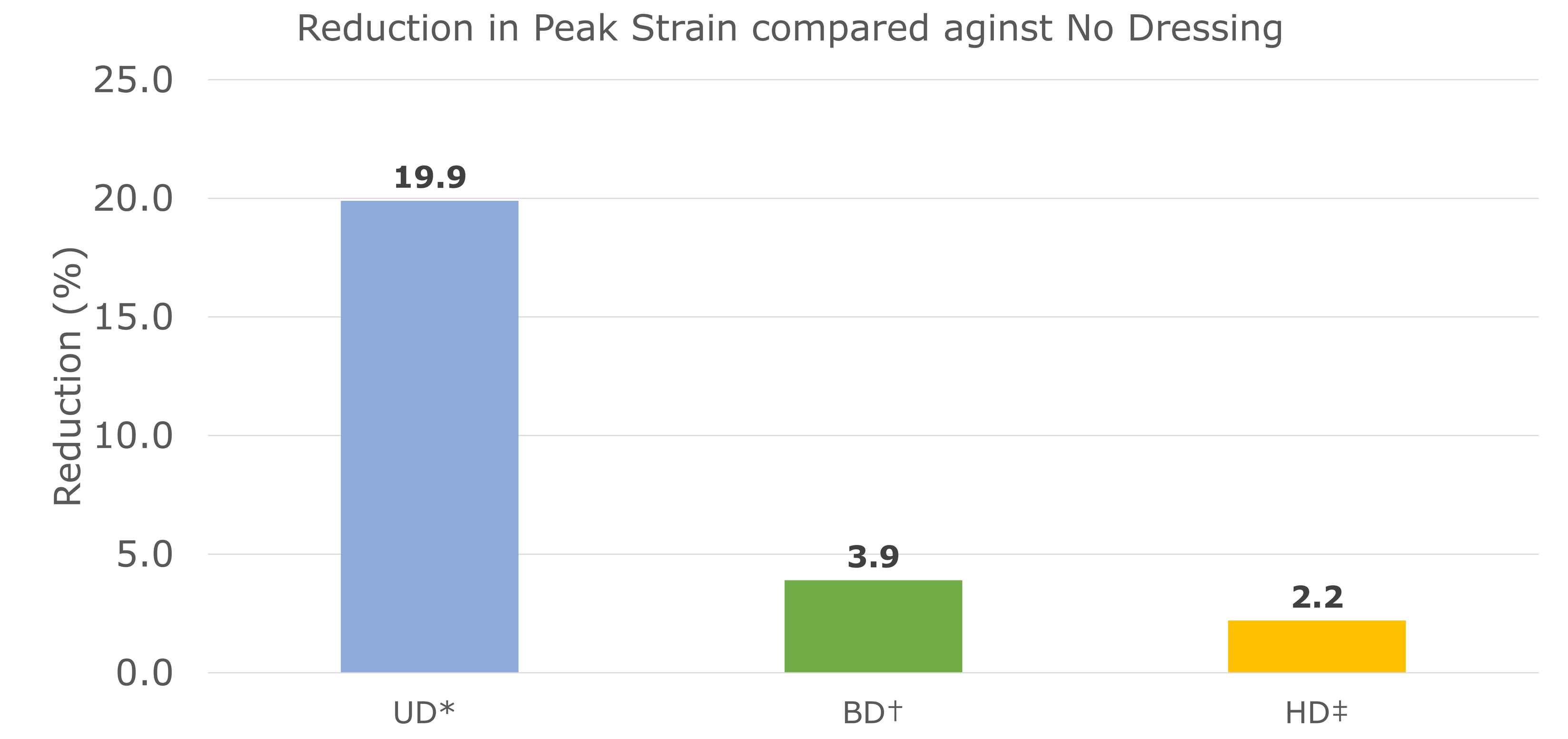

Figure 4. Maximum peak strain reduction (%) for each of dressing compared against ND in adipose.

- FE simulations indicated that UD* delivered the highest peak strain reduction of 19.9% compared to the ND‡ condition, whereas BD† and HD obtained 3.9% and 2.2% respectively (**Figure 4**).

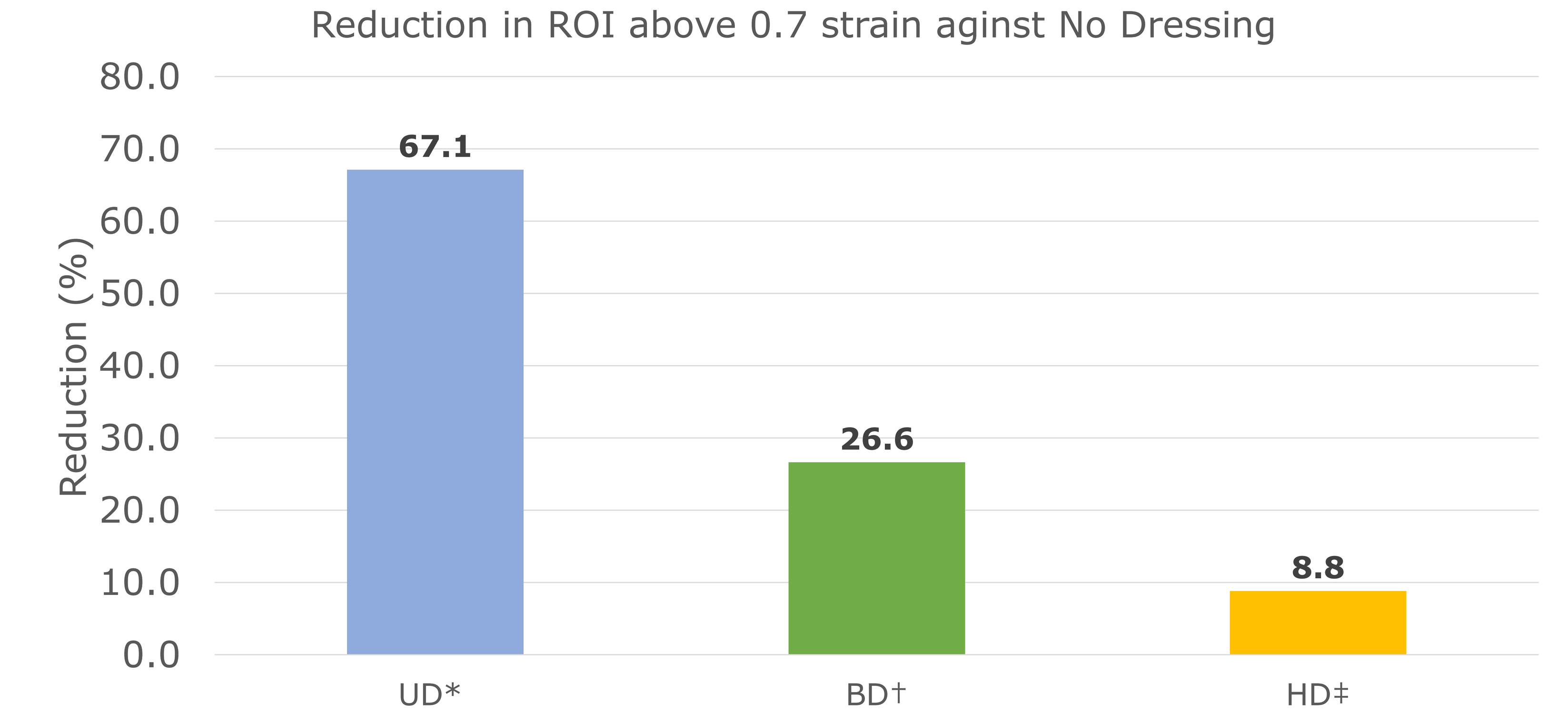

Figure 5. Maximum principal strain reduction (%) in ROI above 0.7 strain for each of dressing compared against ND in the adipose.

- Under compressive and shear loading, the FE simulations showed that UD* delivered greatest reduction in percentage, 67.1%, of ROI experiencing high strain (>0.7 strain), whereas BD† and HD‡ obtained 26.6% and 8.8% protective effect of reducing strain when compared against the ND condition. When comparing the % of elements above 0.7 strain within the ROI of UD* and BD†, a difference of 55.3% was calculated. In another study, when comparing UD* and HD ‡a difference of 63.9% was calculated.

Conclusions

- UD* showed the greatest reduction in peak strain and percentage of the ROI experiencing high strain compared to other prophylactic dressings.
- These findings suggest that selecting a prophylactic dressing with unbonded, slidable layers can provide additional tissue strain reduction and can effectively contribute to a pressure injury prevention protocol.

References: 1. Orlova D, Orlov A and Gefen A. The Protective Efficacy of a New Soft Silicone MultiLayer Dressing in Reducing the Heel Pressure Ulcer Risk. International Wound Journal 2025; 22: e70764. DOI: https://doi.org/10.1111/iwj.70764

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* ALLEVYN ◊ COMPLETE CARE Foam Dressing, Smith & Nephew.
† Mepilex™ Border Dressing, Molnlycke.
‡ OptiView™, Medline.

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