Moisture-responsive changes in friction and heat transfer of a prophylactic dressing interface

Amit Gefen,[1] Jordan Fisk,[2] Jordyn Bunker,[2] Lauren Elizabeth Bagshaw[2]

[1]Tel Aviv University, Israel; Ghent University & Hasselt University, Belgium, and [2]Convatec, United Kingdom

Background

Pressure injuries (PIs) arise from the interplay of sustained mechanical loading, ischemia and adverse skin microclimate conditions. Moisture and elevated temperatures amplify tissue vulnerability by weakening the stratum corneum and increasing both metabolic demand and frictional shear at the skin-support interface. Prophylactic dressings are intended to mitigate these risks, yet conventional silicone interfaces often exhibit high coefficients of friction (COF) and limited thermal adaptability.

Purpose

This research investigated how moisture-responsive properties of the skin-contacting layer in a prophylactic dressing, namely, the coefficient of friction (COF) and the thermal conductivity (TC), affect the ability of the dressing to attenuate shear forces and dissipate excess heat to the environment, thereby improving pressure injury prevention.

Methods

- Two complementary experimental studies were conducted:
  - (i) A tribological sled test measured static and kinetic COF of a sodium carboxymethylcellulose- (CMC-) based skin interface material versus a silicone interface, against a skin-mimicking substrate under progressive moisture conditions (Figure 1)
  - (ii) A heat-flow meter quantified the TC of the CMC-based material versus polyurethane (PU) foam specimens at normothermic (32 °C) and febrile (40°C) conditions, across increasing hydration levels. Statistical comparisons assessed the material-dependent responses (Figure 2)

Figure 1. The coefficient of friction (COF) measurements. Dressings were adhered to a sled and dragged over a skin simulant at a preset speed to simulate clinically-relevant scenarios, e.g., frictional sliding in bed.

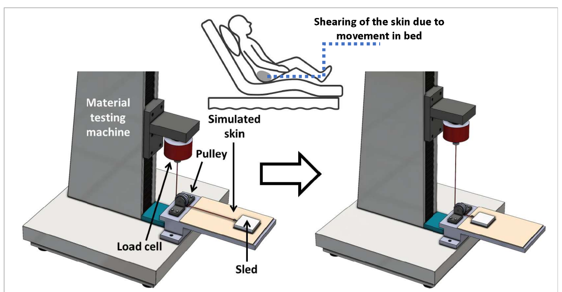
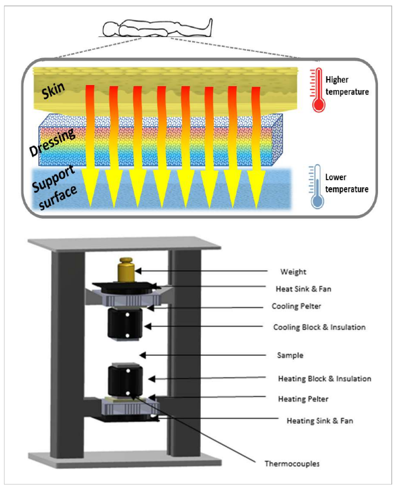


Figure 2. The thermal conductivity (TC) measurements. Illustration of the heat transfer through skin and prophylactic dressing (top), and the heat-flow meter used to measure the TC of dry and moist sodium carboxymethylcellulose (CMC) and polyurethane (PU) foam (bottom).



Results

- The CMC-based interface material demonstrated markedly lower COFs than silicone across all moisture levels
- A sharp reduction to ~0.2 occurred with only 10% hydration, and this low friction was sustained up to full saturation (Figure 3), whereas silicone consistently exhibited high COFs (>1) regardless of moisture (Figure 4)
- The thermal testing further revealed that the dry CMC-based interface exhibited twice the TC of PU foam (0.43 ± 0.01 vs. 0.20 ± 0.01 W/m·K at 32°C; $p < 0.001$) (Figure 5)
- With hydration, the TC of the CMC-based material increased nonlinearly to 4.73 ± 0.12 W/m·K at 15% moisture, a fivefold greater response compared to PU foam (Figure 5)
- The CMC-based material also maintained this superiority under febrile conditions (Figure 5)

Figure 3. Coefficients of friction (COFs) of the sodium carboxymethylcellulose (CMC) decreased as the moisture level increased. Sharp, statistically significant drop in the COF was observed between dry and 5% moisture for both the (a) static and (b) kinetic COFs, followed by a plateau level.

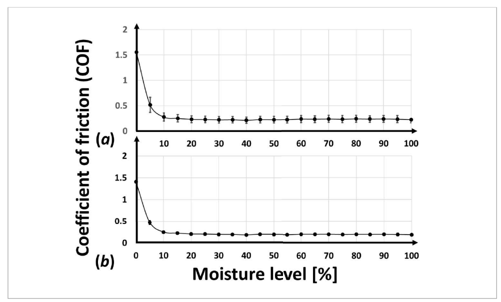


Figure 4. The coefficients of friction (COFs) for the sodium carboxymethylcellulose (CMC) based versus silicone interfaces. The COFs are shown for the dry and fully saturated material states.

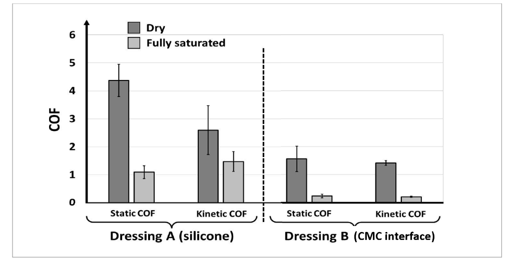
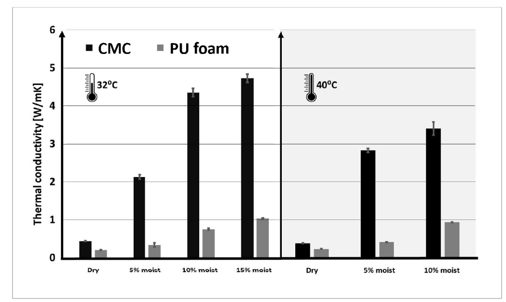


Figure 5. The thermal conductivity (TC) of sodium carboxymethylcellulose (CMC) versus polyurethane (PU) foam. The moisture retained in the CMC increases its effective TC due to the high heat transfer capacity of the trapped water, i.e., moisture exposure transforms CMC into a biphasic material that dissipates metabolic heat more efficiently.



Conclusions

- The CMC-based interface provided a dual biomechanical advantage in PI prevention by simultaneously lowering skin-dressing friction under perspiration and enhancing thermal dissipation when hydrated
- These moisture-responsive adaptations mitigate shear-induced tissue deformations and local heat buildup, thereby better preserving skin viability
- Selection of prophylactic dressings should integrate both frictional and thermal performance criteria, alongside mechanical and absorptive properties, to optimize tissue protection

Presented at the Symposium on Advanced Wound Care (SAWC) Spring | WHS 2026, April 8–12, 2026, Charlotte Convention Center, Charlotte, NC, USA