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How a Moisture-Responsive Coefficient of Friction and Thermal Conductivity of a Skin-Contacting Dressing Layer Contribute to Pressure Injury Prevention

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Objective 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. This research investigated how moisture-responsive properties of the skin-contacting layer in a prophylactic dressing, namely, the COF and thermal conductivity (TC), affect the ability to attenuate shear forces and release excessive heat to the environment for better PI 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. (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.

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, whereas silicone consistently exhibited high COFs (> 1) regardless of moisture. The thermal testing further revealed that the dry CMC-based interface exhibited double the TC of PU foam (0.43 ± 0.01 vs. 0.20 ± 0.01 W/m·K at 32 °C; $P < .001$). 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. The CMC-based material also maintained this superiority under febrile conditions.

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.

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