EVALUATION OF CASUALTY HYPOTHERMIA PROTECTION WITH THE CASEVAC ECOSYSTEM

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BACKGROUND

Effective hypothermia management during cold-weather military operations is critical to a casualty's survival, as increased mortality is associated with worsening of the trauma "triad of death" (i.e., core temperature <36.2 °C with concurrent acidosis and coagulopathy). A novel Casualty Evacuation (CASEVAC) Ecosystem (Casualty Protection Unit; CPU) was designed to mitigate casualty heat loss by integrating full casualty encapsulation (protection from convective heat loss) and a hammock-like suspension system (protection from conductive heat loss). The purpose of this work was to compare casualty core and skin temperature between the CPU and traditional CASEVAC equipment during a simulated cold-weather CASEVAC.

METHODS

Thirty-five active duty service members volunteered for this study, 13 of whom served as simulated casualties (11 males, 2 females; mean ± SD age: 26 ± 7 years, height: 174 ± 9 cm, weight: 75.7 ± 13.2 kg) and were transported 2.7 km through snow for approximately 120 min in either the CPU or traditional (i.e., plastic rescue litter; SKED) CASEVAC system in ambient temperatures from −19 °C to −28 °C. Prior to CASEVAC, participants ingested core temperature sensors and were instrumented with skin temperature sensors. Changes in core and skin temperature were calculated by subtracting temperatures at CASEVAC start from end (positive values represent heat gain; negative values represent heat loss). Temperature changes were compared between systems using independent samples *t*-tests. Statistical significance was set at $p < .05$, and data are presented as means ± SE.

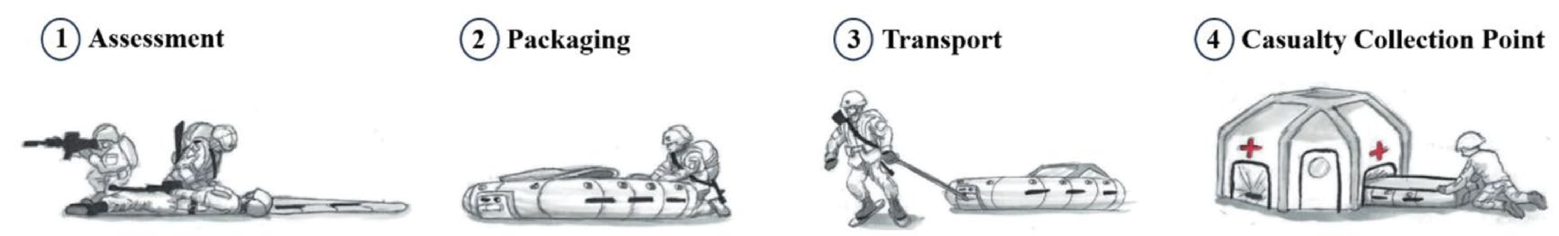

Figure 1. Progression of casualty evacuation training, which included (1) patient assessment at the point of injury, (2) patient packaging, (3) transport, and (4) arrival at the casualty collection point. Figure courtesy of SSgt Kyle Overholser.

Figure 2. (*Left*) Four litter bearers work as a team to transport a simulated casualty across snow-covered terrain using the Casualty Protection Unit (CPU). (*Right*) The Casualty Collection Point (CCP) provides a "bubble of warmth" for medics to triage, treat, and stabilize casualties during cold-weather operations. Both the CPU and CCP are inflated within seconds to provide quickly protection from winds and cold temperatures. Photos courtesy of NHRC.

RESULTS

No significant differences were observed between the CPU and SKED in the change in patient core temperature (CPU: −0.5 ± 0.1 °C; SKED: −0.5 ± 0.1 °C; $p = .93$; $d = 0.05$), skin temperature (CPU: −0.1 ± 1.1 °C; SKED: 0.3 ± 0.3 °C; $p = .76$; $d = 0.20$), transport times (CPU: 90.3 ± 11.3 min; SKED: 95.5 ± 4.8 min; $p = .68$; $d = 0.24$), or perceptual ratings ($ps > .05$) during simulated CASEVAC.

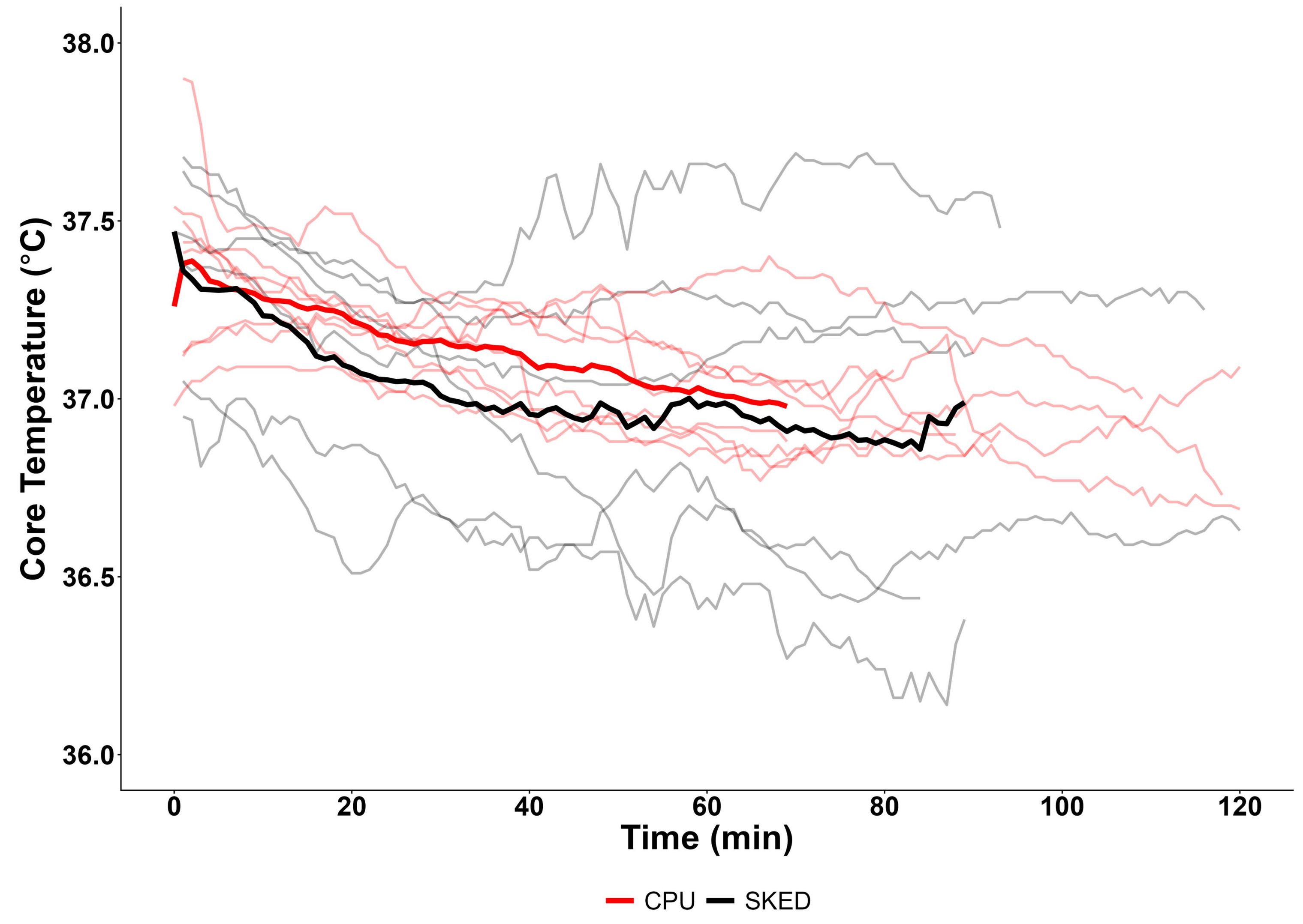

Figure 3. Individual patient core temperatures (thin lines) and group means (thick lines) for the CPU and SKED CASEVAC systems. Due to variable trial durations, group means were calculated using the maximum common trial duration of participants within each system (i.e., CPU: 69 min; SKED: 89 min).

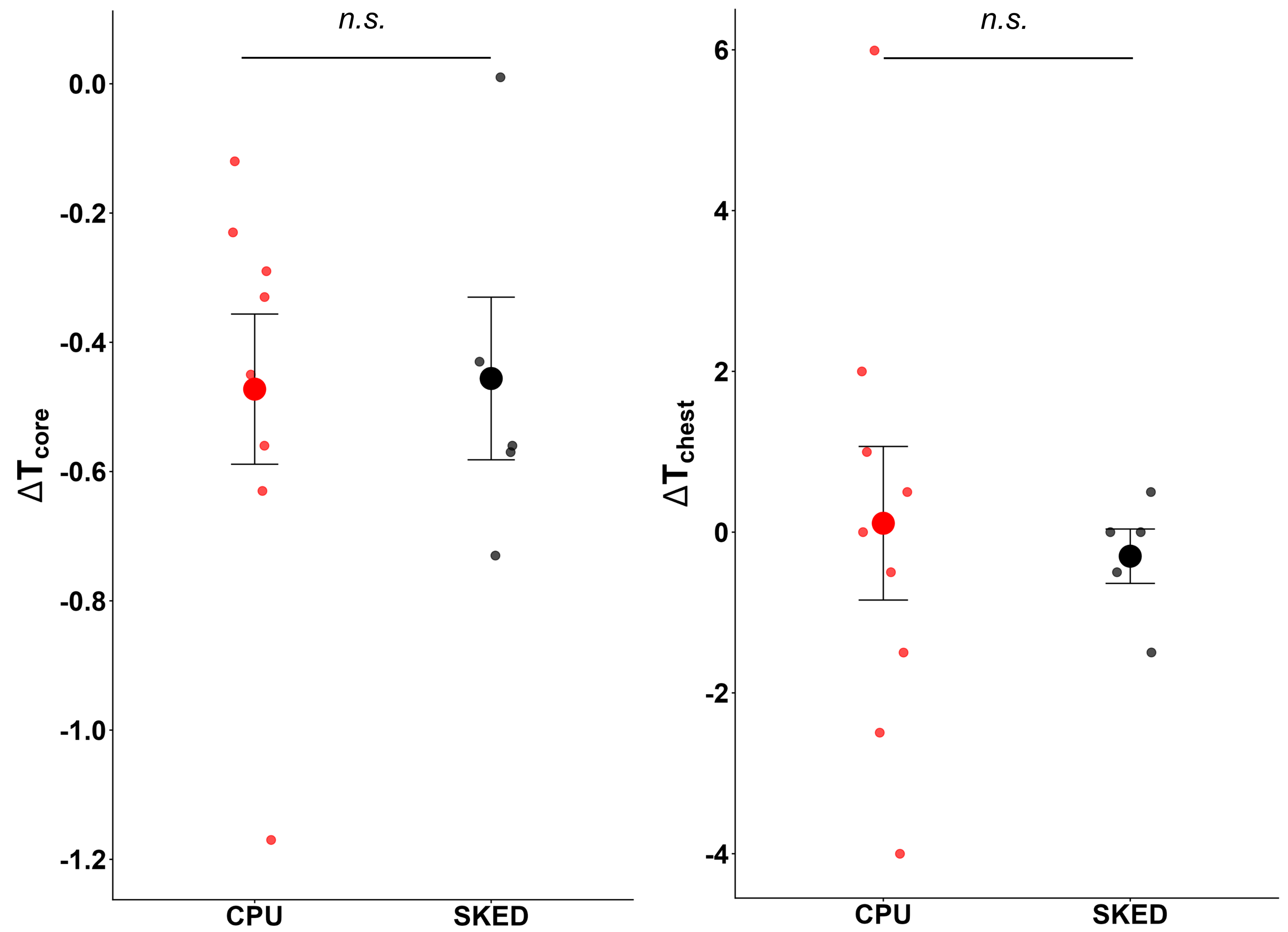

Figure 4. Mean ± SE change in (*Left*) core temperature and (*Right*) chest skin temperature for patients evacuated using each CASEVAC system. Small dots represent individual participant data, and large dots represent group means. n.s. = no significant difference.

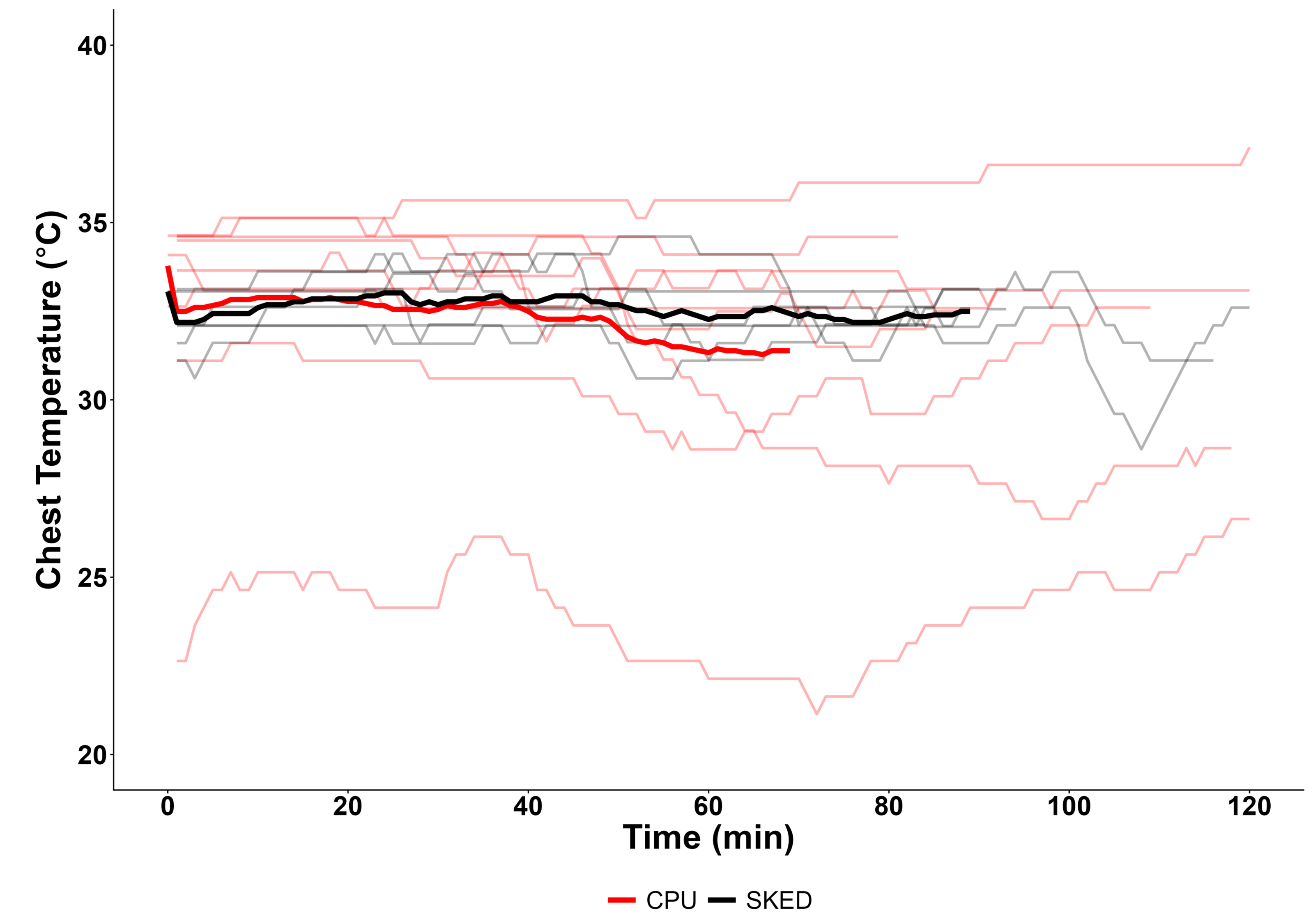

Figure 5. Individual patient chest temperatures (thin lines) and group means (thick lines) for the CPU and SKED CASEVAC systems. Due to variable trial durations, group means were calculated using the maximum common trial duration of participants within each system (i.e., CPU: 69 min; SKED: 89 min).

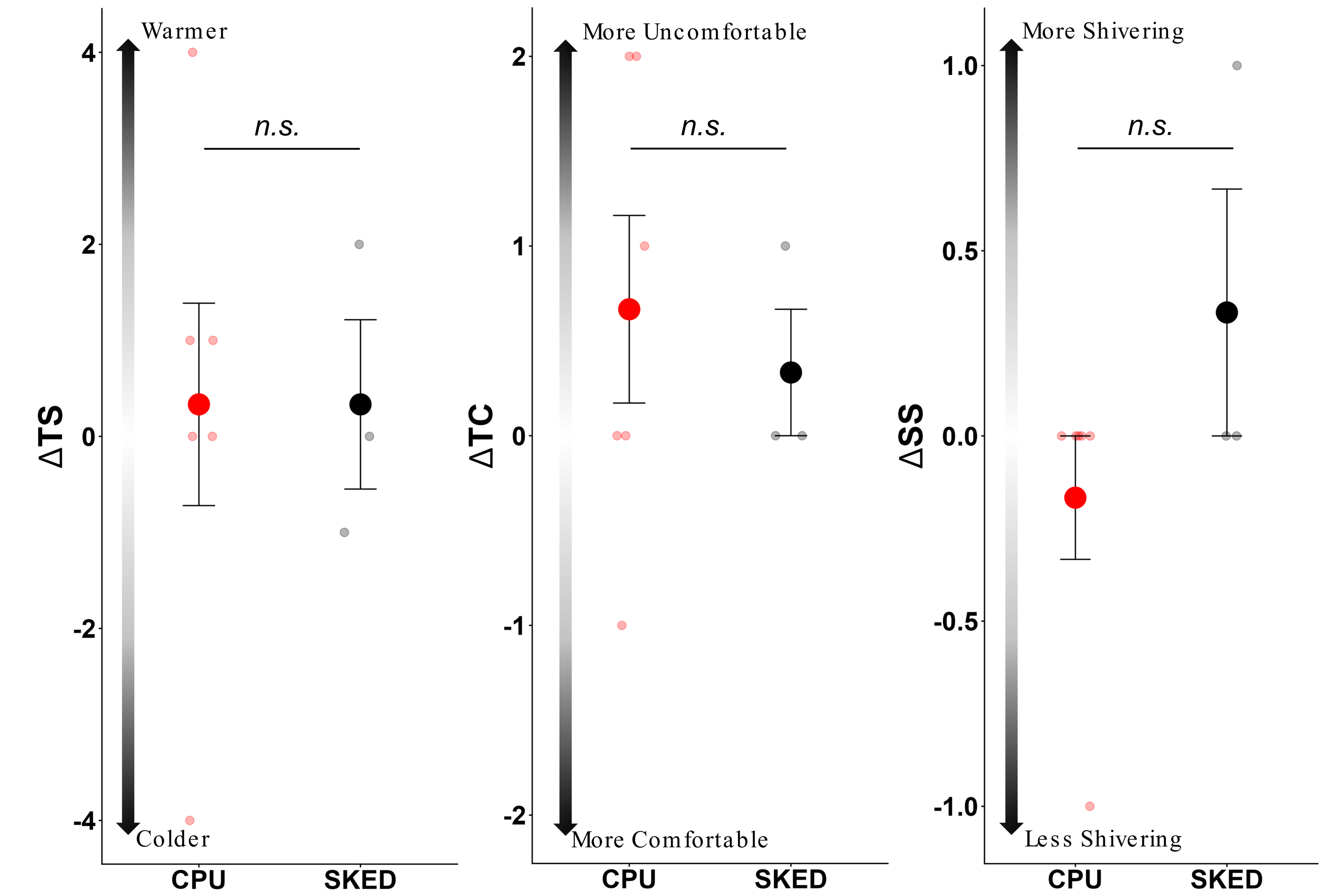

Figure 6. Change in (*Left*) thermal sensation, (*Center*) thermal comfort, and (*Right*) shivering sensation from start to end of simulated CASEVAC. n.s. = no significant difference.

CONCLUSION

The CPU demonstrated thermal protection comparable to the traditional SKED system, suggesting that secondary factors, such as operator ease of use and portability, should be considered when selecting the optimal CASEVAC system. Greater variability in core temperature was observed in the SKED compared with the CPU, suggesting that the CPU may create a more stable environment for managing casualty temperature.

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