COMPARISON OF MODEL PREDICTIONS TO CORE TEMPERATURE RESPONSES DURING PROLONGED INTERMITTENT EXERCISE.

Laurie Blanchard, Samuel N. Cheuvront, and Daniel A. Goodman

Biophysics and Biomedical Modeling Division
U. S. Army Research Institute of Environmental Medicine
Building 42 - Kansas Street
Natick, MA 01760

U. S. Army Medical Research and Materiel Command
Fort Detrick, MD 21702

The USARIEM Heat Strain Decision Aid (HSDA) is an empirically developed tool for mission planning and prevention of heat injury. HSDA uses information about the individual, their environment, clothing, and activity to estimate core temperature (Tc) and calculate recommended safe work times. Data from a recent series of experiments was used to validate the performance of HSDA for the conditions studied.
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US Army Research Institute of Environmental Medicine, Natick, MA USA
Contact person: laurie.blanchard@us.army.mil

INTRODUCTION
The USARIEM Heat Strain Decision Aid (HSDA) is an empirically developed tool for mission planning and prevention of heat injury. HSDA uses information about the individual, their environment, clothing, and activity to estimate core temperature ($T_c$) and calculate recommended safe work times. Data from a recent series of experiments was used to validate the performance of HSDA for the conditions studied.

METHODS
Sixteen volunteers (1 woman and 15 men) participated in a series of experiments consisting of six 60 min walking bouts alternating with 20 min rest periods. The subjects’ characteristics (mean ± SD) were age 22 ± 4 yr, height 177 ± 4 cm, mass 80 ± 13 kg, BSA 2.0 ± 0.2 m$^2$. Experiments were conducted in 4 different environments: $T_{db}$ = 40°C and RH = 40%, $T_{db}$ = 35°C and RH = 30%, $T_{db}$ = 27°C and RH = 40%, and $T_{db}$ = 20°C and RH = 50%. Wind speed was 1m/s for all experiments. Two moderate work rates were used: ~350W for the experiments at $T_{db}$ = 27°C, 35°C, and 40°C and ~450W for the experiments at $T_{db}$ = 20°C, 27°C, and 35°C. Volunteers wore standard army battledress uniforms for all tests. $T_c$ was measured continuously with a temperature telemetry pill.

Experimental conditions were used as inputs to HSDA and its outputs were compared to measured $T_c$ and endurance times. Since HSDA predicts for a 5 hour window, 2 episodes of each test bout were considered for comparison; minutes 0-300 and minutes 160-460. Not all volunteers completed every experiment and some volunteers ingested $T_c$ pills < 4 hours before testing, which resulted in measurement interference from ingested fluids. Thus, a total of 131 model runs were available for comparison with test data.

RESULTS AND DISCUSSION
The overall root mean square deviation (RMSD) for all 131 comparisons was 0.43°C which is less than the SD of the actual $T_c$ data (0.46°C). Predictions by HSDA were slightly better for experiments at the lower work rate (RMSD = 0.39°C, SD = 0.53°C) than the higher work rate (RMSD = 0.46°C, SD = 0.39°C) and slightly better for first 300 minutes of exercise (RMSD = 0.39°C, SD = 0.46°C) than the last 300 minutes of exercise (RMSD = 0.48°C, SD = 0.47°C).

Since HSDA predictions are the basis for much of Army doctrine for prevention of heat injury\textsuperscript{1}, it is important to regularly validate its performance. This comparison of HSDA predictions to actual outcomes during exercise in the heat indicates that it is reasonable to use in guidance for prevention of heat injury for the conditions studied here. A similar level of robustness has been observed during comparisons to other data sets\textsuperscript{2}. Model refinement may be possible to improve its performance to account for individual variability. Further research is required to examine the performance of HSDA for other environments, uniforms, and activities.
REFERENCES

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