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7th World Congress of Biomechanics

July 6-11, 2014

John B. Hynes Veterans Memorial Convention Center
900 Boylston Street | Boston, Massachusetts 02215

Presentation Abstract

Session: MS Poster Competition

Presentation: Prediction of core body temperature, sweat rate, cardiac output and stroke volume for firefighters using a 3D whole body model

Presentation Time: Monday, Jul 07, 2014, 9:00 AM - 5:00 PM

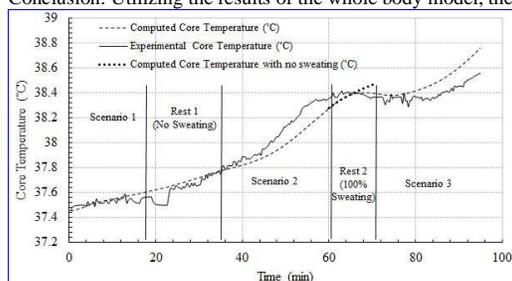
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Abstract: Introduction: This study determines the core body temperature (T_c), sweat rate, cardiac output and stroke volume for individual firefighters using a whole body computational model. The hypothesis of this research is that the heat-induced stress in firefighters can be determined by the whole body model. Inability to dissipate bodily heat during physical exertion caused by firefighting for prolonged periods causes a rise in heat stress. Elevated heat stress could lead to a number of health related adverse events, including unconsciousness and cardiac arrest. To prevent these adverse effects, early determination and mitigation of heat stress is critical for firefighters.

Methods: The method utilizes two equations simultaneously: a) the Pennes bioheat equation in the whole body, and b) an energy balance equation to determine the change in blood temperature in relation to body temperature during a sequence of firefighting activity. The inputs for the model are the heart rate time series, details of firefighting suit, geometry and physiological details of the individual firefighters. The firefighting data assessed in this study includes periodic work and rest periods. T_c obtained from the model is verified with the experimental variation of T_c over time.

Results: The results obtained are: 1) Comparison of computationally obtained T_c with experimentally obtained T_c . Using available data and realistic assumptions, the error between experimental and numerical values is computed to be less than 1%. 2) Cardiac output varied between 13.6 - 35.8 lit/min during the combination of firefighting and resting activities. 3) Stroke volume was computed to be between 0.13 - 0.32 lit/beat. The reported range of stroke volume is moderately higher when compared with literature reported values and is currently under investigation.

Conclusion: Utilizing the results of the whole body model, the heat stress and physical exertion levels can be quantified for firefighters.



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