Thermographic Imaging to Detect Reductions of Central Volume Induced by Simulated Hemorrhage

Ashley Martinez (undergraduate), Gilbert Moralez, Chelsea Barrera, Jesus Lara, and William H. Cooke

University of Texas at San Antonio, Laboratory for Applied Autonomic Neurophysiology

Hemorrhage is the leading cause of death on the battlefield, but the magnitude of blood loss can be difficult to determine. Therefore, medics would benefit from advanced tools to detect blood loss. As skin temperature likely decreases with peripheral vasoconstriction, a portable thermographic imaging (TI) device capable of measuring skin temperature may assist in the detection hemorrhage. **PURPOSE:** To determine whether skin temperature measured with TI track stroke volume reductions during simulated hemorrhage. **METHODS:** We studied fifteen healthy volunteers (7 female and 8 male; 24±1 yrs; 171±3 cm; 69±3 kg). ECG, beat-by-beat finger arterial pressure (Finometer), respiratory rate (pneumobelt and TI at the nose), stroke volume (inert rebreathing) and continuous TI skin temperatures were measured during progressive lower body negative pressure (LBNP; -3mmHg/min) to -60 mmHg. Changes of stroke volume, respiratory rate, and skin temperature were determined with repeated measures ANOVA and linear regression. **RESULTS:** Respiratory rates were consistent during LBNP, and were not significantly different between the pneumobelt (13.5 ± .2) and TI (14.3 ± .3). Stroke volumes decreased directly with negative pressure applied at a rate of -1.3 ml/mmHg (R^2=0.96) from a baseline value of 123 ± 8 ml to 41 ± 3 ml at -60 mmHg (P<0.001). Skin temperature (assessed from the ear) did not change with LBNP (P=.17). Skin temperature was 97.06 F^o at baseline, 97.14 F^o at – 60 mmHg, and did not correlate with stroke volume (R^2=0.13). **CONCLUSIONS:** Changes in temperature measured at the nose with TI are sensitive enough to detect inspiration and expiration, and therefore such measures have utility as a method to detect respiratory rate. Progressive LBNP of a magnitude sufficient to decrease stroke volume by 66% does not change skin temperature at the ear, and therefore TI imaging may not be a good candidate technology to pursue for hemorrhage detection.