

Validation of Heart Rate Derived from a Physiological Status Monitor-Embedded Compression Shirt Against Criterion ECG

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Firefighters are subject to extreme environments and high physical demands when performing duty-related tasks. Recently, physiological status monitors (PSM) have been embedded into a compression shirt to enable firefighters to measure, visualize, log, and transmit vital metrics such as heart rate (HR) to aid in cardiovascular risk identification and mitigation, thereby attempting to improve the health, fitness, and safety of this population. The purpose of this study was to validate HR recorded by the PSM-embedded compression shirt against a criterion standard laboratory ECG-derived HR when worn concurrently with structural firefighting personal protective equipment (PPE) during four simulated firefighting activities. Ten healthy, college-age men (mean $\pm$ SD: age: 21 ± 1 yr; body mass: 91 ± 10 kg; body mass index: 26.9 ± 3.1 kg/m²) completed four tasks that are routinely performed during firefighting operations: outdoor fast-paced walking (FW), treadmill walking (TW), searching/crawling (SC), and ascending/descending stairs (AD). They wore the PSM-embedded compression shirt under structural firefighting PPE. HR was recorded concurrently by the PSM-embedded compression shirt and a portable metabolic measurement system accompanied with a standard 12-lead electrocardiograph that was used to provide criterion measures of HR. For all four tasks combined there was very high correlation of PSM and ECG HR ($r > 0.99$; SEE 0.84 /min) with a mean difference (bias) of -0.02 /min and limits of agreement of -0.07 to 0.02 /min. For individual tasks, the correlations were also high (r -values = 0.99 ; SEE 0.81 – 0.89). The mean bias (limits of agreement) was: FW 0.03 (-0.09 to 0.14); TW 0.04 (-0.05 to 0.12); SC -0.01 (-0.12 to 0.10); AD -0.13 (-0.21 to -0.04) /min. These findings demonstrate that the PSM-embedded compression shirt provides a valid measure of HR during simulated firefighting activities when compared with a standard 12-lead ECG.

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