DHS Science and Technology Directorate

First Responder Physiological Monitoring

Physiological Stress on First Responders

First responders experience significant physiological stress during response operations and face exposure to a myriad of hazards. Miniaturized, wearable sensors attached to or carried by responders can provide incident command with information about an individual's health status and specific threats and hazards at the incident scene. Improved awareness of these factors helps incident command make decisions that increase the safety of responders and the population.

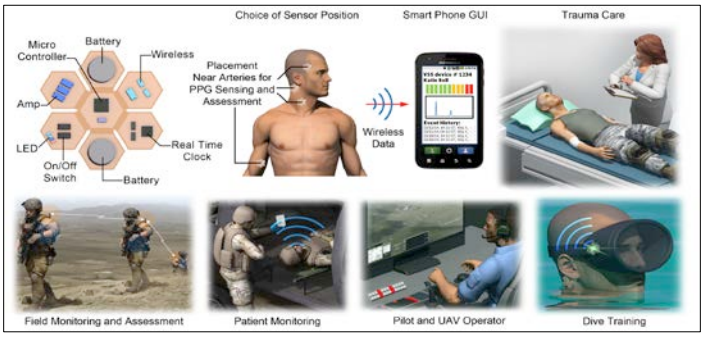
Although commercial sensors are available, they have not been optimized or even validated for the first responder community. These sensors include those capable of monitoring responder heart rate, blood pressure and oxygen levels. Other sensors monitor carbon dioxide levels, radiation, environment temperature and levels of combustible gases. Additionally, there are sensors currently available to monitor general disaster environment elements, such as temperature and smoke presence and position. These sensors often adhere to the outside of responders' personal protective equipment (PPE) and are often damaged or rendered unusable during response operations due to the conditions of the response environment.

Persistent Health and Safety Assessments

In response to this capability gap, the Department of Homeland Security (DHS) Science and Technology Directorate (S&T) is partnering with the Air Force Research Lab (AFRL) to develop real-time wireless physiological capabilities that will be customized and validated for first responder use. The capability of the overall program will also monitor environmental conditions surrounding a first responder and relay the information to the on-scene commander and incident command, giving true situational awareness of the health and performance of the first responder.

The physiological monitoring system provides real-time feedback on the first responder and provides necessary insight to on-scene commanders and incident managers enabling them to make the best decisions possible in situations where time is critical.

On-scene commanders, physical training leaders, and trainers can use this technology to examine individual and team performance data to customize daily training regimens, allowing for proper recovery and avoidance of overtraining that can lead to injury. An overall readiness index can also be calculated with data from human subjects in this project that can ultimately be personalized to the individual first responder to baseline their performance and mission readiness.



A key component to quantifying the physiological state is a persistent assessment of health and performance of the first responder, which can be enabled by continuous and non-invasive physiological monitoring. This monitoring can be broken into two subsets: biometrics, which refers to vital signs such as heart rate, electrocardiogram (ECG) waveform, respiration rate, blood pressure, and blood oximetry; and biomarkers, which are molecular targets present in biofluids such as blood, saliva, urine, and sweat. These molecules can provide a much more precise assessment of a multitude of physiological conditions.

Specific technologies being adopted to monitor biometrics include a wearable, wireless, and disposable ECG and blood oximeter for baseline performance monitoring of first responders. Technology being developed for biomarker analysis includes point-of-care devices as well as wearable and continuous monitoring. An example device is a hydration monitor – currently being led by AFRL – that measures the electrolyte content in sweat and wirelessly transmits hydration status to Android devices via Bluetooth.

Updating Existing Research

As part of this program, DHS S&T and AFRL seek to further mature the Wireless Physiological and Environmental Monitoring (WiPEM) system for physiological monitoring of the first responder. Updates to WiPEM include: An array of physiological sensors integrated directly onto first responder's self-contained breathing apparatus, an array of miniaturized environmental sensors in an off-the-shelf wearable package, and processing and communication electronics compatible with the public safety band of the Long Term Evolution cell phone network.

Future updates will include a ruggedized, ergonomic mechanical packaging and research into integration with first responder PPE. The WiPEM system is designed specifically for unobtrusive human integration so as not to add to the firefighter equipment list, and most importantly, it will retain National Fire Protection Association and IPC certification standards.

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To learn more about Physiological Monitoring, contact SandTFRG@dhs.gov.

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