FIREFIGHTER HEAT STRESS STUDY & SMART FABRICS FOR BODY HEAT DISSIPATION & PROTECTION FROM HEAT

Carbon Nanotube Textiles

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Stakeholders
Fire Chief Sycamore Township: BJ Jetter, PhD (Ret)
Fire Chief Bennett, Fairfield
Medical Director: William Lovett, MD
Firefighters are at **high risk for sudden cardiac arrest**; and one contributor is the **extreme cardiovascular strain due to the work demands and heat stress**

**WARNING!**

“Fire fighters are at risk of dying on the job from **preventable cardiovascular conditions**”

Amit Bhattacharya PhD CPE
(Fire Science Lecture at UC 2012)

Ref: NIOSH 2007-133
Figure 2. Firefighter fatalities due to cardiovascular disease by activity.

Work-relatedness!!

Over 75% of the deaths occurred while traveling to or from an incident, at an incident, or during training activities.

Ref: NIOSH 2007-133
Fatal heart attacks suffered by fire fighters while on-duty are work-related.

Circadian distribution of CHD deaths for fire fighters and the general population (Source: Kales et al. 2003)  

Ref: NIOSH 2007-133
CARDIAC AND CARDIOVASCULAR EFFECTS ARE ALSO ASSOCIATED WITH THE FIRE FIGHTERS’ WORK ENVIRONMENT

Patterns of Sedentary Periods

Interrupted by

Surges of Heavy Physical Exertion

Surges of Sympathetic-Catecholamine Hormones

Risk for Acute Heart Attacks

10/23/2013

Amit Bhattacharya PhD CPE (Fire Science Lecture at UC 2012)
URGENT

Need Real-time remote monitoring of physiological workload/fatigue and heat stress to minimize cardiac death of firefighters while fighting fire.

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Amit Bhattacharya PhD CPE
WHY DO WE NEED REAL-TIME MONITORING OF VITAL SIGNS DURING FIRE FIGHTING?

- Firefighting environments and circumstances are not easily accessed and controlled.
- Usual occupational safety and health practices are not applicable.
- Individual firefighter, whose judgment may be impaired by the high stress and strain cannot make safe decisions about his/her safety.

Therefore, providing the incident commander i.e. Fire Chief with real-time physiological strain monitoring data expands his/her ability to make judgments about the exposure and work practices under changing conditions.
Availability of Real-Time Monitoring system along with validated physiological criteria will permit the incident commander i.e. Fire Chief to make appropriate and timely decision to limit “heat strain” and thereby minimizing casualties among his/her firefighters at the fire scene.
GOOD NEWS!!

REAL TIME WIRELESS SENSOR TECHNOLOGY EXISTS FOR PHYSIOLOGICAL/VITAL SIGN MONITORING DURING LIVE BURN FIREFIGHTING.

POLAR wireless Heart Rate sensor

Ingestible Radio Pill For Core Temperature

YOST wireless Inertial Sensor

Wearable wireless sensors for Postural Balance

Micro-Strain wireless Inertial Sensor

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SPECIFIC AIM 1
Apply emerging technologies for assessing and controlling firefighters’ exposures to heat stress

Sub-Aim 1. Field test the heat stress sensor (ingestible radio pill) and BIOHARNESS during firefighter training activities.

Future Plans (Kincer): Examine the cardiovascular response of firefighters exposed to heat stress and physical exertion to better understand the health and safety risk associated with the development of atrial fibrillation.

Sub-Aim 2. (James) **Wearable Inertial Link sensor** for quantifying the effect of physically demanding tasks performed under hot environment on **postural balance characteristics of firefighters**

Sub-Aim 3 (Zacharia) To adapt the existing Heat Stress Prediction model to evaluate the impact of heat stress on firefighters’ cardiovascular system during live burn training.

Future Plans
- Wearable body cooling system for minimizing heat stress and fatigue
- Wearable EEG system for characterizing fatigue and cognitive status
BioHarness™ 3
The next generation BioHarness™ incorporates BlueTooth, medical-grade ECG, heart rate, respiration and movement in smaller form factor...

http://www.zephyr-technology.com/products/bioharness-3

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LONGTERM GOAL

Develop a remote real-time monitoring system that will enable the fire-chief to monitor the health status of firefighters from outside a burning building.

Such a system would enable the Fire Chief to monitor the firefighters’ condition inside a burning building and decide if it is safe for them to continue fighting fire and when to provide assistance.

Develop protective clothing which can provide optimal protection from heat as well as reduced heat strain for the first responders.
Ingestible Radio-Pill for measuring core body temperature
DATA COLLECTION PROTOCOL

Baseline Measurements & Radio Pill given

Pre Scenario measurements → Scenario 1
Post Scenario measurements → Scenario 2
Post Scenario measurements → Scenario 3

LIVE FIRE TRAINING

Tasks performed during each scenario
- Hose Advancement
- Search & Rescue
- Back-up

A. Mani, Musolin et. al AIHCE Conf 2012
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Physiological data (heart rate and core body temperature) from Live Fire training session for a firefighter (age 30 years)


RESEARCHERS MONITOR FIREFIGHTERS’ VITALS During Live Firefighting!


http://www.newsrecord.org/news/campus/article_44ec4850-3e91-11e2-81b8-0019bb30f31a.html

UC study hopes to help save firefighters' lives
Published 7:21 AM EST Nov 20, 2012


This is the link for the channel 5 news report: http://www.wlwt.com/news/health/UC-study-hopes-to-help-save-firefighters-lives/-/9837732/17483536