NFPA 1584: Firefighter Rehabilitation and Medical Monitoring

2012 Webinar Series
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Overview

This program is designed to accompany the textbook *Rehabilitation and Medical Monitoring: An Introduction to NFPA 1584 (2008 Standards)*.
Overview

- This program was developed through the EMS Section of the International Association of Fire Chiefs (IAFC).
- The IAFC is not responsible for the selection of the authors nor the views and opinions expressed by the authors.
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- Brandon Johnson, FF/NREMT-P
INTRODUCTION

FIREFIGHTER HEALTH
Firefighter Health

- Firefighting is an inherently dangerous occupation.
- On average, over 100 US firefighters die each year while on duty.
Firefighter Health

Occupational Deaths/Year

Source: USFA/FEMA

Actual number is 450 due to WTC FDNY losses.
When trended over time, the overall occupational fatality rate for firefighters is gradually declining.

Source: USFA/FEMA
Firefighter Health

Occupational Deaths per 100,000 Fire Incidents (1996-2006*)

Source: USFA/FEMA

*-Excludes WTC FDNY Loss of 2001
When trended over time, the occupational death rate per 100,000 fire incidents is relatively unchanged.

**Source:** USFA/FEMA

*Excludes WTC FDNY Loss of 2001*
Firefighter Health

- The overall decline in firefighter deaths appears to be most likely due to fewer fires being fought.

- Because the death rate per fire has remained constant, we must modify fire ground practices.
Firefighter Health

Career vs. Volunteer Deaths (1977-2007*)

*Excludes WTC FDNY Loss of 2001

Source: NFPA
Firefighter Health

Career vs. Volunteer Deaths (1977-2007*) with Trends

Occupational death rate for career firefighters is declining more rapidly than for volunteers.

Source: NFPA

*-Excludes WTC FDNY Loss of 2001
Firefighter Health

Type of agency with Firefighter Fatality (1990-2000)

- Volunteer 55%
- Career 28%
- Combination 9%
- Federal 4%
- Private Contractor 3%
- Prison Brigade 1%

Source: USFA/FEMA
Firefighter Health

Preliminary 2010 findings:

85 on-duty firefighter deaths

Classification:

55 (64.7%) Volunteer
26 (32.9%) Career

Causes:

51 (60.0%) heart attacks and strokes
20 (23.5%) trauma
4 (4.7%) asphyxiation
10 (8.5%) other causes

Source: USFA/FEMA
Firefighter Health

Causes of duty-related death in the fire service:

1. Heart attack
2. Trauma
3. Asphyxiation
## Firefighter Deaths

<table>
<thead>
<tr>
<th>CAUSE/CONTRIBUTING CAUSE</th>
<th>CAREER</th>
<th>VOLUNTEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Attack</td>
<td>39%</td>
<td>50%</td>
</tr>
<tr>
<td>Motor Vehicle-Related Trauma</td>
<td>12%</td>
<td>26%</td>
</tr>
<tr>
<td>Asphyxiation</td>
<td>20%</td>
<td>7%</td>
</tr>
<tr>
<td>All Other</td>
<td>29%</td>
<td>16%</td>
</tr>
</tbody>
</table>

Firefighter Deaths

<table>
<thead>
<tr>
<th>HEART ATTACK†</th>
<th>CAREER</th>
<th>VOLUNTEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress/Overexertion</td>
<td>97%</td>
<td>98%</td>
</tr>
<tr>
<td>Other</td>
<td>3%</td>
<td>2%</td>
</tr>
</tbody>
</table>

†-Myocardial Infarction, Dysrhythmias

## Firefighter Deaths

<table>
<thead>
<tr>
<th>MOTOR VEHICLE-RELATED TRAUMA</th>
<th>CAREER</th>
<th>VOLUNTEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Collision/ Crash</td>
<td>68%</td>
<td>73%</td>
</tr>
<tr>
<td>Struck by Vehicle</td>
<td>27%</td>
<td>20%</td>
</tr>
<tr>
<td>Other Vehicle-Related (e.g., fell off/crushed)</td>
<td>5%</td>
<td>7%</td>
</tr>
</tbody>
</table>

## Firefighter Deaths

<table>
<thead>
<tr>
<th>ASPHYXIATION</th>
<th>CAREER</th>
<th>VOLUNTEER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caught/Trapped</td>
<td>76%</td>
<td>69%</td>
</tr>
<tr>
<td>Other (e.g., Lost inside/smoke exposure)</td>
<td>24%</td>
<td>31%</td>
</tr>
</tbody>
</table>

## Firefighter Deaths

### All Other Causes

<table>
<thead>
<tr>
<th>Cause</th>
<th>Career</th>
<th>Volunteer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caught/Trapped</td>
<td>30%</td>
<td>19%</td>
</tr>
<tr>
<td>Fall</td>
<td>7%</td>
<td>15%</td>
</tr>
<tr>
<td>Exposure (e.g., to smoke)</td>
<td>8%</td>
<td>14%</td>
</tr>
<tr>
<td>Stress/Overexertion</td>
<td>15%</td>
<td>14%</td>
</tr>
<tr>
<td>Structure Collapse</td>
<td>7%</td>
<td>3%</td>
</tr>
<tr>
<td>Other</td>
<td>32%</td>
<td>34%</td>
</tr>
</tbody>
</table>

†-Burns, cerebrovascular accidents, drownings, electrocutions, heat exhaustion, and trauma

# Firefighter Deaths

<table>
<thead>
<tr>
<th>DUTY</th>
<th>Deaths (N=449)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire Suppression</td>
<td>32.1%</td>
</tr>
<tr>
<td>Alarm Response</td>
<td>13.4%</td>
</tr>
<tr>
<td>Alarm Return</td>
<td>17.4%</td>
</tr>
<tr>
<td>Physical Training</td>
<td>12.5%</td>
</tr>
<tr>
<td>EMS and Non-Fire Emergencies</td>
<td>9.4%</td>
</tr>
<tr>
<td>Fire Station and Other Non-Emergency Duties</td>
<td>15.4%</td>
</tr>
</tbody>
</table>

Heart Disease

“Fire suppression was associated with the highest risk, which was approximately 10-100 times as high as that for nonemergency duties.”
OCCUPATIONAL HAZARDS

FIREFIGHTER HEALTH
Is there a link between occupational hazards and long-term firefighter deaths?
Firefighter Health

- Review article of 17 articles over 35 year period (1966-2001) on firefighter deaths.
- Retrospective literature review.
- “There was no convincing evidence that employment as a firefighter is associated with increased all-cause, CAD, cancer or respiratory disease mortality.”

Firefighter Health

- Overall a low-power study in a low-tier journal.
- Some interesting findings:
  - Incidence of brain cancer was higher in firefighters.
  - One study showed increased service increases risk.

Firefighter Health

What are the risks of toxic gas exposure in the fire service?
Firefighter Health

Toxic gases of combustion:

- Carbon monoxide
- Carbon dioxide
- Hydrogen cyanide
- Hydrogen chloride
- Nitrogen dioxide
- Toxic hydrocarbon products
Firefighter Health

- Low ambient oxygen
- Superheated air
- Smoke
- Heat
- Air under pressure
Firefighter Health

How do we establish a cause and effect relationship between occupational exposures and firefighter deaths?
Firefighter Health

OBSERVATION:

- There is an increase in mortality and morbidity following carbon monoxide exposure and exposure to other toxic gases.
- Firefighters are at increased risk of occupational exposure to carbon monoxide and other toxic gases.
- Carbon monoxide deaths are primarily due to ill-effects on the heart and central nervous system.
Firefighter Health

- 230 consecutive patients treated for moderate to severe CO poisoning in the HBO chamber at Hennepin County Medical Center.
- Mean age: 47.2 years (72% males).
- 56% active tobacco smokers.
- Other cardiac risk factors uncommon.

Firefighter Health

- Ischemic ECG changes present in 30% of patients.
- Cardiac biomarkers (CK-MB, troponin-I) were elevated in 35%.
- In-hospital mortality: 5%
- Conclusions: “Cardiovascular sequelae of CO poisoning are frequent.”

Firefighter Health

- 230 consecutive patients treated for moderate to severe CO poisoning in the HBO chamber at Hennepin County Medical Center (1/1/94-1/1/02).
- Patients followed through 11/11/05.

Firefighter Health

At median follow-up of 7.6 years:

- 54 (24%) deaths [12 (5%) in-hospital].
- 85 patients sustained myocardial injury from CO poisoning:
  - 32 (38%) eventually died.
- 22 patients did not sustain myocardial injury:
  - 22 (15%) eventually died.

Firefighter Health

“Myocardial injury occurs frequently in patients hospitalized for moderate to severe CO poisoning and is a significant predictor of mortality.”

Firefighter Health

- COHb% was measured from 6/77 to 1/81 in 8,413 men (ages 34-49 years).
- Men with history of MI, cancer and/or stroke were excluded.

Firefighter Health

Cohort analysis:

Never smokers: 2,893

Divided into 4 quartiles based upon COHb%:

- COHb% = 0.43 (0.13-0.49)  [N= 743 men]
- COHb% = 0.54 (0.50-0.57)  [N= 781 men]
- COHb% = 0.62 (0.58-0.66)  [N= 653 men]
- COHb% = 0.91 (0.67-5.47)  [N= 716 men]

## Firefighter Health

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cardiac Event</th>
<th>CVD Deaths</th>
<th>All Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RR</td>
<td>95% CI</td>
<td>RR</td>
</tr>
<tr>
<td>First Quartile</td>
<td>Reference</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Second Quartile</td>
<td>1.20</td>
<td>0.59-2.46</td>
<td>0.80</td>
</tr>
<tr>
<td>Third Quartile</td>
<td>1.73</td>
<td>0.87-3.46</td>
<td>1.11</td>
</tr>
<tr>
<td>Fourth Quartile</td>
<td>3.37</td>
<td>1.84-6.18</td>
<td>3.50</td>
</tr>
</tbody>
</table>

RR = Relative Risk is the risk of an event (or of developing a disease) relative to exposure. Relative risk is a ratio of the probability of the event occurring in the exposed group versus the control (non-exposed) group.

Firefighter Health

“Incidence of CV disease and death in non-smokers was related to COHb%. It is suggested that measurements of COHb% could be a part of risk assessment in the non-smoking patients considered at risk of cardiac disease.”

Firefighter Health

11-year chart review of 1,533 patients admitted to a burn unit.

18 patients with COHb levels ≥10%.

“These data suggest that myocardial damage can result from acute carbon monoxide poisoning, and appropriate screening is indicated for the detection of such injuries.”

Firefighter Health

- Study to measure carboxyhemoglobin (COHb) levels of 18 firefighters during a training exercise.
- SCBA usage actually lowered COHb levels for some firefighters.
- SCBA highly effective against CO.
Firefighters Health

Firefighter Health

Firefighters Health

While firefighters are fairly well protected with SCBAs, CO and toxic gas exposure may be significant during the overhaul phase when SCBAs are often not worn.
Firefighters Health

- Study of 64 firefighters in training exercise.
- Baseline COHb readings: 0-3% (via exhaled CO monitor with error of ± 5%).
- Maximum value in a firefighter wearing SCBA: 3%
- Values in instructors not wearing SCBAs: 14%, 5%, and 4%.

Firefighter Health

- Although the scientific link between toxic gas exposure and early cardiovascular death is evolving, the link seems intuitive.
- Firefighters should minimize exposure to toxic gases as much as possible.
INTRODUCTION

MEDICAL MONITORING
Medical Monitoring:
Ongoing evaluation of members who are at risk of suffering adverse effects from stress or from exposure to heat, cold, or hazardous environments.
**Medical Monitoring**

- **Recovery**: The process of returning a member’s physiological and psychological states to normal or neutral where the person is able to perform additional emergency tasks without any adverse effects.
Medical Monitoring

Emergency Medical Care: Treatment or stabilization of an emergency condition (possibly including ambulance transport).
TEMPERATURE REGULATION
MEDICAL MONITORING
Humans must maintain their body temperature within a relatively narrow range.

Normal temp is 98.6°F (37.0°C) although there is some variation between individuals.
Medical Monitoring

- The core temperature is the temperature deep within the body (usually in a great vessel such as the pulmonary artery or vena cava).

- The core temperature is a more accurate measure of body temperature.
Medical Monitoring

For healthy individuals, when blood flow is good, an oral temperature is usually an accurate reflection of the core temperature.
Medical Monitoring

- For abnormal states (hypothermia, hyperthermia) blood flow through the body may be impaired rendering oral temperature readings unreliable and erroneous.

- In these situations, a rectal reading is preferred.
Environmental extremes, especially heat waves, are common. Heat wave deaths outnumber all other types of weather-related emergencies.
Heat stress is a major occupational hazard for firefighters.

Heat stress is the development of ill-effects or injury secondary to exposure to hot temperatures.
Medical Monitoring

- The more uncommon the environmental emergency for a community, the more likely it will be problematic.
- 1995 5-day Chicago heat wave killed over 600 people.
Medical Monitoring

The core temperature is a function of:

Core Temp = Thermogenesis - Thermolysis

Thermogenesis = Heat Generation
Thermolysis = Heat Loss
Medical Monitoring

Heat-generating mechanisms:

- Metabolic (biochemical) activity
- Muscles at work
- Shivering
Medical Monitoring

- Firefighting can be physically intense.
- The core temperature will quickly rise triggering temperature control centers in the brain:
  - Increased respirations
  - Shunting of blood to the skin
  - Sweating
Medical Monitoring

**Sweating:**

- When sweat glands are activated, the first secrete a fluid called the primary secretion.
  - Similar to plasma
  - High sodium and chloride
  - Low potassium

- The water evaporates and cools the body.
- During low-sweat states the sweat glands slowly reabsorb the electrolytes.
Medical Monitoring

During high-sweat states, such as active firefighting, the sweat glands do not have time to reabsorb lost electrolytes.

The electrolytes are lost from the body.
Medical Monitoring

In hot environments, the difference between an individual’s core temperature and the environmental temperature is relatively small (low thermal gradient).

The smaller the thermal gradient, the more difficult it is to cool.
Medical Monitoring

- A firefighter with a core temp of 101°F (38.3°C) will cool more effectively when the environmental temperature is 50°F (10°C) compared to an environmental temperature of 95°F (35°C).

- Heat must flow from the firefighter to the environment.
Medical Monitoring

Cooling can be accomplished two ways:

- **Passive cooling:** Facilitating the body’s cooling mechanisms, such as removing clothing, moving the subject to a cooler environment, and removing the subject from direct sunlight.

- **Active cooling:** Using external methods or devices (e.g., hand and forearm immersion, misting fan, cold towels) to reduce the elevated body temperature.
Medical Monitoring

- Active cooling is generally preferred because it more quickly lowers the core temp while minimizing the possibility of heat stress.
Medical Monitoring

- Forearm immersion:
  - Effective cooling mechanism.
  - Increased blood flow to the forearms and hands facilitate heat transfer to the cold water.
  - More effective than misting fans in humid environments.
Medical Monitoring

- Wet towels:
  - As effective as forearm immersion.
  - Sometimes more practical and less expensive.
Medical Monitoring

**Misting fans:**

- Effective in dry environments (the drier, the more effective is cooling).
- In humid environments (where evaporation is slowed), water can remain on skin possibly leading to steam burns when the member returns to firefighting.
Often, a combination of techniques is used on the fire ground to prevent heat stress.

Espinoza M, Contreras M. “Safety and performance implications of hydration, core body temperature, and post-incident rehabilitation.” Orange County Fire Authority (CA). December, 2007
Medical Monitoring

When entering rehab on warm days:

- Remove protective clothing
- Drink plenty of fluids
- Cooling should be started as soon as possible:
  - Passive cooling initially
  - For severe conditions, switch to active cooling immediately.
Medical Monitoring

During active cooling:

- Be careful not to overcool a member as shivering may start which will cause body temperature to again rise.
- When body temperature reaches 1-2°F above normal, switch to passive cooling to prevent overcooling the member.
Medical Monitoring

✱ Personnel should not be released from rehab until core temperature is normal.
Best Practices in Rehab

ACTIVE COOLING

Wet or cold towels provide active cooling through conduction and evaporation. Conductive cooling occurs when the skin comes in contact with a cooler object. Conductive cooling is effective in all environments. Ice water and cold towels are inexpensive and can cool multiple members at the same time. Wet, cold towels are generally more comfortable for members.
Medical Monitoring

* A fire department must respond even when members are too hot.

* Activities can be modified to avoid heat stress.

* The key is using the rehab process and active cooling.

* Members should be reminded about heat stress when the Heat Index or Humidex exceeds 95°- 102°F (35° - 39°C).
Medical Monitoring

In cold environments, personnel are at increased risk of losing heat to the environment.
Medical Monitoring

- When the core temp falls below normal, hypothermia can develop.
- The greater the thermal gradient, the greater will be the subsequent heat loss.
- Exposure to water during firefighting can hasten cooling and worsen the situation.
Medical Monitoring

Hypothermia:

- Core temp <95°F (35°C).
- Pose a significant risk to members.
Warming can be accomplished two ways:

- **Passive warming**: Application of measures (e.g., removal of wet clothing, use of blankets or additional clothing, or movement to a warmer environment) that slow heat loss to the environment.

- **Active warming**: The actual application of heat to a victim (e.g., heat packs, warming blankets, warmed IV fluids). Heat is transferred from the heat source to the victim.
Medical Monitoring

- Both passive and active warming should be used as needed on the fire ground.
- Only warm the member until the core temperature returns to normal—avoid overshoot an hyperthermia.
- When body temperature reaches 1-2°F below normal, switch to passive warming to prevent over warming the member.
FLUIDS & ELECTROLYTES
MEDICAL MONITORING
Medical Monitoring

The importance of adequate hydration and nutrition on the fire ground cannot be overemphasized.
Medical Monitoring

Because of the heat and protective clothing, firefighters can rapidly lose large amounts of fluids through sweat and breathing.

All firefighters should begin work properly hydrated.
Medical Monitoring

- Members entering rehab should consume enough fluids to satisfy thirst.
- Rehydration should continue post-incident as it may take more time and fluids than initially thought to restore proper hydration.
Medical Monitoring

Electrolyte maintenance:

Extremely important:
- Sodium
- Potassium
- Chloride
- Magnesium
- Phosphate

Sweating depletes sodium.

Exertion can deplete potassium.
Medical Monitoring

Electrolyte abnormalities are more common when:

- Incidents > 3 hours.
- Incidents where personnel are likely to be working for > 1 hour.

Important to replace electrolytes in addition to water in these situations.
Medical Monitoring

- **Monitoring hydration:**
  - **Dehydration:**
    - Mild (loss of < 5% body weight).
    - Moderate (loss of 5-10% body weight).
    - Severe (loss of > 10% body weight).
# Medical Monitoring

## Signs and Symptoms of Dehydration

<table>
<thead>
<tr>
<th>% Weight Lost</th>
<th>Signs and Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>Increased thirst</td>
</tr>
<tr>
<td>2%</td>
<td>Loss of appetite, dry skin, dark urine, fatigue, dry mouth</td>
</tr>
<tr>
<td>3%</td>
<td>Increased heart rate</td>
</tr>
<tr>
<td>4-5%</td>
<td>Decreased work capacity by up to 30%</td>
</tr>
<tr>
<td>5%</td>
<td>Increased respiration, nausea, increased sweating, decreased urine output, markedly increased fatigue, muscle cramps, headache</td>
</tr>
<tr>
<td>10%</td>
<td>Muscle spasms, markedly elevated pulse rate, vomiting, dim vision, confusion, altered mental status</td>
</tr>
</tbody>
</table>
Medical Monitoring

- Monitoring hydration:
  - Firefighters can lose 32 ounces (1 Liter) of fluid in less than 20 minutes of strenuous firefighting.
  - Sweating will continue after the firefighter stops work.
Medical Monitoring

• Monitoring hydration:
  • Dehydration interferes with the body’s ability to maintain core temp.
  • Dehydration lessens strength and shortens endurance.
  • Dehydration causes nausea and vomiting making it difficult to orally hydrate.
Medical Monitoring

- A 15% reduction in plasma volume and a 40% reduction in stroke volume has been reported following less than 20 minutes of intense firefighting activity.
Medical Monitoring

- There are no practical means for precisely determining hydration status at an incident scene.

- Field assessment can include:
  - Body weight measurement
  - Urine dip
  - Saliva osmolarity (in development).
Medical Monitoring

Problems with body weight:

- Serial measurements required.
- Minimal clothing worn.
- Time consuming.
Medical Monitoring

- The amount of fluid an exhausted, warm and dehydrated firefighter can take orally is about 32 ounces (1 liter) per hour.
- This is due to a delayed gastric emptying time from an overloaded GI system.
Medical Monitoring

- Overhydration should be avoided as well.
- Overhydration can cause:
  - Hyponatremia (a relative decrease in sodium stores in the body due to excessive water).
  - Hyponatremia can cause:
    - Altered mental status
    - Seizures
    - Nausea
    - Vomiting
Medical Monitoring

- Urine testing:
  - Color charts required (or machine).
  - Requires collection, measurement and disposal (biohazard).
  - Can be placed in station bathrooms for post-incident hydration monitoring.
Am I Hydrated?
URINE HYDRATION CHART*

1
2
3
4
5
6
7
8

HYDRATED (Target)
DEHYDRATION
SEVERE DEHYDRATION

*Vitamins and vitamin supplements can change the color of urine. Use another hydration status tool if taking these.
The National Collegiate Athletic Association (NCAA) use urine specific gravity measurements to monitor hydration in athletes. A urine specific gravity $\leq 1.020$ are considered to be adequately hydrated. A urine specific gravity $>1.020$ are considered dehydrated. The appearance of ketones (a product of lipid metabolism) indicates problems with nutrition and hydration.
CALORIES
MEDICAL MONITORING
A large amount of energy is consumed during heat or cold stress.

Energy is usually measured in calories.

When calorie stores are depleted, they must be replaced for the body to continue to function optimally.
Medical Monitoring

- Calorie sources:
  - Carbohydrates
  - Proteins
  - Lipids (fats)

- During high-stress states, virtually all calories are derived from carbohydrate sources.
# Medical Monitoring

## Beverages and Substances to Avoid

<table>
<thead>
<tr>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonated sodas, high-fructose or high sugar drinks (&gt;7% carbohydrates)</td>
</tr>
<tr>
<td>Foods with high-protein/high-fat content</td>
</tr>
<tr>
<td>Alcohol within 8 hours prior to duty</td>
</tr>
<tr>
<td>Excessive fluids (overhydration)</td>
</tr>
<tr>
<td>Caffeine†</td>
</tr>
<tr>
<td>Creatine‡</td>
</tr>
<tr>
<td>Ephedrine</td>
</tr>
<tr>
<td>Tobacco</td>
</tr>
</tbody>
</table>

†-While caffeine is not recommended, its use in society is so prevalent that caffeine users will develop headaches and other symptoms if caffeine is not provided. Also, there is little evidence that caffeine alters hydration status.  
‡-While there is no role for creatine (a protein energy source) in rehab, there is no significant evidence that usage is problematic.
Medical Monitoring

The old “coffee and doughnuts” regimen has no role on the modern incident scene.
Medical Monitoring

- Consider the following factors in providing caloric and/or electrolyte replacement:
  - Duration of the event.
  - Amount of exertion.
  - Time since last meal.
  - General condition of the individual.
FLUID, ELECTROLYTE, & CALORIE REPLACEMENT
MEDICAL MONITORING
Medical Monitoring

- It is essential to drink water before thirst develops.
- On days where there is an increased risk of heat stress, it is ideal to prehydrate before work.
Medical Monitoring

- Alcohol is a central nervous system depressant and a diuretic (causes water loss).

- Alcohol consumption within 8 hours prior to strenuous firefighting can lead to early dehydration.
Medical Monitoring

- If a firefighter is involved in intense physical activities for more than an hour, fluids with a 4%-8% carbohydrate solution should be considered (sports drinks).

- 6-8 ounces (175-235 mL) should be consumed every 15 minutes.

- The drinks should be cool and flavored as the firefighter will tend to consume more.
## Medical Monitoring

### Sports Drink Ingredients

<table>
<thead>
<tr>
<th>Ingredients per 8 ounces</th>
<th>Accelorade® ETD</th>
<th>Cytomax® Thirst Quencher</th>
<th>Gatorade® Endurance</th>
<th>Powerade® Advance</th>
<th>Powerade® Option</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium</td>
<td>120 mg</td>
<td>110 mg</td>
<td>200 mg</td>
<td>53 mg</td>
<td>55 mg</td>
</tr>
<tr>
<td>Chloride</td>
<td>55 mg</td>
<td>90 mg</td>
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<td></td>
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</tr>
<tr>
<td>Potassium</td>
<td>30 mg</td>
<td>30 mg</td>
<td>90 mg</td>
<td>15 mg</td>
<td>32 mg</td>
</tr>
<tr>
<td>Calcium</td>
<td></td>
<td></td>
<td>6 mg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td></td>
<td></td>
<td>3 mg</td>
<td></td>
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</tr>
<tr>
<td>Carbohydrate</td>
<td>15 gm (6%)</td>
<td>13 gm (5%)</td>
<td>14 gm (6%)</td>
<td>17 gm (7%)</td>
<td>17 gm (7%)</td>
</tr>
<tr>
<td>Caffeine</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>47 mg</td>
</tr>
<tr>
<td>Calories</td>
<td>80</td>
<td>50</td>
<td>50</td>
<td>64</td>
<td>66</td>
</tr>
</tbody>
</table>

*Note: All values are approximate.*
Medical Monitoring

- Bottled sports drinks are preferred.
- If using powdered sports drinks, mix according to the manufacturer’s recommendations.
- Ideally, water and sports drinks should be available.
Medical Monitoring

- Medical monitoring is the process of observing personnel for possible adverse effects from physical stress, heat or cold exposure, and environmental hazards.
Medical monitoring may be provided by fire-based and non-fire-based EMS personnel.
Regardless of the personnel type, all must understand the goals and principles of rehab, medical monitoring, and treatment.
Medical Monitoring

- Documentation for medical monitoring MUST be separate from documentation for medical treatment.
- Medical monitoring records are part of the incident records.
- Medical treatment reports are medical records.
Medical Monitoring

- Personnel in the rehab area should undergo medical monitoring and, if necessary, receive medical care.

- NFPA 1584 requires BLS providers in the rehab area (however ALS providers should be available).
EMS personnel should assess incoming personnel to rehab and provide any needed treatment per established protocols.
Medical Monitoring

- PPE should be removed, stowed, and checked.
- Tracking should begin as they enter the area.
Medical Monitoring

EMS should evaluate for the following signs/symptoms:

- Chest pain
- Dizziness
- Shortness of breath
- Weakness
- Nausea
- Headache
- General complaints (cramps, aches and pains)

- Symptoms of environmental stress (heat or cold)
- Mental status changes
- Behavioral changes
- Changes in speech
- Changes in gait (ataxia)
- Abnormal vital signs (per departmental guidelines)
**Medical Monitoring**

**REHAB MEDICAL DECISION-MAKING SCHEME**

- **INITIAL REHAB MEDICAL EVALUATION**
  - Immediate transport to an emergency medical facility
  - Close monitoring and treatment in the rehab area
  - Release from rehab
Medical Monitoring

- A transport capable ambulance must be available, on scene, to assure rapid transport.
- The transport ambulance must not take EMS personnel used in medical monitoring.
VITAL SIGNS

MEDICAL MONITORING
Medical Monitoring

Vital signs:

- Pulse rate
- Respiratory rate
- Blood pressure
- Temperature
- Oxygen saturation (SpO$_2$)
- Carbon monoxide (SpCO or exhaled CO)
Medical Monitoring

While many fire departments measure vital signs in rehab, not all choose to.
Medical Monitoring

- Vital sign measurement can help with medical decision-making (monitoring, treatment and transport) and can help establish a baseline.

- However, they must be interpreted within the context of the general appearance and ongoing health status of the individual.
Medical Monitoring

Utility of vital sign measurement:

- Help identify medical conditions requiring follow up.
- A process should be in place in the SOGs to refer firefighters with abnormal vital signs for further assessment and follow-up medical care.
Medical Monitoring

**Temperature:**

- Oral and tympanic thermometers may be used but tend to read lower than core body temperature:
  - Oral: ~1° F (0.55° C) lower than core temp
  - Tympanic: ~2° F (1.1° C) lower than core temp
- Both can be highly affected by many variables.
Medical Monitoring

Temperature:

Regardless of the type of thermometer used, it is important to use the same device each time to accurately measure changes and trends.
Medical Monitoring

Temperature:

Core temperature of firefighters continues to rise following cessation of physical activity and remains elevated following 20 minutes of rest even with active cooling measures.
Medical Monitoring

**Pulse rate:**

- Normal is 60-100 beats per minute.
- Common to exceed 100 during exertion.
- After resting for a period of time, heart rate should return to normal.
- Heart rate must be interpreted within the context of the individual (baseline recorded resting heart rates are helpful).
Medical Monitoring

Pulse rate:

- Pulse rate can be easily measured by palpation.
- Pulse oximetry or CO-oximetry can also be used.
- However, detection of dysrhythmias and assessment of perfusion requires palpation of a peripheral pulse.
Medical Monitoring

Respiratory rate:

- Normal is 12-20 breaths per minute.
- In rehab, most firefighters will have a higher than normal respiratory rate.
- Respiratory rates should fall to normal before discharge from rehab.
Medical Monitoring

Blood Pressure (BP):

- One of the most frequently measured and least understood vital signs.
- BP measurement is extremely prone to error.
- Because of the extreme variability and difficulty interpreting blood pressure changes, many authorities choose not to routinely measure BP in rehab.
Medical Monitoring

**Blood Pressure (BP):**

- **Potential for errors:**
  - Wrong cuff size:
    - Too large (falsely low readings)
    - Too small (falsely elevated readings)
  - Malpositioning:
    - Above heart (falsely low readings)
    - Below heart (falsely elevated readings)

- BP cuffs and stethoscopes are often dirty and can spread antibiotic-resistant bacteria.
Medical Monitoring

**Blood Pressure (BP):**

- Regardless, members with a systolic blood pressure > 160 mmHg or a diastolic blood pressure > 100 mmHg should not be released from rehab.

- Always follow local protocols and SOGs related to BP measurement in rehab.
Blood pressures measurements are prone to error and interpretations can be controversial. Members of ethnic and racial groups respond differently to physiological stress. If BP is measured, NFPA 1584 recommends that members with a systolic BP >160 or a diastolic BP >100 **NOT** be released from rehab. Additional research is needed to define the role of BP in rehab.
Medical Monitoring

★★ Pulse Oximetry:

★ Noninvasive measure of oxygen saturation (SpO₂) and pulse rate.

★ Good assessment tool prior to and during oxygen administration and medical treatment.

★ Fire fighters with SpO₂ <92% on room air should not be released from rehab.
# Medical Monitoring

## Pulse Oximetry Interpretation

<table>
<thead>
<tr>
<th>SpO₂ Reading (%)</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>95 – 100</td>
<td>Normal</td>
</tr>
<tr>
<td>91 – 94</td>
<td>Mild Hypoxemia</td>
</tr>
<tr>
<td>86 – 90</td>
<td>Moderate Hypoxemia</td>
</tr>
<tr>
<td>&lt; 85</td>
<td>Severe Hypoxemia</td>
</tr>
</tbody>
</table>
Medical Monitoring

**Carbon Monoxide (CO) Assessment:**

- CO is the leading cause of death at fire scenes.
- Most commonly encountered contaminant found in environmental studies of firefighters.
- EMS personnel in the rehab area must be alert for symptoms of CO poisoning.
- CO can be detected through exhaled CO measurement or in the bloodstream with Pulse CO-Oximetry.
Medical Monitoring

• **Pulse CO-Oximetry:**
  - Noninvasive measure of oxygen saturation (SpO₂), carboxyhemoglobin (SpCO), and methemoglobin (SpMet)†.
  - Rapid rehab assessment tool for possible CO exposure on the fire ground.
  - Pulse CO-Oximetry can serve as a replacement and/or adjunct to standard pulse oximetry.

†-Methemoglobin not available on all models.
Medical Monitoring

★ Pulse CO-Oximetry:

★ Normal values:
  ★ 0-5% (non-smokers)
  ★ 5-10% (smokers)

★ SpCO 10-15%:
  ★ Assess for signs and symptoms of CO poisoning.

★ SpCO > 15%:
  ★ Treat with 100% oxygen
  ★ Member must have a normal SpCO to be released from rehab.
Medical Monitoring

- Signs and symptoms of shock, seizures, cardiac arrest, **AND** a normal or low SpCO?
- Consider cyanide and have a low threshold for treatment (preferably with hydroxocobalamin).
Medical Monitoring

* The health and well-being of our personnel should be our primary concern.
Firefighter safety is intricately tied to organized rehabilitation efforts.

Firefighters cannot be counted on to self-report problems.
Rehab should be included in all operations where environmental, physical, and psychological stress can occur.
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