Firefighter Rehab: An Introduction to NFPA 1584

Rehabilitation Practices and Medical Monitoring

INTRODUCTION

FIREFIGHTER HEALTH

Firefighter Health

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

Causes of duty-related death in the fire service:
1. Heart attack
2. Trauma
3. Asphyxiation

Toxic gases of combustion:
- Carbon monoxide
- Carbon dioxide
- Hydrogen cyanide
- Hydrogen chloride
- Nitrogen dioxide
- Toxic hydrocarbon products
Firefighter Health

The following weather conditions should be considered on a routine basis:
- Temperature
- Relative humidity
- Direct sunlight
- Wind speed
- Precipitation

The higher the relative humidity, the less effective will be evaporation. Evaporation (sweat) is a major cooling mechanism for humans.

Humidity and air temperature are reflected in the Heat Stress Index. Developed by the United States Fire Administration. Stratifies results into danger categories.

In cold weather, the thermal gradient is a key factor in predicting heat loss. A firefighter with a core temperature of 100°F in a 32°F environment (78°F thermal gradient) will lose heat quite rapidly.

Firefighter Rehabilitation

Elements of the rehabilitation process:
1. Initiate rehab.
2. Define responsibilities.
4. Assure safety.
5. Release personnel only when safe to do so.
Firefighter Rehabilitation

Preparedness
Standard Operating Guidelines (SOGs) should address:
- Relief from climactic conditions
- Rest and recovery
- Active and/or passive cooling or warming as needed based upon the event and climate
- Rehydration
- Calorie and electrolyte replacement
- Medical monitoring
- EMS treatment in accordance with local protocols
- Member accountability
- Release

Best Practices in Rehab

SMALL DEPARTMENTS
For small departments or those with scarce resources, the best practice is to develop a regional rehabilitation plan. This allows consistent performance and joint purchase of needed equipment, and safety at training operations. It also facilitates mutual aid.

THE REHAB SECTOR

FIREFIGHTER REHAB

Establishing the rehab sector too close to the incident will prevent adequate mental and physical rest for firefighters.

Specialized rehabilitation vehicles are now common in the fire service. These can protect personnel from the environment and the media.

Consider environmental conditions when locating rehab sector:
- Wind
- Precipitation
- Direct sunlight

Specialized rehabilitation vehicles are now common in the fire service. These can protect personnel from the environment and the media.
Firefighter Rehabilitation

- The rehab sector should be readily accessible for personnel.
- Access by the public and the media should be restricted.

For high-rise incidents, consider putting the rehab sector on a lower floor (if the building is safe).

Large scale incidents may require multiple rehabilitation areas.
- Each rehab area must have a specific name consistent with location to avoid confusion.

Best Practices in Rehab

INFORMAL COMPANY OR CREW REHAB

Rehab often takes place informally at the company or crew level. This can occur with SCBA bottle changes, during transitions between activities, at routine incidents (e.g., single-family house fire), or when the incident commander fails to recognize the need for rehab. Tools and supplies needed for informal rehab should be available on each piece of apparatus.

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.

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.

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.

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.

- 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.

Medical Monitoring

- Environmental extremes, especially heat waves, are common. Heat wave deaths outnumber all other types of weather-related emergencies.

Medical Monitoring

- 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

- 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.

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.

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.

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.

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.

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.
**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.
- 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.

**Medical Monitoring**
- 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.
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 and hyperthermia.
- When body temperature reaches 1-2°F below normal, switch to passive warming to prevent over warming the member.

FLUIDS & ELECTROLYTES

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.

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:
- 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

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

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

Best Practices in Rehab

DILUTING SPORTS DRINKS
Sports drinks should not be diluted or concentrated as these lessen the benefits. The ingredients and taste are carefully formulated to ensure maximum absorption of electrolytes, carbohydrates, and water. Diluting or concentrating a sports drink may inhibit absorption. Sweetening sports drinks will slow gastric emptying time thus inhibiting hydration.
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.

Calorie sources:
- Carbohydrates
- Proteins
- Lipids (fats)
During high-stress states, virtually all calories are derived from carbohydrate sources.

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.

Beverages and Substances to Avoid
- Carbonated sodas, high-fructose or high sugar drinks (>7% carbohydrates)
- Foods with high-protein/high-fat content
- Alcohol within 8 hours prior to duty
- Excessive fluids (overhydration)
- Caffeine
- Creatine
- Ephedrine
- Tobacco

† 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.
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.

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 is the process of observing personnel for possible adverse effects from physical stress, heat or cold exposure, and environmental hazards. 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.
Personnel in the rehab sector should undergo medical monitoring and, if necessary, receive medical care. NFPA 1584 requires BLS providers in the rehab sector (however ALS providers should be available).

EMS personnel should assess incoming personnel to rehab and provide any needed treatment per established protocols.

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)

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 (SpO₂)

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

Medical Monitoring
- Vital sign must be interpreted within the context of the general appearance and ongoing health status of the individual.

Medical Monitoring
- 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

Medical Monitoring
- Both can be highly affected by many variables.

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**

- **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.

- **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.

- **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.

- **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.

**Pulse Oximetry Interpretation**

<table>
<thead>
<tr>
<th>SpO2 Reading (%)</th>
<th>Interpretation</th>
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<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>
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<tr>
<td>&lt; 85</td>
<td>Severe Hypoxemia</td>
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- **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 sector 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:
- 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.

Signs and symptoms of shock, seizures, cardiac arrest, AND a normal or low SpCO should be considered as cyanide poisoning.
- Consider cyanide and have a low threshold for treatment (preferably with hydroxocobalamin).

ACCOUNTABILITY
MEDICAL MONITORING

All personnel who enter rehab must be accounted for.
- Tracking systems and records are essential for medical monitoring.
- Medical monitoring records and medical treatment records should be separate.

Incident Rehab - Individual Rehabilitation Report

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Sex</th>
<th>Condition</th>
<th>Incident Location</th>
<th>Date</th>
<th>Time</th>
<th>Rehab Officer</th>
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Each crew or company should stay together when entering rehab.
- Individual crew members have the responsibility to alert their supervisor as to the need for rehab.
Best Practices in Rehab

ACCOUNTABILITY

Pursuant to the NIMS and NFPA 1561, incident commanders are responsible for tracking and accounting for all personnel and assets operating at an emergency scene. A good accountability system should be scalable for minor and major events, be interoperable with other agencies, be simple, utilize a standard tagging system, and use interoperable communications.

RELEASE

MEDICAL MONITORING

Medical Monitoring

- **Release from rehab:**
  - EMS personnel should evaluate members prior to release from rehab.
  - EMS personnel must assure there are no contraindications to returning to work.

Medical Monitoring

- For smaller incidents, rehab may occur at the company/crew level outside of the standard rehab sector.
- Accountability rests with the company officer.

MENTAL HEALTH

MEDICAL MONITORING

As personnel rotate through rehab, sector personnel should observe for signs of psychological or emotional stress.

Personnel experiencing psychological and/or emotional stress should not be allowed to return to the fire ground and should be evaluated by a licensed mental health professional who has knowledge of the fire service and fire operations.
Medical Monitoring

If one or more members of a crew or company are seriously injured or killed during an incident, all members of the company or crew should be removed from emergency responsibilities as soon as possible.

Medical Monitoring

- The provision of mental health services should be voluntary and not mandated.
- Psychological first aid (providing comfort needs and information) may be provided.

MEDICAL TREATMENT

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Credits

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