

EMS on the Fireground

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Acknowledgments

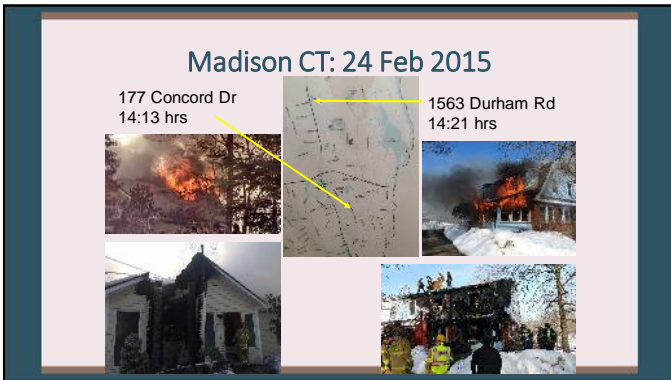
- Robert B. Dunne, MD
 - Detroit East Medical Control Authority
- Sandy Bogucki, MD, PhD
 - Branford (CT) Fire Department
- Allen Yee, MD
 - Chesterfield (VA) Fire and EMS

• Disclosures: none

Core Content

- 1.3.7.1 Clinical management of toxins
 - 1.3.7.1.1 Carbon monoxide
 - 1.3.7.1.2 Cyanide
- 2.1.1.3 Assessment of provider competence and fitness for duty
- 2.3.3.2.5 Occupational health screening
- 2.3.3.1.3 Emergency incident rehabilitation
- 4.1.1.1 Integration with fire ICS/medical operations
- 4.2.2 Immediately Dangerous to Life and Health (IDLH) environments





EMS Roles on the Fireground


- 1. Standby for possible illness / injury to firefighters
- 2. Treatment & transport of ill / injured firefighters
- 3. Treatment & transport of civilian victims
- 4. Management and staffing of rehab area

Vol 2, Ch 40: EMS on the fireground. Dickenson, Bogucki, van Gelder

- EMS physician should be ready to assume any of these roles.
- Other related environments include confined space (Vol 2 Ch 41), high-angle, tactical (Vol 2 Ch 39), and hazmat (Vol 2 Ch 35)

Fireground Health & Safety

- Starts with fit, healthy firefighters
 - Bimodal distribution
- Also depends heavily on training, equipment, policies/procedures, communications
- This is (occasionally) a physically very demanding job
 - Rapid ramp-up of both aerobic and anaerobic activity without warm-up




NFPA 1583: Standard on Health-Related Fitness Programs for Fire Department Members

Training requirements

- OSHA 1910.156(c)(2) – quarterly training for interior firefighters (10 areas) →
 - 1. Safety and protective equipment
 - 2. Chemistry of fire and fire behavior
 - 3. Self contained breathing apparatus
 - 4. Fire streams
 - 5. Hose
 - 6. Pumping fire apparatus
 - 7. Ladders
 - 8. Rescue
 - 9. Forcible entry
 - 10. Ventilation
- OSHA 1910.120(q)(6) – training of department responders for hazmat incidents
- OSHA 1910.120(q)(6)(v) – ICS for hazmat incidents
- OSHA 1910.1030 – communicable disease risk exposure and prevention of the transmission of blood borne pathogens for emergency responders

My Basic Gear – 38.5 lbs / 17.5 kg

- Turnout Jacket
 - Flashlight
 - Radio (fireground)
 - SCBA mask
 - R pocket: extrication gloves, goggles
 - L pocket: wire cutters, multi-tool, door wedges, 25' webbing, trauma shears
- Turnout Pants
 - R pocket: hood, fire gloves
 - L pocket: 25' bailout rope & hardware
 - Gemtor belt/harness & hardware (carabiners, rescue-8 rappel device)
- Helmet
- Boots
- Radio (dispatch)



NFPA 1971: Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

Firefighting Roles & Equipment Carried

- Interior attack: SCBA, hose, "irons" (halligan & axe), TIC
- Search & rescue: SCBA, water can, irons, TIC
- Roof / ventilation: SCBA, power saw, ceiling hooks
- Rapid Intervention Team: SCBA, Stokes or sled with extensive list of equipment
- Overhaul: SCBA, irons, ceiling hooks, four-gas meter
- Everybody has box light, portable radio

Prevention is key!

- 2.3.3.2.5 Occupational Health Screening
- Hiring / annual physical exams: OSHA 1910.134(e), NFPA 1582
 - Required for NMVFC "interior" members, encouraged for all members
 - Spirometry, EKG (after age 40 or as indicated), vision, hearing, blood/urine, basic physical exam, CXR "as indicated" (?), immunizations, cancer screening
- Annual SCBA mask fit testing: OSHA 1910.134(f)(2)
- 2.1.1.3 Assessment of provider competence and fitness for duty
- EMS physician can credential EMS roles for firefighters, but should not be determining fitness for duty (e.g. return to work after injury)

NFPA 1582: Standard on Comprehensive Occupational Medical Program for Fire Departments

Firefighter line-of-duty deaths: ~100/yr

Line-of-Duty Deaths

6 U.S. firefighters annually died in the line of duty, 100+ firefighters were killed worldwide, and nearly 1000 the result of injuries sustained on the job, and one death was the result of a motor vehicle accident. The following statistics are indicative of these firefighters:

INTERIOR INCIDENTS: 20% of the 1.9 thousand firefighter deaths occurred in interior incidents. 24,000 firefighters were injured in interior incidents by 1.5 million fires working in the last 10 years. 100,000 firefighters were injured in other incidents. 100,000 firefighters were injured in other incidents. 100,000 firefighters were injured in other incidents.

TRUCK CHIEF: 10% of the 1.9 thousand firefighter deaths occurred in truck chief incidents. 24,000 firefighters were injured in truck chief incidents by 1.5 million fires working in the last 10 years. 100,000 firefighters were injured in other incidents. 100,000 firefighters were injured in other incidents.

VEHICLE ACCIDENTS: 10% of the 1.9 thousand firefighter deaths occurred in vehicle accidents. 24,000 firefighters were injured in vehicle accidents by 1.5 million fires working in the last 10 years. 100,000 firefighters were injured in other incidents. 100,000 firefighters were injured in other incidents.

WATER RESCUES: 10% of the 1.9 thousand firefighter deaths occurred in water rescues. 24,000 firefighters were injured in water rescues by 1.5 million fires working in the last 10 years. 100,000 firefighters were injured in other incidents. 100,000 firefighters were injured in other incidents.

HAZARDOUS MATERIAL: 10% of the 1.9 thousand firefighter deaths occurred in hazardous material incidents. 24,000 firefighters were injured in hazardous material incidents by 1.5 million fires working in the last 10 years. 100,000 firefighters were injured in other incidents. 100,000 firefighters were injured in other incidents.

OTHER INCIDENTS: 10% of the 1.9 thousand firefighter deaths occurred in other incidents. 24,000 firefighters were injured in other incidents by 1.5 million fires working in the last 10 years. 100,000 firefighters were injured in other incidents. 100,000 firefighters were injured in other incidents.


114 - FIRESTATS 1000000 1111

- 29 y/o M – falling tree
- 47 y/o M – MVA returning from wildfire assignment
- 61 y/o M – w/in 24 hrs of a training exercise
- 60 y/o M – during S&R training
- 58 y/o M – w/in 24 hrs of a structure fire
- 71 y/o M – while responding to a call

Used with permission

Causes of FF LODD

- Sudden cardiac death 51%
 - "As an occupational group, firefighters are more likely to die of a heart attack while on duty than other US workers." Ward MJ, IAFC/NFPA Fire Officer, p 101
- Caught or trapped 25%
- Struck by object 13%
- Falls 8%





• Burns rarely account for >10% of FF LODD in any given year

<https://www.cdc.gov/wisards/ffmap/>

Causes of FF LODD

- Motor vehicle accidents
 - >75% not wearing seat belts
 - 75% of victims are volunteers
 - 40% of these are in their personal vehicles
 - Tanker rollovers second leading cause of MVA death (after responding in POV)
 - 3000 gal x 8.34 lbs/gal = 25,010 lbs H₂O

27 December 2017

North Madison Volunteer Fire Company

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9 of 570

Mayday Called at WA Fire; No Serious Injuries Reported
A mayday was called for a Bellingham firefighter as crews battled an apartment fire on Christmas Day.

NJ Firefighter Dies 10 Days After Suffering Cardiac Arrest
Frank Matragano, 75, was arrested while responding to an emergency on Dec. 13. He died 10 days later.

Colleagues Mourn the Loss of OK Firefighter
Oklahoma City Lt. Jeffrey S. White suffered a fatal cardiac arrest while on duty at Station 35.

Firefighter Found Dead in Bus at KIS Station
Kansas City firefighters found Jason Garrett, 46, dead in his bunk Tuesday morning.

Veteran NJ Firefighter Dies from Cardiac Event
Haddonfield firefighter Craig Mehl, 71, was found dead Thursday of an apparent heart attack.

NIOSH LODD #F2015-21

- Volunteer fire department: South Dakota
- Single-family house fire with trapped occupant



• “According to the coroner’s report, the cause of death was listed as asphyxia due to smoke inhalation. Soot was present in his airway with a minimal carbon monoxide level. Thermal injuries consisted of generalized second-degree burns with third-degree burns on his face, hands, and lower left leg. Acute ethanol intoxication was present in his blood stream, with a blood alcohol content of 0.189.”

4.1.1.1 Integration with fire ICS / medical operations

- Where do you as the EMS physician fit?
 - Are you working for the FD, the EMS agency, the hospital, the county medical oversight authority?
 - Could you end up the EMS Branch Director (under Operations Section) or the Medical Unit Supervisor (under Service Branch / Logistics Section)?
 - Happens to me more often in departments with dual-role firefighter/paramedics
- Is the FD leadership OK with self-dispatch? If so, in what roles?
- Identify yourself to the IC, only accept assignments if IC aware
- Avoid freelancing

NFPA 1561: Standard on Emergency Services Incident Management System and Command Safety

Fireground PPE for EMS Personnel



- Reflectivity
 - especially at night, and on “highways” – ANSI 107-1999, Class 2 or 3
 - “Turnout gear” does not meet ANSI specifications for reflectivity
- Identification of agency and role
- If your gear gets contaminated, don’t take it home or leave it in your car.
- Trivia question: San Diego Intl Airport is the second-busiest single-runway airport in the world – what is the busiest?
 - First correct answer texted to me at 203-515-4127 gets an NMVFC t-shirt

4.2.2 IDLH Environments

Didn't catch my cell number?
203-515-4127

- 1.3.7.1.1 Carbon monoxide
 - PEL 35 ppm, IDLH 1200 ppm (produces COHb of 10-13% in 30 min)
- 1.7.7.1.2 Cyanide
 - HCN: PEL 10 ppm, IDLH 50 ppm
- “Two-in two-out rule” OSHA 1910.134(g)(4)
- A chronic fireground health/safety error: removing SCBA to conduct “overhaul” without metering the atmosphere first

4.2.2 IDLH Environments



• Four-gas meters cover the four most likely IDLH environments that firefighters encounter:

1. Oxygen – electrochemical sensor
 - Lowest we recorded at a structure fire drill was 18.2% (24" above the floor)
 - If no combustion, a 1% drop in oxygen means 50,000 ppm of something else!
2. Carbon monoxide
 - Very easy to exceed the 2000 ppm meter limit in a structure fire
3. Hydrogen sulfide (H₂S)
 - IDLH is only 100 ppm! Meter alarm will trigger at 10 ppm
 - Heavier than air – confined space / basement hazard
4. LEL (lower explosive limit)



Lower Explosive Limit

- The reading is NOT a measure of concentration (e.g. ppm), but is instead what % of the LEL has been reached.
- An LEL of 10 means that you have 10% of the LEL of the gas present – not that you have 10 ppm or 10% concentration or some other “level”
- But there are many gases that can explode – the meter uses a catalytic combustion sensor calibrated to a typical mid-range explosive gas
- The LEL of propane is 2.1%, so in the presence of propane, a reading of “10” on the meter means the presence of 0.21% propane in the air

Bonstell N. Four-gas monitoring for the fire service. Firehouse, May 2017, pp 36-40

What else is in smoke beside CO and HCN?

- Underwriters Laboratories study of structure fire smoke, 2010
 - Asphyxiants (carbon monoxide, carbon dioxide, and hydrogen sulfide)
 - Irritants (ammonia, hydrogen chloride, phenol, particulates, sulfur dioxide)
 - Allergens (isocyanates, a main ingredient in polyurethane foam)
 - Carcinogens (asbestos, arsenic, benzene, styrene, mercury, lead)
 - Particulates: "ultrafine" (<0.1 micron)
- "Carcinogenic chemicals may act topically, following inhalation, or following dermal absorption, including from contaminated gear."
- UL Final Report Project Number: 08CA31673 April 1, 2010 Firefighter Exposure to Smoke Particulates Report
- <http://www.commandsafety.com/2010/11/09/firefighter-exposure-to-smoke-particulates/>

Exposure during overhaul

470 Respiratory Effects of Firefighter Overhaul • Burgess et al

TABLE 2
Chemical and Particulate Exposure During Overhaul

Analyte ^a	Turbines			Pile-ups		
	n	μMDF ^b	Mean ± SD ^c	n	μMDF ^b	Mean ± SD ^c
Carbon monoxide	58	18	12.3 ± 15.5	23	13	34.1 ± 24.7
Carbon monoxide (H)	25	25	1.95 ± 2.15	20	20	0.20 ± 0.20
Nitrogen dioxide	58	18	0.056 ± 0.028	23	13	0.025 ± 0.028
Sulfur dioxide	58	18	0.440 ± 0.247	23	13	1.32 ± 1.42
Hydrogen cyanide	25	15	0.085 ± 0.121	22	12	0.105 ± 0.036
Formaldehyde	22	21	0.140 ± 0.127	22	19	0.252 ± 0.249
Acrolein	22	5	0.113 ± 0.027	22	12	0.245 ± 0.244
Acetone	22	9		22	1	0.010
Benzaldehyde	22	0		22	0	0.000
Gluteraldehyde	22	0		22	0	0.000
Nonylaldehyde	22	0		22	0	0.000
Hydrofluoric acid	22	17	0.287 ± 0.126	22	9	0.085 ± 0.016
Sulfuric acid	22	0	1.25 ± 2.12	22	10	0.45 ± 0.65
Hexamine	22	0		22	10	0.052 ± 0.048
Respirable dust (mg/m ³)	24	2		22	11	0.12 ± 0.20

^a Analytes not in parts per million except as otherwise indicated.
^b Number of samples exceeding the limit of detection (LOD).
^c Mean and standard deviation were calculated using only concentrations > LOD.

Burgess JL et al. Adverse respiratory effects following overhaul in firefighters. *JOEM* 2001;43(5):267-273

2.3.3.1.3 Emergency Incident Rehabilitation

- A huge topic for another day – just a few pearls
- Federal guidance, 2011 – pages 18-22
- "Rehab is designed to prevent, detect, and treat such conditions as heat exhaustion, hyperthermia, and dehydration among the workforce, and to remove operational personnel from duty if they cannot safely rotate back into emergency response efforts." (p 18)

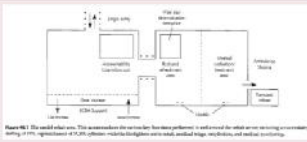


NFPA 1584: Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises

DHS-Wide Protocols

- “The IC should establish a Rehab Sector or Group when conditions indicate that rest and rehabilitation is needed for personnel operating at an incident scene or training exercise. This determination should be made based upon the anticipated duration of the operation, level of physical exertion, and environmental conditions, including temperature, humidity, and windchill. Guidelines to consider include:
 - Heat stress index > 90° F
 - Wind chill index < 10° F
 - Personnel have completed (or will complete) exertional work with second 30 minute SCBA cylinder, if fire fighting involved
 - Personnel have used (or will use) SCBA or other protective breathing devices for > 45 minutes of physical exertion”

Rehab Area



- 5. Medical Evaluation:
 - a. Ask members arriving at the Rehab Area if they have any symptoms of dehydration, heat/cold stress, physical exhaustion, cardiopulmonary abnormalities, or emotional/mental stress.
 - b. Complete a medical evaluation, and appropriate treatment and/or transport, for all members who report such symptoms.
- 6f. Management, BLS:
 - (Even if the patient is not transported to the hospital, he/she may not return to active duty for the duration of that duty cycle or 24 hours, whichever is longer.)

Downed Firefighter – the EMS Approach

- Trauma or medical? Burns?
- Air-related (out of air, oxygen-deficient, exposed to smoke)?
- Cardiovascular (12-lead EKG)?
- High-flow oxygen if suspect air-related
- Consider cyanide antidote if altered mentation and hypotension in the absence of obvious trauma
- Destinations: trauma center, STEMI/PCI center, stroke center, burn center

Questions?

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