CHEMICAL EXPOSURES ON THE FIREGROUND - ILLNESS/INJURY

Kristin Thompson, RN
EMS Division Chief Newport Beach Fire
Motivation: Freeway Complex Fire Nov, 2008
- Lack of research/best practices
- Concern
  - Toxins effecting short term and long term health
    - CA not the only health risk

2009 – what were your practices?
- SCBA during overhaul, PPE in living qtrs?
- Cleaning of PPE?

9/11
SMOKE: COMPOSITION

- Solid & liquid mist (water vapor) - particulates and gases
- Visible and “invisible”
- Depends on what’s burning & conditions of combustion – heat and O2 availability
IT’S NOT YOUR DAD’S FIRE!

- Composition change:
  - High numbers of man-made products
  - Plastics, synthetics
  - Foam
  - Pesticides
  - Electronics, metals
  - **Flame Retardants** chemicals (1975)
  - Wood preservatives
  - 84,000+ chemicals
“Particulate Matter”
Just “Soot & Ash”??
- Ride Sharing—depends on what’s burning
- Solids, liquids, gases
- Trace Compounds—metals
Incomplete Combustion
Toxins:

Particulate:

- Cardiotoxicant
- Pulmonary function
- Premature death

WHAT ARE THE HEALTH RISKS OF PARTICULATE MATTER?
Particulate matter poses a serious health risk because it can travel into the respiratory tract. PM2.5 is especially dangerous because it can penetrate deep into the lungs and sometimes even into the bloodstream.

HEALTH EFFECTS
- Decreased lung function
- Chronic bronchitis
- Increased respiratory symptoms
- Cardiac arrhythmias
  (heartbeat irregularities)
- Heart attacks
- Premature death

GROUPS SENSITIVE TO PM2.5
- People with heart or lung disease
- Older adults
- Children
- Pregnant women

Source: www.epa.gov
SMOKE: COMPOSITION

Toxins in smoke (gases/particulate):

- Asphyxiates
- Neurotoxic
- Cardiotoxic
- Respiratory Irritant/Sensitizer
- Endocrine Disruptors
- Compromise Immune System
- Carcinogenic
- Combo of all of the above

- Affect short term and long term health!!
SMOKE: COMPOSITION

Incomplete Combustion

Toxins: TMTC!

Asphyxiants:

- Carbon Monoxide
- Cyanide
- Hydrogen Sulfide
- Nitrogen

Cause asphyxia
/near asphyxia

- Deprive body of O2
- Can’t absorb O2
- Can’t transport O2

You guys do realize that the smoke is just as dangerous as the fire, right?
Incomplete Combustion Toxins:
Respiratory/ Pulmonary Irritant and Sensitizers:

- Aldehydes
- Acrolein
- Sulfur Dioxide
- Acids
- Nitrogen Dioxide
- Benzene
- Arsenic
- Creosote &
- Coal Tar Pitch
Respiratory/Pulmonary Irritant and Sensitizers:

• Damage upper/ lower airway - destroy integrity of mucosal barrier (corrosive)
  • Cause airway swelling, O2 uptake

• Bronchospasm, bronchoconstriction
• Decreased lung capacity/function
• Bronchitis, Chemical Pneumonia, Pulmonary Edema
Incomplete Combustion: Toxins

- Pesticides
  - Respiratory, Carcinogenic, Neurotoxic

- Trace Compounds: Heavy Metals
  - Cadmium, Lead, Chromium, Zinc, Titanium, Teflon,

- Mercury, Arsenic
  - Carcinogenic
  - Poison
  - Neurotoxic
  - Nephrotoxic
  - Hepatotoxic
SMOKE COMPOSITION

- Polymer Fume Fever (Teflon)  
  - Flu like s/s 24-48 hours later

- Metal Fume Fever  
  - Zinc oxides, metal oxides  
  - 4-12 hours later  
  - Flu like s/s, HA, N/V  
  - Myalgias

Last days/weeks/months
Smoke: Composition

Toxins in smoke:
- PAH’s (Hydrocarbons)
- VOC’s
  - Respiratory Irritant
  - Carcinogenic (most)
  - Blood/liver abnormalities
- Flame Retardants
  - Carcinogenic
  - Neurotoxic
  - Endocrine Disruptor
SMOKE: COMPOSITION

• Complex mix of cancer causing chemicals

Group 1 agents (known to cause cancer in humans)
• Arsenic
• Asbestos
• Benzene
• Benzo[a]pyrene
• 1,3-butadiene,

Polycyclic Aromatic Hydrocarbons (PHA’s, PNA’s)
• Formaldehyde
• Dioxin
• Soot
• Diesel engine exhaust

• Coal tar
• PCB’s (flame retardant)

Group 2A agents (probable human carcinogens)

• Creosote
• Wood combustion products

IARC Carcinogens in the Fire Fighting Environment
http://monographs.iarc.fr/ENG/Classification/index.php
# Chemicals of Concern

<table>
<thead>
<tr>
<th>CHEMICAL CLASS</th>
<th>POTENTIAL HEALTH EFFECTS</th>
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</thead>
<tbody>
<tr>
<td>Polycyclic aromatic hydrocarbons (PAHs)</td>
<td>Carcinogenic (benzo[a]pyrene)</td>
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<tr>
<td>Volatile organic compounds (VOCs)</td>
<td>Carcinogenic (benzene, 1,3-butadiene), central nervous system effects</td>
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<tr>
<td>Aldehydes</td>
<td>Carcinogenic (formaldehyde), respiratory sensitizer (formaldehyde), pulmonary edema (acrolein)</td>
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<tr>
<td>Acid gases</td>
<td>Respiratory irritation, pulmonary edema, chemical asphyxiation (HCN)</td>
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<tr>
<td>Phthalates</td>
<td>Endocrine disruption, liver tumors in animals (DEHP)</td>
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<tr>
<td>Polybrominated diphenyl ethers (PBDEs)</td>
<td>Accumulates in the body, thyroid, liver, immune system effects, neurodevelopmental effects, liver tumors in animals (deca-BDE)</td>
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<tr>
<td>Dioxins and furans</td>
<td>Accumulates in the body, similar health effects as PBDEs, carcinogenic (TCDD)</td>
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<tr>
<td>Organophosphate flame retardants (OPFRs)</td>
<td>Neurotoxicity, cytotoxicity</td>
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<tr>
<td>Diesel exhaust</td>
<td>Carcinogenic</td>
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Consistent Excess Cancer in Pooled Studies

<table>
<thead>
<tr>
<th>Cancer</th>
<th>NIOSH</th>
<th>Nordic</th>
<th>Australian</th>
<th>Korean</th>
<th>French(^3)</th>
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<td>lung(^2)</td>
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CA in the Fire Service

Remember – it ain’t your daddy’s fire!
CA in the Fire Service
IAFF

Line of Duty Deaths 2002-2012

- Trauma 8%
- Stroke 2%
- Respiratory Arrest 1%
- Infectious Disease 2%
- Heart Disease 22%
- Cancer 56%
- Unknown-Other 1%
- Asphyxiation 5%
- Burn 3%

Since 2002, 60% of the names on the IAFF Fallen Fire Fighter Memorial Wall of Honor have died from CANCER.

http://www.iaff.org/

2000-2018 LODD - 56% - 60%!
IN OTHER WORDS...
HOW ARE FF’S EXPOSED?

- Gases and Particulate Matter
- Chemicals
- Enter blood stream and cells thru skin, eyes, lungs, mouth
- Transported, stored in fat cells, organs, filtered in lymph
HOW ARE FF’S EXPOSED?

• Ingestion
  • Particulate on lips, in the mouth
  • Swallowing it, coughing it up then swallowing it
  • Eating/drinking while contaminated
How are FF’s exposed?

- Skin absorption
- Particulate, gases/vapors, liquids
- Permeation/penetration of skin
  - Increased skin permeability
  - Through or around PPE
  - Cross Transfer of contaminants from PPE to skin
  - Carried by water
HOW ARE FF’S EXPOSED?

- Inhalation
  - Gas/particulate
  - Into lungs
- Not wearing SCBA
- Off-gassing from PPE
NEW NORM: CASE STUDIES

- Incident lasting days/weeks
- Not in full PPE
- SCBA rare or non-existent
- No clean up (self or PPE)
- Exertion/ intensity levels
- Eating, drinking, sleeping, working in smoky, hot conditions
- High winds keep toxins in breathing zone
Firefighter illness following a fire

- Fill out Industrial Injury/Illness Reports encourage it!
- Treatment if needed
- W/C paperwork

- Skin:
  - rashes, blistering, redness, painful areas
- Eye:
  - Pain/watering/irritated/discharge
  - Vision changes
Firefighter illness following a fire

- Cough/SOB/wheezing
- Continual nasal discharge/sinus issues
- Nasal/oral burning feeling

- Cardiac Issues

- Hearing Issues

- “General Malaise”
- Flu like sx – feel like sh#%'
- N/V

- Especially if:
  Chronic/recurrent/unusual
FIREFIGHTER ILLNESS FOLLOWING A FIRE

- ED vs OCC Med/UCC
- Burn Center ??
- Pulmonologist F/U - Resp SX
- Advocate/persistent

- Smoke/fireground related illness unless proven otherwise
- Risk Management/Work Comp provider
Firefighter illness following a fire

Extended incidents:
• Follow up with returning crews
• Pay attention to sick calls – esp when it’s the same crew
Budget

- Wipes $6
  - 50-80%
  - Washing Station

- PPE
  - Well Fitting
  - 2nd set-
    - Hoods ($40-140), gloves, wildland
    - Replace: Helmets, liners
    - Gear Bags (for transporting “clean” PPE)
    - Trash bags – contaminated gear
    - N95/ P100 $5-10
**BUDGET**

- **PPE CLEANING**
  - Extractor $20k
  - Dryer $10k
  - Cleaning: $3k Ultrasonic SCBA, mask
  - Decon kits: $100
BUDGET

- **Station**
  - Design (Zones)
  - Sinks
  - PPE Storage
  - Gym Equipment?
  - Ice Machine placement?
BUDGET

• Exhaust Systems

• Physicals
  • Tests for types of CA,
  • Cardiac, Pulm
  • Heavy Metals (& S/S)
• Free!
  • Culture
  • Education – yours and troops!
  • Policy/practice
    • Wearing SCBA
    • Rehab
    • Gross Decon
    • OOS after IDLH
    • PPE cleaning
• Investing in equipment: mitigates risks of negative health effects
• Awareness: WC clinics/Local ED/HR/Risk Mang
• Extended events without ability to practice Best Practices
CHALLENGES

• Clearinghouse for medical issues
  • CA, Neuro, Pulm, etc

• Research/testing after events

• Equipment and PPE – allows you to do your job and till be protected!

• Presumptives – not just CA and cardiac!
• LEAD BY EXAMPLE!
• BE SAFE!
• Not just being wimps
• Change what we can!

WHY ALL FIREFIGHTERS GO TO HEAVEN.