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:

- 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!!
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, Pulm 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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<td>Diesel exhaust</td>
<td>Carcinogenic</td>
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## Consistent Excess Cancer in Pooled Studies

<table>
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<tr>
<th>Cancer</th>
<th>NIOSH</th>
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<th>Australian</th>
<th>Korean</th>
<th>French&lt;sup&gt;3&lt;/sup&gt;</th>
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</table>
CA in the Fire Service

Remember – it ain’t your daddy’s fire!
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.

PART 1: CARDIAC VS. CANCER
IAFF LODD ANALYSIS
FEBRUARY 1, 2002 - MAY 1, 2019

Cancer: 60%
Cardiac: 16%
Burns: 12%
Collapse: 5%
Unknown: 4%
Other: 3%
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

“I don't trust anybody who didn't inhale.”

PETER FONDA
NEW NORM: CASE STUDIES

- Incident lasting days/week
- 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/ recurring/ 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
• Wipes $6
  • 50-80%
• Washing Station
• PPE
  • Well Fitting
  • 2nd set-
  • Hoods ($40-140), gloves, wildland
  • Replace: Helmets, liners
• Gear Bags (for transporting “clean” P
• Trash bags – contaminated gear
• N95/ P100 $5-10
• **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?
• Exhaust Systems

• Physicals
  • Tests for types of CA,
  • Cardiac, Pulm
  • Heavy Metals (& S/S)
BUDGET

• Free!
  • Culture
  • Education – yours and troops!
  • Policy/practice
    • Wearing SCBA
    • Rehab
    • Gross Decon
    • OOS after IDLH
    • PPE cleaning
CHALLENGES

• 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.