Addressing Cancer in the Fire Service

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Fire Service Advisory Committee
League of Minnesota Cities
St. Paul, MN March 18, 2015
“The connection between fire fighting and cancer is real, and there is scientific data to support our position. But we cannot stop here – we must continue to learn more so we can prevent our members from contacting this horrible disease and help them if they do.”

— Harold Schaitberger, IAFF General President
Line of Duty Related Deaths

http://www.iaff.org/
Rise in Firefighter Cancer Deaths
1950-2014

Source: IAFF Line of Duty Deaths Database: http://www.iaff.org
Firefighter Cancer Deaths vs Other Causes
1950-2014

Source: IAFF Line of Duty Deaths Database: http://www.iaff.org
Does Firefighting Cause Cancer?  
Making the Connection

In 2007, the International Agency for Research on Cancer (IARC) classified firefighting as possibly carcinogenic to humans (Group 2B).

In 2015, IARC may upgrade the classification to probably carcinogenic to humans (Group 2A).
Epidemiology vs Forensics

Statistical studies of cancer incidence and mortality from records of fire fighters over time

VS

Exposure studies measure actual chemical Concentrations in fire fighters’ blood and urine
Epidemiological Evidence

Fire fighters at excess risk for multiple site-specific cancers

Cancer risk increases with the duration of firefighting

LeMasters et al. 2006 Meta-analysis of 32 studies
NIOSH Cancer Study Daniels et al. 2013
Nordic Fire Fighters Study Pukkala et al. 2013
Monash Study Australian Fire Fighters Glass et al. 2014
Cancer Risk Among Firefighters: A Review and Meta-analysis of 32 Studies

- Multiple myeloma
- Non-Hodgkin's lymphoma
- Prostate
- Testicular

– LeMasters et al, 2006
- Digestive cancers - stomach, small intestine, large intestine
- Respiratory cancers - esophageal, lung adenocarcinoma
- Malignant mesothelioma

– NIOSH Cancer Study 2013
- Prostate cancer (ages 30-49)
- Skin melanoma (ages 30-49)
- Non-melanoma skin cancer (>70)
- Multiple myeloma (>70)
- Adenocarcinoma of the lung (>70)
- Mesothelioma (>70)

Nordic Fire Fighter Study (2014)
Australian Firefighters Health Study  
(Monash University, Melbourne)

- Three types of firefighters: Full-time career, Part-time paid, Volunteer
- Males: >193,000 subjects with 84% volunteer firefighters
- Females: >39,000 subjects with 95% volunteer firefighters

Fire Fighter Cancer Risk
(Relative to General Population)

- Testicular (2.02x greater risk)
- Multiple myeloma (2.53x greater risk)
- Non-Hodgkin’s lymphoma (1.51x greater risk)
- Prostate cancer (1.28x greater risk)
- Colon Cancer (1.21x greater risk)
- Leukemia (1.14x greater risk)
- Breast Cancer in women (6x greater risk)
- Skin Cancer (1.39x greater risk)
- Malignant Melanoma (1.31x greater risk)
- Brain Cancer (1.31x greater risk)

Exposure
in the New Fire Environment
Fires Today Are More Toxic

Toxic flame retardants, perfluoroalkyl chemicals, phthalates in synthetics, plastics

Foam furniture, carpets, mattresses, plastics, TVs, computers, electronics building insulation

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Toxic Chemicals Released During Structure Fires

* Flame retardants (PBDEs, chlorinated Tris, phosphate FRs)
* Combustion by-products - dioxins and furans (PBDD/Fs, PCDD/Fs)
* PCBs, carbon tetrachloride, vinyl chloride, pesticides

Gases: hydrogen sulfide, hydrogen cyanide, and hydrogen oxides

Acids and aldehydes (formaldehyde*)

Benzene*, polycyclic aromatic hydrocarbons (PAHs*)

Plasticizers (pthalates)

Metals: cadmium*, lead, chromium*

* Carcinogenic
Halogenated Flame Retardants
(PBDEs, HBCDs, Firemaster, Tris, PBDE Alternatives)
In foam furniture, textiles, upholstery, TVs, computers, plastics, electronics, housing insulation: dust (80%)
Endocrine disruptors, developmental neurotoxins, cancer

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Flame Retardants Increase Fire Toxicity

<table>
<thead>
<tr>
<th></th>
<th>Seconds to Ignition</th>
<th>Smoke m²/kg</th>
<th>Carbon Monoxide kg/kg</th>
<th>Soot kg/kg</th>
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<tbody>
<tr>
<td>No retardant</td>
<td>16</td>
<td>413</td>
<td>.02</td>
<td>.01</td>
</tr>
<tr>
<td>PentaBDE retardant</td>
<td>19</td>
<td>833</td>
<td>.13</td>
<td>.88</td>
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</table>


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Perfluorinated Chemicals (PFAS)

Stain-resistant coating on upholstery, carpets (Scotchgard), performance clothing (Gortex), non-stick cookware (Teflon), food wrapping, fire-fighting foams; found in drinking water

Endocrine disruptors, liver, heart disease, stroke, cancer

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Combustion By-Products

- Chlorinated and brominated dioxins and furans
- Plasticizers (Pthalates)
- PAHs (polycyclic aromatic hydrocarbons)
- Large amounts formed when flame retarded furniture and plastics burn
- Toxic and carcinogenic

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Exposure Routes & Scenarios

- Inhalation
- Ingestion
- Skin Absorption
“Because of the multiple exposures and the multiple routes of exposure—they inhale carcinogens and absorb them through the skin—it is also highly unlikely for firefighters to get only one type of cancer.”

– LeMasters et al. (2006)
Skin’s permeability increases with temperature and for every 5° increase in skin temperature, absorption increases 400%.

“Taking Action Against Cancer in the Fire Service.”
Fire Fighter Cancer Support Network 2013
“Fire fighters are present day chimney sweeps covered in carcinogens. We are going to see more cancers in fire fighters before this gets better.”

-Alex Forrest, Canadian Trustee IAFF Manitoba, Canada; P. Pott, 1776
Exposure During Overhaul

Concentrations of air contaminants during overhaul exceed occupational exposure limits.

–Weiss and Miller, Phoenix FD (2011)
Cumulative Exposure

Soiled coats, gloves, hoods, face pieces

"Bunker gear goes unwashed for months at a time, even after significant fires."

Taking Action Against Cancer in the Fire Service
Fire Fighter Cancer Support Network 2013
Exposure Studies
(Forensics)


Earlier studies focused on few chemicals - PCBs, dioxins, PAHs
No. California Fire Fighter Study

Persistent organic pollutants including polychlorinated and polybrominated dibenzo-p-dioxins and dibenzofurans in firefighters from Northern California

Most extensive exposure assessment
Firefighters accumulate high levels of flame retardants, combustion by-products (PBDD/Fs) – Shaw et al 2013
Chemicals Analyzed in Blood

**Combustion by-products:** PBDD/Fs, PCDD/Fs (brominated & chlorinated dioxins and furans)

**Flame retardants:** (PBDEs – penta, octa, deca), TBBPA (tetrabromobisphenol-A)

**Perfluorochemicals:** PFCs: PFOS, PFOA (8/11 detected)

**Industrial chemicals:** PCBs (Polychlorinated biphenyls)

**Pesticides:** DDT (p,p’-DDE), HCB (Hexachlorobenzene), BPA (Bisphenol-A)

*levels and patterns in CA firefighters compared with general population, other firefighters, other workers*
Fire fighters have 2-3 X higher levels of PBDE flame Retardants in blood than the general population

Hormonal changes seen in men with PBDE levels at and above this concentration (Turyk, 2008)
Deca (BDE209) a Major FR in Fire Fighters (orange bars) (~ 75% in FF#4 who did not wear SCBA)
Deca the Major FR in E Waste Recyclers Exposed to Burning Plastics*

Guiyu, South China

*Note: no respiratory protection
Fire fighters have 100 X higher levels of FR dioxins (combustion by-products) than general population.
Highest Levels PBDD/Fs in 2 California Fire Fighters

CAUCASIAN MALE (AGE 40)
15 YEARS FIREFIGHTING
ROLE BREAK INTO ROOF AND OVERHAUL
DID NOT WEAR SCBA

CAUCASIAN MALE (AGE 59)
28 YEARS FIREFIGHTING
SMOKER
LIVER CONDITION
DID WEAR SCBA

TEQ pg/g lw

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Perfluorochemicals in Fire Fighters, WTC Responders & General Population

PFCs

(ng/ml ww, median)

China Population
US Population
NY WTC Responders
CA Firefighters

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Carcinogenic Chemicals Elevated in Fire Fighter Blood

- Flame retardants (PBDEs, DecaBDE) 2-3 X higher vs population levels
- Combustion by-products (PBDD/Fs, dioxins and furans) 100 X higher in fire fighters
- Perfluorochemicals (stain and water repellants) higher in fire fighters
California Fire Fighters At Risk

Cancers

Exposure to carcinogens - PBDEs, PBDD/Fs, PCDD/Fs, PFCs (PFOA)

Neurotoxicity

Chronic high exposure to DecaBDE

Cardiovascular effects, stroke

Exposure to PFCs (PFOA) in smoke and dust

Thyroid, reproductive, immune effects

Exposure to PBDEs, PFCs in smoke and dust
THE QUESTION: Does Fire Fighter Exposure Cause Cancer?

Not Proven
Causal evidence lacking
Research needed to fill data gaps
National Fire Fighter Cancer Biomarker Study
2016 - 2020
Participating Fire Departments

Portland, Maine
Minneapolis, MN
St Paul, MN
Arlington, VA
District of Columbia
Seattle, WA
Project Scope

Comprehensive assessment of chemical exposures and biomarkers of health effects related to cancer risk among 300 active-duty fire fighters

GOALS: Identify chemicals of highest concern, exposure pathways, and biomarkers of early health effects of exposure that may predict cancer risk
What Will Be Measured

One-time sample collection blood & urine after a fire

Chemicals in FF blood & urine samples:
  Halogenated chemicals (flame retardants, PFCs, PAHs) metals, VOCs (benzene), plasticizers (phthalates, parabens)

Chemicals (same) in gear wipes and skin wipes

Markers of Effects in FF blood & urine:
  Inflammatory/immune, pre-cancer, cancer biomarkers
    C reactive proteins, cytokines, interferon, cell surface markers, clinical chemistry markers, vitamin D panel, cholesterol profile

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Research Team

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“The relationship between firefighting exposure and cancer risk is not clear. “

“The National study will address research gaps and will be a model for future studies.”

– Dr. Susan Shaw, DrPH
Principal Investigator
Benefits to Fire Fighters

1. Close data gaps: Identify probable factors (exposures) in FF cancer development and other diseases

2. Confidential data shared w participants to support their needs (reduce exposure, minimize disease onset, provide early medical treatment, compensation)

3. Inform interventions, protective practices; presumptive cancer laws; safe chemicals policy
Protecting Fire Fighter

HEALTH

Presumptive Cancer Legislation
Exposure Reduction
Safe Chemicals Legislation
Presumptive Cancer Law

- 33 states provide compensation under new presumptive disability laws to fire fighters stricken with cancer
- 17 states do not provide coverage
- Even in states with legislation, fire fighter cases are being denied
Exposure Reduction
Limiting Exposures in the Fire Environment

- PPE/SCBA during fire suppression & overhaul
- On scene DECON (gear, skin)
- Hoseline
- Compressed air
- Gear laundering: new equipment
On Scene Decontamination
(Hosing, Skin Wipes)

Dr. Shaw with Chief Tupper, Ellsworth Fire Department

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Gear Bagged at Station
Exposure Source in Vehicles, Living Quarters
Laundered at Resource Mgmt (Extractor)
Dried With No Heat
Glove Dryer
Pants Dryer
Gear Storage in New Stations
Critical: Back Up Set of Gear

While contaminated gear is being cleaned and dried...
Reporting Hazardous Exposures

- History of non-reporting
- 0400 hrs. Paperwork?
- Usually Happens in Cancer Claims
- Requirement for coverage under Presumptive Cancer Laws
On-Line Reporting Systems
Safe Chemicals Legislation

Protecting Fire Fighters and All Americans from Harmful Exposure to Toxic Chemicals
Greater Boston Video: Flame Retardants Pose Health Risk To Firefighter

It may not seem like it given recent major fires, but the risk of dying in a residential fire has sharply declined in the past 15 years. One of the reasons is the widespread use of flame retardants in household goods. But the use of flame retardants may have a larger hidden cost. Some of the chemicals used in the retardants pose health risks, particularly to firefighters.

GUEST

- Dr. Susan Shaw is the president of the Marine Environmental Research Institute in Blue Hill, Maine. She's researching the effects flame retardants have on firefighters, including those in the Northeast.

"All of us are exposed to these indoor chemicals, and it's not only flame retardants," said Susan Shaw, director of the Marine Environmental Research Institute. "That's bad enough. But firefighters are exposed to exponentially higher levels of these compounds when they go into a house fire."
California Study Gains Attention in Congress, the Media
Improving first responder health and safety
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  (2016-2020)

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