Cancer In The Fire Service

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Cancer In The Fire Service

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Cancer in the Fire Service Workshop: NIOSH Epidemiologic Research

2015 John P. Redmond Symposium

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Centers for Disease Control and Prevention (CDC)
National Institute for Occupational Safety and Health (NIOSH)
Cancer

• Large group of diseases involving abnormal cell growth.
• Multiple contributing causes or “risk factors”:
  – Modifiable (environment, occupation, and lifestyle)
  – Non modifiable (genetics and chance)
• Long time periods between exposure and symptoms.
• Risks increase with age. About 77% of all cancers are diagnosed in persons 55 years of age and older.
• Prevention is first line of defense.
• Early diagnosis and treatment are key to survival.
U.S. Cancer Facts

• About 1.7 million new cancer cases each year.
• Men have about a 1 in 2 lifetime risk of developing cancer; for women, the risk is a little more than 1 in 3.
• Cancer accounts for 1 in 4 deaths; 2nd most common cause.
• Direct costs of cancer are about $124 billion per year.
• About 33 million disability-days per year; $7.5 billion in lost work productivity.
• Occupational cancer comprises about 4 to 10% of cases.
Why Study Firefighters?
Hazardous Exposures

• Multiple carcinogens
  – PAHs (e.g., benzo[a]pyrene)
  – Diesel exhaust
  – Benzene
  – Asbestos

• Numerous exposure settings

• All routes of entry
  – Inhalation
  – Ingestion
  – absorption
Why Study Firefighters?
Risk Management Options

Hierarchy of Controls

- Elimination
  - Physically remove the hazard

- Substitution
  - Replace the hazard

- Engineering Controls
  - Isolate people from the hazard

- Administrative Controls
  - Change the way people work

- PPE
  - Protect the worker with Personal Protective Equipment

Most effective

Least effective
Why Study Firefighters?
Causality: More Evidence is Needed

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Example</th>
<th>Existing Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength of Association</td>
<td>The larger the association, the more likely the exposure is causing the disease.</td>
<td>Associations are modest (&lt;2-fold)</td>
</tr>
<tr>
<td>Consistency</td>
<td>The association is observed repeatedly in different persons, places, times, and circumstances.</td>
<td>Results vary between studies</td>
</tr>
<tr>
<td>Dose-Response</td>
<td>Persons who have increasingly higher exposure levels have increasingly higher risks of disease.</td>
<td>Information lacking</td>
</tr>
</tbody>
</table>

NLC (2009): “…a lack of substantive scientific evidence currently available to confirm or deny linkages between firefighting and an elevated incidence of cancer.”
NIOSH Firefighter Study

• **External comparison:** *Is cancer associated with firefighting?*
  - Determine mortality and cancer incidence
  - Compare to the general population

• **Internal comparison:** *Are higher-exposed firefighters more at risk?*
  - Estimate exposures
  - Examine dose-response relation
# Excess Cancers

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Obs</th>
<th>Mortality SMR (95% CI)</th>
<th>Incidence SIR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All mortality</td>
<td>12,028</td>
<td>0.99 (0.97, 1.01)</td>
<td>NA</td>
</tr>
<tr>
<td>All Cancers</td>
<td>3,285</td>
<td>1.14 (1.10, 1.18)</td>
<td>4,461 1.09 (1.06, 1.12)</td>
</tr>
<tr>
<td>Esophagus</td>
<td>113</td>
<td>1.39 (1.14, 1.67)</td>
<td>90 1.62 (1.31, 2.00)</td>
</tr>
<tr>
<td>Intestine</td>
<td>326</td>
<td>1.30 (1.16, 1.44)</td>
<td>398 1.21 (1.09, 1.33)</td>
</tr>
<tr>
<td>Lung</td>
<td>1,046</td>
<td>1.10 (1.04, 1.17)</td>
<td>716 1.12 (1.04, 1.21)</td>
</tr>
<tr>
<td>Kidney</td>
<td>94</td>
<td>1.29 (1.05, 1.58)</td>
<td>166 1.27 (1.09, 1.48)</td>
</tr>
<tr>
<td>Oral cavity†</td>
<td>94</td>
<td>1.40 (1.13, 1.72)</td>
<td>174 1.39 (1.19, 1.62)</td>
</tr>
<tr>
<td>Mesothelioma</td>
<td>12</td>
<td>2.00 (1.03, 3.49)</td>
<td>35 2.29 (1.60, 3.19)</td>
</tr>
</tbody>
</table>


Oral cavity includes lip (excluding skin of the lip), tongue, salivary glands, gum, mouth, pharynx, oropharynx, nasopharynx, and hypopharynx.

SMR, standardized mortality ratio; SIR, standardized incidence ratio.
## Risk Differences by Age

Excess bladder and prostate cancer among younger age groups

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Age Group (years)</th>
<th>Obs</th>
<th>Incidence SIR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bladder</td>
<td>All ages</td>
<td>316</td>
<td>1.12 (1.00, 1.25)</td>
</tr>
<tr>
<td></td>
<td>17-64</td>
<td>97</td>
<td>1.33 (1.08, 1.62)</td>
</tr>
<tr>
<td>Prostate</td>
<td>All ages</td>
<td>1261</td>
<td>1.03 (0.98, 1.09)</td>
</tr>
<tr>
<td></td>
<td>17-64</td>
<td>426</td>
<td>1.21 (1.10, 1.33)</td>
</tr>
<tr>
<td></td>
<td>45-59</td>
<td>249</td>
<td>1.45 (1.28, 1.64)</td>
</tr>
<tr>
<td></td>
<td>45-49</td>
<td>31</td>
<td>2.14 (1.46, 3.04)</td>
</tr>
</tbody>
</table>

### Women (n=991, 3.3%)

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Obs</th>
<th>SIR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cancers</td>
<td>40</td>
<td>1.24 (0.89, 1.69)</td>
</tr>
<tr>
<td>Breast</td>
<td>18</td>
<td>1.45 (0.88, 2.29)</td>
</tr>
<tr>
<td>Bladder</td>
<td>&lt;5</td>
<td>12.53 (3.41, 32.1)</td>
</tr>
</tbody>
</table>

Bladder cancer elevated; however, there were few cases observed.

### Minorities (n=4,657 males, 15.5%)

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Obs</th>
<th>SIR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All cancers</td>
<td>240</td>
<td>0.92 (0.81 to 1.05)</td>
</tr>
<tr>
<td>Prostate</td>
<td>94</td>
<td>1.26 (1.02 to 1.54)</td>
</tr>
<tr>
<td>Leukemia</td>
<td>11</td>
<td>1.90 (0.95 to 3.40)</td>
</tr>
</tbody>
</table>

Prostate cancer and leukemia appeared elevated among males of other race/ethnicity.

Summary of Findings

• Excess cancer mortality and incidence among firefighters:
  – All cancers
  – Digestive (colon, esophagus) cancers
  – Genitourinary cancers
    • Kidney
    • Bladder cancer in women and in men at younger ages (<65y)
    • Prostate at younger ages (<65y)
  – Oral sites (mouth, throat, tongue)
  – Respiratory (larynx, lung) cancers
  – Mesothelioma
• Lung cancer and leukemia risk increased with exposure.

**Strengths**

- Large cohort (~30,000 career firefighters)
  - Includes all races and gender
  - Includes multiple fire departments
- Long observation (~850,000 person-years)
  - Includes both historical and recent firefighting experience (1950-2009)
- Examined multiple endpoints
  - Cancer and non cancer
  - Mortality and cancer incidence
  - Examined dose-response
- Provides framework for future studies
Main Limitations

- Few women and minorities
- Population limited to urban career firefighters
- No direct exposure information
- Incidence data prior to Mid 1980s is not available
- Information on other risk factors is lacking (e.g., tobacco use, alcohol consumption, diet, obesity)
Other Criticisms (NLC-RISC 2013)

- Exposures were uncharacteristic
  - “old-line cities where the firefighters would be expected to fight more fires and encounter asbestos and chemicals...”
- Small effect sizes (no association?)
  - “finds only small to moderate increases in risk...”
- Findings inconsistent with current knowledge:
  - “numerous cancers already targeted by state presumption statutes do not have a significant excess incidence or mortality...”

Reiss C (2013). NLC Risk Information Sharing Consortium (NLC- RISC)
## Comparison with other Studies

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>NIOSH Study(^1)</th>
<th>Nordic Study(^2)</th>
<th>Australian study(^3)</th>
<th>California Study(^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>cohort</td>
<td>cohort</td>
<td>cohort</td>
<td>case-control</td>
</tr>
<tr>
<td>Outcomes</td>
<td>mortality &amp; incidence</td>
<td>incidence</td>
<td>mortality &amp; incidence</td>
<td>incidence</td>
</tr>
<tr>
<td>firefighters</td>
<td>29,993</td>
<td>16,422</td>
<td>17,394</td>
<td>NA</td>
</tr>
<tr>
<td>Sex &amp; race</td>
<td>all</td>
<td>males, all races</td>
<td>all</td>
<td>all</td>
</tr>
<tr>
<td>Cancer deaths</td>
<td>3,285</td>
<td>NA</td>
<td>329</td>
<td>NA</td>
</tr>
<tr>
<td>Diagnoses</td>
<td>4,461</td>
<td>2,536</td>
<td>1,208</td>
<td>3,996</td>
</tr>
<tr>
<td>Exposure</td>
<td>emp, fire runs, time @ fire</td>
<td>none</td>
<td>emp., no. fires</td>
<td>none</td>
</tr>
</tbody>
</table>

## Other Studies: Excess Cancer Risk

<table>
<thead>
<tr>
<th>NIOSH Study¹</th>
<th>Nordic Study²</th>
<th>Australian study³</th>
<th>California Study⁴</th>
</tr>
</thead>
<tbody>
<tr>
<td>all cancers</td>
<td>all cancers</td>
<td>all cancers</td>
<td>melanoma</td>
</tr>
<tr>
<td>esophagus</td>
<td>prostate*</td>
<td>prostate</td>
<td>myeloma</td>
</tr>
<tr>
<td>intestine</td>
<td>melanoma*</td>
<td>melanoma</td>
<td>leukemia (AML)</td>
</tr>
<tr>
<td>lung</td>
<td>myeloma#</td>
<td>myeloma</td>
<td>esophagus</td>
</tr>
<tr>
<td>kidney</td>
<td>lung#</td>
<td>lung</td>
<td>prostate</td>
</tr>
<tr>
<td>oral cavity</td>
<td>mesothelioma#</td>
<td>mesothelioma#</td>
<td>brain</td>
</tr>
<tr>
<td>mesothelioma</td>
<td></td>
<td></td>
<td>kidney</td>
</tr>
<tr>
<td>prostate*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bladder*</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* At younger ages.
# At older ages.

Australian study results restricted to career firefighters.

References:
Future Research
Improved Study Design

• Statistical power:
  – Larger populations
  – Longer followup

• Ascertainment:
  – Incidence vs. mortality

• Control for potential bias:
  – healthy worker effects:
  – Other risk factors (e.g., tobacco, alcohol, diet)

• Exposure-response
Future Research
Examine Risk in Other Groups

<table>
<thead>
<tr>
<th>Firefighters Studied</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Career firefighters</td>
<td>2 in 3 U.S. firefighters are volunteers. Less than 10% of fire departments consist of career firefighters only.</td>
</tr>
<tr>
<td>White, non-Hispanic</td>
<td>1 in 5 career firefighters are other race/ethnicity.</td>
</tr>
<tr>
<td>Men</td>
<td>1 in 25 career firefighters are women.</td>
</tr>
<tr>
<td>Structural Fires</td>
<td>Federal wildland firefighters comprise about 5% of career U.S. firefighters.</td>
</tr>
<tr>
<td>Urban settings</td>
<td>Nearly half of all departments protect populations of 2,500 or less.</td>
</tr>
</tbody>
</table>
Thank you

Robert D. Daniels, PhD
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Centers for Disease Control and Prevention (CDC)
National Institute for Occupational Safety and Health (NIOSH)
Firefighters’ Exposures to Potential Carcinogens

August 28, 2015

Kenny Fent, PhD, CIH
LCDR, U.S. Public Health Service
National Institute for Occupational Safety and Health
Combustion Byproducts

- Hundreds of hazardous compounds
  - Respiratory irritants (acrolein, acids, sulfur dioxide)
  - Respiratory sensitizers (isocyanates, aldehydes)
  - Chemical asphyxiants (carbon monoxide, hydrogen cyanide)
  - Cardiotoxicants (fine particulate, chemical asphyxiants)
  - Carcinogens:
    - Single-ring aromatic hydrocarbons (benzene)
    - Polycyclic aromatic hydrocarbons (benzo[a]pyrene)
    - Aldehydes (formaldehyde)
    - Halogenated compounds (vinyl chloride, polychlorinated biphenyls, certain dioxins)
    - Diesel exhaust
Primary Exposure Routes

- **Inhalation route** during the response if not wearing SCBA (e.g., overhaul) or after the response from off-gassing equipment.
- **Dermal route** during the response due to penetration or permeation of contaminants through gear.
- **Dermal or ingestion route** after the response due to transfer of contaminants from the gear to the skin.

Studies have found increasing biomarkers of PAHs and benzene following live fire training, but were not able to differentiate between the routes of absorption (Caux et al. 2002; Laitinen et al., 2010).
NIOSH Firefighter Dermal Exposure Study

Specific Aims

1. To characterize dermal exposure to chemicals in firefighters who wear the highest level of protective equipment available
2. To assess biological uptake of chemicals in firefighters
3. To assess accumulation and off-gassing of contaminants on turnout gear
Study Design

- **Firefighter participants suppressed controlled structure fires**
  - Firefighters entered the structure, observed the fire growth for ~10 min before knockdown and subsequent overhaul operations
  - 20 to 30 minutes of exposure
- **Wore laundered turnout gear, gloves, and hoods**
- **Wore SCBA until completion of overhaul**
  - Did not remove until 30 meters upwind of the burn structure

Dermal route during the response due to penetration or permeation of contaminants through gear
Study Design

- 2 rounds, 3 days per round, 1 burn evolution per day, 5 firefighters per burn

- Each burn took place in the morning with samples collected throughout the day:
  - Pre exposure (~1 h before the burn)
  - Exposure (during the burn)
  - Post exposure (10-40 min after the burn)
  - 3 h post exposure
  - 6 h post exposure
Analytes

- **PAHs** – measured in personal breathing zone, on skin, and metabolites in urine
  - Skin wipes collected pre and post exposure
  - Urine collected pre, post, and 3 h post exposure
- **Single-ring aromatics** – measured in exhaled breath (alveolar air)
  - Collected pre, post, and 6 h post exposure
- **VOCs** – measured off-gassing from turnout gear
  - Gear placed into an enclosure after the fire
Findings

- Of all monitored skin sites (arm, hand, neck, face, and scrotum), the neck was the only one with a statistically significant increase in PAH levels (round 1).

- Several aromatic hydrocarbons were significantly elevated in breath after firefighting (both rounds).

- Increasing personal air concentrations of PAHs were correlated with...
  - Increasing “3 h vs. pre” change in urinary PAH levels (round 1)
  - Increasing “post vs. pre” change in breath levels of benzene (round 2)

- Increasing off-gas concentrations of benzene, toluene, ethyl benzene, xylenes, and styrene (BTEXS) were correlated with...
  - Increasing “post vs. pre” change in breath levels of BTEXS (round 2)
Absorption Routes for BTEXS

- **Could have been inhaled during doffing of gear**
  - Doffing took just a few minutes
  - Would only contribute partially based on compartmental model

- **Could have been absorbed through skin**
  - BTEXS vapor can be absorbed through skin\(^1,2,3\)
  - Increased skin temperature, sweat, and humidity can increase absorption\(^1,3\)
  - Animal study showed dermal uptake and exhalation of benzene within 30 min\(^4\)

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2. Hanke J et al. (1961)
4. Thrall et al. (2000)
Absorption Routes for PAHs

- PAHs (except naphthalene) have low volatility so inhalation exposure during doffing of gear is unlikely

- Absorption through skin
  - 20–56% absorption has been reported\(^1\)
  - Faster absorption for thinner skin (e.g., scrotum and neck\(^2\)
  - Neck skin most exposed area of body

1. VanRooij et al. (1993)
Biological Relevance

- 3 h post exposure urinary PAH levels were comparable to nonsmokers without occupational PAH exposures\(^1\)
  - Participants were nonsmokers and told to avoid eating char-grilled foods

- Post-exposure breath concentrations of benzene were comparable to nonsmoking automobile mechanics after 4 h of work\(^2\)
  - Amount of uptake was not enough to cause an increase of benzene metabolite in urine

---

1. Osborn et al. (2011); Smith et al. (2011)
2. Egeghy et al. (2002)
Comparison with Recent Studies

- **Fluorescent aerosol study**¹
  - Neck most exposed

- **University of Cincinnati dermal exposure study**²
  - Measured similar PAH levels on neck and face wipes

- **Australia turnout gear study**³
  - Found similar levels of BTEXS off-gassing from contaminated turnout gear
  - Of all contaminants tested, HCN was the highest (by factor of 10)
  - Laundering returned levels to background

---

1. Jeff Stull, RTI study commissioned by IAFF
2. Baxter et al. (2014)
Conclusion

- Even when firefighters wear the highest level of dermal and respiratory protection available...
  - Biological uptake of PAHs and BTEXS can take place
  - For PAHs, the route of absorption is most likely through neck skin
  - For benzene, the route of absorption may be through skin, inhalation of off-gassing contaminants, or both

- Biological uptake will vary according to:
  - Air concentrations
  - Response duration
  - SCBA use
  - How gear is maintained and worn

What would we find in real world conditions?
Current Work

DHS-funded study
Assessing chemical exposures and cardiovascular changes when fighting a fire with modern furnishings

- June 2015
- Conducted air, dermal exposure, and biological monitoring (breath, urine, blood)
- Measured turnout gear contamination
- Analytes:
  - PAHs, VOCs, HCN, flame retardants, dioxins/furans, perfluorinated compounds, particulates
- Explore exposures and physiological outcomes by:
  - Tactical response (interior attack vs. transitional attack)
  - Assignment
  - Use of SCBA
  - Field decontamination of gear
  - Cleaning of skin

Video
Flame Retardants (FRs), Dioxins/Furans, and Perfluorinated Compounds (PFCs)

- FRs are ubiquitous and have been found on used turnout gear\(^1\)
- PFCs are often used in stain resistant and non-stick coatings\(^2\)
- Firefighters can have higher levels of these compounds than general population\(^3\)
- Persistent with long biological half-lives (weeks to years)
- Animal studies have shown adverse effects to the thyroid, liver, and immune system, as well as neurobehavioral and developmental alterations\(^4\)
- Health effects in humans are not well understood

2. NIEHS (2012) PFCs
3. Shaw et al. (2013); Park et al. (2015)
4. ATSDR (2004) Toxicological Profile for PBDEs; Brewster et al. (1989); Birnbaum et al. (2003)
What can be done now to protect firefighters?

**To minimize dermal exposures:**
- Clean visibly soiled gear that could contact skin
- Wash hands or other contaminated skin and shower as soon as possible following a response
- Put on clean station uniforms after showering
- Launder hoods / hood exchange program
- Routine laundering and decon of turnout gear (?)

**To minimize inhalation exposures:**
- Wear SCBA
- Rehab away from off-gassing gear
- Do not store gear in personal vehicles
- Remain upwind of fires if not directly involved in fire response
- Provide natural ventilation to structures after suppression
For More Information

- NIOSH HHE Report 2010-0156-3196

Also lookout for articles in *Fire Engineering* and *Fire Protection Engineering*
Thank you!

Kenny Fent, PhD, CIH
LCDR, U.S. Public Health Service
National Institute for Occupational Safety and Health
Cancer in the Fire Service: Policy Implications

Virginia M. Weaver, MD, MPH
Associate Professor, Environmental Health Sciences and Medicine
Johns Hopkins University
How Do We Decide Which Chemicals Cause Cancer?

• The International Agency for Research on Cancer (IARC)
  – Part of the World Health Organization (WHO)
  – Authoritative agency on cancer causation
### IARC Carcinogens in the Fire Fighting Environment

<table>
<thead>
<tr>
<th>Group 1 agents (known to cause cancer in humans)</th>
<th>Group 2A agents (probable human carcinogens)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Arsenic</td>
<td>• Creosote</td>
</tr>
<tr>
<td>• Asbestos</td>
<td>• Wood combustion products</td>
</tr>
<tr>
<td>• Benzene</td>
<td>• Shift work</td>
</tr>
<tr>
<td>• Benzo[a]pyrene</td>
<td></td>
</tr>
<tr>
<td>• 1,3-butadiene</td>
<td></td>
</tr>
<tr>
<td>• Formaldehyde</td>
<td></td>
</tr>
<tr>
<td>• Dioxin</td>
<td></td>
</tr>
<tr>
<td>• Soot</td>
<td></td>
</tr>
<tr>
<td>• Diesel engine exhaust</td>
<td></td>
</tr>
</tbody>
</table>
Connecting Exposure to Cancer

• Animal studies

• Human epidemiology studies
  – Cancer in fire fighters
    • Death certificates or cancer registries
    • Compare rates of cancers in fire fighters to non-fire fighter comparison groups or less exposed fire fighters
  – Similar exposures or fire fighter occupation in patients with specific types of cancer
Biologic Plausibility of Disease Pattern Seen

• Does type of cancer excess make sense in terms of:
  – **Sufficient latency** (passage of time from onset of exposure to disease development)
  – Agent and route of exposure
  – Dose and duration of exposure
  – Pattern of organ site excess
    • Consistent with animal data
    • Consistent with other populations exposed to same agent
http://www.surgeongeneral.gov/library/reports/50-years-of-progress/exec-summary.pdf; latest cancers causally linked in red
Relevant Epidemiologic Studies

• Meta-analysis - research technique combining multiple studies
  – Increased power to detect risk with more participants
  – Quality, consistency of data

• LeMasters, JOEM, 2006
  – Combined data in 32 studies of fire fighters for 20 different cancer types
    • Risks for 10 types of cancer (50%) were significantly increased in fire fighters
    • Risks for the other 10 were increased but did not reach statistical significance
Other Recent Studies

• Cohort study of cancer incidence (diagnosis) in 16,422 fire fighters from 5 Nordic countries
  – National cancer registries linked to census data on occupation from 1961-2005
• Cohort study of cancer mortality and incidence in fire fighters from 8 Australian agencies
  – Full-time (n=17,394), part-time (n=12,663) and volunteer (n=163,159) from ~1980-2010 (depending on agency data)
  – Strong healthy worker effect
    • All cause death decreased (FT FF = 0.67, 0.6-0.7)
    • Relatively short follow-up

Pukkala, OEM, 2014; http://www.coeh.monash.org/ausfireftr.html
Other Recent Studies

• Cohort study of cancer incidence in 29,438 Korean fire fighters
  – Limitations common to other studies
    • Mean job duration as a firefighter was 12 years
    • Limited power due to small numbers (N ≤ 20 for 3 of 4 significant cancers and only total 446 cancer diagnoses)

• Case–control study using California Cancer Registry data (1988–2007)
  – 3,996 male fire fighters with cancer

Ahn et al. AJIM, 2012; Tsai et al. AJIM, 2015
Which Cancers Are Work-related in Fire Fighters?

- No updated meta-analysis
  - Study quality
- Consider consistency across studies
<table>
<thead>
<tr>
<th>Cancer</th>
<th>LeMasters</th>
<th>NIOSH</th>
<th>Nordic</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bladder</td>
<td></td>
<td>*</td>
<td></td>
<td>K</td>
</tr>
<tr>
<td>Brain</td>
<td>✓</td>
<td></td>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Colon</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>K</td>
</tr>
<tr>
<td>Kidney</td>
<td></td>
<td>✓</td>
<td></td>
<td>C, K</td>
</tr>
<tr>
<td>Lung</td>
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<tr>
<td>Melanoma</td>
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<td></td>
<td>✓</td>
<td>A, C</td>
</tr>
<tr>
<td>Mesothelioma</td>
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<td>✓</td>
<td>*</td>
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<tr>
<td>Multiple myeloma</td>
<td>✓</td>
<td></td>
<td>*</td>
<td>C</td>
</tr>
<tr>
<td>NHL</td>
<td>✓</td>
<td>*</td>
<td></td>
<td>K</td>
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<tr>
<td>Prostate</td>
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<td>✓</td>
<td>A, C</td>
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<tr>
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<td>✓</td>
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<tr>
<td>Stomach</td>
<td>✓</td>
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<td>*</td>
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</tr>
<tr>
<td>Testis</td>
<td>✓</td>
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</tbody>
</table>

Significant ✓ overall or in *specific age group; A=Australia, C=California, K=Korea; Cancers listed if significant in ≥ 2 studies
Challenges in Epidemiologic Studies in Fire Fighters

- Exposure misclassification
  - Exposure variability by fire
  - No perfect exposure estimate
    - Last held job, longest held job, duration of fire fighting
  - Death certificates and cancer registry data often have missing or inaccurate work histories
  - This limitation a key reason IARC classified fire fighting as possibly carcinogenic (2B) to humans
  - NIOSH study – optimized for available data

http://monographs.iarc.fr/ENG/Monographs/vol98/mono98.pdf
Challenges in Epidemiologic Studies in Fire Fighters

• Healthy worker effect
  – Fire fighters on average are healthier than many comparison groups
    • In the LeMasters study, fire fighters have a 10% lower risk of dying from all causes at a given age than the general population
    • Equal risk (RR = 1) actually 10% higher risk
    • Huge impact in the Australian study

• Small studies
  – Fire fighting is not a common occupation
  – Each cancer is a different type with different causes
    • Prostate ≠ colon ≠ brain ≠ lung
  – True risk may not be statistically significant because too few cases
Study Population Sizes

- NIOSH
  - 3285 deaths; 4461 diagnoses; 858,938 person-years
- Nordic
  - 2536 diagnoses; 412,991 person-years
- Australian (male, full-time firefighters)
  - 329 deaths; 1208 diagnoses
- Korean
  - 446 diagnoses; 313,666 person-years
- LeMasters (uncertain due to different study types)
  - 4535 deaths; 367 diagnoses
Challenges in Epidemiologic Studies in Fire Fighters

• Lack of data on other cancer risk factors
  – Smoking
  – Family history
  – Diet
  – Other exposures
Impact of Challenges

• All except lack of data on other cancer risk factors result in underestimation of true risk
  – Cancer risks in fire fighters may appear the same or less than the comparison group
  – Statistical significance is not achieved

• Effect size issue – What is risk of lung cancer from environmental tobacco smoke?
  – ~ 1.25

Presumptive Legislation

• Presumptive Legislation Does:
  – Remove the burden for proof of causation from the affected fire fighter
  – Allow for individual case evaluation

• Present in > 30 US states, Canadian provinces, Australia

• Presumption Legislation Does NOT:
  – Guarantee a fire fighter who develops cancer will be covered by workers’ compensation
Presumptive Legislation

- Other factors may have a greater role in causation
  - Smoking, inadequate exposure duration
  - Estimates that 4-10% of all cancer is occupational, higher in chemically exposed populations
- IAFF assistance
Canadian Presumptive Examples

- Minimum years of fire fighting
- Smoking exclusions
- Manitoba similar but also includes lung and skin cancer

<table>
<thead>
<tr>
<th>Cancer</th>
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<tbody>
<tr>
<td>Bladder</td>
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<td>NHL</td>
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<td>Prostate</td>
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</tbody>
</table>

http://www.wsib.on.ca - Cancers in Firefighters and Fire Investigators; Doc # 23-02-01
Workers’ Compensation

- Workers’ compensation burden of proof is 51% rather than the 95% used in scientific studies
  - More likely than not

- Individual causation complex

- IAFF can be of assistance
  - Documents summarizing
    - Exposure in fire fighters
    - Science on risk for specific cancers for these occupational exposures
Thank you

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CANCER AWARENESS: What’s Next?

Lawrence G. Petrick Jr.
Deputy Director Occupational Health & Safety
International Association of Fire Fighters
Colon
Lung
Melanoma
Mesothelioma
Multiple myeloma
Non-melanoma skin cancer
Prostate
Rectal
Non-Hodgkin’s lymphoma
Stomach
Evaluation of Dermal Exposure to Polycyclic Aromatic Hydrocarbons in Firefighters

Kenneth W. Ganz, Ph.D., CHI
John Hodge, M.D., M.P.H.
Deborah Barnett
Shawn Harbison
Graud Sutcliff, Ph.D.
John Butcher, M.S.
Mark Kuchler
Eugene Pelletier
Matthew Sipress, Ph.D.
Gwen Pilcher, Ph.D.

Report No. 2010-01706-S1096 Summary
December 2010

Health Hazard Evaluation Program

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FIREFIGHTER EXPOSURE TO SMOKE PARTICULATES
(2013 IAFD Grant #1764F-2013-EP-92093)

Final Report
Project Identifier: OSHA-1764F
Fire Number: DI-1764F

April 1, 2012

Prepared by:
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An independent organization working for a safer, greener world through standards, verification, and knowledge.
PM 2.5
Combustion particles, organic compounds, metals, etc.

< 2.5 μm (microns) in diameter

PM 10
Dust, pollen, mold, etc.

< 10 μm (microns) in diameter

HUMAN HAIR
50-70 μm (microns) in diameter

90 μm (microns) in diameter
FINE BEACH SAND

Image courtesy of the U.S. EPA
NFPA

Investigation of Turnout Clothing Contamination and Validation of Cleaning Procedures
FIRE STATION DUST STUDY

In conjunction with UC Berkeley

Flame retardant particles
Cancer Awareness and Prevention
On-Line Course

Module 1: What is cancer and what causes it?
Module 2: Exposures to carcinogens in the firefighting environment
Module 3: Cancers associated with firefighting: know your risks
Module 4: What you can do to reduce your risks
Module 5: Exposure tracking
Module 6: Expectations for the fire service
Module 7: What to do after a cancer diagnosis
What Are You Doing?
Thank you

Lawrence G. Petrick Jr.
Deputy Director Occupational Health & Safety
International Association of Fire Fighters
Two Chances to Win an iPad Mini!

When you submit your workshop and overall evaluations, you are automatically entered in two drawings for an iPad mini!

Winners will be announced September 7, 2015.
Fill out your workshop evaluations using the 2015 IAFF app:

- Login to the Frontline App
- Select the 2015 Redmond/EMS Menu
- Go to “My Agenda”
- Go to “My Workshop” and select the title of the workshop you are attending
- Select the “Click here” link next to Evaluation
- Complete the evaluation – be sure to answer all questions that are required (*)
- Click Submit

*You will receive a message on screen that the form was submitted successfully. If there is an error message, correct the errors and resubmit.

Thank you!