

Cancer in the Fire Service: Policy Implications

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Overview

- Fire fighters are exposed to occupational cancer risks
 - Carcinogens in smoke
 - Limitations of protective equipment
- Evidence that fire fighters have an increased risk of certain cancers
- Actions to reduce risk and assist affected fire fighters

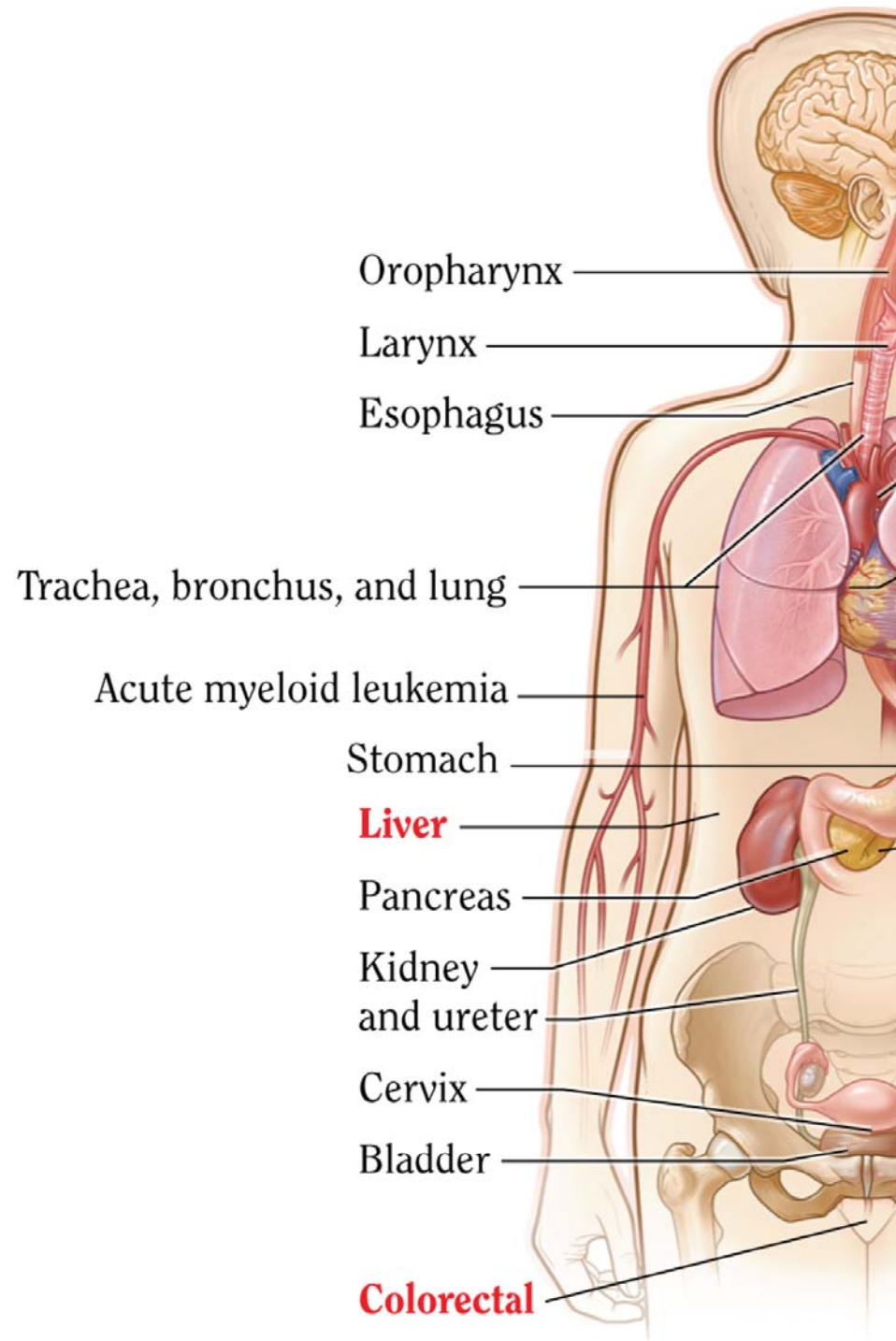
Concern Regarding Occupational Exposures of Fire Fighters

- During fire suppression and overhaul, fire fighters encounter smoke that contains combustion products
- Complex mixture of cancer causing chemicals





The Health
Consequences of
Smoking
—50 Years of Progress.
A Report of the Surgeon
General; 2014
<http://www.surgeongeneral.gov/library/reports/50-years-of-progress/exec-summary.pdf>; latest
cancers causally linked in
red



Exposure Duration/Characterization

- Chronic – over working lifetime
- Uncontrolled environment
- Air contaminants measured at structural fires
 - Benzene detected in 181 of 197 (92%)
 - Air sampling units placed on chests
 - Almost 15% of the samples were found to be at or above the Short Term Exposure Limit (STEL) of 5 ppm benzene
- Air contaminants measured during overhaul
 - Formaldehyde > ceiling value at 22/25 fires
 - Benzene > STEL at 2/25 fires

Exposure Comparisons

- Majority of US workplaces
 - Exposed jobs
 - Outsourced to low or middle income countries
 - Workplace controls
- Hierarchy of exposure controls
 - Substitution
 - Fiberglass for asbestos, toluene for benzene
 - Enclosure
 - Ventilation – general or local
 - Administrative controls
 - Reduced work hours, training

Personal Protective Equipment (PPE)

- Lowest on hierarchy of controls
- Increasingly protective models but still limited
 - SCBA traditionally not used in overhaul to better detect re-ignition potential
 - Not 100% effective
 - Dermal absorption
 - Neck, seams



Recent Data on Exposure

- Synthetic materials generate more smoke than wood
- Concentrations of combustion products vary tremendously depending on
 - Size; materials involved (synthetic versus wood); ventilation conditions
- Numerous carcinogens detected
 - Benzene, formaldehyde, arsenic, chromium, PAHs in soot

<http://www.ul.com/global/eng/pages/offerings/industries/buildingmaterials/fire/fireservice/smokeparticulates/>

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

Group 1 agents (known to cause cancer in humans)

- Arsenic
- Asbestos
- Benzene
- Benzo[a]pyrene
- 1,3-butadiene
- Formaldehyde
- Dioxin
- Soot
- Diesel engine exhaust

Group 2A agents (probable human carcinogens)

- Creosote
- Wood combustion products
- Shift work

Connecting Exposure to Cancer

- How do we determine if these exposures result in an increased risk for developing cancer in fire fighters?

Overall Cancer Risk

- Cancer is the second leading cause of death in the United States (after heart disease)
- Cancer takes years to develop (latency)
- There are multiple factors that affect a person's risk for developing cancer e.g., smoking, diet, genetics/family history, environmental exposures, etc.

Which Cancers Are Work-related in Fire Fighters?

- 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

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
- NIOSH, Nordic, Australian

Relevant Epidemiologic Studies

- Ahn et al. Cancer Morbidity of Professional Emergency Responders in Korea, AJIM, 2012
- Despite title, fire fighters comprised 88.1% of cohort (n = 29,438)
 - Mean job duration as a firefighter was 12 years
- Significantly increased standardized incidence ratios for colorectal, kidney, and bladder cancer and non-Hodgkin's lymphoma although only 446 cancer diagnoses
 - Risk not different by exposure duration dichotomized by 10 years
 - Bladder cancer exception but only 1 case < 10 y
- Same limitations as Dr. Daniels noted for other studies
 - Limited power due to small numbers (N ≤20 for 3 significant cancers, limited exposure and other risk factor data, relatively short follow-up given cancer latency)

Challenges in Epidemiologic Studies in Fire Fighters

- Exposure Misclassification
- Healthy Worker Effect
- Small Study Sizes



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

Healthy Worker Effect

- Fire fighters must enter the workforce very fit and healthy in order to perform such physically demanding work
- Must maintain physical ability
- 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
- 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

Impact of Research Hurdles

- All result in underestimation of true risk
 - Cancer risks in fire fighters appear the same or less than the comparison group
 - Statistical significance is not achieved
- Effect size – Environmental tobacco smoke and lung cancer with increased risk of ~ 1.25

Increased Cancer Risks

- In the absence of a new meta-analysis, one option:
 - Increased risk overall or in a specific age group in at least 2 studies (LeMasters, NIOSH and Nordic)
 - All cancers as a group
 - Colon
 - Lung
 - Melanoma
 - Mesothelioma
 - Multiple myeloma
 - Non-Hodgkin's lymphoma
 - Non-melanoma skin cancer
 - Prostate
 - Rectal
 - Stomach
 - Bladder and kidney if Korean study also used

Policy Implications

- Exposure prevention
- Cancer prevention
- Presumptive legislation and workers' compensation

Exposure Prevention

- Exposure prevention
 - Personal Protective Equipment such as self-contained breathing apparatus (SCBA – respirators)
 - Even during overhaul
 - Clean PPE, shower
 - Continued research to improve PPE
 - Diesel exhaust containment

Cancer Prevention

- Cancer risk prevention
 - Don't smoke!
 - Diet – more fruits, vegetables, and whole grains (fiber), less fried and fatty foods
 - Exercise regularly
 - Weight control
 - Alcohol in moderation
 - Sunscreen
 - Wellness – Fitness in the Fire Services - screening

Presumptive Legislation and Workers' Compensation

- Presumption Legislation Does NOT:
 - Guarantee a fire fighter who develops cancer will be covered by workers' compensation
 - Other factors may have a greater role in causation
 - smoking
- Presumptive Legislation Does:
 - Remove the burden for proof of causation from the affected fire fighter
 - Allow for individual case evaluation
- Workers' compensation burden of proof is 51% rather than the 95% used in scientific studies

Questions

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