National League of Cities

ASSESSING STATE FIREFIGHTER CANCER PRESUMPTION LAWS AND CURRENT FIREFIGHTER CANCER RESEARCH

April 2009
Revised

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Table of Contents

List of Tables

PREFACE

TriData, a division of System Planning Corporation, was asked by the National League of Cities (NLC) to examine the status of firefighter cancer presumption laws in the United States and to investigate whether there is adequate scientific research to determine if firefighters face a higher risk of developing cancer than the general population.

In March of 2008, the TriData study team leaders met with the NLC Presumption Task Force in Washington, D.C. to present an initial proposal to assist state municipal leagues with the challenges faced by firefighter cancer presumption legislation. The formal proposal included an analysis of state presumption laws, a review of pertinent scientific literature, identification of expert witnesses, and the identification of municipal liabilities created by these laws.

In June of 2008, the study team met with the NLC staff to determine a statement of work and to execute a contract for services. On October 25, 2008, preliminary study findings were presented at the National League of Cities Risk Information Sharing Consortium seminar in San Diego, CA. The enclosed report represents the study findings on firefighter cancer presumption in the United States. The report is based on the study team's analysis of the current state legislation and scientific information currently available. Included are suggested actions for NLC's consideration.

TriData has undertaken research on topics of interest to the fire service for over 25 years. Founded in 1981 under the premise that day-to-day decision-making, policy initiatives, and program evaluation must be grounded in well-articulated research and analyses of data, TriData has become known in the national and international fire world for technical excellence, responsibility, and objectivity.

The authors would like to thank Maria Argabright and Alexis Bobrik for their assistance in the production of this report.

EXECUTIVE SUMMARY

Introduction

Cancer, the second leading cause of death in the United States in 2005, affects millions of Americans each year. According to the National Cancer Institute, 1 in 2 men and women born today will be diagnosed with cancer at some time during their lifetime. This research project's primary goal was to investigate whether there is adequate scientific research to determine if firefighters face a higher risk of developing cancer than the general population.

Forty-three states have enacted laws that allow firefighters and emergency medical services (EMS) providers who develop certain injuries, illnesses, and diseases to qualify for workers' compensation and certain other benefits under a presumption that the injuries, illnesses, and diseases are work-related. Cancer is one of the diseases covered in 24 state presumption laws. Eight other states have pending cancer presumption legislation.

Presumption is a concept that assumes that certain injuries, illnesses, or diseases are a consequence of work and are compensable without evidence provided by the employee that the affliction is work-related. Normally, employees must prove that their injuries, illnesses, or diseases are caused by the work or workplace conditions.

Employers may be able to dispute (rebut) a presumption claim and deny benefits under the workers' compensation program if the law creates a rebuttable presumption. However, the employer must prove that the injury, illness, or disease could not have resulted from work—a standard that is, at best, very difficult to meet. The passage of a presumption statute could result in cities and towns paying for workers' compensation benefits for employees and others who may have developed cancer irrespective of their employment as firefighters.

Few will disagree that firefighting is a dangerous profession. With the significant cost to cities and towns of cancer presumption and recognizing questions about the fairness of preferential treatment for one group of employees when other groups may have similar exposures to dangers and hazardous substances, there is concern that conclusive evidence is lacking to demonstrate a causal relationship between firefighting and cancer.

Purpose of the Study

This research report, prepared by TriData Division, System Planning Corporation, seeks to determine whether there is adequate scientific evidence linking firefighting and cancer to justify the adoption of state cancer presumption statutes by asking five basic questions:

1. What is the current status of state firefighter and EMS provider cancer presumption laws?

2. What is the quality of peer-reviewed and non-peer-reviewed firefighter/EMS literature on cancer presumption?
3. What are the differences in cancer rates between firefighters or EMS providers and the general public for cancers covered by presumption laws?
4. What are the potential costs of cancer presumption laws to municipalities?
5. Who are the recognized experts in the area of cancer presumption laws?

Firefighter Cancer Presumption Issues and Considerations

There are many issues that influence the perceptions of and reactions to firefighter cancer presumptions and all need to be considered when dealing with the enactment of legislation and the consequences of creating presumption laws. The most significant issues are:

1. **Social Issues.** Fire and EMS professionals enjoy a special place in the hearts of Americans. Firefighting is considered one of the most prestigious jobs in the United States. Given the high esteem in which firefighters are held and the respect the public has for the risks they face, the arguments offered by proponents of cancer presumption are compelling.
2. **Occupational Disease.** Assigning the origin of a disease to specific employment is problematic because outside activities may also contribute to the disease. For example, career firefighters may have part-time positions and volunteer firefighters may have full-time jobs that contribute to the developing cancer.

   Some individuals may have a genetic, congenital, or behavioral predisposition that may be impossible to differentiate from workplace exposures.
3. **Technology.** Technological advancements such as self-contained breathing apparatus and increased enforcement of department policies requiring the use of protective equipment will raise questions about presumption in the future. The relationship between safety equipment and the incidence of cancer in firefighters may be affected by technological advancements.
4. **Economic.** One of the greatest issues involving firefighter presumption is the cost of a state-mandated program that is borne by municipal employers. Firefighters are often eligible for benefits for many years, even after retirement. Even if there is a limitation tied to retirement, volunteer firefighters often do not retire and the eligibility period is longer. This is significant because the National Fire Protection Association estimates that over 70 percent of all firefighters are volunteers.

   Two other economic issues are the inability to forecast accurately the short-term and long-term costs of presumption claims and the inability to manage healthcare costs in the workers' compensation system. The medical cost component of workers' compensation has risen at twice the rate of medical cost inflation and is projected to continue the trend well into the next decade.

For the firefighter, medical coverage under most healthcare systems results in some financial liability. However, financial liability assigned to the employee for a work-related injury can be regarded as an assessment of fault, which is contrary to workers' compensation principles.

Because cancer is widely prevalent in the general population, the adoption of presumption statutes for firefighters means that cities may be extending workers' compensation benefits to individuals who would have developed cancer even if they were not firefighters. Moreover, this transfer of medical expenses to the workers' compensation system from the healthcare system has serious cost implications. Payments for workers' compensation claims are assigned to the policy in effect when a claim is filed. When the policy is written, the insurer must take into account all future costs and possible changes in the laws. Pricing this unknown future liability is problematic and puts insurers' capital at risk. As a result, the private market for insurance may no longer be available.

5. **Extension of Worker Benefits.** Municipalities have a vested interest in assuring that job-related benefits are awarded in the appropriate situation because of the additional benefits that are available to employees with cancers that are deemed work-related. These benefits include accident-related illness/injury leave, tax-free workers' compensation, temporary total disability payments or permanent partial disability payments, special death benefits, extension of pension benefits, continuation of health benefits, and more.

6. **Equity Concerns.** There are questions about the fairness of one class of employees obtaining expanded benefits when other municipal employees (sanitation workers, automotive fleet personnel, and others) may also be exposed to hazards similar to firefighters.

7. **Political.** Political pressure to pass cancer presumption legislation has often resulted in laws and regulations that lack traditional scientific validity or financial stewardship.

Common Provisions in Cancer Presumption Statutes

The report analyzes the laws in 24 states that have a cancer presumption benefit focusing on:

1. **Eligible Personnel.** Some laws apply to firefighters, others to firefighters and EMS providers. Another distinction in the laws is the treatment of career and volunteer firefighters.
2. **Cancers Covered.** Some laws refer to "all cancers," while others refer to system-based cancers such as the central nervous system or the digestive system, and others list specific cancers such as bladder, brain, and colon.
3. **Age Limits.** Most statutes are silent on age limits, but a few have provisions such as limiting coverage until age 65.
4. **Minimum Length of Service.** Some states have a minimum length of service requirement for an employee to qualify for benefits under the cancer presumption statute. For example, some states don't provide the benefit unless the firefighter has at least five years of service.
5. **Retroactive Coverage.** A few states extend benefits retroactively to employees.
6. **Post-Employment Eligibility.** The length of time of post-employment eligibility can be a number of months to the lifetime of the employee.
7. **Physical Examination.** The requirement for a physical examination prior to employment or sometime during employment is not uncommon. Volunteer firefighters eligible for the benefit may not be required to have a physical exam.
8. **Tobacco Use.** Many states list tobacco use as a provision for the employer to rebut the presumption claim. The claimant may be denied benefits under the presumption statute.
9. **Provisions for Rebuttal.** Most state laws provide some type of rebuttal provision that allows for the denial of a claim. For an employer to rebut the claim, the burden of proof is transferred from the employee to the employer.
10. **Cancerous Agents and Exposure Classification.** States rely on various organizations to provide definitions for what may qualify as a cancer-causing exposure.

Epidemiological Research on Firefighters and Cancer

A critical part of the study was the investigation of published information involving firefighters and cancers that have been diagnosed in the firefighter population. A literature review was conducted to determine what cancers have been studied, who studied the cancers, what specific geographic areas/regions have been investigated, and what conclusions were made based on the scientific research that was conducted.

To ensure that the published research represented the current status and scope of the research problem, only relevant documents published between 1995 and 2008 were reviewed. Of the thousands of cancer studies conducted during this period, 71 addressed firefighters and cancer. These documents were further classified based on their scientific value. Of these 71 documents, 17 identified firefighting as a possible risk factor for cancer and were determined to have met accepted scientific methods. Essentially one peer-reviewed study was published each year in the last 14 years.

Of the 35 categories of cancers identified in the 17 studies, the following levels of association were found between firefighting and cancer:

1. 10 strong associations
2. 15 moderate associations
3. 23 weak associations
4. 185 no associations
5. 1 unable to establish an association

The researchers noted several study limitations and concluded that due to the lack of high-quality research studies done on firefighting and its possible cancer risks, the current research studies need to reconsider their findings and possible associations because, as a general rule, the current studies reference the results and findings of earlier studies that have limitations. The limitations discussed are:

1. Studies usually had homogeneous populations and did not take into account career/volunteer status or suburban/rural firefighters.
2. Small sample sizes prevented research results from achieving statistical significance.
3. Patients in studies were lost to follow-up, making long-term outcomes difficult to determine.
4. Many commonly occurring cancers were not studied.
5. Cancers that are exclusive to women were studied least.

Major Research Findings

Overall, the researchers concluded that there is a lack of substantive scientific evidence currently available to confirm or deny linkages between firefighting and an elevated incidence of cancer. Although several studies found supporting associations between firefighting and bladder, brain, colon, Hodgkin's lymphoma, kidney, malignant melanoma, multiple myeloma, Non-

Hodgkin's lymphoma, prostate, testicular, thyroid, and ureter cancers, the researchers found that considerable research needs to be undertaken before definitive linkages can be supported or refuted. Due to the inconsistency between studies regarding the establishment of associations and the strength of the associations, the research team could not support or refute firefighting as a cause of cancer for firefighters.

The research studies provide solid groundwork from which future studies can be developed and improved, but there were weaknesses in the literature. To establish any substantial conclusions about the risk of firefighting to cancer development the researchers recommend that steps be taken to deal with study limitations by removing sources of potential bias from the study designs and methodology. It is also important to develop a standardized measurement of risk estimates that can be comparable to past studies and provide guidelines for other similar studies.

The number of cancer research studies that investigate firefighting as a potential risk factor for cancer incidence is extremely small when compared to the overall amount of cancer research done every year within the United States. A drawback is the lack of firefighter cancer incidence rates in the literature. This gap limits accurate analyses on the magnitude of cancer occurrence in the firefighter population and on the potential costs to treat.

With respect to the evaluation of state laws, the researchers found that state presumption statutes are not uniform—varying greatly between states in both cancers addressed and the requirements necessary to receive benefits. Generally, the laws are also inconsistent with the scientific evidence currently available.

Experts in cancer presumption could not be identified. The researchers did not find any individuals who could be considered experts in presumption because the issue of presumption is complex, transcending the areas of epidemiology, law, human resource management, labor, and politics.

Finally, there are currently no estimates available on the financial magnitude of firefighter cancer presumption state mandates. There are no estimates on the number of firefighter cancer presumption claims and no estimates on the overall costs associated with firefighter cancer claims. Furthermore, it is not possible to estimate what the cost of a regimen may be that provides a lifetime of care for a medical condition that may be diagnosed today. There also is no certainty on the kinds of cancers that may be covered in the future as state laws may be modified.

Areas for Further Consideration

The researchers identified some policy questions that merit further consideration for implementation or provisions for inclusion in state presumption statutes:

1. What actions can municipalities take to require and encourage the use of safety equipment?

2. What actions can municipalities take to curtail smoking by career and volunteer firefighters?
3. Should municipalities take actions to eliminate or limit second jobs held by firefighters that may increase the probability that firefighters develop cancer?
4. How should volunteers be treated under the presumption laws since they often never retire from service?
5. Are firefighters' exposures significantly less now that fire departments are responding to fewer fires and are spending a greater percent of their on-duty time responding to EMS and other calls? According to the National Fire Protection Association, 60 to 90 percent of a fire department's service calls now involve EMS.
6. Should state laws combine substantial minimum service requirements and pre-employment physicals and health histories to protect employers from bearing the responsibility for non-work related cancer?
7. Should state laws take into consideration firefighter duty assignments which can lead to different levels of exposure?
8. Should firefighter cancer medical costs be shifted from the workers' compensation system to the healthcare system? Treatments in the healthcare system are more carefully managed and pricing is more responsive to changes in medical techniques as well as changes in the cost of medicines. This might help municipalities cope with burgeoning medical costs.

Recommendations

The researchers made the following recommendations for collaborative efforts by governmental organizations, scientists, firefighters, municipalities, national associations, and others on firefighter and cancer research:

1. Undertake a large, longitudinal study of firefighters that tracks the same type of information on the same subjects at multiple points in time.
2. Establish a national firefighter cancer database that collects detailed data on firefighters diagnosed with cancer.
3. Establish public-private partnerships to guide cancer research.
4. Work with the Congressional Fire Service Caucus to secure funding for a clearinghouse for fire service research.
5. Encourage unbiased research at institutions of higher learning.

CHAPTER I: INTRODUCTION

Forty-three states have enacted laws that allow firefighters and emergency medical services (EMS) providers who develop certain diseases to qualify for workers' compensation benefits under a presumption that the disease is work-related. Proponents of the presumption laws observe that firefighters and EMS providers put their lives on the line to protect their communities and merit the protection these laws afford the first responder. The degree to which certain diseases are work-related, however, has been questioned.

Originally limited to cardiac and respiratory diseases, these state presumption laws apply to career and, in some states, volunteer firefighters. Recently, presumption coverage has been expanded to include EMS providers and more volunteer firefighters as well as certain cancers and other diseases. The financial costs of cancer treatment are a burden to those diagnosed with cancer, their families, and society as a whole. As states consider expanding presumptive coverage for firefighters and other first responders for cancer, illnesses, and other diseases, it is appropriate to consider both the impact of these new laws on municipalities and the validity of the presumptions. Because of the additional cost liabilities for cities and risk pools associated with the inclusion of cancer in presumption statutes, this is an area of considerable interest.

Cancer, the second leading cause of death in the United States in 2005, affects millions of Americans each year.[1]According to the National Cancer Institute's sample registries, approximately 1 in 2 men and women born today will be diagnosed with cancer at some time during their lifetime.[2,3] This research seeks to determine the scientific validity of cancer presumption for firefighters and answer the fundamental question of whether there is sufficient justification for presumptive statutes. Lacking the information to identify the frequency of cancer occurrence and the costs of medical care and benefits cancer presumption incurs, municipalities cannot plan to meet these mandated obligations. Lacking the scientific validation of cancer presumption, municipalities question why these obligations are mandated.

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[1] U.S. Centers for Disease Control, National Vital Statistics Reports, 56(10); 1. April 28, 2008. http://www.cdc.gov/nchs/data/nvsr/nvsr56/nvsr56_10.pdf.

[2] The National Cancer Institute's cancer data is collected from 17 cancer registries that attempt to represent the composite U.S. demographics. It is not a statistically selected sample although it attempts to represent a balanced population profile.

[3] National Cancer Institute, *SEER Stat Fact Sheets*, http://seer.cancer.gov/statfacts/html/all.html, all cancer sites, invasive cancers only, accessed March 31, 2009. Based on data from 2003–2005, the actual probability of developing cancer over a lifetime (up to and beyond age 95) is 40.4 percent. This statistic translates to 2 in 5 men and women will develop cancer in their lifetime. For men, the probability of developing cancer is higher (43.9%), more closely matching the "1 in 2" approximation noted on the *Fact Sheet.* The average life expectancy in the United States in 2005 was 77.8 years; the probability of developing cancer during the average lifetime is approximately 30 percent (26.4% at age 75; 31.9% at age 80).

Presumption and Workers' Compensation

What is Presumption?

Presumption of injury, illness, or disease is a concept under workers' compensation law that certain disease or illness claims are compensable without evidence provided by the employee that the injury, illness, or disease is work-related. These injuries, illnesses, or diseases are then presumed to be caused by the employment or the work required under the employment. Evidence that the injury, illness, or disease is work-related, therefore, is not necessary or required.

Workers' Compensation and Work-Related Injuries

In general, access to benefits under workers' compensation and other benefit programs depends on whether or not an injury, illness, or disease is work-related. An employee with a work-related injury, illness, or disease can apply for workers' compensation benefits regardless of who was at fault—the employee, the employer, or some other third party. In exchange for these guaranteed benefits, employees usually do not have the right to sue the employer in court for damages for those injuries. In many cases, employee claims may be disputed (rebutted) by employers. In these cases, the employee must produce evidence that the injury, disease, or illness was caused as a result of the work or workplace conditions.

In certain instances, presumption laws fundamentally change the burden of proof in the workers' compensation system. The injury, illness, or disease is presumed to be work-related and the burden of proof on the cause is *shifted* from the employee to the employer. It is the employer who must dispute the claim. To successfully rebut a claim, the employer must produce evidence that the injury, illness, or disease was caused by circumstances other than employment, e.g., prior exposure, pre-existing conditions, lifestyle choice, and the like. Moreover, in some states there is no provision for rebuttal.

Workers' compensation systems vary significantly from state to state. Under most state workers' compensation systems, an employee with a work-related illness or injury generally has access to five types of benefits:

- *Medical benefits* pay for necessary medical care to treat the work-related injury, illness, or disease. The injured employee has the right to reasonable necessary treatment to cure or relieve the effects of the injury. Included under medical treatment compensation are all medical bills, prescriptions, and transportation to the hospital, if necessary.

- *Income benefits* replace a portion of any wages lost because of the work-related injury, illness, or disease. States provide different types of wage-loss benefits. These wage-loss benefits fall into two general categories: temporary disability payments and permanent disability payments, with variations in both categories.

  Temporary partial disability and *temporary total disability* benefits are two types of temporary income-related benefits that may be available. *Temporary partial disability* benefits are payable to an employee who has experienced a work injury and is temporarily disabled, but is still able to earn some wages despite a temporary disability. *Temporary total disability* benefits are generally payable to injured employees who are temporarily prohibited from working, in any capacity, as result of the work injury.

  If the worker cannot completely recover from the effects of a work-related injury, illness, or disease and cannot return to gainful employment, the worker may be entitled to *permanent disability*. The amount and rate at which permanent disability is paid depends on how great a limitation the injury places on the worker's activities. Like temporary disability benefits, permanent disability benefits may be available for *permanent partial* or *permanent total disability*. Elements taken into consideration are age, occupation, and earnings at the time of injury and payments can involve tens of thousands of dollars (usually, as compensation for future wages).

- *Death benefits* replace a portion of lost family income for dependent eligible family members of deceased workers whose work-related injury, illness, or disease resulted in death.

- *Rehabilitation and retraining benefits* are designed to assist an injured employee return to work in some capacity, even if in a different role or outside the employer for whom the employee was working.

- *Burial benefits* pay for some of the deceased employee's funeral expenses.

These benefits are by no means an exhaustive list of the types of benefits that injured workers may be entitled to, and they may not be available in every jurisdiction or payable for the type of disability sustained. They are described here merely as an example of the type and variety of benefits that may be available under workers' compensation.

For gradual onset illnesses and diseases, however, access to workers' compensation benefits may not be as clear cut. In general, the worker must demonstrate that the disease or illness is the result of work or workplace conditions. Presumptive disability laws were developed as a simplifying principle to relieve the employee of a lengthy application process while the employee is in need of benefits and compensation coverage. These laws move the burden of proof from the employee to the employer.

Cancer Presumption

Cancer presumption then is the legal pre-determination that if an employee develops certain types of cancer, it is presumed that the cancer was acquired because of job activities. While benefits assigned under presumption statutes are not automatic—the employee must still file for them—there is no burden of proof for the employee. Employers have limited rebuttal provisions to deny benefits and must prove that the illness was not job connected. If medical benefits are included, as an occupational illness or injury, these benefits become a cost in the workers' compensation system rather than the healthcare system. In the case of firefighters, these presumptive laws can be quite broad. The resulting benefits can be quite expensive to the insuring municipality.

Research Approach

The study team's approach to researching firefighter cancer presumption was to combine recognized professional research techniques with an understandable and usable presentation without loss of scientific rigor. The National League of Cities (NLC) and the study team mutually agreed that the research approach would be objective and that achieving scientifically-based results was the primary goal.

Research Questions

Five basic questions formed the core of the research. In addressing these questions and working towards their answers, the study team was able to investigate how firefighter and EMS provider cancer presumption laws affect local municipalities. These research questions were:

- What is the current status of state-based firefighter and EMS provider cancer presumption laws?
- What is the quality of peer-reviewed and non-peer-reviewed firefighter/EMS literature on cancer presumption?
- What are the differences in cancer rates between firefighters or EMS providers and the general public for cancers covered by presumption laws?
- What are the potential costs of cancer presumption laws to municipalities?
- Who are the recognized experts in the area of cancer presumption laws?

The team followed a two-pronged strategy to answer these questions. State firefighter presumption laws were researched and analyzed, and a detailed literature review of recent scientific research pertaining to firefighters and cancer was undertaken. The main objective of this study was to determine whether there is sufficient scientific evidence to support a cancer presumption for firefighters.

Research Methods

Descriptive research methods were used to determine the characteristics of state cancer presumption laws for firefighter/EMS providers. Descriptive research seeks to present what already exists in a group or population. Descriptive studies do not seek to measure an effect; they seek only to describe. This method allows the research team to paint a straightforward description of the current presumption laws for firefighter and EMS providers in the United States.

Evaluative research methods were used to determine what evidence exists to determine if cancers covered by presumption laws for firefighters have a scientific basis. This method focuses on objective measurement and scientific neutrality to minimize subjectivity.

Research Procedures

Members of the research team identified and obtained copies of each state's firefighter presumption legislation and reviewed them to determine, state-by-state, the cancers covered and the criteria for the presumption. Concurrently, members of the research team surveyed available literature regarding the relationship between firefighting and cancer. The bulk of this research was carried out using The George Washington University library and electronic journals. Resources included several research databases, professional texts and journals, and other sources. A project bibliography was established using Endnote 2X software. Data collection was performed by extracting results from professional literature, telephone interviews, review of state legislation, and meetings with NLC and study team members. Data were recorded using Microsoft Office Word and Excel Programs.

Project Management

The project manager, the Director of TriData's Center for Data Analysis, was responsible for project oversight, management of deliverables, representing the project staff, coordination of staff services, and review of deliverable items for quality. The project research manager, a senior member of the TriData staff with a doctorate in Health Services, was responsible for assuring appropriate methods were followed and provided technical guidance. This role included supervision of two researchers who are second-year Master of Public Health degree candidates in Epidemiology at The George Washington University.

NLC-TriData Interaction. Senior NLC project officials met with the study project manager and research manager, in-person or by telephone, at regular intervals. Prior to producing deliverable items, the parties formulated general outlines and timelines. Specific methods were not discussed, and the NLC did not oversee the conducting of the research.

Preliminary Results. Preliminary results were shared with the NLC project team and were presented by the project manager and research manager to state municipal league staff in October 2008. General comments were solicited from conference attendees and used in this research. All preliminary results were reviewed and updated as part of the final report.

Primary Project Staff. Patricia Frazier, the Director of the Center for Data Analysis at TriData, served as the project manager. Ms. Frazier is a mathematician by training, with a degree in Mathematics from Smith College and graduate work in Mathematics and Operations Research at The George Washington University.

For the past 20 years, Ms. Frazier has participated in and directed research and special study programs. These efforts have focused on the analysis of fire and fire-related issues and the development of performance indicators for the fire problem for federal, local government, and private sector clients. She is the lead author of the last eight editions of *Fire in the United States.*

As part of her research and analyses of fire issues, Ms. Frazier conducted a landmark study on the overall cost of firefighter injuries in terms of the human cost (cost of medical care, additional staffing, etc) and associated costs (cost of injury prevention, protective gear, fire research, insurance, etc.). Ms. Frazier led a National Institute for Occupational Health and Safety (NIOSH) contracted research study team to investigate current and emerging technology solutions that improve, or hold promise to improve, firefighter radio communication systems. She was the project manager and lead author for the Congressionally-mandated Firefighter Safety Study and was responsible for the review of available response information for hazardous materials for first responders. She is a contributing author to National Fire Protection Association's *Handbook.* Prior to her career in fire-related research, Ms. Frazier was an intelligence analyst.

Dr. Harold C. Cohen, the project research manager, is a senior analyst with TriData who specializes in emergency medical services, fire operations, fire/EMS health and safety, and healthcare management. Dr. Cohen has a PhD in Health Services and an MS in Emergency Health Services Administration and Management. Dr. Cohen has attended the Harvard University, JFK School of Government, as an IAFC/NFPA Fellow at the Senior Executive Program in State and Local Government. He is also a Fellow of the American College of Healthcare Executives and is board-certified in healthcare management.

Dr. Cohen spent 22 years with the Baltimore County Fire Department achieving the rank of division chief. His experiences include command of emergency operations, emergency medical services, information services and communications, and logistical services. He is a graduate of the National Fire Academy Executive Fire Officer Program and now serves as an instructor. Dr. Cohen's academic career includes an adjunct professorship with the University of Baltimore, School of Public Affairs, Health Management Program and the Andrew Jackson University.

Ms. Clara Kim is a research analyst at TriData who works on health and safety issues. Prior to joining TriData, Ms. Kim was a research assistant at the American Cancer Society for the National Colorectal Cancer Roundtable (NCCRT) and was as a clinical research coordinator for clinical trials on women's reproductive cancers at the Dana-Farber Cancer Institute in Boston, Massachusetts. Ms. Kim has also served as an emergency medical technician. Concurrent with her employment, Ms. Kim is a graduate student at The George Washington University pursuing a Masters degree in Public Health with a concentration in Epidemiology. She will be continuing her studies at The George Washington University as a PhD candidate in Epidemiology, focusing on cancer research.

Ms. Sweta Dharia is also graduate student in Epidemiology at The George Washington University and research analyst at TriData. Ms. Dharia works on health and safety issues with Ms. Kim and Dr. Cohen. Prior to joining TriData, Ms. Dharia was a constituent relations management intern at the American Cancer Society National Government Relations Department and at the Cancer Action Network. Ms. Dharia gained experience in pre-clinical laboratory research as a pathology technician while working for Bridge Laboratories in Gaithersburg, MD, and has worked as a part-time physical therapy aide at Shady Grove Adventist Hospital in Rockville, MD for over five years. Ms. Dharia will graduate with honors in May of 2009 with a Masters degree in Public Health with a concentration in Epidemiology. She will be pursuing a degree in Medicine.

Report Organization

This chapter introduces why firefighter cancer presumption research was undertaken. Included is a discussion of presumption, why cancer presumption in particular is to be studied, and the team's general research approach. This background served as a foundation for developing a balanced, evidence-based report on firefighter cancer presumption. The report attempts to determine, qualitatively and quantitatively, the status of presumption laws, the quality of literature, the evidence that links cancer and firefighters, and the potential financial costs of presumption laws to municipalities.

Chapter II presents and discusses issues and considerations that relate to firefighter cancer presumption.

Chapter III presents the results of the review of state legislation that establishes cancer presumption for firefighters.

Chapter IV presents the review of medical and epidemiological research studies on the relationship between firefighters and the incidence of cancer.

Chapter V, the final chapter, presents a summary of the major research findings, discusses remaining unanswered questions and implications, and provides recommendations and guidance on future actions.

A bibliography follows Chapter V. Subsequent Appendices describe the specific methodology of data collection and provide supporting information for analyses in the body of the report. The final Appendix is an annotated bibliography with synopses of the documents reviewed during the course of the research.

CHAPTER II: THE ISSUES OF PRESUMPTION

A number of background issues may influence the perceptions of and reactions to firefighter cancer presumption. Each topic adds a level of complexity to the overall issue of cancer presumption and all need to be considered when dealing with potential legislation and consequences of creating presumption laws. While there may be many more issues that accompany firefighter cancer presumption, this chapter seeks to address the most significant ones.

Social Issues

Fire and EMS professionals enjoy a special place in the hearts of Americans. Public surveys have shown that firefighting is considered one of the most prestigious jobs in the United States.[4] Few will disagree that firefighting is a dangerous profession. Exposure to toxic environments, medical waste, infectious and contagious diseases, violence, and terrorism has lead to the public's great endearment with fire and EMS providers. The social position of firefighters has been further solidified by media portrayal. Movies such as *Ladder 49* and *Backdraft*, and television shows such as *Emergency* and *Rescue 911* have placed the firefighter in everyone's home.

Life-threatening illness and injuries, such as cancer, can be devastating to the individual and his family. Treatment is often extensive and recovery, if it occurs, is often a slow and painful process. There is usually lost time from work, with the resulting pay loss, and some medical treatments may not be covered by insurance. Given the high esteem in which firefighters are held, it is wholly understandable that the firefighter's situation would be keenly felt by the public, who themselves have an abiding respect for the challenges of cancer.

Proponents of cancer presumption note that firefighters devote their careers to protecting the public, often at risk of their own life. When faced with risk to their life, it is argued that firefighters deserve the same consideration from their public employer. Further, when faced with serious or life-threatening illness, should this firefighter be placed into a position where the cost of treatment or cost of living is a question? The stress and hardship induced by cancer is devastating enough that additional stresses may contribute to the firefighter's mortality. It is an argument, based on moral grounds, that is compelling.

As well, the employer has a vested interest in maintaining the health and well-being of its employees. The care of public employees is a priority for every municipality.

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[4] "Firefighters, Scientists and Teachers Top List as 'Most Prestigious Occupations,' According to Latest Harris Poll', *The Harris Poll*® #77, August 1, 2007, http://www.harrisinteractive.com/harris_poll/index.asp?PID=793.

Occupational Disease

As a counterpoint to these social issues is the issue of establishing the relationship between a disease and an occupation. There is the basic concern that the supporting evidence for cancer as an occupational disease of firefighting does not achieve scientific certainty. There are conflicting opinions among epidemiological experts as to the interpretation of the science of presumption. For example, what level of certainty is necessary to conclude causality? What level of association has to be present to establish a relationship between a disease and an occupation? And, on the other hand, it is observed that the body of scientific research is often discarded by some for the single article that supports a few specific cancers and that the refutable literature is ignored.

Assigning the origin of a disease to specific employment is problematic when outside activities may also contribute to the disease. This issue includes career firefighters and EMS providers who hold other part-time positions that may contribute to developing cancer and volunteer firefighters whose full-time jobs are also likely to cause cancer. In addition, without a clear definition of firefighter that differentiates between duty assignments (e.g., differentiating between members whose duties do not involve emergency response and those whose duties do) such an origin may be unevenly or inequitably applied. The liabilities that accompany single-role EMS providers who work for fire departments are also not well addressed.

As well, some individuals may have predispositions to conditions that could be instigated or aggravated by the workplace environment. These issues can be genetic, congenital, or behavioral. Genetic and congenital predispositions may be nearly impossible to differentiate from workplace exposures. The qualities that both make firefighters valuable in the role that they play in their communities may also be qualities that may extend outside the work environment to other, non-work activities and may have consequences attributed the workplace.

Outside employment also muddies the issue of occupational disease, especially if the secondary employment has similar risks or exposures that could be attributed to firefighting.

Lifestyle choices such as smoking, diet, and other activities outside the work environment could also be influencing factors.

Technology

Prior to the 1970s, many firefighters did not have access to modern technologies that offered protection from chemical exposure. By the 1980s, protective equipment including self-contained breathing apparatus (SCBA), firefighting gear that included boots, pants, coats, gloves, helmets, and similar devices were made available to most firefighters. During the 1990s, protective devices became more sophisticated and many departments increased their enforcement of policies to require the use of protective equipment during hazardous situations. By the turn of the 21st century, protective ensembles continued to improve firefighter protection. Enforcement of safety rules and advocacy from within the fire service has strengthened the use of SCBA.

Many organizations have contributed leadership and advocacy to the creation of a culture of safety. The International Association of Fire Chiefs (IAFC), The International Association of Firefighters (IAFF), and the National Volunteer Fire Council (NVFC) advocate for the provision of safety gear and support the enforcement of safety regulations.

Technological advancements also raise questions regarding firefighter cancer presumption. What is the relationship between better safety technologies and cancer in firefighters? Will the impact of cancer among firefighters peak among the pre-1970s firefighters and begin to decline? Are other technologies on the horizon that will increase firefighter protection? Whose responsibility is it to ensure technologies reach the firefighter and are embraced?

Economic

Cost Considerations

Among the greatest issues involving firefighter cancer presumption is the cost that is borne by the employer. In most cases, medical costs are paid through the workers' compensation program, often the most expensive funding mechanism. Considered by some as an "unfunded mandate," medical costs, combined with disability payments and death benefits, are challenging municipal governments and insurers to cover both these costs and the rising costs of insurance plans.

Theoretically, one cancer claim could cause severe financial distress to smaller municipalities. Many municipalities participate in "pools" that qualify them for group insurance rates. The cost of these insurance products, even at group pricing, can present a financial challenge. Even a relatively small number of claims can cause group rates to rise significantly. Without access to insurance pool products, some municipalities may not qualify or could not afford needed coverage. For those municipalities or pools that are self-insured, the financial implications are large.

The combination of medical costs and additional disability awards that are paid over time are often referred to as *legacy* costs. In some states, firefighters are eligible for benefits over many years, even after being diagnosed many years after retirement.

Perhaps the most overriding of concerns is the inability to forecast accurately the short-term and long-term costs. During the study team's presentation to state municipal league staff, it was noted that some leagues did not consider presumption a considerable financial problem. Seminar respondents observed that no claims had been filed or that the numbers of claims covered were low. While the current number of claims may be low, it is anticipated that the situation is unlikely to remain so, particularly in states without time limitations for the presumption. The unquantified legacy costs have the potential for a substantial impact: retired employees could be eligible for benefits 20 to 30 years after retirement. Between 2002 and 2005, Los Angeles County paid over $1.2 million for presumption claims.[5] The significance of this amount depends on the municipality affected.

Municipalities note they are facing further unfunded mandates with regard to the safety equipment that is provided to firefighters. Respiratory protection, protective clothing ensembles, and monitoring devices are costly and are designed to protect firefighters from sudden, episodic, and chronic illness and injury. It can be reasoned that preventive healthcare programs, required annual physicals for certain firefighters, and the high cost of medical insurance that is currently provided are already straining municipal budgets. Without additional sources of funding, needed safety equipment and safety practices that require additional staffing, may be unmet. Presumption adds to these funding issues.

Funding

A serious issue related to presumption is the difficulty workers' compensation insurance providers encounter in pricing the benefit. Insurers have to price their policies today for a lifetime of benefits, both medical and otherwise. From the date an illness is diagnosed and a claim is filed, all payments and treatments are assigned to the policy in effect on the date of discovery of the illness if the claimant is still employed or assigned back to a policy in existence on the last day of employment.

When the policy is written, the insurer does not know how the law might change. Pricing this unknown future liability is problematic and puts the insurer's capital at risk. This is a potentially unsustainable situation and could ultimately result in the loss of the private insurance market.

This funding approach is very different from that of the healthcare system. In the healthcare system, the actual cost of treatment is handled annually on a pay-as-you-go basis that is responsive to changes in medical techniques and procedures as well as changes in the cost of medicines.

Medical Cost Management

The medical costs associated with cancer presumption can be viewed from a healthcare system perspective as well as a workers' compensation perspective. Proponents of removing the medical costs for cancer presumption from the workers' compensation program note that the in the workers' compensation the employer is buying the same care as provided in the healthcare

[5] Chaing. (2007). *Firefighter' cancer presumption program: Chapters 1568, Statutes of 1982*, July 1, 2000 thru June 30, 2003, Revised Report, City of Los Angeles.

system, but at a higher price. There are also fewer controls on the distribution of care, leading to increased costs. Some municipalities believe that traditional medical care plans will better control access and costs. While the placement of medical costs in one system or the other may be debated, what *is* known is that, over the last two decades, the medical component of workers' compensation has risen at twice the rate of the medical inflation rate and is projected to continue the trend well into the next decade.[6] Medical costs are now the driver in workers' compensation costs.

The above concept contains a degree of logic that should not be ignored. The concept, however, may leave gaps that are substantial for work-related conditions. First, all negotiated medical benefits are not the same in breadth and depth of coverage. Gaps in coverage could exclude diagnostic testing, treatment, pharmaceuticals, and rehabilitation costs. Second, most negotiated medical plans contain variable deductibles, copayments, and maximal benefits. While the out-of-pocket costs appear minimal, 15–20 percent of a $250,000 treatment program is quite significant for most firefighters. Third, financial liability assigned to the employee for a work-related injury can be regarded as an assessment of fault, which is contrary to workers' compensation principles. Lastly, managed care programs are often accused of concentrating their efforts on denying care and benefits to ill or injured workers, not to high-quality, cost-effective care.

To help manage medical costs, some states allow municipalities to control worker's compensation medical costs by providing occupational medicine programs that, at a minimum, provide oversight of care. This is often restricted to municipalities that are self-insured and who act as the payor. Most municipalities, however, have to rely on the employee's physician, who is often unaware of municipal constraints and liabilities. These control mechanisms vary, because once care is determined necessary, workers' compensation laws usually allow the employee to seek care from any qualified provider.

Another medical issue is the treatment of volunteers. There is a two-fold question to consider: Are volunteers eligible for benefits under the workers' compensation definition of employee and are they eligible under the municipality's personnel policies or the insurer's definition of employee for the purposes of purchasing municipally-sponsored health benefits. In most cases, volunteers are not considered employees for the purpose of accessing municipally-offered health benefits. A growing number of volunteer fire departments are seeking access to these benefits as a tool for member recruitment and retention. According to the National Fire Protection Association, over 70 percent of all firefighters are volunteers.

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[6] Robert P. Hartwig, "The Financial Crisis & the P/C Insurance Industry Challenges Amid the Economic Storm", presentation to the Excess Surplus Lines Claims Association, Scottsdale, AZ, September 23, 2008.

Extension of Worker Benefits

As discussed in the previous chapter, once the cancer is ruled as work-related, additional benefits for firefighters are typically available. These benefits often include:

- Accident-related illness/injury leave – The firefighter may receive up to one year of time off at full pay and benefits. This leave does not usually count against earned or accrued sick leave, paid time off, vacation, or other types of leave.
- Workers' Compensation Temporary Total Disability (TTD) payment – A specified tax-free payment for each week of disability. The payment rate varies but is usually up to 66 2/3 percent of the normal salary. Note: Firefighters who receive pay under a negotiated municipal accident-related illness/injury leave program are usually not eligible for TTD, unless the total benefit is less than the TTD.
- Workers' Compensation Permanent Partial Disability (PPD) payment – A specified tax-free payment based on a calculated percentage of permanent disability multiplied by a specific number of weeks (usually up to 200). This benefit is in addition to accident leave or TTD payments.
- Extension of Pension Benefits and Continuation of Health Benefits – The employer may be required to pay the employer contributions for family health benefits and retirement for an extended period.

If the firefighter does not survive the illness, survivors may be eligible for federal benefits, state benefits, a survivor pension (usually tax-free, including medical benefits), a one-time, two-year workers' compensation death benefit payment, and other similar benefits. These benefits vary among individual states. Volunteer firefighters may receive some or all of the above benefits.

Municipalities have a vested interest in assuring that job-related illness/injury benefits (workers' compensation benefits) are awarded in the appropriate situation. Part of a municipal government's role is stewardship, assuring that taxpayer money is managed appropriately. It is reasonable for government to expect evidence above *the benefit of the doubt* be presented in order to assume financial liability for work-related injuries.

Both labor groups and municipalities have a vested interest in assuring that workers who are injured on the job are appropriately cared for and compensated. Labor groups note that these benefits have not come easily and attempts to dilute them invite resistance.

Equity

There is also the concern that the lack of evidence of firefighting and cancer causation, coupled with the question of whether firefighter benefits should be different from other municipal employees, is leading to an unfair advantage for one class of employees. Other municipal employees—sanitation workers, automotive fleet personnel, and others—may be exposed to hazards similar to firefighters. Yet, few, if any, are covered by presumption statutes. At least one city has argued that the state's cancer presumption law is unconstitutional because it provides special treatment for firefighters.[7]

Over 70 percent of firefighters in the United States are volunteers, many who serve without any stipend or reimbursement for expenses. Not all volunteer departments are small—many volunteer departments run as many calls as their neighboring career departments. Volunteer firefighters who develop cancer are often not covered by presumption or in some cases are not eligible for workers' compensation benefits. Some individual volunteer firefighters have no personal medical insurance and there are many small volunteer fire departments that cannot afford to offer medical or disability insurance coverage. It can be argued that in communities where volunteers play a role in fire protection, that they also be protected from unnecessary dangers and financial devastation.

Political

The political environment often collides with other aspects of firefighter cancer presumption. Political pressure to pass cancer presumption has often resulted in laws and regulations that lack traditional scientific validity or financial stewardship and as a result, some state cancer presumption laws provide benefits to their firefighters regardless of validated scientific research. As well, pressure to limit or control legacy costs and entitlement programs results in other states not offering benefits to affected firefighters due to the lack of incontrovertible evidence of the association of certain cancers with firefighting. Perhaps neither case is realistic or correct.

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This chapter has presented a variety of issues and considerations that go into making firefighter cancer presumption a difficult topic to navigate. The next two Chapters will present and discuss the research on state firefighter cancer presumption statutes and recent scientific literature on the topic.

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[7] "Edmond firefighters with cancer battling for benefits," NewsOK.com, http://newsok.com/edmond-firefighters-with-cancer-battling-for-benefits/article/3349709.

CHAPTER III: STATE-BASED LEGISLATION COLLECTION AND ANALYSIS

The World Health Organization states that chronic diseases are now the major cause of death and disability worldwide.[8] The United States Centers for Disease Control and Prevention (CDC) rank cancer second among the top five leading chronic disease killers in the United States and the second leading cause of death in the United States overall.[9,10] There are several occupations where environmental exposures may lead to cancer development, and firefighting has been debated to be one such occupation. To this end, many states have already enacted legislation to provide benefits for firefighters who, presumably due to occupational exposures encountered during firefighting activities, have developed cancer. Other states are considering enacting or have not yet enacted such legislation.

The purpose of the review of state presumption legislation was to determine how many states have enacted illness/injury presumption laws for firefighters and EMS providers that include cancer, what cancers were included, why the cancers were included, and what requirements were necessary for the presumption.

A scientific approach towards establishing support or reasoning for such legislation had not been undertaken previously.[11] The aim of the current effort was to approach cancer presumption on a scientific basis and use objective reasoning to analyze issues related to firefighter cancer presumption legislation for firefighters. Performing this analysis may help understand possible relationships between presumptively-covered cancers and the research literature and may provide a stronger basis for supporting or refuting such legislation in the future.

Methods

Study team members contacted NLC state municipal league representatives to discuss and review firefighter cancer presumption legislation in their respective states. Telephone interviews were conducted with the NLC state league contacts between July 30, 2008 and September 2, 2008. These interviews provided insights on the state-based cancer presumption laws and their genesis. Through either the state league contact, Internet searches, or direct

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[8] World Health Organization, Global Strategy on Diet, Physical Activity and Health, Facts related to chronic diseases, http://www.who.int/dietphysicalactivity/publications/facts/chronic/en/index.html.
[9] United States Centers for Disease Control and Prevention, *The Burden of Chronic Diseases and Their Risk Factors*, 2004. http://www.cdc.gov/NCCDPHP/burdenbook2004/pdf/burden_book2004.pdf.
[10] U.S. Centers for Disease Control, National Vital Statistics Reports, 56(10); 1. April 28, 2008. http://www.cdc.gov/nchs/data/nvsr/nvsr56/nvsr56_10.pdf.
[11] For several years, the NLC has surveyed its member state leagues on the specifics of presumption legislation in the members' states. This survey included the broad range of presumption statutes. The survey, however, did not address cancer legislation specifically or separately.

contact with state legislative offices, copies of presumption statutes were collected for those states with presumption legislation. The legislative text, notes from the interviews, and results of the January 2008 NLC Risk Information Sharing Consortium (NLC-RISC) disease/illness presumption survey were used in the review and analyses of the cancer presumption legislation. The preliminary analyses of the state firefighter presumption statutes were presented to NLC staff in October 2008.

A detailed description of the information collection methodology can be found in Appendix A.

The questionnaire developed to use as a guide for the interviews with NLC league representatives can be found in Appendix B.

Results

The review of existing state-based legislation provided details on the various aspects of the state firefighter cancer presumption legislation, including who is eligible, what cancers are covered, cancer coverage by state, provisions for coverage, provisions for rebuttal of the legislation, and when used, definitions of cancerous agents and exposures. The sections below address the major elements of 26 firefighter cancer presumption statutes.

Heart and Lung Presumption Legislation

Heart and lung disease have long been covered by most of the states in the U.S., as much more research has been done for this area of firefighter health. Overall, 43 of 50 states (86.0%) have presumption legislation pertaining to heart or lung diseases, commonly referred to as heart/lung presumption. Most, but not all, states with heart/lung presumption cover diseases of both heart and lung. The states having heart/lung presumption legislation are shown in Table 1.

Table 1: Summary of State-based Firefighter Heart/Lung Presumption Legislation

States with Firefighter Heart/Lung Presumption Legislation			
Alabama	Indiana	Nevada	South Carolina
Alaska	Iowa	New Hampshire	South Dakota
Arizona	Kansas	New Jersey	Tennessee
California	Louisiana	New York	Texas
Colorado	Maine	North Carolina	Utah
Connecticut	Maryland	North Dakota	Vermont
Florida	Massachusetts	Ohio	Virginia
Georgia	Michigan	Oklahoma	Washington

States with Firefighter Heart/Lung Presumption Legislation			
Hawaii[12]	Minnesota	Oregon	West Virginia
Idaho	Missouri	Pennsylvania	Wisconsin
Illinois	Nebraska	Rhode Island	

Summary results for heart/lung legislation data are also included in Table 3. The status of state-by-state heart/lung presumption legislation is included in Appendix B.

Cancer Presumption Legislation

Twenty-six states have cancer presumption legislation enacted for firefighters. In two of these states, Kansas and South Dakota, the presumption statute applies to pension benefits alone; workers' compensation benefits could not be identified. The remaining 24 states are listed in Table 2.

Table 2: Summary of State-based Firefighter Cancer Presumption Legislation (Workers' Compensation Benefits)

States with Firefighter Work-Related Cancer Presumption Legislation		
Alabama	Maryland	Oklahoma
Alaska	Massachusetts	Rhode Island
Arizona	Minnesota	Tennessee
California	Missouri	Texas
Colorado	Nebraska	Vermont
Illinois	Nevada	Virginia
Indiana	New Hampshire	Washington
Louisiana	North Dakota	Wisconsin

New York's cancer presumption legislation expired on June 30, 2005.[13] The remainder of the discussion will focus on the 24 states that provide workers' compensation benefits under cancer presumption.

All of the states with firefighter cancer presumption legislation also have a heart/lung presumption legislation. Overall, over half (55.8%) of the states with heart/lung presumption legislation also have cancer presumption legislation.

[12] Hawaii does not have an NLC state league, but it is noted that they do have heart/lung legislation for firefighters.
[13] Obtained from New York Laws: General Municipal : (200 - 209-y) Firemen And Policemen, Article 10, 207-kk (http://law.justia.com/newyork/codes/general-municipal/gmu0207-kk_207-kk.html)

Eight states have firefighter cancer presumption legislation pending (16%). These states include Florida, Idaho, Michigan, New Jersey, New Mexico, Ohio, Oregon, and Pennsylvania. Summary results for cancer presumption legislation data are found in Table 3 below.

Table 3: Summary of State-based Firefighter Cancer Presumption Legislation

Category	Number of States	Total	Percent of Total
Heart/Lung Presumption	43	50	86.0
Cancer Presumption of those states with Heart/Lung Presumption	24	43	55.8
Cancer Presumption Pending	8	50	16.0

Eligible Personnel

Personnel who are covered under firefighter cancer presumption legislation vary from state to state. Of the 24 states implementing firefighter cancer presumption laws, 9 (37.5%) states also cover Emergency Medical Service (EMS) providers who are not firefighters. A number of states use both career and volunteer firefighters for firefighting activities; however, only 13 out of 24 states (54.2%) cover both career and volunteer firefighters, while 11 out of the 24 states (45.8%) cover only career firefighters. Table 4 provides a summary of these results.

Table 4: Personnel Eligible for Presumptive Cancer Coverage

Personnel	States	Count
EMS Providers	Illinois, Indiana, Maryland, Minnesota, Nebraska, Nevada, New Hampshire, Rhode Island, Texas	9
Volunteer Firefighters	Alaska, California, Colorado, Illinois, Maryland, Minnesota, Nevada, New Hampshire, Oklahoma, Rhode Island, Texas, Vermont, Virginia	13
Career /Paid Firefighters Only	Alabama, Arizona, Indiana, Louisiana, Massachusetts, Missouri, Nebraska, North Dakota, Tennessee, Washington, Wisconsin	11

Note: Kansas and South Dakota are not included as their presumption statutes apply to pensions/retirement only.

Cancers Covered Under Presumption

Slightly more than half the states with presumption laws (13 states or 54.2%) contain broad or nonspecific language that can interpreted to cover all cancers. The language used in these 13 statutes varies widely. Phrasings range from "any cancer … not revealed by the physical examination passed by the member upon entry into the department" (Oklahoma) to "cancer that may be caused by exposure to heat, smoke, radiation, or a known or suspected carcinogen as determined by the International Agency for Research on Cancer" (Texas).

The remaining 11 states (45.8%) cover site-specific cancers (e.g., bladder cancer) with six states also covering cancers of organ systems—thereby covering any site-specific cancer that could arise in the system (e.g., digestive system which could cover esophageal, stomach, colon, or rectal cancers as well as other cancer sites). A few states, such as Nevada, are both broad and specific in defining the cancers covered. The named cancers are clearly covered; others could be covered on a "case by case basis" if certain requirements are met, e.g., exposure to a known carcinogen that is reasonably associated with the cancer. Any statute with similar language was not considered to cover all cancers. Table 5 details the cancers covered in the state presumption statutes and which states cover them. The relevant state statute language pertaining to the cancers covered is included in Appendix C.

Table 5: Summary of Cancer Coverage for States with Firefighter Cancer Presumption Based on State Legislation

Type of Cancer Referenced in the State Laws	Number of States with Legislation	State(s)
All (non-specific) Cancers		
All Cancers Includes states that reference simply "cancer," states that reference both specific and non-specific cancers, and states that reference "cancers resulting from exposure to … [carcinogens, heat, smoke, etc.]"	13	Alabama, California, Illinois, Indiana, Minnesota, Missouri, Nebraska, New Hampshire, North Dakota, Oklahoma, Rhode Island, Tennessee, Texas
System Based		
Central Nervous System	2	Massachusetts, Wisconsin
Digestive System/ Gastrointestinal Tract	5	Colorado, Louisiana, Massachusetts, Vermont, Wisconsin
Genitourinary System	1	Colorado
Hematopoietic Cancer	1	Nevada
Hematological System	3	Colorado, Massachusetts, Wisconsin
Lung/Respiratory Tract	1	Massachusetts
Lymphatic System	3	Massachusetts, Nevada, Wisconsin
Oral System	2	Massachusetts, Wisconsin
Prostate System	1	Massachusetts
Reproductive System	1	Wisconsin
Skeletal System	2	Massachusetts, Wisconsin

Type of Cancer Referenced in the State Laws	Number of States with Legislation	State(s)
Skin	5	Colorado, Louisiana, Massachusetts, Vermont, Wisconsin
Urinary System	2	Massachusetts, Wisconsin
Specific Cancers		
Bladder	6	Alaska, Arizona, Louisiana, Nevada, Vermont, Washington
Brain	7	Alaska, Arizona, Colorado, Louisiana, Nevada, Vermont, Washington
Breast	2	Virginia, Wisconsin
Colon	5	Arizona, Louisiana, Nevada, Vermont, Washington
Kidney	5	Alaska, Louisiana, Nevada, Vermont, Washington
Leukemia	7	Alaska, Arizona, Louisiana, Maryland, Vermont, Virginia, Washington
Liver	2	Nevada, Vermont
Hodgkin's Lymphoma	4	Arizona, Louisiana, Nevada, Vermont
Non-Hodgkin's Lymphoma	6	Alaska, Arizona, Louisiana, Nevada, Vermont, Washington
Lung	1	Massachusetts
Mal Melanoma	2	Alaska, Washington
Mesothelioma	1	Arizona
Multiple Myeloma	3	Louisiana, Vermont, Washington
Ovarian	1	Virginia
Pancreatic	3	Maryland, Vermont, Virginia
Prostate	4	Alaska, Maryland, Virginia, Washington
Rectal	4	Arizona, Maryland, Virginia, Washington
Testicular	2	Vermont, Washington
Throat	2	Maryland, Virginia
Ureter	2	Alaska, Washington

Because of the lack of standardization in the cancer nomenclature used in the state statutes, it is difficult to answer the seemingly straightforward question of "how many states cover…?" Take the case of thyroid cancer: no state specifically names it. Two states cover "throat" cancer. Thirteen states potentially cover all cancers. It could be that 13 states or 15 states cover thyroid cancer.

Even with this lack of clarity, several cancers stand out.[14] Leukemia is covered by all 24 states that have firefighter cancer presumption legislation; bladder, brain, Non-Hodgkin's lymphoma, and rectal cancers are covered by 22 states (91.7%). Colon and kidney cancers are covered by 21 states (87.5%). Table 6 presents an accounting of the cancers named in the state statutes.

Table 6: Accounting of Cancers Named in State Cancer Presumption Legislation

Cancer in State Statute	States
Leukemia	24
Bladder	22
Brain	22
Non-Hodgkin's Lymphoma	22
Rectal	22
Colon	21
Kidney	21
Hodgkin's Lymphoma	20
Mal Melanoma	20
Multiple Myeloma	20
Pancreatic	20
Prostate	20
Throat	20
Liver	19
Skin	18
Digestive System/Gastrointestinal Tract	18
Other Skin Cancers	18
Ureter	18
Testicular	17
Hematological System	16
Lymphatic System	16
Ovarian	16
Central Nervous System	15

[14] These cancers are by no means an exhaustive list. They represent an accounting of only those cancers that were named in the statutes. For example, as noted, thyroid cancer is not specifically named in any state statute and is therefore not included in the discussion. A cancer was considered covered if the state specifically covered it, if all cancers were covered, or the cancer site was part of a covered body system.

Cancer in State Statute	States
Urinary System	15
Skeletal System	15
Oral System	15
Breast	15
Lung	15
Mesothelioma	15
Hematopoietic cancer	14
Genitourinary System	14
Prostate System	14
Lung/Respiratory Tract	14
Reproductive System	14

Age Limits

Only three states include age limitations. Arizona and Vermont provide presumption coverage until the age of 65. In addition, Oklahoma's legislation states that the firefighter must be hired no later than the age of 45, and must retire by 65, unless twenty years of service has not yet been completed. Lastly, Washington only covers prostate cancer for those less than 50 years of age. The remaining states are silent on age limitations.

Minimum Length of Service

Some states have minimum length of service requirements in order to qualify under their cancer presumption legislation. Alabama covers firefighters after at least three years of continuous service. Eleven states cover firefighters after five years of service, including Arizona, Colorado, Illinois, Maryland, Massachusetts, Missouri, Nebraska, Nevada, North Dakota, Texas, and Vermont. In Arizona, presumption is only provided for those who perform at least five years of hazardous duty. Alaska covers firefighters after seven years, while Louisiana, Washington, and Wisconsin, cover firefighters after 10 years, and Virginia covers firefighters after 12 years of service. Tennessee, California, Indiana, Minnesota, New Hampshire, Oklahoma, and Rhode Island do not have any minimum years of service requirement (Table 7).

Several states have requirements unique to their state. Vermont firefighters must have served their minimum of five years of service within Vermont only. Tennessee legislation states that the firefighter must work in a metropolitan area of a county in a department that serves a population of 400,000 persons or more and work in a "toxic environment."[15]

Table 7: Summary of Minimum Length of Time of Service

Length of Time of Service	States	Count
3 Years	Alabama	1
5 Years*	Arizona◇, Colorado, Illinois, Maryland, Massachusetts, Missouri, Nebraska, Nevada, North Dakota, Texas, Vermont**	11
7 Years	Alaska	1
10 Years	Louisiana, Washington, Wisconsin†	3
12 Years	Virginia	1
Not Indicated	California, Indiana, Minnesota, New Hampshire, Oklahoma, Rhode Island, Tennessee	7

* Does not include Kansas (minimum of 1,000 hours per year for 5 years.) Kansas only covers pensions under presumption law.
** All 5 years of service must have been in Vermont
‡ Only applies to counties with firefighter departments in metropolitan areas of 400,000 or more
◇ For those who have worked hazardous duty
† Firefighters working more than 49 percent of time in fire suppression

Wisconsin firefighters must have worked in fire suppression for more than 49 percent of the time, leaving out other firefighter duties such as mechanics and administrators. This criterion was not directly reflected in the cancer presumption legislation, but was obtained from a section of a document from the Wisconsin Employee Trust Funds (ETF).[16]

Retroactive Coverage

Few states indicate retroactive cancer coverage. Only Alaska, California, and Rhode Island specifically address the topic. Alaska and Rhode Island do not specify a retroactive period. Alaska allows "claims made on or after the effective date of this Act, even if the exposure leading to the occupational disease occurred before the effective date of this Act." Rhode Island presumption legislation states the law applies retroactively for retired firefighters: "The provisions of this section apply retroactively in the case of any retired member of the fire

[15] Tennessee Code Title 7 Consolidated Government, Chapter 51 Miscellaneous Government and Proprietary Functions, Part 2 Employee Compensation and Indemnification, *Firefighters-disease, cancer or death-presumptions §* 7-51-205 (a).
[16] Wisconsin ETF. (2008). *Duty disability and survivor benefits*. Wisconsin State Statute & 40.65. [Revised – April, 2008]. p. 3.

department of any city or town." California allowed a 3-year retroactive period, including a reapplication provision for denied claims.

Post-Employment Eligibility

Post-employment eligibility also varies from state to state. Five states—Alaska, California, Louisiana, Nevada, and Washington—all indicate coverage up to three months per year of service after retirement or separation,[17] not exceeding a total of five years of coverage. Three states (Indiana, Massachusetts, and Minnesota) cover up to five years post retirement or separation. Two states imply lifetime post-employment coverage (Illinois and Rhode Island) and). Alabama, Colorado, Oklahoma, Tennessee, and Wisconsin do not specify post-employment eligibility limits. Texas requires that the disease or illness be discovered during employment as a firefighter or EMT. Maryland's legislation refers to the retirement statute for their post-eligibility requirements and is not specifically mentioned in the presumption legislation. Missouri notes that their limitations on post-employment eligibility are covered by the respective city's insurance plans. New Hampshire covers their retired firefighters up to 20 years post retirement. In North Dakota, post-employment eligibility is determined by the length of employment: if a firefighter has served less than 10 years, post-employment eligibility is limited to two years after the full-time employment ends; if a firefighter has served more than 10 years, post-employment eligibility is limited to five years after the full-time employment ends. Vermont covers up to ten years post-employment, but not past the age of 65. Virginia sets the limits at two years past the time of reporting the initial diagnosis to the employer, or five years past the first exposure to the disease. Arizona provides coverage to retired firefighters up to the age of 65. It is important to note, however, that Nebraska and Rhode Island do not cover separated firefighters. The results of length of service after separation or retirement are displayed below in Table 8.

Table 8: Length of Time of Coverage Post-Employment

Length of Time of Coverage	States	Count
Up to 3 months per year of service, up to and not exceeding a total of 5 years of coverage	Alaska, California, Louisiana, Nevada, Washington	5
5 Years	Indiana, Massachusetts, Minnesota	3
10 Years up to age 65	Vermont*	1

[17] Separation means a firefighter has left their position due to death, retirement, resignation, or any involuntary reason.

Length of Time of Coverage	States	Count
Up to age 65	Arizona	1
Retirement plus 20 years (must agree to participate in municipally sponsored physicals)	New Hampshire	1
Lifetime	Illinois, Rhode Island†	2
2 years for less than 10 years of service; 5 years for more than 10 years of service	North Dakota	1
2 years reporting initial diagnosis to employer or 5 years past the first exposure to the disease, whichever is first	Virginia	1
Unspecified or None	Alabama, Colorado, Maryland, Missouri**, Nebraska†, Oklahoma, Tennessee, Wisconsin	8
No post employment coverage	Texas	1

* Not past the age of 65
** Must have passed a physical 5 years post retirement
† Does not apply to separated firefighters
Note: South Dakota and Kansas presumption pertains to retirement/pension. South Dakota has the least amount of specified coverage with only six months post-employment. Kansas does not specify a time limit on post-retirement coverage.

Physical Examination

Many states require a physical exam prior to employment or sometime during employment to establish that no disease was present at the time of hire. Nineteen states require a physical exam on entry as a paid firefighter: Alabama, Alaska, Arizona, California, Colorado, Massachusetts, Minnesota, Missouri, Nebraska, New Hampshire, North Dakota, Louisiana, Oklahoma, South Dakota, Texas, Vermont, Virginia, Washington, and Wisconsin. Missouri does not specifically require the physical exam to be at entry, but it must have occurred at least five years prior to the claim being filed. In New Hampshire, if requested by their department, volunteer firefighters are responsible for getting their own physical examination done to establish that they are free of disease prior to service. If the employer does not require a physical, the disease is presumed to be occupationally related. Tennessee recommends the pre-employment physical, but it is not required and must be completed only prior to a claim being filed. Maryland only requires physical examinations from volunteer firefighters, not paid/career firefighters. The results can be found in Table 9 in the "Provisions for Rebuttal" section below.

Alaska and North Dakota also require annual physical exams in addition to the pre-employment physical exam. Alaska requires a physical exam to be completed every year for all of the first seven years of service. North Dakota requires a physical exam must be done every five years for the first 10 years of service, every three years for 11–20 years of service, and every year for those with 20 or more years of service (Table 9).

Tobacco Use

Many states also list tobacco use as a limiting provision[18] and a basis for rebuttal of presumption claim. These states include Alaska, Arizona, Missouri, North Dakota, Texas, Vermont, Washington, and Wisconsin. These findings are summarized in Table 9 below.

Provisions for Rebuttal

Every state with cancer presumption, with the exception of Arizona and Maryland, has some type of rebuttal provision. As noted above, 19 states require pre-employment physicals that show no evidence of disease for cancer presumption to apply, and two states require annual physicals in addition to the pre-employment physical. Failure to adhere to these circumstances may result in rebuttal of the presumption. There are additional reasons that municipalities may attempt to rebut a claim under cancer presumption laws. These reasons include:

- the claimant did not acquire the illness/injury on the job and based on a clear and convincing preponderance of the evidence, the claim should be denied,
- the claimant failed to meet the requirements under the law (i.e., challenge to years of service),
- the claimant's personal behavior and lifestyle contributed to the illness, including the use of tobacco products,
- the illness cannot be traced to a specific incident, or
- the presumption law is unconstitutional as it provides special treatment for one class of municipal workers.

While these are only a few reasons that municipalities may attempt to rebut a claim, the key issue is that in a presumption state, for a municipality to rebut a claim successfully, the burden of proof is on the municipality and not the claimant.

Some of the newer legislation offer specifics on what evidence is acceptable to rebut a claim. Alaska, for example, includes not only the use of tobacco products, physical fitness and weight, and lifestyle but allows hereditary factors and exposure from other employment or nonemployment activities.

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[18] A limiting provision places bounds on the claimant's ability to file for benefits. For example, a firefighter who develops bladder cancer in the state of Alaska (a cancer covered under Alaska's presumption legislation) and who has a history of smoking may be denied benefits under the statute.

Table 9: Provisions for Rebuttal and Limiting Factors

Provision	States	Count
Pre-Employment Physical Exam Required	Alabama, Alaska, Arizona, California**, Colorado, Louisiana**, Massachusetts, Minnesota, Maryland*, Nebraska, New Hampshire‡, North Dakota, Oklahoma, South Dakota, Texas, Vermont**, Virginia, Washington, Wisconsin	19
Pre-Employment Physical Optional	Tennessee	1
Annual Physical Exam Required	Alaska, North Dakota	2
Tobacco	Alaska, Arizona, Missouri, North Dakota, Texas, Vermont**, Washington**, Wisconsin	8

* Maryland only requires pre-employment physical exams for volunteer firefighters
** Results from the NLC January 2008 Survey
‡ Volunteer firefighters in New Hampshire have to obtain their own pre-employment physical exams, which is not mandatory under New Hampshire legislation

Cancerous Agents and Exposure Classification

Thirteen states refer to professional or regulatory organizations to provide definitions for what may qualify as a cancer-causing exposure. Organizations such as the International Agency for Research on Cancer (IARC), the National Toxicology Program, and the National Institute of Occupational Safety and Health (NIOSH) are referenced in legislation as the primary source for definitions of carcinogens and other exposure classifications. All 13 states reference IARC as their means for determining the cancerous nature of an agent and/or exposure a firefighter may have experienced. Alaska and Nevada also reference the National Toxicology Program for similar purposes, while Indiana also references NIOSH (Table 10).

Table 10: Organizations Referenced to Classify Cancerous Exposures

Organization	States	Count
IARC	Alaska, Arizona, California, Indiana, Louisiana, Massachusetts, Minnesota, Missouri, Nebraska, Nevada, New Hampshire, Texas, Virginia	13
National Toxicology Program	Alaska, Nevada	2
NIOSH	Indiana	1

Discussion

Differences in Legislation Terminology and Presentation

Despite the commonalities between states with firefighter cancer presumption legislation, there exist several differences in how cancer coverage is defined. Some states defined cancers by body system; others were specific, while others simply stated "cancer." For example, if the state listed "digestive system" this description could include areas of the throat, the esophagus, liver, colon, and rectum; however it could also apply to other cancers within the digestive system as well and is not limited to these five cancers. Such is the case for Colorado, Massachusetts, and Wisconsin, who list digestive system in their legislation. As well, Louisiana and Vermont use the term "gastrointestinal system" which, for all intents and purposes, is synonymous with "digestive system."

Additionally, there is no standard method for listing specific types of cancer. The vocabulary used in legislation is often not what is commonly used to identify cancers. Maryland and Virginia reference throat cancer as a type of covered cancer. Throat cancer is an example of using a layman's term (throat) for the description of a cancer that could encompass a variety of cancers. Because the term is non-specific, there are different interpretations of the included cancers.[19] As well, the throat is a region with several organ systems within it, such as the digestive (esophagus), respiratory (trachea), and lymphatic (lymph nodes) systems. Because of this ambiguity it is likely that the interpretation of the legislation will be resolved in the courts.

Arizona presents an interesting situation. The statute uses the term "aden carcinoma," which could easily be applied to any organ containing or associated with glandular tissue. The punctuation used in the language of the legislation may (or may not) mask the original intent.[20] The sentence is as follows, "…any disease, infirmity or impairment of a firefighter's … health that is caused by brain, bladder, rectal or colon cancer, lymphoma, leukemia or aden carcinoma or mesothelioma of the respiratory tract and that results in disability or death is presumed to be an occupational disease…" In this case, one can interpret aden carcinoma in at least two ways: any carcinoma (cancer) in an organ containing or associated with glandular tissue or a carcinoma associated with lung tissue. The study team interpreted it as aden carcinoma of the lung.

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[19] For example, the Mayo Clinic notes that throat cancer "refers to cancerous tumors that develop in your throat (pharynx) or voice box (larynx)." Mayo Clinic website: http://www.mayoclinic.com/health/oral-and-throat-cancer/DS00349. The American Cancer Society presents a different interpretation, observing that oropharyngeal cancer, a cancer that develops in the part of the throat just behind the mouth called the oropharynx, is sometimes called throat cancer. The ACS describes the oropharynx as the area beginning where the oral cavity stops and includes the base of tongue (the back third of the tongue), the soft palate (the back part of the roof of the mouth), the tonsils, and the side and back wall of the throat. American Cancer Society website: http://www.cancer.org/docroot/CRI/content/CRI_2_4_1X_What_is_oral_cavity_and_oropharyngeal_cancer_60.asp.

[20] The issue with the Arizona punctuation is not unlike that of "eats shoots and leaves" (describing what is eaten) versus "eats, shoots, and leaves" (describing actions.) The placement (or lack thereof) of commas creates very different meanings.

Many states, such as Colorado, use broad/general terms to identify covered cancers. Colorado uses “hematopoietic cancers,”[21] which can mean lymphomas, both Hodgkin’s and Non-Hodgkin’s, or other lymph and blood cancers; therefore, there may be terms used in legislation which may not be directly reflected in the report findings.

For the term “lymphomas,” the counts shown in the analysis (Table 6) list two separate categories: Hodgkin’s Lymphoma and Non-Hodgkin’s Lymphoma. Hodgkin’s Lymphomas was counted for a state if the state included all cancers or if the state’s legislation text specifically stated Hodgkin’s Lymphoma. Non-Hodgkin’s Lymphoma was counted if the legislation specifically covered Non-Hodgkin’s Lymphoma or included all cancers.

In the case of other states, such as Nevada and Virginia, a list of specific cancers is provided but the legislation also states that the cancers covered may not be limited to those specified in the legislation, which leads one to believe that all cancers may be covered under the law. Washington lists specific provisions for brain and prostate cancers, and the law only applies if these provisions are met. Washington only covers brain cancer if it is a primary brain cancer and only covers prostate cancer for individuals less than 50 years of age.

Other Limiting Provisions

Many of the states that cover all cancers also have stipulations which *may* limit the term “all.” A majority of the states reference the International Agency for Research on Cancer’s (IARC) standard for a known carcinogen as their basis for coverage, with some states citing any cancer caused by heat, smoke, radiation, a known carcinogen, etc. as defined by IARC. Some states, such as Indiana, even use the National Institute for Occupational Safety and Health (NIOSH) guidelines in addition to IARC guidelines to determine carcinogenic exposures. Thus, if a firefighter develops a cancer which may be included within the legislation with an etiology not consistent with what IARC or other stated organizations deem as a legitimate exposure, the firefighter may not be covered under the law.

[21] Hematopoietic: pertaining to the formation of blood or blood cells.

CHAPTER IV: LITERATURE REVIEW

A critical part of this study was to investigate published information involving firefighters and the cancers that have been diagnosed in the firefighter population. The purpose of this literature review was to determine what cancers have been studied, who studied the cancers, what specific geographic areas/regions have been investigated, and what conclusions were made based on the scientific research studies that were conducted. Collecting this information allowed the study team to evaluate what areas have been well studied such as specific hazardous materials, cancers most commonly seen in firefighters, exposures and risks to firefighters, and use of personal protective equipment. Evaluation of the published literature also allowed the research team to see the gaps in the current science. The gaps represent areas where more information needs to be presented and more research studies need to be conducted to make any scientific conclusions.

This chapter uses a Reference section in addition to footnotes to allow the flow of the text and to alleviate repetitive footnotes.

Methods

Document Collection

The most current information and new research findings for cancer and firefighters were collected during an extensive literature search. The researchers, trained in epidemiologic methods including surveillance, information collection, data analysis, and data reporting, used a variety of resources to identify and acquire literature of interest—journal articles, newspaper articles, reports, court cases, books and the like. Resources included:

- Internet search resources: Google, Google Scholar, and PubMed (U.S. National Library of Medicine).
- National research institution websites: National Institutes of Health, National Cancer Institute, United States Fire Administration, Federal Emergency Management Agency, and the Occupational Safety and Health Administration.
- The George Washington University electronic journal collection and library.
- Contacts with organizations dedicated to occupational and general worker wellness as well as organizations dedicated to the health and safety of firefighters and EMS providers to assist the team with finding or providing evidence-based information on firefighter cancer presumption. (None of these organizations were able to assist or provide the team with information.)

Relevant documents published in between 1995 and 2008 were included in the document collection. This year range allowed for the most recent research studies and documents to be collected and evaluated. Using recently published research studies provides the most accurate representation of the current status and scope of a problem under study.[22] Recently published papers also suggest future areas of study and possible recommendations to address current issues in evaluating cancer presumption. In addition, the "classic" research studies (e.g., Guidotti 1993, Demers et al 1992, Demers et al 1994, Hansen 1990, and Howe 1990) on firefighting and cancer presumption were included.

The literature search produced 161 documents that were included in the overall bibliography, 71 of which were chosen for the literature review. These documents were chosen for their relevance to cancer and firefighters.[23]

The remaining 90 documents were retained as references of interest. These documents included information and literature related to cancer costs and cost analyses, 9/11 specific events, other occupations, and overall cancer rates in the general United States population. They were not included in the main literature review because they did not pertain directly to the research questions.

Literature Review

The researchers independently reviewed and assessed the 71 documents based on the quality and type of research. Using the following standard classifications, each reviewer assigned a score to each document according to the literature's scientific value:

- Class I – Peer-reviewed research from refereed journals[24] whose research design, methods, and results have lead to findings that achieve statistical significance.
- Class II – Peer-reviewed research from refereed journals whose research design, methods, and results were of appropriate quality, but were unable to achieve statistical significance.

[22] Bates MN. Registry-Based Case-Control Study of Cancer in California Firefighters, *American Journal of Industrial Medicine*, 2007:50; 339-344.
[23] During the course of the literature search, a limited number of documents were identified that may have had relevance to cancer and firefighters but the researchers were unable to obtain copies either because the original publishing entity no longer exists or the researchers were unable to access archives As the articles identified were not published in peer-reviewed journals, the research team deemed the articles unnecessary to pursue at this time.
[24] Refereed journals are well-known, published collections of journal articles on various topics. The referred journals that were used in this document are based on scientifically conducted research and have a structured reviewing system in which at least two reviewers, excluding in-house editors, evaluate each unsolicited manuscript and advise the editor as to acceptance or rejection.

- Class III – Research that identified diseases, co-morbidities, confounding variables or other evidence-based outcomes that were published in non-peer-reviewed (non-refereed) journals.[25]
- Class IV – Research published in peer reviewed or non-peer reviewed journals whose methods or presentation are of questionable value.

If both researchers assigned the same classification to a document, then the classification was considered final; if the researchers disagreed on classification for a document, then the research manager made the final decision on the grade. Of the 71 reviewed documents, 35 (49%) were categorized as being class 1. Ten documents (14%) were considered class 2. Twenty-two documents were classified as category 3 (31%) documents. Of the 41 peer-reviewed journal articles classified in class 1 or 2, 17 of the articles were considered substantial research articles based on exact scientific methods. These articles were chosen for closer evaluation because the reported studies distinguished specific sample groups of firefighters and comparable control groups from the general population or other occupational group (i.e. police officers), and created a specific methodology to measure the association between firefighting and various cancer risks.

A detailed description of the methodology can be found in Appendix A.

Results

The findings from the literature review established the current knowledge and understanding of the research problem addressing firefighting and cancer risk. The research problem was put into context comparing firefighter related cancer studies versus the entire spectrum of cancer studies. Several specific cancers were identified from the research. These cancers were used to compare to cancers identified in state legislation. The strength of associations found between firefighting and cancer risk were reported and categorized according to their strengths. Disparities between the studies and study limitations are also addressed in this report.

Context of Literature Review

In the United States, several hundred cancer research studies are conducted in a given year. These studies cover many cancer related topics such as treatment, diagnosis, prognosis, cost analysis, surveillance, and interventions. Occupational cancer research was identified in 1996 as a priority research area in the National Occupational Research Agenda.[26] They focused

[25] A confounding variable or factor is a variable other than the one being tested which can affect the incidence or degree of a parameter being measured. Morbidity is the state of poor health or sickness, or the degree or severity of a health condition. Co-morbidity is when two or more diseases are affecting a person at the same time.
[26] Ward EM, Schulte PA, Bayard S, Blair A, Brandt-Rauf P, Butler MA, Dakovic D, Hubbs AF, Jones C, Karstadt M, Kedderis GL, Melnick R, Redlich CA, Rothman N, Savage RE, Sprinker M, Toraason M, Weston A. *Priorities*

on occupational cancer research because occupational factors play a significant role in a number of cancers, resulting in significant morbidity and mortality. Several different occupational cohorts often provide unique opportunities to evaluate health effects of environmental toxins and carcinogens. Despite a vast increase in new methods of overall cancer research, until recently these methods have not been applied to occupational cancer research.

Of all the cancer studies published in the past decade, only a few studies have looked at firefighting as a possible risk factor for cancer. The literature review included 17 research studies that specifically studied cancer risk in firefighters and were published in peer-reviewed journal articles between 1995 and 2008, including the classic studies. Essentially one peer-reviewed study relating to firefighters and cancer risk was published each year in the last 14 years. Compared to the hundreds of cancer studies done each year, the lack of research studies shows that there is a lack of definitive research in the field of cancer risk and firefighting.[27] A bill recently passed this year in Rhode Island will sponsor more research studies to address this problem, but the study results will not be available in the near future.[28]

Cancers Identified in Literature Review

The literature review established 31 individual cancers that were investigated in the 17 peer-reviewed research studies. Three specific organ systems were also established. The digestive system included the esophagus, stomach, colon, rectum, liver, and pancreas (Ma et al 2005, Ma et al 2006). The lymphopoietic system included Hodgkin's lymphoma, Non-Hodgkin's lymphoma, and leukemia (Ma et al 2005, Ma et al 2006). The respiratory system included the larynx and lung/bronchus (Ma et al 2005, Ma et al 2006). Some studies reported estimates for all cancers that were investigated within a given study (Baris et al 2001, Bates et al 2001, Demers et al 1992, Demers et al 1994, Guidotti 1993, Hansen 1990, LeMasters et al 2006, Ma et al 2005, and Ma et al 2006). For example, Baris et al 2001 investigated buccal cavity and pharynx cancer, esophageal cancer, stomach cancer, colon cancer, rectal cancer, liver cancer, pancreatic cancer, laryngeal cancer, lung cancer, skin cancer, prostate cancer, bladder cancer, kidney cancer, brain cancer, Non-Hodgkin's lymphoma, multiple myeloma, and leukemia. The authors of that study reported individual risk estimates[29] for each cancer studied, but also reported an estimate reflecting the group of cancers studied as a whole. Other authors reported a group risk estimate for all of the cancers evaluated within their research studies. The category is labeled "all cancers"

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for Development of Research Methods in Occupational Cancer. *Environmental Health Perspectives*. 2003:111(1);1-12.

[27] Finding the exact number of cancer related studies published during a given year is extremely difficult. Cancer studies can involve several different topics including: diagnosis, treatment, prognosis, cost analysis, surveillance, special populations, interventions, and prevention. Several types of these studies were included in our literature review and we attempted to categorize the studied by type of information they presented.

[28] "Bill would study rates of cancer among R.I. firefighters." June 8, 2008. *The Providence Journal*.

[29] A risk estimate is a description of the probability that an organism exposed to a specific dose of a chemical or other dangerous substance will develop an adverse response, e.g., cancer.

in the specified tables. The individual studies and specific cancers (31 individual cancers, 3 organ systems, 1 "all cancers" category) evaluated within those studies is shown in Table 11 below.

Table 11: Cancers Studied by Literature Source

Study	Cancers Studied
Aronson et al. 1996	Prostate
Band et al. 2004	Non-Hodgkin's Lymphoma
Baris et al. 2001	Buccal cavity and pharynx, esophagus, stomach, colon, rectum, liver, pancreas, larynx, lung, skin, prostate, bladder, kidney, brain, Non-Hodgkin's lymphoma, multiple myeloma, leukemia
Bates et al. 2001	Esophagus, stomach, colon, rectum, pancreas, lung, melanoma, prostate, testis, bladder, kidney, brain, myeloleukemia; All cancers evaluated within study as a group.
Bates 2007	Esophagus, stomach, cecum, colo-rectal, pancreas, lung & bronchus, melanoma-skin, prostate, testis, bladder, kidney & renal pelvis, brain, thyroid, Non-Hodgkin's lymphoma, multiple myeloma, leukemias
Demers et al. 1992	Oral & pharyngeal, oesophageal, stomach, colon, rectal, liver, pancreatic, laryngeal, lung, prostate, kidney, bladder and other urinary cancers, skin, brain and nervous system, Hodgkin's, leukemia, other lymphatic and haematopoietic; All cancers evaluated within study as a group.
Demers et al. 1994	Oral and pharynx, esophagus, stomach, colon, rectum, pancreas, sinus, larynx, lung, trachea &bronchus, melanoma, breast, prostate, bladder, kidney, occular melanoma (eye), brain, thyroid, Hodgkin's, Non-Hodgkin's lymphoma, multiple myeloma, leukemia All cancers evaluated within study as a group.
Firth et al. 1996	Buccal cavity, oesophagus, stomach, colon, rectum, liver, pancreas, larynx, lung, melanoma, prostate, testis, bladder, other urinary, eye, brain, lymphosarcoma, Hodgkin's, leukemia
Guidotti 1993	Oral, stomach, colon & rectum, pancreas, lung, skin, prostate, bladder, kidney & ureter, brain, leukemia, lymphoma, myeloma All neoplasms (cancers) evaluated within study as a group.
Hansen 1990	Lung
Howe 1990	Lung, colon, brain, malignant melanoma, multiple myeloma

Study	Cancers Studied
Kang et al. 2008	Lip, buccal cavity, nasopharynx, esophagus, stomach, colon, rectum, liver, pancreas, larynx, lung, skin melanoma, breast, prostate, testicular, kidney, bladder, brain, thyroid, leukemia, Non-Hodgkin's lymphoma, Hodgkin's, multiple myeloma
LeMasters et al. 2006	Multiple myeloma, Non-Hodgkin's lymphoma, prostate, testis, skin, malignant melanoma, brain, rectum, buccal cavity and pharynx, stomach, colon, leukemia, larynx, bladder, esophagus, pancreas kidney, Hodgkin's, liver, lung All cancers evaluated within study as a group.
Ma et al. 2005	Buccal/pharynx, Digestive (esophagus, stomach, colon, rectum, liver, pancreas), Respiratory (larynx, lung & bronchus), bone, skin, bladder, brain/CNS, thyroid, All lymphopoietic (lymphosarcoma, Hodgkins, leukemia), prostate, breast All cancers evaluated within study as a group.
Ma et al. 2006	Buccal digestive (esophagus, stomach, colon, rectum, liver, pancreas), respiratory (larynx, lung/bronchus), bone, skin, bladder, kidney, eye, brain/CNS, thyroid, all lymphopoietic (Non-Hodgkin's lymphoma, Hodgkins, leukemia) prostate, testes, breast, cervix All cancers evaluated within study as a group.
Stang et al. 2003	Testicular
Zeegers et al. 2004	Prostate

Note: “All cancers” refers to the group of cancers that were investigated within a given research study. The authors found a group estimate for the cancers as well as individual cancer estimates.

Evaluation of Literature Review

Of the 71 total documents evaluated in the literature review, the research team focused on the 17 research studies published in peer-reviewed journal articles, all of which were classified as either class 1 or class 2. Two articles categorized as class 3 were included in the literature review, but were not further evaluated because they pertained to health concerns not specifically related to firefighters and cancer risk. The research team focused on peer-reviewed journal articles that reported statistically significant associations found between firefighting and various cancer risks. Each journal article was evaluated for the range of cancers studied within the research study, any associations found between firefighting and cancer, and strength of the associations.

Association of Cancers with Firefighting. All of the research studies developed their own study design and methodology to find statistically significant associations between firefighting exposure and elevated cancer risk. The research studies used their own methods to decide how to establish those associations and how to report the significant results. All associations reported in this document are statistically significant unless specifically noted as not significant. Based on the associations that were found for each study, the research team compared their risk estimates to establish a specific level of significance[30] and strength. A risk estimate is reported as statistically significant if it is unlikely to have occurred by chance alone. This means that it is highly likely that another factor or exposure played a significant role in the development of the cancers.

The analysis included specific criteria that were used to establish the strength of associations as found in the 17 research studies. These criteria are based on Hill's causality criteria and are considered the gold standard.[31] Hill uses nine criteria that needed to be considered to determine whether an association is likely to be causal. The nine criteria are:

- Strength: How strong is the association between a potential risk factor and the observed outcome?
- Consistency: Does the association hold in different settings and among different groups?
- Specificity: How closely are the specific exposure factor and specific health outcome associated?
- Temporality: Does the cause (exposure) come before the outcome?
- Biologic gradient: Does a dose-response relationship exist between the exposure and the health outcome?
- Plausibility: Does the apparent association make sense biologically?
- Coherence: Is the association consistent with what has already been established in previous research studies? Is the association consistent with what is known of the natural history and biology of the disease?
- Experimental evidence: Does any experimental evidence support the hypothesis of an association?
- Analogy: Are there other examples with similar risk factors and outcomes?

Hill's criteria have been used in every epidemiological study assessing strength of association between an exposure factor and an outcome. All nine criteria need to be met to establish causality between an exposure and an outcome. Table 12 shows the range of rate ratios

[30] Statistical significance refers to the likelihood that an association between exposure and disease risk could have occurred by chance alone. In statistics, a result is called statistically significant if it is unlikely to have occurred by chance.

[31] Hill's criteria of causation outline the minimal conditions that need to be met in order to establish a causal relationship between an exposure and outcome. Hill's criteria provide a valuable measure by which to evaluate proposed explanations and form the foundation for all epidemiologic research, which attempts to establish scientifically valid causal connections between potential exposures and outcomes.

that are associated with different strengths of association. Rates between 1.0 and 1.2 were categorized as having no association. Rates between 1.2 and 1.5 had a weak association. Rates between 1.5 and 3.0 had moderate associations. Strong associations were categorized by rates between 3.0 and 10.0. Rates higher than 10 were considered to have an infinite association meaning that the strength of the association was extremely strong and can be considered causal. These criteria were used to measure the strength of association of all rates found in the 17 research studies.

Table 12: Strength of Association Criteria

Rate Ratio Range	Strength of Association
1.0-1.2	None
1.2-1.5	Weak
1.5-3.0	Moderate
3.0-10.0	Strong
≥10.0	Infinite

Source: Levy BS, Robbins A, Wegman DH. 1983 Occupational Health: Recognizing and Preventing Work-Related Disease. Boston: Little, Brown, and Company. Chapter 5: Epidemiology of Occupational Diseases, 50-51.

Disparities Among Studies. Overall, the study results point to possible relationships between firefighting and bladder, brain, colon, Hodgkin's lymphoma, kidney, malignant melanoma, multiple myeloma, Non-Hodgkin's lymphoma, prostate, testicular, thyroid, and ureter cancers. All of the above mentioned cancers showed a range of association strengths linked to firefighting (weak to strong associations) established by more than one study. Cancers that showed only one association to firefighting were not included in the overall list regardless of the strength of the association. Those links have not been consistently established by more than one study. The research results have shown various levels of association for linking firefighting and elevated cancer risk among the cancers that were studied in the research studies. However, several of the studies have also reported finding no associations for firefighting and the specific cancers evaluated in the literature review. There are several discrepancies within the 17 research studies about the level of association between certain cancers and firefighting. While one study may find a weak, moderate, or strong association, a few studies will refute that result by finding no association between firefighting and cancer risk. In the example of brain cancer, Demers et al 1992 and Kang et al 2008 found moderate associations, three studies (Bates 2007, Howe 1990, and LeMasters et al 2006) found weak associations, and 7 studies (Baris et al 2001, Bates et al 2001, Demers et al 1994, Firth et al 1996, Guidotti 1993, Ma et al 2005, and Ma et al 2006) found no associations. Similar trends follow for the remainder of the cancers evaluated in the literature review. Aronson et al 1996 was unable to establish an association for prostate cancer.

The authors did not have a large enough sample size of firefighters to find a statistically significant association between firefighting and prostate cancer risk.

Table 13 below summarizes the associations found in the literature review. Specific studies, rates, and 95 percent confidence intervals for all associations are reported in the Appendix D.

Table 13: Summary of Cancer Association Strengths

Cancer	Level of Association					
	Strong	Moderate	Weak	None	Unable to Establish	No. of Studies
Bladder	0	1	3	7	0	11
Bone	0	0	0	2	0	2
Brain	0	2	3	7	0	12
Breast	1	0	0	3	0	4
Buccal cavity and pharynx	0	0	1	8	0	9
Cecum	0	0	0	1	0	1
Cervix	1	0	0	0	0	1
Colon	0	1	2	9	0	12
Digestive System	0	0	0	2	0	2
Esophageal	0	0	1	9	0	10
Eye	0	0	0	3	0	3
Hodgkin's Lymphoma	1	1	0	5	0	7
Kidney	1	0	2	6	0	9
Laryngeal	1	0	0	7	0	8
Leukemia	0	0	1	9	0	10
Liver	0	0	0	7	0	7
Lung	1	0	0	12	0	13
Lymphatic	0	0	0	7	0	7
All Lymphopoietic	0	0	0	2	0	2
Malignant Melanoma	0	2	1	7	0	10
Multiple Myeloma	0	2	0	6	0	8
Non-Hodgkin's Lymphoma	1	1	0	5	0	7
Pancreatic	0	0	0	11	0	11
Prostate	0	0	3	9	1	13
Rectal	0	0	1	10	0	11
Respiratory	0	0	0	2	0	2
Sinus	0	0	0	1	0	1
Skin	0	0	1	5	0	6
Stomach	0	0	1	10	0	11
Testicular	0	4	0	3	0	7

Cancer	Level of Association					
	Strong	Moderate	Weak	None	Unable to Establish	No. of Studies
Throat	0	0	1	5	0	6
Thyroid	2	1	0	3	0	6
Ureter	1	0	1	1	0	3
Urethra	0	0	1	1	0	2
Total	10	15	23	185	1	17
All cancers*	0	2	3	4	0	9

* All cancer refers to the group of cancers that were investigated within a given research study. The authors found a group estimate for the cancers as well as individual cancer estimates.

Weak Associations. Among all of the cancers specified in the literature review, the research studies showed 23 weak associations between cancers and firefighting. Three studies (Baris et al 2001, Guidotti 1993, and Ma et al 2005) found weak associations for the all cancers estimates from each study. Firefighting and bladder cancer were found to have weak associations in three studies, Demers et al 1992, Kang et al 2008 and Ma et al 2006. Bates 2007, Howe 1990, and LeMasters et al 2006 reported three weak associations were found in research studies looking at brain cancer risk. LeMasters et al 2006 found a weak association between firefighting and buccal cavity and pharynx cancer. Colon cancer was found to have 2 weak associations according to Kang et al 2008 and LeMasters et al 2006. Esophageal cancer was found to have a weak association in the Bates 2007 study. Two weak associations were found in observing kidney cancer rates in the Demers et al 1992 and Kang et al 2008 studies. LeMasters et al 2006 reported a weak association in leukemia. Malignant melanoma was found to have a weak association in the LeMasters et al 2006 study. Three weak associations were found for prostate cancer in the Bates 2007, Demers et al 1994, and LeMasters et al 2006 studies. Rectal, skin, stomach, and throat cancers showed weak associations in the LeMasters et al 2006 study as well. Demers et al 1992 found weak associations for ureter and urethra cancers. Three weak associations were found for all cancers that were investigated within the studies in the Baris et al 2001, Guidotti 1993, and Ma et al 2005 studies. Overall, the associations found by the studies were statistically significant based on the sample sizes of each study, study design, and methodology. Comparison of the rate ratios from each study show similar trends pointing to weak associations between firefighting and above mentioned cancers.

Moderate Associations. Fifteen moderate associations were also found between firefighting and elevated cancer risk. Ma et al 2005 found a moderate association in bladder cancer. Demers et al 1992 and Kang et al 2008 reported moderate associations in brain cancer. Colon cancer had a medium association according to Baris et al 2001. Kang et al 2008 found a moderate association between firefighting and Hodgkin’s Lymphoma. Two moderate associations were found in malignant melanoma in the Bates 2007 and Howe 1990 studies. Two moderate associations were found in multiple myeloma in Howe 1990 and LeMasters et al 2006. LeMasters et al 2006 also found a moderate association for Non-Hodgkin's lymphoma. Four moderate associations were seen for testicular cancer in the Baris et al 2001, Bates 2007, LeMasters et al 2006, and Ma et al 2006 studies. Thyroid cancer had a moderate association according to the Ma et al 2006 study. Hansen 1990 and Ma et al 2006 also showed moderate associations for all cancers that were evaluated in their research study. The moderate associations found were established using the criteria based on Hill's causality criteria. Studies that found moderate associations based their rates on sufficient sample size and methodology; therefore, the resulting relationships seen between firefighting and cancer risk are appropriate. Rates ranged from 1.5 to 3.0 for all moderate associations.

Strong Associations. Some studies did present strong associations between firefighting and elevated cancer risk, especially in male breast cancer, cervical cancer, Hodgkin's lymphoma, kidney cancer, laryngeal cancer, lung cancer, Non-Hodgkin's lymphoma, ureter cancer, and thyroid cancer. Ma et al 2005 found a strong association for male breast cancer. Ma et al 2006 found a strong association for cervical cancer. Ma et al 2006 found a strong association for Hodgkin's lymphoma. Guidotti 1993 established a strong association for kidney cancer. Firth et al 1996 found a strong association for laryngeal cancer. Hansen 1990 found a strong association for lung cancer. Band et al 2004 found a strong association for Non-Hodgkin's lymphoma. Two strong associations were reported in the Ma et al 2005 and Ma et al 2006 studies for thyroid cancer. Guidotti 1993 found a strong association for ureter cancer. Comparison of rates from each study show support for the strong associations found in the above mentioned cancers. Strong associations had rates ranging from 3.0 to 8.

Cancers Studied. Table 13 above represents the list of cancers that were identified and evaluated in the 17 peer-reviewed research studies that investigated the potential association between firefighting and cancer risk. The table shows how many of the research studies evaluated each particular cancer. A number of cancers were evaluated multiple times in different research studies including bladder, brain, colon, esophageal, leukemia, lung, malignant melanoma, pancreatic, prostate, rectal, and stomach cancer. These cancers were studied in 10 or more studies out of the 17 total research studies. As well, these cancers were well established as potential occupational cancers that affected firefighters from previous classic studies (Howe 1990, Hansen 1990, Guidotti 1993). Other cancers including buccal cavity and pharynx, Hodgkin's lymphoma, kidney, laryngeal, liver, lymphatic, multiple myeloma, Non-Hodgkin's lymphoma, skin, testicular, throat, and all cancers (inclusive of cancers studied in a given research study) were evaluated in 5 to 9 of the research studies. These cancers show potential elevated risks in firefighters, thus more research studies are starting to investigate these cancers more carefully (Demers et al 1992, Kang et al 2008, Firth et al 1996, Band et al 2004, LeMasters et al 2006). Some cancers were rarely evaluated (4 studies or less) including bone, breast, cecum, cervical, eye, sinus, ureter, and urethra cancers. These cancers are very rare and may be the reason why they were not thoroughly examined in the research studies that were evaluated (Ma et al 2005, Bates 2007, Demers et al 1994, Firth et al 1996, Demers et al 1992). Only one author of two studies, Ma et al 2005 and 2006, evaluated cancers of certain organ systems including the digestive system, respiratory system, and lymphopoietic system. In general, researchers reported specific rates and results for individual cancers as opposed to cancers grouped together under one body system. Interestingly, two particular cancers were included in state legislation but were not evaluated in the 17 research studies that were investigated. Mesothelioma and ovarian cancer were not included in the cancers identified within the research studies.

Study Limitations. The research studies did have several limitations including lack of substantial background information, confounding factors[32], and study biases. These study limitations are discussed individually below. As a general rule, all research studies reference the results and findings of previous research studies that evaluated the same exposure factors and outcome, and in this case, firefighting and possible cancer risks. Due to the lack of high-quality research studies done on firefighting and cancer risks, the current research studies need to consider their findings and possible associations in the context of previously reported results (Baris et al 2001, Aronson et al 1996, Guidotti 1993). As more and more studies are done, more detailed information on firefighting exposure will be classified according to several categories: length of exposure during fire and overhaul, type of exposure (wild land fires v. urban fires), materials burned (Demers et al 1992, Demers et al 1994, Guidotti 1993), temperature of fire (Demers et al 1992), length of employment (Demers et al 1994, Guidotti 1993), type of employment (Demers et al 1994), and type of protective equipment worn or not worn during exposure (Bates 2007, Guidotti 1993). The American Medical Association, National Cancer Institute, American Cancer Society, and National Institutes of Health have already distinguished Cancer outcomes; however, the detailed classification of cancer needs to be continually updated for future research studies (Ma et al 2006).

When assessing firefighting exposure as a potential risk factor for elevated cancer risk, several confounding factors need to be taken into consideration. These confounding factors are associated with the exposure of firefighting and may alter the true association between firefighting and cancer risk. These factors may heighten an estimated risk, meaning that the true association is actually lower than stated, or they may lessen an estimated risk, meaning that the true association is higher than reported. The first scenario can cause serious problems due to monetary concerns. If a firefighter is told that they have a high risk of developing cancer, they may seek out all the medical services they can in order to avoid a cancer diagnosis. This can lead to severe financial burdens for the patient, treating facility, and overall healthcare system of the

[32] In statistics, a confounding factor is a variable other than the one being tested which can affect the incidence or degree of a parameter being measured. A confounding factor in a study is a variable which is related to one or more of the variables defined in a study. A confounding variable may mask the actual association or falsely demonstrate an apparent association between the study variables where no real association between them exists.

municipality. The second scenario is a serious problem because it would be interpreted as firefighters have less risk of certain cancers when in fact they have a much higher risk, but that risk was hidden among the confounding factors. Several confounders were also mentioned in the research studies including smoking habits (Bates 2007, Hansen 1990, LeMasters et al 2006, Ma et al 2005, Ma et al 2006), baseline health status (Howe 1990), family history of disease and cancers (Ma et al 2005), incomplete records on firefighting activities (Bates 2007, Demers et al 1992), alcohol consumption, firefighting duties (Bates 2007), length of employment (Ma et al 2006), age, use of personal protective equipment (Demers et al 1994, Ma et al 2006). Findings of associations between firefighting and increased risk of specific types of cancer may be causes for concern and should encourage future development of better personal protective equipment so that firefighters can perform their duties without compromising their health. Future studies should evaluate confounding factors and use stratified analysis to control them to estimate the real risk of cancer in firefighters.

Another major difference between the studies corresponds to the use of control groups. The research studies used comparison groups including the general population cancer rates (Baris et al 2001, Demers et al 1994, Kang et al 2008, Ma et al 2006, Stang et al 2003, Zeegers et al 2004), local/regional controls (Bates 2007, Hansen 1990), hospital controls, and occupational controls such as police officers (Demers et al 1992, Demers et al 1994, Firth et al 1996, Kang et al 2008). The estimated rates obtained from using different control comparison groups can alter the range of association rates between firefighting and cancer risk. This makes the studies difficult to compare to one another because none of the studies use a standardized method to find the significant associations. The majority of the studies used their own methodology to establish risk rates for their target population of firefighters. LeMasters et al 2006 did a complete meta-analysis[33] of research studies published before and including 2006 involving firefighting and cancer risk. This study was a follow-up to the Howe and Birch 1990 meta-analysis study. LeMasters et al 2006 established a summary risk estimate which was based on a series of statistical equations to make the various estimate risks from each study comparable. Similar meta-analysis studies may be conducted regularly to establish comparable rates among all of the published studies looking at firefighting and cancer risk.

One potential concern cited by several of the studies is that the actual risk of cancer may be underestimated due to the healthy worker effect when the comparison group is the general population (Baris et al 2001, Bates et al 2001, Hansen 1990, Demers et al 1992, Aronson et al 1996, Guidotti 1993, Demers et al 1994, Howe 1990, LeMasters et al 2006, Ma et al 2005, Ma et al 2006). The concern is that the actual risk of cancer may be underestimated because firefighters

[33] In statistics, a meta-analysis represents the combination of the results from several studies that address a set of related research hypotheses. A meta-analysis is an overview of published research results and uses quantitative methods to summarize the results.

tend to be in better physical shape than the general population to which they are compared. Career firefighters also have strict physical entry requirements.[34] Thus they are at a decreased risk of developing health problems than the general population. However, the healthy worker effect bias may be less noticeable when compared to cancer cases (as opposed to other chronic diseases such as heart disease or diabetes) since most cancers develop at later ages in both the firefighter population and general population (Baris et al 2001, Bates et al 2001, Demers et al 1992, Guidotti 1993, Demers et al 1994, LeMasters et al 2006, Ma et al 2005, Ma et al 2006).

Another issue that was raised was loss to follow-up of study participants in many of the studies that had cohort study designs[35] (Baris et al 2001, Bates et al 2001, Demers et al 1992, Demers et al 1994, Firth et al 1996, Guidotti 1993, Hansen 1990, Ma et al 2005, Ma et al 2006). Lost information on the firefighters could have resulted in biased resulting rate ratios in all of the studies. The problem lies in the missing information from those firefighters and control comparisons that dropped out of the study. The researchers would be unable to use their follow-up data in their final calculations for the estimated rates of firefighting and cancer risk. By missing some information, it is likely that the true association would be lower than what the estimated risk would be from a particular study. This would lead to an inaccurate interpretation of the data stating that firefighters are at a lower risk of developing certain cancers when they are actually at higher risk.

Bates 2007 reported missing information as a bias that has been identified in other studies (Howe 1990, Kang et al 2008). It was a serious limitation to rely on incomplete medical records of firefighters for the sample population. A substantial proportion of records either had missing data, firefighter responses in the records were not standardized making it difficult or even impossible to compare to other records, or firefighter responses to specific health questions were limited to a few phrases which did not reveal enough information to make a significant assessment. Missing data on a single individual or a group of individuals gives an incomplete picture of the sample population, thus any estimated risks are inaccurate. Any biased estimates will lead to an inaccurate estimate of the true association between firefighting and cancer risk.

Another limitation involves the differences between using incidence risk estimates compared to mortality risk estimates. One main focus of the study was to investigate cancer incidence among firefighters since the interest lies in finding the target population, providing a beneficial health intervention to reduce cancer rates among firefighters, and eventually preventing cancer incidence among firefighters. Using research studies that incorporated mortality risk estimates was helpful in terms of establishing potential associations between

[34] This is usually true for career firefighters but not universal for volunteer firefighters.
[35] Cohort studies are systematic follow-ups of a group of people for a defined period of time or until a specified event, e.g., cancer diagnosis, disability, death. These kinds of studies are also known as longitudinal or prospective studies.

firefighting and specific cancers, but they did not address new cases of cancers among firefighters. Due to the availability of data, more research studies have used mortality risk estimates (Baris et al 2001, Demers et al 1992, Guidotti 1993, Hansen 1990, Howe 1990, Ma et al 2005). More recently published research studies have begun to look at incidence rates of cancer among firefighters since the information has started being collected by cancer registries and hospital medical records (Bates et al 2001, Demers et al 1994, Firth et al 1996, Ma et al 2006). The ultimate goal would be to develop a standardized system of collecting information on firefighting exposure and capturing outcome information on new cancer cases among firefighters.

Discussion

The extensive literature search and review enabled the research team to determine which cancers have been distinguished as possibly linked to firefighting exposure. Several studies have found supporting associations between firefighting and bladder, brain, colon, Hodgkin's lymphoma, kidney, malignant melanoma, multiple myeloma, Non-Hodgkin's lymphoma, prostate, testicular, thyroid, and ureter cancers. However, due to the inconsistency between studies regarding the establishment of associations and the strength of established associations, the research team cannot confirm causality between firefighting exposure and elevated cancer risk. Authors of occupational epidemiologic research studies such as these can only report statistically significant associations. As such, the more studies that are conducted with statistically significant results, the more confidently researchers can assert whether or not the exposure of firefighting can be a risk factor for elevated cancer incidence.

The research studies do provide solid groundwork from which future studies can be developed and improved. Future studies need to take all previously noted study limitations from the published research studies into consideration. They should remove as many sources of potential bias and limitations from the design and methodology of the study as possible to accurately define the risk estimates between firefighting and cancer risk. Future studies also need to develop a standardized measurement of risk estimates that can be comparable to past studies and provide guidelines for other similar studies. For purposes of targeting new cancer cases with the ultimate goal of prevention of cancer, standardized measurements of risk estimate should pertain to incidence rates and rate ratios. These risk estimates will provide a better picture of the magnitude of the cancers that are affecting the firefighter population. These recommendations will strengthen the studies and allow them to establish more statistically supported and appropriate conclusions. As more studies are conducted and more research results are available, any associations that may or may not be found between firefighting and specific cancers will then be validated by additional supporting associations or lack thereof. The more consistent the standardized risk estimates, the higher the likelihood that firefighting exposure can or cannot be directly linked to cancer incidence. However, more research is necessary to establish any substantial conclusions about the risk of firefighting to cancer development.

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CHAPTER V: SUMMARY OF RESEARCH RESULTS

A primary objective of this study was to establish the scientific basis for firefighter cancer presumption. During the course of the study, the research team gathered and examined sufficient information to make four determinations with regard to firefighter cancer presumption. First and foremost among these: there is a lack of substantive scientific evidence currently available to confirm linkages between firefighting and an elevated incidence of cancer. There is still considerable research to be undertaken before definitive linkages can be supported or refuted.

Second, state presumption statutes are not uniform: these laws vary greatly between states in both cancers addressed and the requirements necessary to receive benefits under the presumption laws.

Third, state presumption statutes are inconsistent with respect to the cancers covered and the scientific evidence currently available.

Finally, there are many individuals with in-depth knowledge on the issues of firefighter cancer presumption. As well, there are many individuals, specifically the authors of the research studies, with substantive knowledge of epidemiologic methods and their applications in the investigation of disease causality. While each of the individuals is knowledgeable in a prescribed area, nonetheless, the research team could not comfortably identify any of these individuals as "experts" in firefighter cancer presumption. The issue of presumption is complex, transcending the areas of epidemiology, law, human resource management, labor, and politics. We have not identified anyone who could be considered an "expert" in the combined aspects of presumption.

Summary of Key Findings: Literature Review

The research team was unable to conclude from the review of literature on firefighting and cancer that there was a firm and consistent scientific basis to associate cancer with firefighting. While there is some indication that certain cancers may be associated with firefighting, there is also some indication that other cancers are not associated. In contrast, the scientific literature also did not demonstrate that there was *not* an association between firefighting and increased cancer incidence. While the findings did not provide answers to the research questions, specifically to identify differences in cancer rates between firefighters or EMS providers and the general public, there were several interesting results worth noting.

In addition, the review and evaluation of the literature revealed weaknesses in the available scientific literature. These problems may be an indication as to why state presumption legislation varies in cancers covered, inclusion criteria, and other areas.

Results of Note

As noted above, despite the lack of scientific literature to support or refute firefighting as a cause of cancer, several findings were of interest:

- Studies that established statistically significant associations were those with larger sample sizes. Larger studies may provide a better representation of the population that the study is observing. Studies that found moderate and strong associations all had sample sizes that exceeded 1000 persons and often extended into a few thousand study participants. [36,37,38,39]
- Studies found strong associations between firefighting and male breast cancer, cervical cancer, Hodgkin's lymphoma, kidney cancer, laryngeal cancer, lung cancer, Non-Hodgkin's lymphoma, ureter cancer, and thyroid cancer.[40,41,42,43,44]
- There were conflicting results between studies concerning the association of cancer to firefighting. For example, some studies found moderate association between firefighting and brain cancer,[45,46] while others found no association.[47,48] Conflicting results between studies also apply to the strong associations noted above. With the

[36] Baris et al. (2001). Cohort Mortality Study of Philadelphia Firefighters. *American Journal of Industrial Medicine, 39*, 463-376.
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exception of cervical and thyroid cancers, cancers with strong associations to firefighting had at least an equal number of lower or no associations.

Paucity of Literature

Of 161 documents identified as relevant to firefighters and cancer, only 71 (44.1%) were scientific research studies or data-driven analyses that occurred after 1995 or that could be identified as *classic studies*. Of the 71, 45 (63.4%) were rated as Class I or Class II, meaning that the methods used could yield some type of scientific value. Of the 45 Class I or Class II studies, 17 (37.8%) provided any results that reached the .95 level of statistical significance—the standard acceptable probability for determining statistical significance. In summary, since 1995, the number of research papers on firefighting and cancer were produced at a rate of less than one per year. The number of cancer research studies investigating firefighting as a potential risk factor for cancer incidence is extremely small when compared to the overall amount of cancer research done every year within the United States.

Lack of Firefighter Cancer Incidence Rates

One of the core research questions was to determine the differences in cancer rates between firefighters or EMS providers and the general public regarding common cancers. Firefighter cancer rates are not available in the literature. Each research study used its own methodology and reported different rate measures. The lack of incidence rates limits accurate analyses on the magnitude of cancer occurrence in the firefighter population and further, on the potential costs incurred.

Weaknesses of Literature

A study that uses rigorous, academically accepted research methods does not necessarily produce significant results. Many of the firefighter cancer studies were narrowly focused, meaning that industry-wide generalizations could not be realized. Some methods that lead to weaknesses of the literature include:

- Study populations that were usually homogeneous, not taking into account career/volunteer status or suburban/rural firefighters.
- Small sample sizes that prevented research results from achieving statistical significance.
- Patients in the studies were lost to follow-up, making long-term outcomes difficult to determine. Nine of the studies that were cited made reference to this factor.
- Many cancers that commonly occur were not studied.

- Cancers that are exclusive to women were studied least. While the firefighting profession is still overwhelmingly male, more women are entering the profession. In addition, as more departments add EMS to their service line, the number of women will likely increase.
- The United States does not have a cancer registry[49] similar to European countries, Australia, and New Zealand.

The IAFF recently released an article echoing these concerns, citing interviews with various scientists and academicians who called for further scientific studies on cancer in firefighters. They concluded that research studies must include an emphasis on quantitative analysis of the problem.[50]

Need for Further Study

These findings from the literature review together with remarks from the research studies' authors indicate that all results, including those with strong and moderate association and those with low or no associations, should continue to be addressed and vetted in future research studies. Additional and continued research is necessary.

Summary of Key Findings: State Firefighter Cancer Presumption Laws

Not unexpectedly, the examination of state firefighter cancer presumption legislation found a variety of legislation. Some states have a wide range of coverage while others are more stringent. Some states' legislation imposes no conditions or restrictions on when the disease was diagnosed, how the disease was found, or any mitigating factors. Other states' legislation has very specific eligibility criteria for cancer presumption. Significant considerations are discussed below.

Covered Employees

The definition of a covered employee may have the single largest impact on the overall scope of a state's presumption legislation. Thirteen of 24 (54.2%) states with cancer presumption laws cover both career and volunteer firefighters. Depending on the state, the pool of potentially covered individuals can increase significantly—nationally, there are 2.5 times as many volunteer firefighters as there are career firefighters. Nine of 24 (37.5%) of states with cancer presumption

[49] A cancer registry is a systematic collection of data about cancer and tumor diseases. The information collected includes data on patient medical history, diagnosis, treatment, current health status, and other demographic information on every cancer patient in the population. A cancer registry allows researchers to gain a better understanding of demographic patterns as well as the underlying cause of cancers.

[50] International Association of Firefighters. (2008). Fighting Fires. Fighting Cancer. International Fire Fighter. November/December 2008, 22-24.

cover EMS providers who are not firefighters. There are no national estimates on the number of EMS providers.

Covered Cancers

Cancers covered under presumption are generally broadly defined. More than half the states with presumption laws (13 states) cover all cancers. The language used in these 13 statutes varies widely and can be subject to interpretation. Nonetheless, the overall result is that any cancer could be covered. The remaining 11 states cover a variety of site-specific cancers with six states also covering cancers of organ systems—thereby covering any site-specific cancer that could arise in the system.

Service Requirements

Approximately one-third of the presumption statutes do not specify a minimum length of service prior to eligibility. The remaining states require a specific number of years of service before a claimant is eligible under cancer presumption laws. It may be difficult, however, to determine a definition for *years of service* or *active service.* Arizona specifies that the employee must have performed "hazardous duty" and Wisconsin requires that 49 percent of work hours be in fire suppression. How these definitions apply to volunteer firefighters, if covered, is usually not specified.

Nineteen states require pre-employment physicals for career firefighters to determine that the applicant is cancer free. Fourteen states require that the cancer must be secondary to an exposure to known carcinogens. As firefighters are often exposed to known carcinogens during the combat and overhaul stages of fire suppression, trying to determine specific numbers, dosage, time and other variables is difficult and improbable. The requirement is legitimate for check and balance purposes, but is difficult for municipalities to measure.

Post-Employment Coverage

Several states have enacted legislation that includes post-employment restrictions. Post employment coverage refers to service retirement, disability retirement, voluntary separation, or involuntary separation. Nebraska and Rhode Island provide no coverage after separation, while other states provide coverage for six months to lifetime. Eight states provide a five year maximum coverage window, one state 10 years, one state 20 years, one state six months, two states have a post-retirement limit that expires at age 65, and the remaining have lifetime coverage.

For states that include volunteer firefighters in cancer presumption, it is difficult to determine when a volunteer "retires," as many continue their memberships in other than emergency roles or are declared "life members," considered as active members for the rest of their lives.

Rebuttal

The ability for municipalities to rebut a claim under presumption laws is arguably the most sensitive issue within firefighter cancer presumption. It may be the level of evidence needed is almost impossible to achieve. Twenty-two states have rebuttal provisions, including 19 that require pre-employment physicals, and two that require annual physicals. These physicals are used to establish a baseline. Failure to participate in these physicals may constitute a rebuttal if the firefighter elects not to participate. If the municipality fails to provide or require the physical, it is not likely to hold up as a rebuttal. Eight states provide for rebuttal if the claimant used tobacco products during employment.

Although legal issues are beyond the scope of the report, the study team found that it is difficult to rebut a presumption law. Generally, the employer must present clear and convincing preponderance of evidence that: (a) the primary site[51] of the cancer is different than claimed, (b) the employer presented factors rebuttable by law (tobacco use, no pre-employment physical), or (c) an exposure did not occur. Rebuttal, while difficult, is not impossible and courts have upheld tobacco use as a rebuttal to presumption.

Analysis of Covered Cancers and Scientific Literature

While the research confirmed the lack of sufficient and recent scientific literature to support or refute firefighting as a cause of cancer, state cancer presumption laws nonetheless extend workers' compensation benefits to defined cancers. Table 3 presents the cancers identified in the state cancer presumption laws from Chapter 2 together with the relevant associations from the literature review from Chapter 3.

Of the 14 cancer groups, i.e., "all cancers" and system-based cancers, none had refereed studies identified to support the presumption. Nine of these cancer groups were not studied in the literature. The remaining five had research studies that yielded no association between firefighting and cancer. Of the 20 site-specific cancers, four had no refereed studies identified to support the presumption, four had studies indicating no associations stronger than "weak," six had at least one moderate association as the strongest level of association, and six had strong associations but only one study each. Ovarian and mesothelioma cancers, while covered under some state statutes, were not found in the studies reviewed. The average number of studies for the site-specific cancers was eight.

[51] A primary site of cancer refers to the original site (tissue or organ) where the cancer started. A secondary site of cancer refers to the spread of the primary cancer to a new area in the body.

**Table 14: Summary of Covered Cancers:
Firefighter Cancer Presumption Legislation and Strength of Association with Firefighters**

Type of Cancer	States with Legislation	State(s)	Studies	Associations	
All (non-specific) Cancers [a]					
All Cancers	13	Alabama, California, Illinois, Indiana, Minnesota, Missouri, Nebraska, New Hampshire, North Dakota, Oklahoma, Rhode Island, Tennessee, Texas	None	Not studied	
System Based					
Central Nervous System	2	Massachusetts, Wisconsin	None	Not studied	See also partial component of the central nervous system: Brain
Digestive System/ Gastrointestinal Tract [b]	5	Colorado, Louisiana, Massachusetts, Vermont, Wisconsin	2	None: 2	See also partial components of the digestive system/gastrointestinal tract: Colon, Rectal, Liver, and Pancreatic
Genitourinary System	1	Colorado	None	Not studied	See also partial components of the genitourinary system: Bladder, Kidney, Prostate, Testicular, and Ureter
Hematopoietic Cancer [b]	1	Nevada	2	None: 2	See also partial components of the hematopoietic system: Leukemia, Hodgkin's Lymphoma, Non-Hodgkin's Lymphoma, and Multiple Myeloma
Hematological System	3	Colorado, Massachusetts, Wisconsin	2	None: 2	Same as hematopoietic system
Lung/ Respiratory Tract [b]	1	Massachusetts	2	None: 2	See also partial components of the lung/respiratory tract: Lung and Throat. See also Mesothelioma, a specific type of lung cancer
Lymphatic System	3	Massachusetts, Nevada, Wisconsin	7	None: 7	
Oral System	2	Massachusetts, Wisconsin	None	Not studied	
Prostate System	1	Massachusetts	None	Not studied	See also partial components of prostate system: Prostate, Testicular, and Ureter
Reproductive System	1	Wisconsin	None	Not studied	See also partial components of reproductive system: Breast, Ovarian, Prostate, and Testicular
Skeletal System	2	Massachusetts, Wisconsin	None	Not studied	See also partial component of skeletal system: Bone
Skin	5	Colorado, Louisiana, Massachusetts, Vermont, Wisconsin	None	Not studied	See also Mal Melanoma, a specific type of skin cancer.
Urinary System	2	Massachusetts, Wisconsin	None	Not studied	See also partial components of urinary system: Bladder, Kidney, and Ureter

Type of Cancer	States with Legislation	State(s)	Studies	Associations
Specific Cancers				
Bladder	6	Alaska, Arizona, Louisiana, Nevada, Vermont, Washington	11	Moderate: 1 Weak: 3 None: 7
Brain	7	Alaska, Arizona, Colorado, Louisiana, Nevada, Vermont, Washington	12	Moderate: 2 Weak: 3 None: 7
Breast	2	Virginia, Wisconsin	4	Strong: 1 None: 3
Colon	5	Arizona, Louisiana, Nevada, Vermont, Washington	12	Moderate: 1 Weak: 2 None: 9
Kidney	5	Alaska, Louisiana, Nevada, Vermont, Washington	9	Strong: 1 Weak: 2 None: 6
Leukemia	7	Alaska, Arizona, Louisiana, Maryland, Vermont, Virginia, Washington	10	Weak: 1 None: 9
Liver	2	Nevada, Vermont	7	None: 7
Hodgkin's Lymphoma	4	Arizona, Louisiana, Nevada, Vermont	7	Strong: 1 Moderate: 1 None: 5
Non-Hodgkin's Lymphoma	6	Alaska, Arizona, Louisiana, Nevada, Vermont, Washington	7	Strong: 1 Moderate: 1 None: 5
Lung	1	Massachusetts	13	Strong: 1 None: 12
Mal Melanoma	2	Alaska, Washington	10	Moderate: 2 Weak: 1 None: 7
Mesothelioma	1	Arizona	None	Not studied
Multiple Myeloma	3	Louisiana, Vermont, Washington	8	Moderate: 2 None: 6
Ovarian	1	Virginia	None	Not studied
Pancreatic	3	Maryland, Vermont, Virginia	11	None: 11
Prostate	4	Alaska, Maryland, Virginia, Washington	13	Weak: 3 None: 9 Unable to establish: 1[c]
Rectal	4	Arizona, Maryland, Virginia, Washington	11	Weak: 1 None: 10
Testicular	2	Vermont, Washington	7	Moderate: 4 None: 3
Throat	2	Maryland, Virginia	6	Weak: 1 None: 5
Ureter	2	Alaska, Washington	3	Strong: 1 Weak: 1 None: 1

[a] "All cancers" includes states that reference simply "cancer"; states that reference both specific and non-specific cancers; and states that reference "cancers resulting from exposure to…[carcinogens; heat; smoke; etc.].

[b] Literature review established studies that included the system. The studies did not find associations. However, the system cancers, as defined by the study, only include those specific cancers that were observed in the particular research study and did not necessarily include cancers that could be included from legislation.

[c] Aronson et al (1996) was unable to establish a level of association due to small sample size.

Costs Associated with Cancer Presumption

There are currently no estimates available on the magnitude of firefighter cancer presumption issue: there are no estimates on the number of firefighter cancer presumption claims and there are no estimates on the overall costs associated with firefighter cancer presumption claims. To put firefighter cancer presumption in context with other municipal issues, the study team attempted to quantify the size and scope of the problem. The preferred basis for both estimates was workers' compensation claim data. Failing the availability of that data, the next preferred method was to create separate estimates for the number of affected firefighters, medical costs, and disability payments.

Determining these estimates proved to be exceptionally complicated. There were several key inputs that were difficult to quantify and minute changes in these inputs produced substantial variations in the estimates. The study team concluded that creating estimates on the magnitude of firefighter cancer presumption at this juncture involved too many uncertainties and were dependent on poorly quantified variables. As the sections below indicate, the lack of reliable data was the overriding challenge.

Workers' Compensation Claim Data

Cost data from workers' compensation for cancer presumption claims was not readily available. This lack of information may reflect a low number of filed claims or it may be that costs associated with firefighter work-related cancer are absorbed elsewhere. It may also reflect both situations. For firefighters and former firefighters over age 65 who are covered under cancer presumption, the medical costs may have been borne already by Medicare. As this group of firefighters is likely to be retirees, disability payments from workers' compensation are rarely applicable. And, benefits paid from pension funds would not be captured. While there are workers' compensation claims for work-related cancers, it may be that those cancers were not covered under the presumption statutes.

Another possibility is that claims are not submitted as presumption claims. The first report of injury notes the date, time, and nature of injury. It is not until an evaluation of the claim is made that it is identified as a workers' compensation claim. Regardless of the situation, there is very little data available on workers' compensation cancer presumption claims.

Estimating Cancer Presumption Costs

With workers' compensation data not readily available, the study team worked to derive a first order estimate of the number of firefighters who would qualify for workers' compensation benefits under cancer presumption and subsequently, the potential costs. To pursue these estimates, four general data elements were needed:

- Overall numbers of firefighters,
- Firefighter cancer incidence rates,
- Cost of cancer care, and
- Cost of disability benefits.

Estimating the number of firefighters in a given year who are expected to develop the cancers covered by state presumption statutes could be considered as a close approximation of the potential number of worker's compensation claims. Applying estimated cancer treatment costs and the cost of benefits to these potential claims would yield an annual estimate of the potential cost of the presumption claims. While straightforward in approach, the data to create the intermediate estimates was also not readily available.

The study team discovered that first item of data, state-based estimates of the career and volunteer firefighter populations, are not generally available. Even State Fire Marshal offices generally refer such requests to the National Fire Protection Association (NFPA), a trade association that also conducts surveys of the fire community. However, NFPA publishes national estimates of career and volunteer firefighters, but not state estimates. As each state presumes different cancers for firefighters, these state-based firefighter population estimates are necessary. The research team was able to secure unvetted firefighter data from the U.S. Fire Administration's (USFA) Fire Department Census project. The USFA Fire Department Census project relies on voluntary data submission and, despite its name, is not a complete census of all U.S. fire departments. Nonetheless, about 85 percent of NFPA's estimated number of fire departments submit data. While the data from the Fire Department Census is not yet vetted, it is nonetheless the *only* data source available for state estimates of firefighters. The state-based estimates of firefighters are included as Appendix E.

Incidence rates, or an equivalent measure, are necessary to estimate the number of firefighters who would qualify for workers' compensation benefits under cancer presumption. In turn, the number of these claims drives the cost estimate. A major finding of this study, however, is that incidence rates associated with firefighters and cancer are not established. An alternative measure, odds ratios, could be used as an estimate of a relative adjustment to general cancer incidence rates. At least one state legislature (Vermont) found that the results from this approach were not acceptable.[52,53] Nevertheless, the range of cancers covered under the various statues far exceeded the small amount of potential firefighter cancer rate data from the literature.

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[52] Conversation and email correspondence with David Sichel, Deputy Director of Group Services for External Affairs and Planning, Vermont League of Cities and Towns.

[53] In actuality, Vermont did not question the incidence rate method but rather that the "medical data used was outdated; was for only one year, rather than the average of several years." The data Vermont used was from one of

The net result then was that creating a reasonable and supportable estimate of the number of firefighters who qualify for workers' compensation under cancer presumption was not possible.[54]

The team also researched annual and lifetime costs of cancer with the intent of deriving estimates of costs by class of cancer. Twenty-six cost studies were reviewed. The majority of these studies used Medicare data to evaluate the cost of care. As a measure of medical costs under workers' compensation, these data are likely to be inadequate. Moreover, with the constant changes in cancer treatment options it was not possible to estimate future medical costs with any precision. In lieu of medical claim data, a proxy for annual medical cost was derived by using the medical component of the most recent National Institutes of Health estimate of overall cancer costs and the American Cancer Society's estimates of cancer patients. While "usable," this estimate in no manner reflected the mix of cancers covered under state firefighter presumption.

Lastly, disability benefits and payments vary considerably across fire departments as well as across the states. The study team decided against quantifying a "typical" cost as the variations in benefits among a selected sample of fire departments was sizeable. Any estimate of a "typical" cost would have been difficult to support.

Recommendations

Two major areas of further emphasis are recommended. These areas—a longitudinal research study of firefighters to track cancers and cancer incidence and support for other research avenues—are addressed below.

Longitudinal Study: Threshold for Establishing Presumption/Causality

Establishing a consistent and appropriate method to determine whether firefighting is a risk factor for elevated cancer incidence has proven to be a substantial challenge to researchers. A major factor in establishing causality between the risk factor and outcome is to continually verify scientifically, rigorous results that have been confirmed by cancer research studies which examine the firefighter population. The studies that are currently available acknowledge firefighting as a potential cancer risk factor that needs more observation; the studies do not ascribe causality. The preferred approach to establishing causality would be to initiate large studies from multiple sites to observe all potential risk factors in the firefighter population. The research studies underscored the need for continued research and at least one study indicated the

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the most highly regarded meta-analyses to date, underscoring that even some of the best research does not provide sufficient credibility.

[54] To estimate the number, at least one additional area needs consideration. The age profile of the firefighter population is not likely to conform to the general population. Without this age profile, on a state-by-state basis, and the appropriate cancer incidence rate(s) for that population, any estimate of the numbers of affected firefighters will no be reliable.

need for such an approach.[55] Creating firm guidelines and standardized methods to measure rates of disease in the population will also contribute to establishing any associations.

Creating this large, longitudinal study[56] to investigate firefighter risk factors and cancer rates takes substantial resources. Such a study could be a difficult challenge to start; however, the results of the study would provide more foundational information necessary for appropriate legislation. Potential factors to consider in the study would be the effects of personal protective equipment, overall health maintenance, evaluation of firefighter duties, and secondary jobs among others. Examining these factors in a large-scale study would ultimately lead to the identification of high risk factors, moderate risk factors, and low risk factors. The classification of risk factors alone would be means for effective and informed legislation.

Furthering Research and Research Mechanisms

Research comes in many forms and serves many purposes. Each piece becomes part of the larger picture and significant progress on a specific research question can be achieved. In the case determining possible relationships between firefighting and cancer, this critical mass of research has not yet been achieved.

- The establishment of a national firefighter cancer database (firefighter cancer registry). The registry differs from the longitudinal study in that it collects detailed data on only those firefighters diagnosed with cancer. The longitudinal study follows a group of firefighters who may (or may not) develop cancer to analyze the differences in the two groups.
- Establishing public-private partnerships to guide cancer research. An example of such a partnership might be a partnership between NLC (private) and the National Center for Health Statistics (NCHS) to establish protocols for cancer data collection.
- Work with the Congressional Fire Service Caucus to secure funding for NIH, NIOSH, the CDC, the United States Fire Administration, or a similar governmental organization to become a clearinghouse for fire service cancer research. Priority should be given to establishing a major research study, such as the longitudinal study recommended above, to determine the association between firefighting and cancer. A federal initiative will most likely be necessary to complete this research in a timely manner.

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[55] Bates MN. Registry-Based Case-Control Study of Cancer in California Firefighters, *American Journal of Industrial Medicine*, 2007:50;339-344.

[56] Data are longitudinal if a data set tracks the same type of information on the same subjects at multiple points in time. The primary advantage of longitudinal databases is that they can measure *change*. The longitudinal data extend into the past as well as the present. If sufficient types of data are collected, various risk factors can be assessed to determine their possible roles in the determining outcomes.

- Continue to encourage unbiased research at institutions of higher learning. Schools of Public Health are valuable resources that could be harnessed to assist in a variety of health initiatives.

Further Areas of Consideration

The Impact of Protective Ensembles

Early studies (pre-1995) included firefighters whose careers occurred before the universal acceptance of self-contained breathing apparatus (SCBA) and other PPE. Some firefighters had access to SCBA but the use of SCBA was limited and local protocols for its use were often not enforced. During the 21st century, compliance with SCBA use is increasing. The IAFC, the IAFF, and the NVFC [57] have fully supported the enforcement of SCBA use and organizations including FirefighterCloseCall.com are urging firefighters to comply with these standards.

Firefighters are often exposed to known carcinogens while on the fireground during the combat and overhaul stages of fire suppression. The effects of better respiratory and protective equipment on cancer in firefighters may not be known for years. These engineering controls could significantly decrease or eliminate some suspected workplace-related cancers. The NLC should consider supporting municipalities to provide proper safety equipment and require its use. Further, the NLC should consider supporting municipalities to require firefighters to observe safety mandates, encourage proactive safety initiatives, and provide incentives to firefighters to comply with regulations. Management personnel should be held responsible for training and enforcement.

Predispositions

Certain firefighters may have predispositions to conditions that are instigated or aggravated by the workplace environment. These issues can be genetic, congenital, and even behavioral. The nature of the firefighting profession often attracts persons with certain personality characteristics. Firefighters are often confident, driven, and more likely to participate in risky activities (in this case, firefighting)—qualities that both make them valuable in the role that they play in the community and that may put them unnecessarily and unwisely in harm's way. The participation in potentially hazardous activities may extend outside the work environment to include activities such as smoking and the choice of second jobs, both of which are discussed below. These activities may have consequences that are nearly impossible to separate from workplace exposures. Because there are often many factors that contribute to disability, including workplace exposure and predisposition, the following question arises:

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[57] NVFC. (n.d.). In pursuit of fire fighter safety and health: An introductory guide to standards, regulations, and resources. [Electronic Version]. National Volunteer Fire Council Foundation.

should presumption statutes cover all aspects of disability regardless of what other factors may have played a role?

Smoking

There is little dispute that tobacco use increases the probability of cancer development in smokers and probably those living and working in second-hand smoke environments. Therefore, one way to decrease firefighter cancer risk is to prohibit firefighters from smoking. For those firefighters who currently smoke, most medical plans cover smoking cessation programs, including physician prescribed medications. Prohibiting tobacco use among newly hired firefighters is also reasonable and prudent. In July 2008, the IAFF joined with Pfizer Pharmaceuticals to launch an initiative whose goal is "…to help make the IAFF the first smoke-free union in North America."[58]

Perhaps a bigger challenge is the ability to limit smoking in volunteer firefighters. Some local volunteer or combination departments may be reluctant to approach the situation because it could hinder recruiting efforts. National volunteer organizations have joined the fight to end smoking among firefighters. In 2008, the NVFC released a guide to heart-healthy living that included a description of smoking cessation programs, the benefits of smoking cessation, and where to get assistance.[59]

While these types of initiatives do not guarantee local success, they do emphasize that assistance from national organizations is available.

Except for documentable substance abuse, at the time of injury, workers' compensation laws prohibit assigning fault or contributory negligence. Smoking can be construed as such negligence. For example, in McDaniel v. North Dakota Workers Comp. Bureau, the North Dakota Supreme Court reversed the denial of benefits to a firefighter who developed bladder cancer but was also a cigarette smoker. Although acknowledging that smoking was inadvisable, it could not overcome the evidence of linkage to bladder cancer to firefighting.[60]

Second Jobs

The practice of "moonlighting" adds a level of uncertainty to the genesis of work-related cancers and presumption statutes. With the current lack of established causality, determining which work place correctly has liability for a long-onset illness such as cancer is extremely challenging. This is especially true of second jobs that also carry some level of exposure risk.

[58] International Association of Firefighters. *Campaign for a Smoke-Free Union*. http://www.iaff.org/smokefree.
[59] National Volunteer Fire Council. *Health and Wellness Guide for Volunteer Fire and Emergency Services*. 2008. Washington, DC: National Volunteer Fire Council.
[60] McDaniel v. North Dakota Workers Comp. Bureau, 1997 ND 154, 567 N.W.2d 833

Short of limiting choices available for second jobs, or prohibiting them entirely, if the claimant meets the thresholds for benefits, the municipality bears the responsibility for the presumption.

Volunteers, EMS Providers, and Their Effect on Presumption Legislation

There are two interesting variables that will continue to confound firefighter cancer presumption, namely volunteers and EMS providers.

Volunteers. The issues with the volunteer fire service are beyond the scope of this report but nonetheless may pose considerations to municipalities. The majority of volunteers serve in rural or suburban communities, but many also serve in larger communities and supplement the career staff. Of the total estimated 1,140,900 firefighters across the country, 823,950 (72%) are volunteers.[61]

Slightly more than half of the states with cancer presumption laws cover career and volunteer firefighters. As firefighting is a high-risk activity, a cancer presumption benefit is likely to assist in retention of trained volunteers because the presumption provides protection from catastrophic economic loss.

A major challenge to municipalities is the legacy costs of covering volunteers. Many states do not specify post-retirement restrictions, few discuss specific duties of a firefighter, and many volunteers never "retire." Many who discontinue providing fire suppression duties continue in administrative or non-emergency capacities such as traffic direction (fire-police), rehabilitation unit response, fire prevention, or public education duties. In most communities, after 20-30 years of service, volunteer firefighters are often granted "life membership." Most volunteer fire organizations consider life members as being *active* members regardless of their level of activity. It may be reasonable for volunteers to meet volunteer pension eligibility to be credited with an active year of service.[62] While this does not necessarily indicate active emergency response, it offers a legitimate way to limit presumption from members who are simply *card-carrying* with only a few years' service.

Firefighter/EMS Provider. Currently, 60 to 90 percent of a fire department's service involves EMS.[63] The team found that 9 of 24 (37.5%) of states with cancer presumption cover EMS providers who are not firefighters. Arguably, single-role EMS providers may not be exposed to cancer causing carcinogens at the same rate as those involved in fire suppression. It is not clear that EMS providers who function in EMS-only roles would be covered under cancer

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[61] *U.S. Fire Department Profile Through 2006.* National Fire Protection Association, Quincy, MA, November, 2007.
[62] A volunteer pension program is a Length of Service Awards Program (LOSAP) that provides a small monthly pension after 20-30 years of qualified service and attaining retirement age of 55-60.
[63] IAFC (n.d.). America's Fire Service: An Open Letter to Congress from the President of the International Association of Fire Chiefs. Available: [On-line]. http://iafc.org/associations/4685/files/fireservice.pdf.

presumption. In contrast, most EMS providers are not provided the level of protective clothing issued to firefighters and their exposures may be more subtle.

Regardless, most constituents agree that fire departments' role in EMS will increase. Even where commercial services are responsible for transportation, fire departments are increasing their on-duty role in first responder and patient care activities. With the slow decline in the number of fires across the nation and the increase in EMS calls, many departments struggle with deciding whether dual-role/cross-trained or single-role firefighters should be hired. The issue will continue to resurface and municipalities should expect to be confronted with the issue.

Minimum Service Requirements and Pre-employment Qualifications

Developing a significant cancer after a few months on the job is highly unlikely. Many states require substantial minimum service requirements. Until full-body radiography or tomography is readily available, accurate, and reasonably priced, municipalities may want the protection of this approach. Other states use more in-depth pre-employment screening, such as pre-employment physicals and health histories. A two-pronged approach combining pre-employment screening and minimum service requirements may be a reasonable method.

Exposure

Another check and balance is the requirement that the cancer must have developed after exposure to known carcinogens. Firefighters are often exposed to known carcinogens during the combat and overhaul stages of fire suppression. Determining specific numbers of exposures, dosage, time, and other variables is difficult and improbable. While this requirement is a legitimate exercise to document exposure, it is difficult to measure. At this point, perhaps the best way to control this variable is to provide proper safety equipment and require its use.

Assignments

A factor to consider is a firefighter's duty assignment. Previous reports and studies did not define the specific duties of firefighters and thus very little, if any, information is available on cancer incidence and firefighter duties. While some studies have suggested that future studies indicate specific firefighter assignments, no results have been published yet. Firefighters perform a range of duties including field work, fire suppression, overhaul, department maintenance, and in some cases, office work. Differing assignments can lead to differing levels of exposure. Firefighters who have on-scene fire duties are more exposed to carcinogens than firefighters who primarily work at the fire department.

Assignment considerations are not exclusively career firefighter issues. Some volunteer departments are significantly busier and attend more fires than their brother career departments.

Concluding Remarks

This research has sought to determine the scientific validity of cancer presumption for firefighters in an objective and thoughtful manner. The primary goal of the research was to answer the fundamental question of whether there was sufficient justification for cancer presumption statutes. The research has demonstrated that this question cannot be resolved at this time. While there is some evidence that there may be associations between exposures to carcinogens linked to firefighting and specific cancers, there is also evidence that could question those associations. Still, other associations are not well-established. Whether these less-well established associations will be clarified through further research remains to be seen.

Clearly, further rigorously designed research is necessary in this area. Whether funding for this research is or will be available will likely be decided by the level of interest demonstrated in the municipal and firefighting communities. The research is needed, as is a means to collect the data necessary for such a study. A firefighter cancer registry that tracks cancer incidence may be the in the best interest of firefighters and other parties.

The possibility of shifting firefighter cancer medical costs from the workers' compensation system and placing it into the currently established medical system to help municipalities cope with burgeoning medical cost is intriguing. Treatments in the healthcare system are more carefully managed and pricing is more responsive to changes in medical techniques as well as changes in the cost of medicines. While the logical extension is to move all workers' compensation medical costs to the healthcare system, the authors of this report feel it is beyond the scope of this research to make such a recommendation. Certainly alternative mechanisms for providing quality care to workers injured on the job can be investigated. One of those alternatives might be to provide *all* municipalities with the control that larger, self-insured, municipalities have. These municipalities use a contracted adjustor or municipal employees to determine whether care expenditures should be authorized. Other avenues might be investigated as well.

Until further research can provide more definitive answers, the complexities of the issues that surround presumptive laws will continue to make this topic a challenge for some time to come.

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APPENDIX A: RESEARCH METHODS

State Presumption Statutes

The purpose of the review of state presumption legislation was to determine how many states have enacted cancer presumption laws for firefighters and EMS providers that include cancer, what cancers were included, why the cancers were included, and what requirements were necessary for the presumption.

The NLC provided the study team with two Microsoft Excel spreadsheets that served as the basis of the legislative investigation. The first spreadsheet contained the results from the most recent NLC state presumption legislation survey (NLC survey spreadsheet). Based on the information compiled in the NLC survey spreadsheet, the study team created an independent spreadsheet to track the cancers cited in each state's presumption legislation (state-based legislation spreadsheet). This preliminary state-based legislation spreadsheet was modified as additional cancers were found in the legislation after review or correction.

The second NLC spreadsheet contained contact information for each state league (NLC contact spreadsheet). The team developed a questionnaire to use as a guide for the interviews with NLC league representatives (Appendix B). The questionnaire, with questions listed in a logical order, ensured that team members collected the appropriate information for analysis during the interview and helped limit the burden of unnecessary contact on the NLC state league representatives.

The research team conducted telephone interviews with representatives from each state league. Records were kept regarding the states contacted, states where messages were left, and any other pertinent information.

Telephone interviews were conducted with the NLC state league contacts between July 30, 2008 and September 2, 2008. Each state representative or representative's office was contacted. If the representative was not available or if a message was left unreturned, subsequent attempts were made; thus, in some cases, multiple attempts were made to contact the state league representative. Each attempt was recorded. Each state's answers were recorded on a separate questionnaire. Included on the response sheet were the date of the interview, the interviewee's name, and the state interviewed. The representative would follow-up with an e-mail with any requested information. Each representative was also asked to provide a copy of the relevant legislation. The legislation was used for as reference material for later questions and confirmation of survey answers. Legislation, as either an electronic copy or a website link, was usually provided via email. If a state was not contacted during the initial round of interviews, at least two more attempts were made.

For states who declined to participate, or those who were not successfully contacted during the interview period, an Internet legislative search was performed on each state's respective legislative website. For states whose legislation was unclear upon retrieval, or for states where legislation could not be found, follow-up telephone calls to were made to obtain the legislation itself, clarification, or the in case for Alabama and Mississippi, clarification of the bill status. In a few circumstances, telephone calls were made to bill sponsors to obtain legislation information, especially if a bill appeared to be pending. Enacted legislation was obtained from all states with existing legislation. Proposed legislation, when available, was obtained from states with pending firefighter cancer presumption legislation.

The research team was not successful in contacting representatives from Alabama, Mississippi, South Carolina, and South Dakota.

Data collected from the interviews and from the legislation were entered into the state-based legislation spreadsheet. For each state, the status of the legislation was entered (existing, none, pending), whether cancer was covered by the state's presumption legislation. If cancer was covered, it was noted. As more cancers were encountered in state cancer presumption legislation and from interviews, they were added to the data and checked off for each state thereafter that included the specific cancer. The state-based legislation spreadsheet was also expanded to include other provisions of state cancer presumption legislation, including whether the legislation covered career firefighters or career and volunteer firefighters, the rebuttable nature of the presumption, specific provisions for rebuttal, the minimum number of years of service necessary for the presumption to apply, number of years of coverage after separation or retirement, contingencies, tobacco use, requirement for physical exams, the text specifying the cancers covered, and any other important information contained in the legislation. Pending legislation was defined as a bill awaiting review in a house or senate committee or expected to appear in the next legislative session, as confirmed by Internet legislative searches, telephone interviews, and telephone conversations with bill sponsor offices.

For quality assurance purposes, following the compilation of all relevant legislative information, all data was re-evaluated using the legislation text alone. This review double-checked the responses from telephone interviews and ensured validity of data. While the data was collected independently from the NLC survey, the two data sets were compared from time to time to ensure as much verifiable data as possible was collected.

The legislation text, notes from the interviews, and results of the January 2008 NLC Risk Information Sharing Consortium (NLC-RISC) disease/illness presumption survey were used in the review and analyses of the cancer presumption legislation. The analyses of the state firefighter presumption statutes were presented to NLC staff in October 2008.

Data Collection Issues. There were many steps which went into data collection and verification, and several challenges arose along the way. There were some administrative challenges in contacting the state league representatives, understanding of the legislation, and where best to obtain clarification when the language of the legislation was unclear.

There were some instances where questions needed to be answered for analysis purposes. In these instances, many representatives were called back for additional explanation. If unable to get an answer, the study team conducted further research that included Internet searches, telephone interviews with legislative staff members, and even direct discussions with elected legislators.

Literature Review

Document Collection

The purpose of the literature review was to assess the most current information and new research findings for cancer and firefighters. As part of this effort, the research staff conducted an extensive literature search. Any relevant documents that were published between 1995 and 2008 were included in the document collection. This year range allowed for the most recent research studies and documents to be collected and evaluated. Using recently published research studies provides the most accurate representation of the current status and scope of a problem under study.[1] Recently published papers also suggest future areas of study and possible recommendations to address current issues in evaluating cancer presumption. Exceptions were made for “classic” research studies such as Guidotti 1993, Demers et al 1992, Demers et al 1994, Hansen 1990, and Howe 1990 conducted on firefighting and cancer presumption. These studies are considered classic because they provided the foundation for the original research and current research studies have incorporated their findings into their own methodology and results. The authors of these classic studies are considered experts in the field of occupational cancer research of which firefighting has been identified as a potential risk factor for occupational cancer. The classic studies have been well established due to the quality of their research, timeliness of the research, multiple citations in other research studies, and innovation of research in a field that has not been given much attention.

During the course of the literature search, a limited number of documents were identified that may have had relevance to cancer and firefighters but the researchers were unable to obtain copies either because the original publishing entity no longer exists or the researchers were unable to access archives As the articles identified were not published in peer-reviewed journals, the research team deemed the articles unnecessary to pursue at this time.

[1] Bates MN. Registry-Based Case-Control Study of Cancer in California Firefighters. *American Journal of Industrial Medicine*. 2007:50; 339-344.

The primary researchers, both second-year Master of Public Health degree candidates in Epidemiology at The George Washington University, were well-versed and trained in epidemiologic methods including surveillance, information collection, data analysis, and data reporting. The researchers used Internet searches to find journal articles, newspaper articles, reports, court cases, textbooks, and any other relevant information. Internet resources included Google, Google Scholar, and PubMed (U.S. National Library of Medicine). Search phrases such as "cancer and firefighters," "cancer presumption," and "cancer presumption and firefighters" were used to find Internet documents related to cancer presumption and firefighters mostly within the United States. Some documents pertain to cancer presumption and firefighters in Canada, New Zealand, Australia, Germany, and Scotland. The researchers also collected information from national research institution websites including the National Institutes of Health, National Cancer Institute, United States Fire Administration, Federal Emergency Management Agency, and the Occupational Safety and Health Administration. Actual journal articles were retrieved using The George Washington University electronic journal collection and library.

In addition, the research team contacted organizations that are dedicated to occupational and general worker wellness as well as organizations dedicated to the health and safety of firefighters and EMS providers to assist the team with finding or providing evidence-based information on firefighter cancer presumption. Of these organizations contacted, only the United States Centers for Disease Control, National Institute for Occupational Safety and Health, was able to assist or provide the team with information. The remainder of the organizations contacted included:

- American Cancer Society
- United States Bureau of Labor Statistics
- National Institutes of Health
- International Association of Firefighters
- International Association of Fire Chiefs
- National Volunteer Fire Council
- Firefighter Cancer Survival Network

All documents were saved (or scanned and saved) as PDF files and placed in a literature database that was contained on the researchers' servers. The documents were catalogued by the researchers using EndNote X2 bibliographic software.

The majority of the document collection effort was undertaken between June 2008 and August 2008. Included in this collection were documents previously identified by the project and research managers. A second round of document collection was undertaken during October 2008.

Preliminary Document Review

The literature search produced 161 documents that were included in the overall bibliography. Of these 161 documents, 71 were chosen for the literature review. These documents were chosen for their relevance to cancer and firefighters. All of the information was organized by specific categories depending on their content. One category contained 35 articles of interest that referred to diseases seen in firefighters, information on personal protective equipment, dangerous exposures that firefighters face, and general anecdotal information from previous firefighters. Several journal articles and documents, 21 in total, specifically referred to firefighting and an association with various cancer risks. Other documents reviewed in the literature search related to specific health claims made by firefighters, newspaper articles discussing claim costs for cancer presumption, court decisions, support for legislative bills for cancer presumption, and documents related to appropriate methodology to study cancer presumption.

The remaining 90 documents were retained as references of interest. These documents included information and literature related to cancer costs and cost analyses, 9/11 specific events, other occupations, and overall cancer rates in the general United States populations. They were not included in the main literature review because they did not pertain directly to the research questions.

Literature Review

The researchers independently reviewed the 71 documents chosen for literature review. The researchers were blinded to each others' classification of each document. Blinding eliminated potential reviewer bias since the researchers could not discuss the literature review articles. The researchers were instructed to categorize the documents based on quality and type of research. Each document was then assigned a score according to the literature's scientific value using the following standard classifications:

- Class I – Peer-reviewed research from refereed2 journals whose research design, methods, and results have lead to findings that achieve statistical significance.

[2] Refereed journals are well-known, published collections of journal articles on various topics. The referred journals that were used in this document are based on scientifically conducted research and have a structured reviewing system in which at least two reviewers, excluding in-house editors, evaluate each unsolicited manuscript and advise the editor as to acceptance or rejection.

- Class II – Peer-reviewed research from refereed journals whose research design, methods, and results were of appropriate quality, but were unable to achieve statistical significance.
- Class III – Research that identified diseases, co-morbidities, confounding variables or other evidence-based outcomes that were published in non-peer-reviewed journals.
- Class IV – Research published in peer reviewed or non-peer reviewed journals whose methods or presentation are of questionable value.

If both researchers assigned the same classification to a document, then the classification was considered final and recorded on a final Excel spreadsheet. If the researchers disagreed on classification for a document, then the research manager made the final decision on the grade. Final evaluation of all scores was placed on an Excel spreadsheet for the final report. Of the 71 reviewed documents, 35 (49%) were categorized as being class 1. Ten documents (14%) were considered class 2. Twenty-two documents were classified as category 3 (31%) documents. Lastly, 4 documents were categorized as class 4 (6%). These results are summarized in Table A-1 below. The number of peer-reviewed journal articles within each classification group is also included in the table.

Table A-1: Literature Classification Results

Document Classification	Number of Documents Reviewed	Percentage of Total	Number of Peer-Reviewed Journal Documents	Percentage of Total
Class I	35	49	34	79
Class II	10	14	7	16
Class III	22	31	2	5
Class IV	4	6	0	
Total	71	100	43	100

Of the 41 peer-reviewed journal articles classified as class 1 or 2, 17 were considered substantial research articles based on exact scientific methods. These articles were chosen for closer evaluation because the reported studies distinguished specific sample groups of firefighters, comparable control groups from the general population or other occupational group (i.e. police officers), and created specific methodology to measure the association between firefighting and various cancer risks.

Inter-rater agreement between the two researchers was calculated using the Wilcoxon rank sum test.[3] This test was used to assess the degree to which the different researchers gave consistent scores of the same article review. Inter-rater agreement was found to be 73% meaning that there was good reliability among the scores given by the two researchers. Another interpretation would be that about 73% of the time, both researchers gave the same article the same score. Out of the 71 documents in the literature review, the two researchers differed by more than one score (score of 1 vs. 3 or 4, score of 2 vs. 4) 7 times (9.9%).

[3] In statistics, the Wilcoxon rank sum test (a.k.a. Mann-Whitney U test, Wilcoxon-Mann-Whitney) is a test used to assess whether two samples of observations come from the same distribution.

APPENDIX B: INTERVIEW QUESTIONS

State: ___________________ Spoke with: ____________________

Questions for Phone Interview

1. Does your state have a cancer presumption law for firefighters? Yes No
   a. For EMS providers? Yes No
2. If yes, what cancers does it cover?
   a. How long has it been in effect?
3. If no, is there pending legislation to cover cancer presumption? Yes No
   a. Has the legislation been active within the last 2 years? Yes No
4. What is the minimum time of service needed for an employee to qualify?
5. How long after retirement or separation is the employee covered?
6. What provisions exist for rebuttal of presumption?
7. How many claims have been filed since the cancer presumption law took effect?
   a. How many were for death?
   b. How many for injury/illness?
8. What pre-employment medical testing is required in order to assure the condition did not exist before employment?
9. How is coverage changed if the employee is a cigarette smoker?
10. Are both career and volunteers covered? Yes No
11. Is there a copy of the presumption law available?

APPENDIX C: HEART AND LUNG PRESUMPTION LAWS BY STATE

State	Presumption Law	
	Heart Lung	Cancer
Alabama	Yes	Yes
Alaska	Yes	Yes
Arizona	Yes	Yes
Arkansas	No	No
California	Yes	Yes
Colorado	Yes	Yes
Connecticut	Yes	No
Delaware	No	No
Florida	Yes	Pending
Georgia	Yes	No
Hawaii	Yes	No
Idaho	Yes	Pending
Illinois	Yes	Yes
Indiana	Yes	Yes
Iowa	Yes	No
Kansas*	Yes	Yes
Kentucky	No	No
Louisiana	Yes	Yes
Maine	Yes	No
Maryland	Yes	Yes
Massachusetts	Yes	Yes
Michigan	Yes	Pending
Minnesota	Yes	Yes
Mississippi	No	No
Missouri	Yes	Yes
Montana	No	No
Nebraska	Yes	Yes
Nevada	Yes	Yes
New Hampshire	Yes	Yes
New Jersey	Yes	Pending
New Mexico	Pending	Pending
New York	Yes	No

State	Presumption Law	
	Heart Lung	Cancer
North Carolina	Yes	No
North Dakota	Yes	Yes
Ohio	Yes	Pending
Oklahoma	Yes	Yes
Oregon	Yes	Pending
Pennsylvania	Yes	Pending
Rhode Island	Yes	Yes
South Carolina	Yes	No
South Dakota*	Yes	Yes
Tennessee	Yes	Yes
Texas	Yes	Yes
Utah	Yes	No
Vermont	Yes	Yes
Virginia	Yes	Yes
Washington	Yes	Yes
West Virginia	Yes	No
Wisconsin	Yes	Yes
Wyoming	No	No

* Cancer presumption applies only to pension, not workers' compensation or other benefits

APPENDIX D: STATUTES AND PENDING LEGISLATION

Table D-1: States with Active Statutes

State	Coverage	Rebuttable?	Career/ Career & Volunteer	EMS Covered?	Cancer in Legislation	Specifications
States with Active Statutes:						
Alabama	All	Yes	Career	No	Cancer which …provided the fire fighter demonstrates that he or she was exposed, while in the employ of the city, to a known carcinogen which is reasonably linked to the disabling cancer	
Alaska	Specified Cancers	Yes	Career & Volunteer	No	Primary brain cancer, malignant melanoma, leukemia, non-Hodgkin's lymphoma, bladder cancer, ureter cancer, kidney cancer, prostate cancer	
Arizona	Specified Cancers	No	Career	No	Brain, bladder, rectal or colon cancer, lymphoma, leukemia, or aden carcinoma or mesothelioma of the respiratory tract	
California	All	Yes	Career & Volunteer	No	Cancer including leukemia…exposed…known carcinogen*, as defined, and the carcinogen is reasonably linked to the disabling cancer.	*As defined by International Agency for Research on Cancer (IARC) or by "the director"
Colorado	Specified Cancers	Yes	Career & Volunteer	No	Brain, skin, digestive system, hematological system, or genitourinary system	
Illinois	All	Yes	Career & Volunteer	Yes	Cancer resulting in any disability	
Indiana	All	Yes	Career	Yes	Exposure related cancer*	*As determined by IARC and NIOSH
Kansas*	All	Yes	Career	Yes	Cancer	*Caused by heat, radiation, or known carcinogen; applies to pension; no provisions for Workers' Compensation found
Louisiana	Specified Cancers	Yes	Career	No	Disabling cancer*… limited to a cancer originating in the bladder, brain, colon, liver, pancreas, skin, kidney, or gastrointestinal tract, and leukemia, lymphoma, multiple and myeloma.	*Must be due to an exposure to heat, smoke, radiation, or a known carcinogen defined by IARC
Maryland	Specified Cancers	No	Career & Volunteer	Yes	Leukemia or pancreatic, prostate, rectal, or throat cancer	
Massachusetts	Specified Cancers	Yes	Career	No	Cancer affecting the skin or the central nervous, lymphatic, digestive, hematalogical, urinary, skeletal, oral or prostate systems, lung or respiratory tract resulting in total disability or death...shall only apply if the disabling or fatal condition is a type of cancer which may, in general, result from exposure to heat, radiation, or a known or suspected carcinogen*	*As deemed by IARC
Minnesota	All	Yes	Career & Volunteer	Yes	Disabling cancer of a type caused by exposure to heat, radiation, or a known or suspected carcinogen*	*As determined by IARC
Missouri	All	Yes	Career	No	Any condition of cancer affecting the skin or the central nervous, lymphatic, digestive, hematological, urinary, skeletal, oral, breast, testicular, genitourinary, liver or prostate systems, as well as any condition of cancer which may result from exposure	

State	Coverage	Rebuttable?	Career/ Career & Volunteer	EMS Covered?	Cancer in Legislation	Specifications
Nebraska	All	Yes	Career	Yes	Cancer, including, but not limited to, cancer affecting the skin or the central nervous, lymphatic, digestive, hematological, urinary, skeletal, oral, or prostate systems … exposed to a known carcinogen* and carcinogen is reported by the agency to be a suspected or known cause of the type of cancer	*As deemed by IARC
Nevada	Specified Cancers	Yes	Career & Volunteer	Yes	Cancer, resulting in either temporary or permanent disability, or death, … was exposed, while in the course of the employment, to a known carcinogen* and the carcinogen is reasonably associated with the disabling cancer: (a) bladder cancer (b) brain cancer (c) colon cancer (d) Hodgkin's lymphoma (e) kidney cancer. (f) liver cancer (g) lymphatic or haemotopoietic cancer	*As deemed by IARC
New Hampshire	All	Yes	Career & Volunteer	Yes	Exposure to heat, radiation, or a known or suspected carcinogen*	*As deemed by IARC
North Dakota	All	Yes	Career	No	Cancer…due to injury due to exposure to smoke, fumes, or carcinogenic, poisonous, toxic, or chemical substances	
Oklahoma	All	Yes	Career & Volunteer	No	Cancer	No specifics stated
Rhode Island	All	Yes	Career & Volunteer	Yes	Cancer…exposures to smoke, fumes, carcinogenic, poisonous, toxic, or chemical substances	
South Dakota*	All		Career	No	Cancer resulting in total or partial disability	Applies to pension; no provisions for Workers' Compensation found
Tennessee	All	Yes	Career	No	Cancer resulting in hospitalization, medical treatment or any disability	
Texas	All	Yes	Career & Volunteer	Yes	Cancer that may be caused by exposure to heat, smoke, radiation, or a known or suspected carcinogen as determined by the International Agency for Research on Cancer.	As deemed by IARC
Vermont	Specified Cancers	Yes	Career & Volunteer	No	Disabling cancer shall be limited to leukemia, lymphoma, or multiple myeloma, and cancers originating in the bladder, brain, colon, gastrointestinal tract, kidney, liver, pancreas, skin, or testicles	
Virginia**	Specified Cancers	Yes	Career & Volunteer	No	Leukemia or pancreatic, prostate, rectal, throat, ovarian or breast cancer	
Washington	Specified Cancers	Yes	Career	No	Prostate cancer diagnosed prior to the age of fifty, primary brain cancer, malignant melanoma, leukemia, non-Hodgkin's lymphoma, bladder cancer, ureter cancer, colorectal cancer, multiple myeloma, testicular cancer, and kidney cancer	
Wisconsin	Specified Cancers	Yes	Career	No	Skin, breasts, central nervous system or lymphatic, digestive, hematological, urinary, skeletal, oral or reproductive systems	

*Cancer presumption applies only to pension
**Other non-specific cancers are addressed but not explicitly presumed

Table D-2: States with Pending Legislation

State	Legislation Status
Florida	2008 did not pass, expected to be reintroduced
Idaho	2008 legislation did not pass; bill to be reintroduced in the next session
Michigan	2008 did not pass, expected to be reintroduced
New Jersey	No law is in place but legislation was been proposed for 2008 session (and years past)
New Mexico	Legislation being introduced January 2009
Ohio	2008 legislation was held in a House Committee. Will be reintroduced next legislative session.
Oregon	Legislation is expected to be introduced in 2009 legislative session
Pennsylvania	2008 passed the House but died in the Senate, expected to be reintroduced

APPENDIX E: ADDITIONAL INFORMATION FROM LITERATURE SEARCH

Ordering of Tables

Three tables were created from information taken from the literature search. The first two tables are very large and are displayed across several pages. The pages for each of these two tables are linked horizontally and marked as "table continued." The third table is a summary of the first two tables.

Table E-1: Classes 1 and 2 Studies by Cancer

The first table lists the 17 research studies that were classified as either class 1 or 2. Specific study-related information—classification (1 or 2), study type, and study size (if applicable as meta-analysis studies did not include study size)—was also included. The research articles were evaluated to find the significant associations for the 33 individual cancers and three system cancers (digestive, all lymphopoietic, and respiratory) identified from the literature search. If the cancer was not evaluated, then the cancer was marked as "not studied" within that particular research study. For example, Aronson et al 1996 did not study any cancer except for prostate cancer, thus every other cancer was marked "not studied." Aronson et al 1996 was unable to find statistically significant results for prostate cancer due to not having enough prostate cancer cases recorded among firefighters. The column was marked accordingly as "Unable to find statistically significant results related to firefighters." If a cancer was evaluated in a research study but was not found to have statistically significant results, then the cancer was marked as "no statistically significant results." For example, Baris et al 2001 did not find significant results for bladder, brain, esophageal, laryngeal, leukemia, liver, lung, pancreatic, prostate, rectal, or throat cancers, thus they were all marked "no statistically significant results." If a cancer was found to be statistically significant, then the rates found from the specific research study were reported. Approximately half of the research studies also reported results on the group of cancers studied. These results are shown in the cancers studied as "All Cancers Within Study."

Each research study used their own methodology and reported different rate measures.

- Aronson et al 1996, Band et al 2004, Bates 2007, and Stang et al 2003 used odds ratios
    - Odds ratios are the standard measurement to use for case-control studies when evaluating the difference in rate between cancer cases and controls (who represent persons without a specific cancer).
- Baris et al 2001, Demers et al 1992, Guidotti 1993, Hansen 1990, and Howe 1990 used standardized mortality ratios
    - Standardized mortality ratios are used to evaluate the mortality rates of a given population. These ratios are most frequently used when looking at data

referencing death rates in a cohort study (long term study looking at a sample population group).

- Bates et al 2001, Demers et al 1994, Firth et al 1996, and Ma et al 2006 used standardized incidence ratios
  - Standardized incidence ratios are used to measure rates of new cases of cancer in a given population. These ratios are most frequently used when looking at data referencing new cancer cases in a cohort study.
- Kang et al 2008 and Ma et al 2005 used standardized morbidity ratios
  - Standardized morbidity ratios are used to measure rates of morbidity cases among a given population. These rates can measure cases of illness, disability, and other effects of disease. These rates are generally used in cohort studies conducted over a long period of time.
- LeMasters et al 2006 created summary risk estimates
  - The researchers of this study created their own measurement based on their meta-analysis. The summary risk estimates combined the rates that were used by previously published research studies.
- Zeegers et al 2004 used incidence ratios
  - Incidence ratios are used to measure rates of new cases of cancer in a given population. These ratios are generally used in cohort studies.

All of the research studies used 95% confidence intervals. These measurements are standard measurements in epidemiologic research reporting. The ranges noted by the confidence intervals tell you how sure you are that the rate that was found for the association is within the specified range. For example, for a standardized mortality ratio of 1.68 and a 95% confidence of 1.17-2.40, we can state that we are 95% confident that the rate of 1.68 falls within the interval of 1.17 and 2.40.

Table E-2: Strengths of Association

The second table lists the 17 research studies and the cancers identified from the literature review. The rate measurements and results reported in the previous table, Classes 1 and 2 Studies by Cancer, were translated into strengths of association based on Hill's criteria.[1] If the cancer was not evaluated in a given research study, then the cancer was marked as "not studied." If the cancer was found not to have a statistically significant association, then the cancer was marked as "none." Cancers that were determined to have weak associations based on the criteria were marked as "weak association." Cancers with moderate associations were marked as "moderate association." Lastly, cancers with strong associations were marked as "strong association."

[1] Levy BS, Robbins A, Wegman DH. 1983 Occupational Health: Recognizing and Preventing Work-Related Disease. Boston: Little, Brown, and Company. Chapter 5: Epidemiology of Occupational Diseases, 50-51.

Table E-3: Summary

The last table represents the summary of the previous two tables. This table combined the strengths of association seen for each of the 33 cancers identified in the literature review. The numbers in the columns represent how many of the 17 peer-reviewed research studies found weak, moderate, strong, or no associations. Only one study, Aronson et al 1996, was unable to find an association between firefighting and prostate cancer risk. The table also distinguishes how many of the 17 research studies examined a specific cancer. For example, 11 studies evaluated bladder cancer whereas only 2 studies evaluated bone cancer.

Table E-1: Classes 1 and 2 Studies by Cancer

Study and Sample Size	Bladder	Bone	Brain	Breast	Buccal Cavity and Pharynx	Cecum	Cervix
Aronson et al. 1996 (class 2) Study Type: Case-Control Study Size: 449 prostate cases, 1,550 cancer controls, 533 population controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Band et al. 2004 (class 1) Study Type: Case-Control Study Size: 769 NHL cases, 9076 controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Baris et al. 2001 (class 1) Study Type: Retrospective Cohort Study Size: 7,789 firefighters	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	Not Studied
Bates et al. 2001 (class 1) Study Type: Historical Cohort Study Size: 4,305 firefighters	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	Not Studied	Not Studied	Not Studied
Bates 2007 (class 1) Study Type: Case-Control Study Size: 3,659 firefighters, 800,488 controls	No Statistically Significant Results	Not Studied	71 cases; Odds ratio=1.35; 95% CI=1.06-1.72	Not Studied	Not Studied	No Statistically Significant Results	Not Studied
Demers et al. 1992 (class 1) Study Type: Retrospective Cohort Study Size: 4,401 firefighters	Standardized mortality ratio = 0.23; 95% CI=0.03-0.83	Not Studied	Standardized mortality ratio=2.07; 95% CI=1.23-3.28	Not Studied	No Statistically Significant Results	Not Studied	Not Studied
Demers et al. 1994 (class 1) Study Type: Cohort Study Size: 2,447 male firefighters	No Statistically Significant Results	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	Not Studied
Firth et al. 1996 (class 1) Study Type: Cohort Study Size:	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	Not Studied
Guidotti 1993 (class 1) Study Type: Cohort Study Size: 3,328	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	Not Studied
Hansen 1990 (class 1) Study Type: Historical Cohort Study Size: 886 exposed, 47,694 unexposed	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Howe 1990 (class 1) Study Type: Meta-analysis,11 studies	Not Studied	Not Studied	26 cases; Standardized mortality ratio=1.45; 95% CI=0.95-2.12; Evidence points to statistically significant results	Not Studied	Not Studied	Not Studied	Not Studied
Kang et al. 2008 (class 1) Study Type: Case-Control Study Size: 2,125 firefighters, 2,763 police, 156,890 other controls	113 cases; Standardized morbidity odds ratio=1.22; 95% CI=0.89-1.69	Not Studied	28 cases; Standardized morbidity odds ratio=1.90; 95% CI=1.10-3.26	No Statistically Significant Results	No Statistically Significant Results	Not Studied	Not Studied
LeMasters et al 2006 (class 1) Study Type: Meta-analysis, 32 studies	No Statistically Significant Results	Not Studied	Possible; Summary risk estimate=1.32; 95% CI=1.12-1.54	Not Studied	Possible; Summary risk estimate=1.23; 95% CI=0.96-1.55	Not Studied	Not Studied

Study and Sample Size	Bladder	Bone	Brain	Breast	Buccal Cavity and Pharynx	Cecum	Cervix
Ma et al. 2005 (class 1) Study Type: Retrospective Cohort Study Size: 34,796 men, 2,017 women firefighters	14 cases; Standardized mortality ratio=1.79; 95% CI=0.98-3.00	No Statistically Significant Results	No Statistically Significant Results	4 cases; Standardized mortality ratio=7.41; 95% CI=1.99-18.96	No Statistically Significant Results	Not Studied	Not Studied
Ma et al. 2006 (class 1) Study Type: Cohort Study Size: 34,796 men (970 cases), 2,017 women (52 cases) firefighters	73 cases; Standardized incidence ratio=1.29; 95% CI=1.01-1.62	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	15 cases; Standardized incidence ratio=5.24; 95% CI=2.93-8.65
Stang et al. 2003 (class 2) Study Type: Case-Control Study Size: 269 testicular cancer cases, 797 controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Zeegers et al. 2004 (class 2) Study Type: Prospective Cohort Study Size: 58,279	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied

Table E-1: Classes 1 and 2 Studies by Cancer (continued)

Study and Sample Size	Colon	Digestive System	Esophageal	Eye	Hodgkin's Lymphoma	Kidney	Laryngeal
Aronson et al. 1996 (class 2) Study Type: Case-Control Study Size: 449 prostate cases, 1,550 cancer controls, 533 population controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Band et al. 2004 (class 1) Study Type: Case-Control Study Size: 769 NHL cases, 9076 controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Baris et al. 2001 (class 1) Study Type: Retrospective Cohort Study Size: 7,789 firefighters	64 cases; Standardized mortality ratio=1.51; 95% CI=1.18-1.93	Not Studied	No Statistically Significant Results	Not Studied	Not Studied	No Statistically Significant Results	No Statistically Significant Results
Bates et al. 2001 (class 1) Study Type: Historical Cohort Study Size: 4,305 firefighters	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	Not Studied	No Statistically Significant Results	Not Studied
Bates 2007 (class 1) Study Type: Case-Control Study Size: 3,659 firefighters, 800,488 controls	No Statistically Significant Results	Not Studied	62 cases; Odds ratio=1.48; 95% CI=1.14-1.91	Not Studied	Not Studied	No Statistically Significant Results	Not Studied
Demers et al. 1992 (class 1) Study Type: Retrospective Cohort Study Size: 4,401 firefighters	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Standardized mortality ratio=0.27; 95% CI=0.03-0.97	No Statistically Significant Results
Demers et al. 1994 (class 1) Study Type: Cohort Study Size: 2,447 male firefighters	No Statistically Significant Results	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results
Firth et al. 1996 (class 1) Study Type: Cohort Study Size:	No Statistically Significant Results	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	Standardized incidence ratio=1074; 95% CI=279-2778
Guidotti 1993 (class 1) Study Type: Cohort Study Size: 3,328	No Statistically Significant Results	Not Studied	Not Studied	Not Studied	Not Studied	7 cases; Standardized mortality ratio=414; 95% CI=166-853; $p<0.05$	Not Studied
Hansen 1990 (class 1) Study Type: Historical Cohort Study Size: 886 exposed, 47,694 unexposed	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Howe 1990 (class 1) Study Type: Meta-analysis,11 studies	No Statistically Significant Results	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Kang et al. 2008 (class 1) Study Type: Case-Control Study Size: 2,125 firefighters, 2,763 police, 156,890 other controls	200 cases; Standardized morbidity odds ratio=1.36; 95% CI=1.04-1.79	Not Studied	No Statistically Significant Results	Not Studied	13 cases; Standardized morbidity odds ratio=1.81; 95%CI=0.72-4.53	64 cases; Standardized morbidity odds ratio=1.34; 95% CI=0.90-2.01	No Statistically Significant Results
LeMasters et al 2006 (class 1) Study Type: Meta-analysis, 32 studies	Possible; Summary risk estimate=1.21; 95% CI=1.03-1.41	Not Studied	No Statistically Significant Results	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results
Ma et al. 2005 (class 1) Study Type: Retrospective Cohort Study Size: 34,796 men, 2,017 women firefighters	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	No Statistically Significant Results

Study and Sample Size	Colon	Digestive System	Esophageal	Eye	Hodgkin's Lymphoma	Kidney	Laryngeal
Ma et al. 2006 (class 1) Study Type: Cohort Study Size: 34,796 men (970 cases), 2,017 women (52 cases) firefighters	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	3 cases; Standardized incidence ratio=6.25; 95% CI=1.26-18.26	No Statistically Significant Results	No Statistically Significant Results
Stang et al. 2003 (class 2) Study Type: Case-Control Study Size: 269 testicular cancer cases, 797 controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Zeegers et al. 2004 (class 2) Study Type: Prospective Cohort Study Size: 58,279	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied

Table E-1: Classes 1 and 2 Studies by Cancer (continued)

Study and Sample Size	Leukemia	Liver	Lung	Lymphatic	All Lymphopoietic	Malignant Melanoma	Mesothelioma
Aronson et al. 1996 (class 2) Study Type: Case-Control Study Size: 449 prostate cases, 1,550 cancer controls, 533 population controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Band et al. 2004 (class 1) Study Type: Case-Control Study Size: 769 NHL cases, 9076 controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Baris et al. 2001 (class 1) Study Type: Retrospective Cohort Study Size: 7,789 firefighters	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	Not Studied	Not Studied	Not Studied
Bates et al. 2001 (class 1) Study Type: Historical Cohort Study Size: 4,305 firefighters	Not Studied	Not Studied	No Statistically Significant Results	Not Studied	Not Studied	No Statistically Significant Results	Not Studied
Bates 2007 (class 1) Study Type: Case-Control Study Size: 3,659 firefighters, 800,488 controls	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	Not Studied	323 cases; Odds ratio=1.50; 95% CI=1.33-1.70	Not Studied
Demers et al. 1992 (class 1) Study Type: Retrospective Cohort Study Size: 4,401 firefighters	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	Not Studied	Not Studied
Demers et al. 1994 (class 1) Study Type: Cohort Study Size: 2,447 male firefighters	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	Not Studied	No Statistically Significant Results	Not Studied
Firth et al. 1996 (class 1) Study Type: Cohort Study Size:	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied
Guidotti 1993 (class 1) Study Type: Cohort Study Size: 3,328	No Statistically Significant Results	Not Studied	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied
Hansen 1990 (class 1) Study Type: Historical Cohort Study Size: 886 exposed, 47,694 unexposed	Not Studied	Not Studied	Standardized mortality ratio=317; 95% CI=117-691	Not Studied	Not Studied	Not Studied	Not Studied
Howe 1990 (class 1) Study Type: Meta-analysis,11 studies	Not Studied	Not Studied	No Statistically Significant Results	Not Studied	Not Studied	18 cases; Standardized mortality ratio=1.73; 95% CI=1.03-2.74; Evidence points to statistically significant results	Not Studied
Kang et al. 2008 (class 1) Study Type: Case-Control Study Size: 2,125 firefighters, 2,763 police, 156,890 other controls	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied
LeMasters et al 2006 (class 1) Study Type: Meta-analysis, 32 studies	Possible; Summary risk estimate=1.14; 95% CI=0.98-1.31	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	Possible; Summary risk estimate=1.32; 95% CI=1.10-1.57	Not Studied

Study and Sample Size	Leukemia	Liver	Lung	Lymphatic	All Lymphopoietic	Malignant Melanoma	Mesothelioma
Ma et al. 2005 (class 1) Study Type: Retrospective Cohort Study Size: 34,796 men, 2,017 women firefighters	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied
Ma et al. 2006 (class 1) Study Type: Cohort Study Size: 34,796 men (970 cases), 2,017 women (52 cases) firefighters	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied
Stang et al. 2003 (class 2) Study Type: Case-Control Study Size: 269 testicular cancer cases, 797 controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Zeegers et al. 2004 (class 2) Study Type: Prospective Cohort Study Size: 58,279	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied

Table E-1: Classes 1 and 2 Studies by Cancer (continued)

Study and Sample Size	Multiple Myeloma	Non-Hodgkin's Lymphoma	Ovarian	Pancreatic	Prostate	Rectal	Respiratory
Aronson et al. 1996 (class 2) Study Type: Case-Control Study Size: 449 prostate cases, 1,550 cancer controls, 533 population controls	Not Studied	Not Studied	Not Studied	Not Studied	Unable to find statistically significant results related to firefighters	Not Studied	Not Studied
Band et al. 2004 (class 1) Study Type: Case-Control Study Size: 769 NHL cases, 9076 controls	Not Studied	3 cases; Odds Ratio = 3.64; 90% confidence intervals = 1.22-10.81	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Baris et al. 2001 (class 1) Study Type: Retrospective Cohort Study Size: 7,789 firefighters	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied
Bates et al. 2001 (class 1) Study Type: Historical Cohort Study Size: 4,305 firefighters	No Statistically Significant Results	Not Studied	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied
Bates 2007 (class 1) Study Type: Case-Control Study Size: 3,659 firefighters, 800,488 controls	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	1,144 cases; Odds ratio=1.22; 95% CI=1.12-1.33	No Statistically Significant Results	Not Studied
Demers et al. 1992 (class 1) Study Type: Retrospective Cohort Study Size: 4,401 firefighters	Not Studied	Not Studied	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied
Demers et al. 1994 (class 1) Study Type: Cohort Study Size: 2,447 male firefighters	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	66 cases; Standardized incidence ratio=1.4; 95% CI=1.1-1.7	No Statistically Significant Results	Not Studied
Firth et al. 1996 (class 1) Study Type: Cohort Study Size:	Not Studied	Not Studied	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied
Guidotti 1993 (class 1) Study Type: Cohort Study Size: 3,328	No Statistically Significant Results	Not Studied	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied
Hansen 1990 (class 1) Study Type: Historical Cohort Study Size: 886 exposed, 47,694 unexposed	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Howe 1990 (class 1) Study Type: Meta-analysis,11 studies	19 cases; Standardized mortality ratio=1.51; 95% CI=0.91-2.35; Evidence points to statistically significant results	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Kang et al. 2008 (class 1) Study Type: Case-Control Study Size: 2,125 firefighters, 2,763 police, 156,890 other controls	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied

Study and Sample Size	Multiple Myeloma	Non-Hodgkin's Lymphoma	Ovarian	Pancreatic	Prostate	Rectal	Respiratory
LeMasters et al 2006 (class 1) Study Type: Meta-analysis, 32 studies	Probable; Summary risk estimate=1.53; 95% CI=1.21-1.94	Probable; Summary risk estimate=1.51; 95% CI=1.31-1.73	Not Studied	No Statistically Significant Results	Probable; Summary risk estimate=1.28; 95% CI=1.15-1.43	Possible; Summary risk estimate=1.29; 95% CI=1.10-1.51	Not Studied
Ma et al. 2005 (class 1) Study Type: Retrospective Cohort Study Size: 34,796 men, 2,017 women firefighters	Not Studied	Not Studied	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results
Ma et al. 2006 (class 1) Study Type: Cohort Study Size: 34,796 men (970 cases), 2,017 women (52 cases) firefighters	Not Studied	No Statistically Significant Results	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results
Stang et al. 2003 (class 2) Study Type: Case-Control Study Size: 269 testicular cancer cases, 797 controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Zeegers et al. 2004 (class 2) Study Type: Prospective Cohort Study Size: 58,279	Not Studied	Not Studied	Not Studied	Not Studied	No Statistically Significant Results	Not Studied	Not Studied

Table E-1: Classes 1 and 2 Studies by Cancer (continued)

Study and Sample Size	Sinus	Skin	Stomach	Testicular	Throat	Thyroid	Ureter
Aronson et al. 1996 (class 2) Study Type: Case-Control Study Size: 449 prostate cases, 1,550 cancer controls, 533 population controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Band et al. 2004 (class 1) Study Type: Case-Control Study Size: 769 NHL cases, 9076 controls	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Baris et al. 2001 (class 1) Study Type: Retrospective Cohort Study Size: 7,789 firefighters	Not Studied	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	Not Studied
Bates et al. 2001 (class 1) Study Type: Historical Cohort Study Size: 4,305 firefighters	Not Studied	Not Studied	No Statistically Significant Results	Standardized incidence ratio=3.0; 95% CI=1.3-5.90	Not Studied	Not Studied	Not Studied
Bates 2007 (class 1) Study Type: Case-Control Study Size: 3,659 firefighters, 800,488 controls	Not Studied	Not Studied	No Statistically Significant Results	70 cases; Odds ratio=1.54; 95% CI=1.18-2.02	Not Studied	No Statistically Significant Results	Not Studied
Demers et al. 1992 (class 1) Study Type: Retrospective Cohort Study Size: 4,401 firefighters	Not Studied	No Statistically Significant Results	No Statistically Significant Results	Not Studied	Not Studied	Not Studied	Standardized mortality ratio=0.23; 95% CI=0.03-0.83
Demers et al. 1994 (class 1) Study Type: Cohort Study Size: 2,447 male firefighters	No Statistically Significant Results	Not Studied	No Statistically Significant Results	Not Studied	Not Studied	No Statistically Significant Results	Not Studied
Firth et al. 1996 (class 1) Study Type: Cohort Study Size:	Not Studied	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results
Guidotti 1993 (class 1) Study Type: Cohort Study Size: 3,328	Not Studied	No Statistically Significant Results	No Statistically Significant Results	Not Studied	Not Studied	Not Studied	7 cases; Standardized mortality ratio=414; 95% CI=166-853; p<0.05
Hansen 1990 (class 1) Study Type: Historical Cohort Study Size: 886 exposed, 47,694 unexposed	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Howe 1990 (class 1) Study Type: Meta-analysis,11 studies	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Kang et al. 2008 (class 1) Study Type: Case-Control Study Size: 2,125 firefighters, 2,763 police, 156,890 other controls	Not Studied	Not Studied	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	No Statistically Significant Results	Not Studied
LeMasters et al 2006 (class 1) Study Type: Meta-analysis, 32 studies	Not Studied	Possible; Summary risk estimate=1.39; 95% CI=1.10-1.73	Possible; Summary risk estimate=1.22; 95% CI=1.04-1.44	Possible; Summary risk estimate=2.02; 95% CI=1.30-3.13	Possible; Summary risk estimate=1.23; 95% CI=0.96-1.55	Not Studied	Not Studied
Ma et al. 2005 (class 1) Study Type: Retrospective Cohort Study Size: 34,796 men, 2,017 women firefighters	Not Studied	No Statistically Significant Results	No Statistically Significant Results	Not Studied	No Statistically Significant Results	4 cases; Standardized mortality ratio=4.82; 95% CI=1.30-12.34	Not Studied

Study and Sample Size	Sinus	Skin	Stomach	Testicular	Throat	Thyroid	Ureter
Ma et al. 2006 (class 1) Study Type: Cohort Study Size: 34,796 men (970 cases), 2,017 women (52 cases) firefighters	Not Studied	No Statistically Significant Results	No Statistically Significant Results	54 cases; Standardized incidence ratio=1.60; 95% CI=1.20-2.09	No Statistically Significant Results	20 cases; Standardized incidence ratio=1.77; 95% CI=1.08-2.73 (male)--6 cases; Standardized incidence ratio=3.97; 95% CI=1.45-8.65 (female)	Not Studied
Stang et al. 2003 (class 2) Study Type: Case-Control Study Size: 269 testicular cancer cases, 797 controls	Not Studied	Not Studied	Not Studied	No Statistically Significant Results	Not Studied	Not Studied	Not Studied
Zeegers et al. 2004 (class 2) Study Type: Prospective Cohort Study Size: 58,279	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied

Table E-1: Classes 1 and 2 Studies by Cancer (continued)

Study and Sample Size	Urethra	All Cancers Within Study	Cancers Studied
Aronson et al. 1996 (class 2) Study Type: Case-Control Study Size: 449 prostate cases, 1,550 cancer controls, 533 population controls	Not Studied	Not Studied	Prostate
Band et al. 2004 (class 1) Study Type: Case-Control Study Size: 769 NHL cases, 9076 controls	Not Studied	Not Studied	Non-Hodgkin's Lymphoma
Baris et al. 2001 (class 1) Study Type: Retrospective Cohort Study Size: 7,789 firefighters	Not Studied	500 cases; Standardized mortality ratio=1.10; 95% CI=1.00-1.20	Buccal cavity and pharnyx, esophagus, stomach, colon, rectum, liver, pancreas, larynx, lung, skin, prostate, bladder, kidney, brain, NHL, multiple myeloma, leukemia
Bates et al. 2001 (class 1) Study Type: Historical Cohort Study Size: 4,305 firefighters	Not Studied	No Statistically Significant Results	all cancers, esophagus, stomach, colon, rectum, pancreas, lung, melanoma, prostate, testis, bladder, kidney, brain, myeloleukemia
Bates 2007 (class 1) Study Type: Case-Control Study Size: 3,659 firefighters, 800,488 controls	Not Studied	Not Studied	esophagus, stomach, cecum, colo-rectal, pancreas, lung & bronchus, melanoma-skin, prostate, testis, bladder, kidney & renal pelvis, brain, thyroid, NHL, multiple myeloma, leukemias
Demers et al. 1992 (class 1) Study Type: Retrospective Cohort Study Size: 4,401 firefighters	Standardized mortality ratio=0.23; 95% CI=0.03-0.83	No Statistically Significant Results	all cancers, oral & pharyngeal, oseophageal, stomach, colon, rectal, liver, pancreatic, laryngeal, lung, prostate, kidney, bladder and other urinary cancers, skin, brain and nervous system, Hodgkin's, leukemia, other lymphatic and haematopoietic
Demers et al. 1994 (class 1) Study Type: Cohort Study Size: 2,447 male firefighters	Not Studied	No Statistically Significant Results	all cancers, oral and pharynx, esophagus, stomach, colon, rectum, pancreas, sinus, larynx, lung, trachea &bronchus, melanoma, breast, prostate, bladder, kidney, occular melanome (eye), brain, thyroid, Hodgkin's, NHL, multiple myeloma, leukemia
Firth et al. 1996 (class 1) Study Type: Cohort Study Size:	No Statistically Significant Results	Not Studied	Buccal cavity, oseophagus, stomach, colon, rectum, liver, pancreas, larynx, lung, melanoma, prostate, testis, bladder, other urinary, eye, brain, lymphosarcoma, Hodgkin's, leukemia
Guidotti 1993 (class 1) Study Type: Cohort Study Size: 3,328	Not Studied	92 cases; Standardized mortality ratio=127; 95% CI=102-155, p<0.05	all neoplasms, oral, stomach, colon & rectum, pancreas, lung, skin, prostate, bladder, kidney & ureter, brain, leukemia, lymphoma, myeloma
Hansen 1990 (class 1) Study Type: Historical Cohort Study Size: 886 exposed, 47,694 unexposed	Not Studied	Standardized mortality ratio=173; 95% CI=104-270	Lung
Howe 1990 (class 1) Study Type: Meta-analysis,11 studies	Not Studied	Not Studied	lung, colon, brain, malignant melanoma, multiple myeloma
Kang et al. 2008 (class 1) Study Type: Case-Control Study Size: 2,125 firefighters, 2,763 police, 156,890 other controls	Not Studied	Not Studied	lip, buccal cavity, nasopharynx, esophagus, stomach, colon, rectum, liver, pancreas, larynx, lung, skin melanoma, breast, prostate, testicular, kidney, bladder, brain, thyroid, leukemia, NHL, Hodgkin's, multiple myeloma
LeMasters et al 2006 (class 1) Study Type: Meta-analysis, 32 studies	Not Studied	No Statistically Significant Results	multiple myeloma, NHL, prostate, testis, skin, malignant melanoma, brain, rectum, buccal cavity and pharynx, stomach, colon, leukemia, larynx, bladder, esophagus, pancreas kidney, Hodgkin's, liver, lung, all cancers
Ma et al. 2005 (class 1) Study Type: Retrospective Cohort Study Size: 34,796 men, 2,017 women firefighters	Not Studied	403 cases; Standardized mortality ratio=0.85; 95% CI=0.77-0.94	all cancers buccal/pharynx, Digestive (esophagus, stomach, colon, rectum, liver, pancreas), Respiratory (larynx, lung & bronchus), bone, skin, bladder, brain/CNS, thyroid, All lymphopoietic (lymphosarcoma, Hodgkins, leukemia), prostate, breast

Study and Sample Size	Urethra	All Cancers Within Study	Cancers Studied
Ma et al. 2006 (class 1) Study Type: Cohort Study Size: 34,796 men (970 cases), 2,017 women (52 cases) firefighters	Not Studied	52 cases; Standardized incidence ratio=1.63; 95% CI=1.22-2.14	all cancers, buccal digestive (esophagus, stomach, colon, rectum, liver, pancreas), respiratory (larynx, lung/bronchus), bone, skin, bladder, kidney, eye, brain/CNS, thyroid, all lymphopoietic (NHL, Hodgkins, leukemia) prostate, testes, breast, cervix
Stang et al. 2003 (class 2) Study Type: Case-Control Study Size: 269 testicular cancer cases, 797 controls	Not Studied	Not Studied	Testicular
Zeegers et al. 2004 (class 2) Study Type: Prospective Cohort Study Size: 58,279	Not Studied	Not Studied	Prostate

Table E-2: Strength of Association

Study	Bladder	Bone	Brain	Breast	Buccal Cavity and Pharynx	Cecum	Cervix	Colon	Digestive System	Esophageal	Eye	Hodgkin's Lymphoma	Kidney
Aronson et al. 1996	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Band et al. 2004	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Baris et al. 2001	None	Not Studied	None	Not Studied	None	Not Studied	Not Studied	Moderate Association	Not Studied	None	Not Studied	Not Studied	None
Bates et al. 2001	None	Not Studied	None	Not Studied	Not Studied	Not Studied	Not Studied	None	Not Studied	None	Not Studied	Not Studied	None
Bates 2007	None	Not Studied	Weak Association	Not Studied	Not Studied	None	Not Studied	None	Not Studied	Weak Association	Not Studied	Not Studied	None
Demers et al. 1992	Weak Association	Not Studied	Moderate Association	Not Studied	None	Not Studied	Not Studied	None	Not Studied	None	Not Studied	None	Weak Association
Demers et al. 1994	None	Not Studied	None	None	None	Not Studied	Not Studied	None	Not Studied	None	None	None	None
Firth et al. 1996	None	Not Studied	None	Not Studied	None	Not Studied	Not Studied	None	Not Studied	None	None	None	Not Studied
Guidotti 1993	None	Not Studied	None	Not Studied	None	Not Studied	Not Studied	None	Not Studied	Not Studied	Not Studied	Not Studied	Strong Association
Hansen 1990	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Howe 1990	Not Studied	Not Studied	Weak Association	Not Studied	Not Studied	Not Studied	Not Studied	None	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Kang et al. 2008	Weak Association	Not Studied	Moderate Association	None	None	Not Studied	Not Studied	Weak Association	Not Studied	None	Not Studied	Moderate Association	Weak Association
LeMasters et al. 2006	None	Not Studied	Weak Association	Not Studied	Weak Association	Not Studied	Not Studied	Weak Association	Not Studied	None	Not Studied	None	None
Ma et al. 2005	Moderate Association	None	None	Strong Association	None	Not Studied	Not Studied	None	None	None	Not Studied	None	Not Studied
Ma et al. 2006	Weak Association	None	None	None	None	Not Studied	Strong Association	None	None	None	None	Strong Association	None
Stang et al. 2003	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Zeegers et al. 2004	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied

*Strength of Associations based on Strength of Association Chart from Levy BS, Robbins A, Wegman DH. 1983. *Occupational Health: Recognizing and Preventing Work-Related Disease.* Boston: Little, Brown, and Company.

Table E-2: Strength of Association (continued)

Study	Laryngeal	Leukemia	Liver	Lung	Lymphatic	All Lymphopoietic	Malignant Melanoma	Mesothelioma	Multiple Myeloma	Non-Hodgkin's Lymphoma	Ovarian	Pancreatic
Aronson et al. 1996	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Band et al. 2004	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Strong Association	Not Studied	Not Studied
Baris et al. 2001	None	None	None	None	Not Studied	Not Studied	Not Studied	Not Studied	None	None	Not Studied	None
Bates et al. 2001	Not Studied	Not Studied	Not Studied	None	Not Studied	Not Studied	None	Not Studied	None	Not Studied	Not Studied	None
Bates 2007	Not Studied	None	Not Studied	None	Not Studied	Not Studied	Moderate Association	Not Studied	None	None	Not Studied	None
Demers et al. 1992	None	None	None	None	None	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	None
Demers et al. 1994	None	None	Not Studied	None	Not Studied	Not Studied	None	Not Studied	None	None	Not Studied	None
Firth et al. 1996	Strong Association	None	None	None	None	Not Studied	None	Not Studied	Not Studied	Not Studied	Not Studied	None
Guidotti 1993	Not Studied	None	Not Studied	None	None	Not Studied	None	Not Studied	None	Not Studied	Not Studied	None
Hansen 1990	Not Studied	Not Studied	Not Studied	Strong Association	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Howe 1990	Not Studied	Not Studied	Not Studied	None	Not Studied	Not Studied	Moderate Association	Not Studied	Moderate Association	Not Studied	Not Studied	Not Studied
Kang et al. 2008	None	None	None	None	None	Not Studied	None	Not Studied	None	None	Not Studied	None
LeMasters et al. 2006	None	Weak Association	None	None	None	Not Studied	Weak Association	Not Studied	Moderate Association	Moderate Association	Not Studied	None
Ma et al. 2005	None	None	None	None	None	None	None	Not Studied	Not Studied	Not Studied	Not Studied	None
Ma et al. 2006	None	None	None	None	None	None	None	Not Studied	Not Studied	None	Not Studied	None
Stang et al. 2003	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Zeegers et al. 2004	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied

*Strength of Associations based on Strength of Association Chart from Levy BS, Robbins A, Wegman DH. 1983. *Occupational Health: Recognizing and Preventing Work-Related Disease.* Boston: Little, Brown, and Company.

Table E-2: Strength of Association (continued)

Study	Prostate	Rectal	Respiratory	Sinus	Skin	Stomach	Testicular	Throat	Thyroid	Ureter	Urethra	All Cancers Within Study
Aronson et al. 1996	Unable to Find Association	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Band et al. 2004	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Baris et al. 2001	None	None	Not Studied	Not Studied	None	None	Not Studied	None	Not Studied	Not Studied	Not Studied	Weak Association
Bates et al. 2001	None	None	Not Studied	Not Studied	Not Studied	None	Moderate Association	Not Studied	Not Studied	Not Studied	Not Studied	None
Bates 2007	Weak Association	None	Not Studied	Not Studied	Not Studied	None	Moderate Association	Not Studied	None	Not Studied	Not Studied	Not Studied
Demers et al. 1992	None	None	Not Studied	Not Studied	None	None	Not Studied	Not Studied	Not Studied	Weak Association	Weak Association	None
Demers et al. 1994	Weak Association	None	Not Studied	None	Not Studied	None	Not Studied	Not Studied	None	Not Studied	Not Studied	None
Firth et al. 1996	None	None	Not Studied	Not Studied	Not Studied	None	None	None	Not Studied	None	None	Not Studied
Guidotti 1993	None	None	Not Studied	Not Studied	None	None	Not Studied	Not Studied	Not Studied	Strong Association	Not Studied	Weak Association
Hansen 1990	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Moderate Association
Howe 1990	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Kang et al. 2008	None	None	Not Studied	Not Studied	Not Studied	None	None	None	None	Not Studied	Not Studied	Not Studied
LeMasters et al. 2006	Weak Association	Weak Association	Not Studied	Not Studied	Weak Association	Weak Association	Moderate Association	Weak Association	Not Studied	Not Studied	Not Studied	None
Ma et al. 2005	None	None	None	Not Studied	None	None	Not Studied	None	Strong Association	Not Studied	Not Studied	Weak Association
Ma et al. 2006	None	None	None	Not Studied	None	None	Moderate Association	None	Moderate Association (Males) Strong Association (Females)	Not Studied	Not Studied	Moderate Association
Stang et al. 2003	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	None	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied
Zeegers et al. 2004	None	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied	Not Studied

*Strength of Associations based on Strength of Association Chart from Levy BS, Robbins A, Wegman DH. 1983. *Occupational Health: Recognizing and Preventing Work-Related Disease.* Boston: Little, Brown, and Company.

Table E-3: Summary – Number of Studies Showing Associations

Cancers	Level of Association						
	Strong	Moderate	Weak	No Association	Unable to Establish Association	Studied	Not Studied
Bladder	0	1	3	7	0	11	6
Bone	0	0	0	2	0	2	15
Brain	0	2	3	7	0	12	5
Breast	1	0	0	3	0	4	13
Buccal Cavity and Pharynx	0	0	1	8	0	9	8
Cecum	0	0	0	1	0	1	16
Cervix	1	0	0	0	0	1	16
Colon	0	1	2	9	0	12	5
Digestive System	0	0	0	2	0	2	15
Esophageal	0	0	1	9	0	10	7
Eye	0	0	0	3	0	3	14
Hodgkin's Lymphoma	1	1	0	5	0	7	10
Kidney	1	0	2	6	0	9	8
Laryngeal	1	0	0	7	0	8	9
Leukemia	0	0	1	9	0	10	7
Liver	0	0	0	7	0	7	10
Lung	1	0	0	12	0	13	4
Lymphatic	0	0	0	7	0	7	10
All Lymphopoietic	0	0	0	2	0	2	15
Malignant Melanoma	0	2	1	7	0	10	7
Mesothelioma	0	0	0	0	0	0	17
Multiple Myeloma	0	2	0	6	0	8	9

Cancers	Level of Association						
	Strong	Moderate	Weak	No Association	Unable to Establish Association	Studied	Not Studied
Non-Hodgkin's Lymphoma	1	1	0	5	0	7	10
Ovarian	0	0	0	0	0	0	17
Pancreatic	0	0	0	11	0	11	6
Prostate	0	0	3	9	1	13	4
Rectal	0	0	1	10	0	11	6
Respiratory	0	0	0	2	0	2	15
Sinus	0	0	0	1	0	1	16
Skin	0	0	1	5	0	6	11
Stomach	0	0	1	10	0	11	6
Testicular	0	4	0	3	0	7	10
Throat	0	0	1	5	0	6	11
Thyroid	2	1	0	3	0	6	11
Ureter	1	0	1	1	0	3	14
Urethra	0	0	1	1	0	2	15
All Cancers Within Study	0	2	3	4	0	11	6

APPENDIX F: FIREFIGHTER TABLES

Table F-1: Firefighter Data by State for Fire Departments Reporting to USFA Fire Department Census

State	Number of Fire Departments	Career	Volunteer			Total Firefighters	% Career	% Volunteer
			Volunteer Only	Paid per Call	Total Volunteer			
Alabama	783	5,721	13,679	901	14,580	20,301	28.2%	71.8%
Alaska	141	1,304	2,374	887	3,261	4,565	28.6%	71.4%
Arizona	242	6,686	1,818	1,732	3,550	10,236	65.3%	34.7%
Arkansas	660	2,514	10,126	1,772	11,898	14,412	17.4%	82.6%
California	834	40,472	12,397	7,686	20,083	60,555	66.8%	33.2%
Colorado	321	5,332	7,403	760	8,163	13,495	39.5%	60.5%
Connecticut	243	4,247	10,220	1,069	11,289	15,536	27.3%	72.7%
Delaware	57	357	3,616	67	3,683	4,040	8.8%	91.2%
Dist. of Columbia	3	1,479	0	14	14	1,493	99.1%	0.9%
Florida	459	24,086	6,816	1,872	8,688	32,774	73.5%	26.5%
Georgia	454	11,253	10,453	2,619	13,072	24,325	46.3%	53.7%
Hawaii	11	2,446	386	0	386	2,832	86.4%	13.6%
Idaho	177	1,874	2,391	1,562	3,953	5,827	32.2%	67.8%
Illinois	1,065	14,814	15,304	10,513	25,817	40,631	36.5%	63.5%
Indiana	747	7,683	14,646	3,466	18,112	25,795	29.8%	70.2%
Iowa	706	1,928	13,805	2,458	16,263	18,191	10.6%	89.4%
Kansas	463	3,269	6,637	3,382	10,019	13,288	24.6%	75.4%
Kentucky	668	3,972	14,151	1,795	15,946	19,918	19.9%	80.1%
Louisiana	355	5,365	8,884	974	9,858	15,223	35.2%	64.8%
Maine	338	1,223	3,736	5,451	9,187	10,410	11.7%	88.3%
Maryland	258	7,408	20,280	155	20,435	27,843	26.6%	73.4%
Massachusetts	355	12,067	1,673	5,184	6,857	18,924	63.8%	36.2%
Michigan	934	7,686	5,083	14,982	20,065	27,751	27.7%	72.3%
Minnesota	697	1,843	9,027	8,429	17,456	19,299	9.5%	90.5%
Mississippi	382	3,346	7,293	602	7,895	11,241	29.8%	70.2%
Missouri	720	6,560	12,062	3,103	15,165	21,725	30.2%	69.8%
Montana	259	638	5,071	500	5,571	6,209	10.3%	89.7%
Nebraska	363	1,370	9,567	239	9,806	11,176	12.3%	87.7%
Nevada	85	2,643	2,511	1,164	3,675	6,318	41.8%	58.2%
New Hampshire	209	1,555	1,621	3,846	5,467	7,022	22.1%	77.9%
New Jersey	688	7,123	27,461	864	28,325	35,448	20.1%	79.9%
New Mexico	238	1,434	4,445	205	4,650	6,084	23.6%	76.4%
New York	1,604	7,107	80,791	329	81,120	88,227	8.1%	91.9%
North Carolina	984	8,764	26,335	3,586	29,921	38,685	22.7%	77.3%

State	Number of Fire Departments	Career	Volunteer			Total Firefighters	% Career	% Volunteer
			Volunteer Only	Paid per Call	Total Volunteer			
North Dakota	299	547	7,059	530	7,589	8,136	6.7%	93.3%
Ohio	1,127	14,167	15,838	12,622	28,460	42,627	33.2%	66.8%
Oklahoma	699	4,401	9,503	923	10,426	14,827	29.7%	70.3%
Oregon	293	3,915	6,387	1,172	7,559	11,474	34.1%	65.9%
Pennsylvania	1,774	3,546	58,274	1,046	59,320	62,866	5.6%	94.4%
Rhode Island	74	2,280	1,383	419	1,802	4,082	55.9%	44.1%
South Carolina	432	4,940	10,412	1,710	12,122	17,062	29.0%	71.0%
South Dakota	280	489	6,786	128	6,914	7,403	6.6%	93.4%
Tennessee	594	6,908	12,923	2,108	15,031	21,939	31.5%	68.5%
Texas	1,408	22,960	28,436	9,960	38,396	61,356	37.4%	62.6%
Utah	181	1,771	2,338	1,418	3,756	5,527	32.0%	68.0%
Vermont	190	331	3,201	1,371	4,572	4,903	6.8%	93.2%
Virginia	506	9,065	20,383	817	21,200	30,265	30.0%	70.0%
Washington	404	7,089	9,143	3,887	13,030	20,119	35.2%	64.8%
West Virginia	390	892	9,237	145	9,382	10,274	8.7%	91.3%
Wisconsin	763	4,584	12,721	9,999	22,720	27,304	16.8%	83.2%
Wyoming	104	585	2,645	456	3,101	3,686	15.9%	84.1%
Total Fire Department Census	**26,021**	**304,039**	**588,731**	**140,879**	**729,610**	**1,033,649**	**29.4%**	**70.6%**
Total NFPA	**30,635**	**316,950**			**823,950**	**1,140,900**	**27.8%**	**72.2%**

APPENDIX G: DESCRIPTION OF CANCER SYSTEMS CITED IN LEGISLATION

To better understand the scope of the non-specific or system cancers covered under state legislation, below are the National Cancer Institute (NCI) for definitions and explanations for organ systems and different types of cancer. These definitions and examples of associated cancers are taken from the NCI website, www.cancer.gov.

Skin Cancer. Skin cancer includes cutaneous T-cell lymphoma, Kaposi sarcoma, melanoma, Merkel cell carcinoma, basal cell carcinoma, squamous cell carcinoma, and neuroendocrine carcinoma of the skin.

Digestive System/Gastrointestinal (GI) Tract Cancer. Digestive system and GI tract cancers include the intestines, salivary glands, mouth, anus, extrahepatic bile duct, colon, esophagus, gallbladder, liver, pancreas, rectum, small intestine, and stomach, including carcinoid tumors of the GI tract.

Hematological System/Haematopoieitic Cancers. Hematological system or haematopoietic cancers include leukemias (acute lymphoblastic, acute myeloid, chronic lymphocytic, chronic meylogenous, and Hairy cell), lymphomas (AIDS-related, cutaneous T-cell, Hodgkin, Hodgkin in pregnancy, mycosis fungoides, non-Hodgkin, non-Hodgkin in pregnancy, primary central nervous system, Sézary syndrome, and Waldenström macroglobulinemia), chronic myeloproliferative disorders, multiple myeloma/plasma cell neoplasms, myelodysplastic syndromes, and myelodysplastic/myeloproliferative diseases.

Genitourinary System Cancers. Cancers of the genitourinary system include bladder, kidney and renal cell, penile, prostate, renal pelvis and ureter transitional cell, testicular, urethral, and Wilms tumor and other kidney tumors.

Lymphatic System Cancers. NCI does not address cancers of the lymphatic system. It defines the lymphatic system as “the tissues and organs that produce, store, and carry white blood cells that fight infections and other diseases. This system includes the bone marrow, spleen, thymus, lymph nodes, and lymphatic vessels (a network of thin tubes that carry lymph and white blood cells).” Lymphatic system cancers could apply to any or all of these sites.

Central Nervous System. NCI does not address cancers of the central nervous system. The central nervous system is described as the brain and the spinal cord.

Urinary System Cancer. The urinary system is described by NCI as, “The organs of the body that produce and discharge urine.” Types of cancers included are the kidney, ureter, bladder, and urethral.

Skeletal System Cancers. NCI defines the skeletal system as bone and cartilage. Skeletal system cancers are primarily bone cancers.

Oral System Cancers. The oral system is defined as having to do with the mouth. NCI goes on to state that oral cancer is “cancer that forms in tissues of the lip or mouth. This includes the front two thirds of the tongue, the upper and lower gums, the lining inside the cheeks and lips, the bottom of the mouth under the tongue, the bony top of the mouth, and the small area behind the wisdom teeth.”

Prostate System Cancer. The NCI does not address prostate “system” cancer. Prostate cancer is addressed as a single site cancer.

Lung/Respiratory System Cancers. The respiratory tract is defined as “the organs that are involved in breathing.” Organs included are the nose, throat, larynx, trachea, bronchi, and lungs.

Reproductive System. NCI does not address reproductive system cancers.The NCI defines the reproductive system as, “the organs involved in producing offspring.” For women, organs included are ovaries, the fallopian tubes, the uterus (womb), the cervix, and the vagina (birth canal). For men, organs included are the prostate, the testes, and the penis.

APPENDIX H: ANNOTATED BIBLIOGRAPHY

The following bibliography is a complete list of references with an abstract or a summary for each reference. The references are ordered in three specific categories. The first category represents the documents used in the literature review. The subcategories include the class 1, 2, 3, and 4 documents. The second major category includes documents and articles about cancer costs. The third major category is labeled as “Other” and includes references for 9/11 specific articles, other occupations, rates and statistics, and miscellaneous.

Many of the documents are peer-reviewed research articles in which the authors have prepared scientific abstracts. Those abstracts are included in the bibliography as part of the reference for each research article. The scientific abstracts are generally organized by background information, methodology used, results, and conclusions. We have included these abstracts in the format given in the article itself. However, some of the abstracts do not follow the standardized organization of a scientific abstract. For those abstracts, we labeled them as “Abstract” and did not alter the format. As many of these articles are published in international journals, the spelling in the abstracts may not reflect standard American English. For the remaining documents that do not have published abstracts, TriData prepared summaries of the key concepts established in each document. These summaries are noted as “Summary.”

REVIEWED LITERATURE

Class 1 Documents

Austin, C. C., G. Dussault, et al. (2001). "Municipal Firefighter Exposure Groups, Time Spent at Fires and Use of Self-Contained-Breathing-Apparatus." American Journal of Industrial Medicine 40: 683-692.

Abstract

Background: Previous studies have found significant associations between firefighting and cancer.

Methods: Fires, vehicle movement, and firefighter job assignment were determined, and storage and distribution of self-contained-breathing-apparatus (SCBAs) were tracked for 12 months. Time spent at fires and use of SCBAs were calculated.

Results: Only 66% of fire department personnel were 1st-line combat firefighters. Number of runs was an unreliable surrogate for time spent at fires. Eight firefighter exposure groups were identified (based on job title, firehall assignment, and time spent at fires), ranging from no exposures to 3,244 min/year/firefighter. SCBAs appear to have been used for approximately 50% of the time at structural fires but for only 6% of the time at all fires.

Conclusions: Failure of previous studies to identify homogeneous exposure groups may have resulted in misclassification and underestimates of health risks. The approach used in this study may be used in epidemiological studies to identify exposure/response relationships.

Band, P. R., N. D. Le, et al. (2004). "Identification of Occupational Cancer Risks in British Columbia: A Population-Based Case-Control Study of 769 Cases of Non-Hodgkin's Lymphoma Analyzed by Histopathology Subtypes." Journal of Occupational and Environmental Medicine 46: 479-489.

Abstract

We have, as part of a program aimed at detecting occupational risk factors in British Columbia, collected lifetime occupational histories as well as information on lifetime cigarette smoking and alcohol consumption from 15,643 incident cancer cases, of whom 782 had a diagnosis of non-Hodgkin's lymphoma (NHL). Occupational risks for this cancer site are examined using a matched case- control study design, and the results are presented in this report for all cases and for histopathology subtypes. The results of our study indicate excess NHL risk, particularly for a number of occupations that involve exposures to electromagnetic fields, treated and fresh wood, metals, and solvents.

Baris, D., T. J. Garrity, et al. (2001). "Cohort Mortality Study of Philadelphia Firefighters." American Journal of Industrial Medicine 39: 463-476.

Abstract

Background: Fire fighters are exposed to a wide variety of toxic chemicals. Previous studies have reported excess risk of some cancers but have been limited by small numbers or little information on employment characteristics.

Methods: We conducted a retrospective cohort mortality study among 7,789 Philadelphia firefighters employed between 1925 and 1986. For each cause of death, the standardized

mortality ratios (SMRs) and 95% confidence intervals were estimated. We also compared mortality among groups of firefighters defined by the estimated number of career runs and potential for diesel exposure.
Results: In comparison with U.S. white men, the firefighters had similar mortality from all causes of death combined (SMR=0.96) and all cancers (SMR=1.10). There were statistically significant deficits of deaths from nervous system diseases (SMR=0.47), cerebrovascular diseases (SMR=0.83), respiratory diseases (SMR=0.67), genitourinary diseases (SMR=0.54), all accidents (SMR=0.72), and suicide (SMR=0.66). Statistically significant excess risks were observed for colon cancer (SMR=1.51) and ischemic heart disease (SMR=1.09). The risks of mortality from colon cancer (SMR=1.68), kidney cancer (SMR=2.20), non-Hodgkin's lymphoma (SMR=1.72), multiple myeloma (SMR=2.31), and benign neoplasms (SMR=2.54) were increased among firefighters with at least 20 years of service.
Conclusions: Our study found no significant increase in overall mortality among Philadelphia firefighters. However, we observed increased mortality for cancers of the colon and kidney, non-Hodgkin's lymphoma and multiple myeloma. There was insufficient follow up since the introduction of diesel equipment to adequately assess risk.

Bates, M. N. (2007). "Registry-Based Case-Control Study of Cancer in California Firefighters." American Journal of Industrial Medicine 50: 339-344.

Abstract
Background: There is no consensus whether firefighters are at increased cancer risk for particular cancers. Previous studies have been small, mostly investigated cancer mortality, and suggested increased risks for brain, bladder, testicular, prostate, thyroid and colo-rectal cancers, leukemia, and melanoma.
Methods: Records of all male cancers registered in California during 1988-2003 were obtained. Firefighters were identified from occupation and industry text fields. Logistic regression analysis used other cancers as controls.
Results: Of the 804,000 eligible records, 3,659 had firefighting as their occupation. Firefighting was associated with testicular cancer (odds ratio=1.54, 95% confidence interval: 1.18-2.02), melanoma (1.50, 1.33-1.70), brain cancer (1.35, 1.06-1.72), esophageal cancer (1.48, 1.14-1.91), and prostate cancer (1.22, 1.12-1.33).
Conclusions: Use of other-cancer controls and lack of an occupational history may have biased relative risks towards the null. However, this study, which contained more firefighter cancers than any previous epidemiologic study, produced evidence supporting some prior hypotheses.

Bates, M. N., J. Fawcett, et al. (2001). "Is Testicular Cancer an Occupational Disease of Fire Fighters?" American Journal of Industrial Medicine 40: 263-270.

Abstract
Background: A previous investigation showed an increased risk of testicular cancer among fire fighters in Wellington City, New Zealand, during the 1980s. Other studies of fire fighters had not identified testicular cancer as an occupational disease.
Methods: This was an historical cohort study of mortality and cancer incidence in all paid New Zealand fire fighters, from 1977 to 1995.

Results: The only cancer for which this study provided evidence of an increased risk was testicular cancer, even after excluding cases from the previous investigation. The standardized incidence ratio for 1990-96 was 3.0 (95% confidence interval: 1.3-5.90). There was no evidence that fire fighters were at increased risk from any particular cause of death.
Conclusions: This study confirmed that New Zealand fire fighters are at increased risk of testicular cancer, although the reason is unknown. Other incidence studies of cancer in fire fighters are needed to confirm this finding.

Betchley, C., J. Q. Koenig, et al. (1997). "Pulmonary Function and Respiratory Symptoms in Forest Firefighters." American Journal of Industrial Medicine 31: 503-509.

Abstract
This study evaluated effects on respiratory health of forest firefighters exposed to high concentrations of smoke during their work shift. This is the first study of cross-shift respiratory effects in forest firefighters conducted on the job. Spirometric measurements and self administered questionnaire data were collected before and after the 1992 firefighting season. Seventy-six (76) subjects were studied for cross-shift and 53 for cross-season analysis. On average, the cross-season data were collected 77.7 days after the last occupational smoke exposure. The cross-shift analysis identified significant mean individual declines in FVC, FEV1, and FEF25-75. The preshift to midshift decreases were 0.089 L, 0.190 L, and 0.439 L/sec, respectively, with preshift to postshift declines of 0.065 L, 0.150 L, and 0.496L/sec. Mean individual declines for FVC, FEV1 and FEF25-75 of 0.033 L, 0.104 L, and 0.275 L/sec, respectively, also were noted in the cross-season analysis. The FEV1 changed significantly ($p < 0.05$). The use of wood for indoor heat also was associated with the declines in FEV1. Although annual lung function changes for a small subset (n =10) indicated reversibility of effect, this study suggests a concern for potential adverse respiratory effects in forest firefighters.

Booze, T. F., T. Reinhardt, et al. (2004). "A Screening-Level Assessment of the Health Risks of Chronic Smoke Exposure for Wildland Firefighters." Journal of Occupational and Environmental Medicine 1(5): 296-305.

Abstract
A screening health risk assessment was performed to assess the upper-bound risks of cancer and noncancer adverse health effects among wildland firefighters performing wildfire suppression and prescribed burn management. Of the hundreds of chemicals in wildland fire smoke, we identified 15 substances of potential concern from the standpoints of concentration and toxicology; these included aldehydes, polycyclic aromatic hydrocarbons, carbon monoxide, benzene, and respirable particulate matter. Data defining daily exposures to smoke at prescribed burns and wildfires, potential days of exposure in a year, and career lengths were used to estimate average and reasonable maximum career inhalation exposures to these substances. Of the 15 substances in smoke that were evaluated, only benzene and formaldehyde posed a cancer risk greater than 1 per million, while only acrolein and respirable particulate matter exposures resulted in hazard indices greater than 1.0. The estimated upper-bound cancer risks ranged from 1.4 to 220 excess cancers per million, and noncancer hazard indices ranged from 9 to 360, depending on the exposure group. These values only indicate the likelihood of adverse health effects, not whether they will or will not occur. The risk assessment process

narrows the field of substances that deserve further assessment, and the hazards identified by risk assessment generally agree with those identified as a concern in occupational exposure assessments.

Burgess, J. L., M. A. Fierro, et al. (2004). "Longitudinal Decline in Lung Function: Evaluation of Interleukin-10 Genetic Polymorphisms in Firefighters." Journal of Occupational and Environmental Medicine 46(10): 1013-1022.

Abstract
During annual medical monitoring, some firefighters are found to have rates of decline in forced expiratory volume in one second (FEV1) far exceeding their peers. Interleukin-10 (IL-10) suppresses inflammation, and single nucleotide polymorphisms (SNPs) in the IL-10 gene may confer variable susceptibility to more rapid decline in lung function. In 1204 firefighters with at least six annual FEV1 measurements, increased age and greater initial FEV1 were associated with more rapid decline in lung function. DNA collected from 379 of these firefighters was screened for IL-10 SNPs at -1117, -854, 919, 1668, and 1812. A statistically significant difference in decline in lung function was found based on genotyping at the 1668 SNP. Evaluation of gene polymorphisms regulating lung inflammation may help to explain some of the variation in rate of decline in lung function in firefighters.

Burgess, J. L., C. J. Nanson, et al. (2001). "Adverse Respiratory Effects Following Overhaul in Firefighters." Journal of Occupational and Environmental Medicine 43(5): 467-473.

Abstract
Overhaul is the stage in which firefighters search for and extinguish possible sources of reignition. It is common practice not to wear respiratory protection during overhaul. Fifty-one firefighters in two groups, 25 without respiratory protection and 26 wearing cartridge respirators, were monitored for exposure to products of combustion and changes in spirometric measurements and lung permeability following overhaul of a structural fire. Testing at baseline and 1 hour after overhaul included forced vital capacity (FVC), forced expiratory volume in one second (FEV1), serum Clara cell protein (CC16), and serum surfactant-associated protein A (SP-A). Overhaul increased CC16 in both groups, indicating increased alveolarcapillary membrane permeability. Contrary to expectations, SP-A increased and FVC and FEV1 decreased in the firefighters wearing cartridge respirators. Changes in FEV1, CC16, and SP-A were associated with concentrations of specific products of combustion or carboxyhemoglobin levels. Firefighter exposures during overhaul have the potential to cause changes in spirometric measurements and lung permeability, and self-contained breathing apparatus should be worn during overhaul to prevent lung injury.

Cocco, P., M. Dosemeci, et al. (1998). "Occupational Risk Factors for Cancer of the Central Nervous System: A Case-Control Study on Death Certificates from 24 U.S. States." American Journal of Industrial Medicine 33: 247-255.

Abstract
The risk of cancer of the central nervous system (CNS) by industry and occupation was investigated with a case-control analysis of the death certificates of 28,416 cases and 113,664 controls, selected from over 4.5 million deaths in 24 U.S. states between 1984 and 1992. Industries showing consistent increases in risk by gender and race included

textile mills, paper mills, printing and publishing industries, petroleum refining, motor vehicles manufacturing, telephone and electric utilities, department stores, health care services, elementary and secondary schools, and colleges and universities. CNS cancer risk was increased for administrators in education and related fields, secondary school teachers, and other education- and health-related occupations. The application of job-exposure matrices to the industry/occupation combinations revealed a modest increase in risk for potential contact with the public at work and exposure to solvents. Occupational exposure to electromagnetic fields (EMF) was not associated with CNS cancer, although an association was observed with a few EMF-related occupations and industries. Agricultural exposures were associated with significant risk increases among white women and white men. Further work is required to investigate in more detail specific occupational exposures or possible confounders responsible for the observed associations.

Demers, P. A., H. Checkoway, et al. (1994). "Cancer incidence among firefighters in Seattle and Tacoma, Washington (United States)." Cancer Causes & Control 5(2): 129-135.

Abstract
In order to determine if exposure to carcinogens in fire smoke increases the risk of cancer, we examined the incidence of cancer in a cohort of 2,447 male firefighters in Seattle and Tacoma, (Washington, USA). The study population was followed for 16 years (1974-89) and the incidence of cancer, ascertained using a population-based tumor registry, was compared with local rates and with the incidence among 1,878 policemen from the same cities. The risk of cancer among firefighters was found to be similar to both the police and the general male population for most common sites. An elevated risk of prostate cancer was observed relative the general population (standardized incidence ratio [SIR] = 1.4, 95 percent confidence interval [CI] = 1.1-1.7) but was less elevated compared with rates in policemen (incidence density ratio [IDR] = 1.1, CI = 0.7-1.8) and was not related to duration of exposure. The risk of colon cancer, although only slightly elevated relative to the general population (SIR = 1.1, CI = 0.7-1.6) and the police (IDR = 1.3, CI = 0.6-3.0), appeared to increase with duration of employment. Although the relationship between firefighting and colon cancer is consistent with some previous studies, it is based on small numbers and may be due to chance. While this study did not find strong evidence for an excess risk of cancer, the presence of carcinogens in the firefighting environment warrants periodic reevaluation of cancer incidence in this population and the continued use of protective equipment.

Demers, P. A., N. J. Heyer, et al. (1992). "Mortality among firefighters from three northwestern United States cities." British Journal of Industrial Medicine 49: 664-670.

Abstract
To explore whether exposure among firefighters to fire smoke could lead to an increased risk of cancer, lung disease, and heart disease, the mortality of 4546 firefighters who were employed by the cities of Seattle and Tacoma, WA and Portland, OR for at least one year between 1944 and 1979 were compared with United States national mortalities and with mortality of police officers from the same cities. Between 1945 and 1989, 1169 deaths occurred in the study population and 1162 death certificates (99%) were collected. Mortality due to all causes, ischaemic heart disease, and most other non-malignant diseases was less than expected based upon United States rates for white men. There was

no excess risk of overall mortality from cancer but excesses of brain tumours (standardised mortality ratio (SMR) = 2.09, 95% confidence interval (95% CI) 1.3-3.2) and lymphatic and haematopoetic cancers (SMR = 1.31, 95% CI = 0.9-1.8) were found. Younger firefighters (< 40 years of age) appeared to have an excess risk of cancer (SMR = 1.45, 95% CI 0.8-2.39), primarily due to brain cancer (SMR = 3.75, 95% CI 1.2-8.7). The risk of lymphatic and haematopoetic cancers was greatest for men with at least 30 years of exposed employment (SMR = 2.05, 95% CI 1.1-3.6), especially for leukaemia (SMR = 2.60, 95% CI 1.0-5.4).

Fawcett, J. and N. Garrett (2002). "Follow-up methods for retrospective cohort studies in New Zealand." Australian and New Zealand Journal of Public Health 26(3): 256-261.

Abstract

Objectives: To define a general methodology for maximising the success of follow-up processes for retrospective cohort studies in New Zealand, and to illustrate an approach to developing country-specific follow-up methodologies.
Methods: We recently conducted a cohort study of mortality and cancer incidence in New Zealand professional fire fighters. A number of methods were used to trace vital status, including matching with records of the New Zealand Health Information Service (NZHIS), pension records of Work and Income New Zealand (WINZ), and electronic electoral rolls. Non-electronic methods included use of paper electoral rolls and the records of the Registrar of Births Deaths and Marriages.
Results: 95% of the theoretical person-years of follow-up of the cohort were traced using these methods. In terms of numbers of cohort members traced to end of follow-up, the most useful tracing methods were fire fighter employment records, the NZHIS, WINZ, and the electronic electoral rolls.
Conclusions: The follow-up process used for the cohort study was highly successful. On the basis of this experience, we propose a generic, but flexible, model for follow-up of retrospective cohort studies in New Zealand. Similar models could be constructed for other countries. Implications: Successful follow-up of cohort studies is possible in New Zealand using established methods. This should encourage the use of cohort studies for the investigation of epidemiological issues. Similar models for follow-up processes could be constructed for other countries.

Firth, H. M., K. R. Cooke, et al. (1996). "Male Cancer Incidence by Occupation: New Zealand, 1972-1984." International Journal of Epidemiology 25(1): 14-21.

Abstract

Background: This study was carried out to identify male occupational groups with increased incidence of cancer for the period 1972-1984 in New Zealand. No data on cancer incidence by occupation have been reported previously for New Zealand.
Methods: Age (SIR,) and age and socioeconomic level (SIR2) standardized incidence ratios were calculated for males 15-64 years for all cancers combined and for site-specific cancers by occupational group. Directly age standardized rates were also calculated by socioeconomic level.
Results: In general, occupations in higher socioeconomic levels had lower all-cancer incidence ratios and lower socioeconomic levels had higher ratios. However, the highest socioeconomic level (level 1) had a higher all-cancer incidence rate than levels 2-6. After socioeconomic adjustment an increased incidence ratio for lung cancer was found for

jewellery and precious metal workers (SIR2 = 241; 95% confidence interval [Cl]: 120-433), and bricklayers and carpenters (SIR2 = 130; 95% Cl: 116-146). Woodworkers had increased ratios for stomach (SIR2 = 144; 95% Cl: 110-186) and rectal cancer (SIR2 = 146; 95% Cl: 116-181). Firefighters had an increase for laryngeal cancer (SIR2= 1074; 95% Cl: 279-2776).
Conclusions: Research appears to be warranted to further investigate associations of laryngeal cancer in firefighters, lung cancer in jewellery and precious metal workers and bricklayers and carpenters, and digestive cancers in woodworkers.

Gerin, M., J. Siemiatycki, et al. (1998). "Associations between Several Sites of Cancer and Occupational Exposure to Benzene, Toluene, Xylene, and Styrene: Results of a Case-Control Study in Montreal." American Journal of Industrial Medicine 34: 144-156.

Abstract
Background: Except for the leukemogenic effects of benzene, there is inadequate or sparse evidence on the carcinogenicity of the most common monocyclic aromatic hydrocarbons. The purpose of this study was to generate hypotheses on associations between exposure to benzene, toluene, xylene, and styrene and various common types of cancer.
Methods: In the context of a population-based case-control study carried out in Montreal, 3,730 cancer patients (15 types of cancers, not including leukemia) and 533 population controls were interviewed, and their job histories were translated by a team of experts into occupational exposures, including benzene, toluene, xylene, and styrene. In the present analysis, exposure to these substances was compared between each case series and a control group pooling selected cancer patients and population controls, using logistic regression analysis.
Results: Exposure levels were low for most exposed subjects, and there was a high correlation between exposure to benzene, toluene and xylene. For most sites of cancer there was no evidence of excess risk due to these substances. However, limited evidence of increased risk was found for the following associations: esophagus-toluene, colon-xylene, rectum-toluene, rectum-xylene and rectum-styrene.
Conclusions: These latter observations warrant further investigation.

Guidotti, T. L. (1993). "Mortality of Urban Firefighters in Alberta, 1927-1987." American Journal of Industrial Medicine 23(921-940).

Abstract
The mortality experience of firefighters has been an active topic of investigation. Collateral toxicological evidence suggests that certain causes of death are likely to be associated with firefighting: lung cancer, heart disease, and obstructive pulmonary disease. To date there has not been a clear and consistent demonstration of excess risk due to occupational exposure for these outcomes, but certain other cancers, including genitourinary, colon and rectum, and leukemias, lymphomas, and myeloma, appear to be consistently elevated. A major unproven hypothesis is that risk increased following the introduction, in the 1950s, of combustible plastic furnishing and building materials known to generate toxic combustion products. Mortality by cause of death was examined for two cohorts totaling 3,328 firefighters active from 1927 to 1987 in Edmonton and Calgary, the two major urban centers in the province of Alberta, Canada, examining associations with cohort (before and after the 1950s) and years of service weighted by

exposure opportunity. The study attained 96% follow-up of vital status and over 64,983 person-years of observation, yielding 370 deaths. Mortality from all causes was close to the expected standardized mortality ratio (96; 95% confidence limits (CL) 87, 107) as was that for heart disease (110; 95% CL 92, 131), and neither was statistically significant at the $p < 0.05$ level (N.S.). Excesses were observed for all malignant neoplasms (127; 95% CL 102, 155, $p < 0.05$) and for cancer of lung (142; 95% CL 91, 211, N.S.), bladder (315; 95% CL 86, 808, N.S.), kidney and ureter (414; 95% CL 166, 853, $p < 0.05$), colon and rectum (161; 95% CL 88, 271, N.S.), pancreas (155; 95% CL 50, 362, N.S.) and leukemia, lymphoma, and myeloma (127; 95% CL 233, N.S.); obstructive pulmonary diseases (157; 95% CL 79, 281, N.S.). Fire-related causes showed a marked excess (486; 95% CL 233, 895, $p < 0.01$), but external causes overall showed a marked excess (486; 95% CL 233, 895, $p < 0.01$), but external causes overall showed a significant deficit (66; 95% CL 49, 87, $p < 0.05$). The lung cancer excess was confined to Edmonton; there was no consistent association with duration of employment, exposure opportunity, or cohort of entry (before or after the 1950s) except that the highest risk was observed among Edmonton firefighters with over 35 weighted years. The excess of cancers of the urinary tract was observed mostly among firefighters entering service after 1950, appeared to increase with length of service and exposure opportunity, and was observed in both cities. An occupational association with heart disease and chronic pulmonary disease is not supported in this study on this population. An effect on lung cancer is not obvious, but may be present in the highest exposure group; a weak effect for lung cancer confounded by stronger effects cannot be ruled out. Associations of firefighting with cancers at genitourinary sites and with fire-related injury are strongly suggested in this population.

Guidotti, T. L. (1995). "Occupational Mortality Among Firefighters: Assessing the Association." Journal of Occupational and Environmental Medicine 37(12): 1348-1356.

Abstract

Because of their occupational exposure to a variety of toxic agents, fire fighters may be at risk for a number of exposure-related diseases. We reviewed the current literature on disease risk among fire fighters to compare findings and to infer magnitude of risk. A standard mortality ratio (SMR) of 200 is equal to an attributable risk of 100% of expected, sufficient to justify presumption in most workers' compensation systems that accept this. We therefore concentrated on risks that approach or exceed an SMR of 200 or an equivalent risk estimate, bearing in mind that confidence intervals around these estimates are wide. Based on the criteria for presumption of occupational risk, we suggest the following conclusions with respect to general presumption of risk: (1) Lung cancer: There is evidence for an association but not of sufficient magnitude for a general presumption of risk. (2) Cardiovascular: There is no evidence for an increased risk of death overall from heart disease. Sudden death, myocardial infarction, or fatal arrhythmia occurring on or soon after near-maximal stress on the job are likely to be heart related, but such "heart attacks" occurring away from work cannot be presumed to be work related. (3) Aortic aneurysm: The evidence is incomplete for an association, but if an association does exist, it would probably be of a magnitude compatible with a general presumption of risk. (4) Cancers of the genitourinary tract, including kidney, ureter, and bladder: The evidence is strong for both an association and for a general presumption of risk. (5) Cancer of brain: Incomplete evidence strongly suggests a possible association at a magnitude consistent with a general presumption of risk. (6) Cancer of lymphatic and

hematopoietic tissue: By group, there is some evidence for both an association and a general presumption or risk. However, the aggregation is medically meaningless. We therefore recommend a case-by-case approach. (7) Cancer of the colon and rectum: There is sufficient evidence to conclude that there is an association but not that there is a general presumption of risk. (8) Acute lung disease: Unusual exposures, such as exposure to the fumes of burning plastics, can cause severe lung toxicity and even permanent disability. This does not appear to result in an increased lifetime risk of dying from chronic lung disease.

Guidotti, T. L. (2003). "Presumption for selected cancers and occupation as a firefighter in Manitoba: the rationale for recent Canadian legislation on presumption." International Journal of Risk Assessment and Management 4(2/3): 245-259.

Abstract
Provinces across Canada are suddenly considering or have already passed legislation establishing a rebuttable presumption for compensation for firefighters who develop certain types of cancer. This movement began in Manitoba and was motivated by appreciation of the role of firefighters in public safety. The evidentiary basis for establishing presumption for these cancers was developed in a report prepared in mid-2002 for the Workers. Compensation Board of Manitoba that evaluated the association of specific types of cancer with firefighting: brain, bladder, kidney, non-Hodgkin's lymphoma (often referred to as "lymphatic cancer") together with myeloma and leukaemia (often referred to as "haematopoietic cancer"). This paper summarises the report.

Haas, N. S., M. Gochfeld, et al. (2003). "Latent Health Effects in Firefighters." International Journal of Occupational and Environmental Health 9: 95-103.

Abstract
Firefighter mortality studies that used standardized mortality ratio (SMR) as a summary measure are reviewed and an overview of time-dependent mortality effects for all causes, CAD, cancer, and respiratory deaths is provided. Of 17 studies reporting SMRs for firefighters, three overlapped with larger studies and six did not contain time dependent data, leaving eight for inclusion. The time effects showed no increased mortality with increasing time employed and time since first employment (latency) for all-cause mortality or any specific cause. There were many causes of death for which firefighters' SMRs were below one through all durations of employment and latency. There was no convincing evidence that employment as a firefighter is associated with increased all-cause, CAD, cancer, or respiratory disease mortality.

Hansen, E. S. (1990). "A cohort study on the mortality of firefighters." British Journal of Industrial Medicine 47: 805-809.

Abstract
This study was set up to investigate the effect of exposure to combustion effluents on the chronic health of firefighters. A cohort of firefighters was followed up through 10 years with regard to cause specific mortality. Comparisons were made with another cohort of civil servants and salaried employees in physically demanding jobs. After a latency of five years, an excess mortality from cancer was seen for persons aged 30 to 74 (standardised mortality ratio (SMR) 173, 95% confidence interval (95% CI) 104-270). A

significant increase in lung cancer was seen in the group aged 60 to 74 (SMR 317, 95% CI 117-691), whereas non-pulmonary cancer was significantly increased in the group aged 30 to 49 (SMR 575, 95% CI 187-1341). It is concluded that inhalation of carcinogenic and toxic compounds during firefighting may constitute an occupational cancer risk. An extended use of respiratory protective equipment is advocated.

Howe, G. R. and J. D. Burch (1990). "Fire fighters and risk of cancer: an assessment and overview of the epidemiologic evidence." American Journal of Epidemiology 132(11): 1039-1050.

Summary
This study evaluates exposure data of firefighters to toxins and chemicals in an epidemiologic assessment. The paper evaluates studies that were done to assess for criteria and overall evidence for the existence of any association between fire fighting and increased risk of cancers.

Ide, C. W. (1998). "Failing firefighters: A survey of causes of death and ill-health retirement in serving firefighters in Strathclyde, Scotland from 1985-94." Occupational Medicine 48(6): 381-388.

Abstract
During the decade beginning 1 January 1985,887 full-time firefighters, all male, left the service of Strathclyde Fire Brigade (SFB). There were 17 deaths - compared to 64.4 expected in the Scottish male population aged 15-54 years - giving a standardized mortality ratio (SMR) of 26, and 488 ill-health retirements (IHR). None of the deaths was attributable to service, the major causes being: myocardial infarction - five, (expected = 17.3; SMR = 29); cancers - three (colon, kidney and lung) (expected = 13.6; SMR = 22); road traffic accidents - two (expected = 4.17; SMR = 48) and suicide - two (expected = 4.9; SMR = 41). Amalgamating the deaths and IHRs showed that the six most common reasons for IHR were musculoskeletal (A7=2O2, 40%), ocular (n=61, 12.1%), 'others' (n=58, 11.5%), injuries (n=50, 9.9%), heart disease (n=48, 9.5%) and mental disorders (n=45, 8.9%). Over 300 IHRs (over 60%) occurred after 20 or more years service. When the IHRs were subdivided into two quinquennia, there were 203 and 302 in each period. Mean length of service during each quinquennium was 19.4 vs. 21.3 years (p=0.003) and median length was 21 years in both periods; interquartile range was 12-26 years in the first and 17-27 years in the second period (p=0.002), but when further broken down into diagnostic categories, the differences were not statistically significant, with the exception of means of IHRs attributed to mental disorders (14.5 vs. 19 years, p=0.03).

Kales, S. N., J. M. Aldrich, et al. (1999). "Correlates of Fitness for Duty in Hazardous Materials Firefighters." American Journal of Industrial Medicine 36: 618-629.

Abstract
Background and Methods: From a statewide medical examination program, we identified firefighters who were deemed unfit for duty by attending physicians (ATTENDING FAIL, n.9) and those who would have been disqualified by the application of selected numerical criteria from the 1997 National Fire Protection Association (NFPA) guidelines (NFPA FAIL, n.27) and criteria from a Medical Workshop (WORK FAIL, n.16). The subjects who were unfit for duty or failed numerical criteria were compared with those who were fit for duty and passed all objective criteria (FIT group, n.302). All subjects

were given an overall morbidity rating by a board certified internist. Comparisons on two surrogate measures of fitness, VO2 max predicted and predicted coronary heart disease (CHD) risk, were also performed.
Results: We found a significant tendency towards worse results (e.g. higher blood pressure or lower spirometric function) among the three FAIL groups compared with the FIT group. The FAIL groups shared only a small overlap, however, with the firefighters with the highest morbidity ratings, lowest predicted VO2 max, and highest CHD risks. Increasing morbidity was associated with higher age, lower spirometric function, lower predicted VO2 max, increasing cholesterol, greater BMI, and higher predicted 10 year CHD risk.
Conclusion: Although the presence of a single serious or poorly controlled condition may render an individual unfit for safe performance as a firefighter, examination of our cohort suggests that multiple risk factor models or overall clinical assessments are superior means of identifying firefighters with poor health status and increased CHD risk.

Kales, S. N., E. S. Soteriades, et al. (2003). "Firefighers and on-duty deaths from coronary heart disease: a case control study." Environmental Health: A Global Access Science Source 2(14).

Abstract
Background: Coronary heart disease (CHD) is responsible for 45% of on-duty deaths among United States firefighters. We sought to identify occupational and personal risk factors associated with on-duty CHD death.
Methods: We performed a case-control study, selecting 52 male firefighters whose CHD deaths were investigated by the National Institute for Occupational Safety and Health. We selected two control populations: 51 male firefighters who died of on-duty trauma; and 310 male firefighters examined in 1996/1997, whose vital status and continued professional activity were re-documented in 1998.
Results: The circadian pattern of CHD deaths was associated with emergency response calls: 77% of CHD deaths and 61% of emergency dispatches occurred between noon and midnight. Compared to non-emergency duties, fire suppression (OR = 64.1, 95% CI 7.4-556); training (OR = 7.6, 95% CI 1.8-31.3) and alarm response (OR = 5.6, 95% CI 1.1-28.8) carried significantly higher relative risks of CHD death. Compared to the active firefighters, the CHD victims had a significantly higher prevalence of cardiovascular risk factors in multivariate regression models: age ≥ 45 years (OR 6.5, 95% CI 2.6-15.9), current smoking (OR 7.0, 95% CI 2.8 17.4), hypertension (OR 4.7, 95% CI 2.0-11.1), and a prior diagnosis of arterial-occlusive disease (OR 15.6, 95% CI 3.5-68.6).
Conclusions: Our findings strongly support that most on-duty CHD fatalities are work-precipitated and occur in firefighters with underlying CHD. Improved fitness promotion, medical screening and medical management could prevent many of these premature deaths.

Kang, D., L. K. Davis, et al. (2008). "Cancer Incidence Among Male Massachusetts Firefighters, 1987-2003." American Journal of Industrial Medicine 51: 329-335.

Abstract
Background: Firefighters are known to be exposed to recognized or probable carcinogens. Previous studies have found elevated risks of several types of cancers in firefighters.

Methods: Standardized morbidity odds ratio (SMORs) were used to evaluate the cancer risk in white, male firefighters compared to police and all other occupations in the Massachusetts Cancer Registry from 1986 to 2003. Firefighters and police were identified by text search of the usual occupation field. All other occupations included cases with identifiable usual occupations not police or firefighter. Control cancers were those not associated with firefighters in previous studies.
Results: Risks were moderately elevated among firefighters for colon cancer (SMOR¼1.36, 95% CI: 1.04-1.79), and brain cancer (SMOR¼1.90, 95% CI: 1.10-3.26). Weaker evidence of increased risk was observed for bladder cancer (SMOR¼1.22, 95% CI: 0.89-1.69), kidney cancer (SMOR¼1.34, 95% CI: 0.90-2.01), and Hodgkin's lymphoma (SMOR¼1.81, 95% CI: 0.72-4.53).
Conclusions: These findings are compatible with previous reports, adding to the evidence that firefighters are at increased risk of a number of types of cancer.

Kelly, K. J., E. Connelly, et al. (2002). "Assessment of Health Effects in New York City Firefighters after Exposure to Polychlorinated Biphenyls (PCBs) and Polychlorinated Dibenzofurans (PCDFs): The Staten Island Transformer Fire Health Surveillance Project." Archives of Environmental Health 57(4): 282-293.

Abstract
Following an electrical transformer fire in Staten Island, New York, a health surveillance program was established for 60 New York City firefighters and emergency medical technicians exposed to polychlorinated biphenyls (PCBs) and polychlorinated dibenzofurans (PCDFs). Exposure potential was documented after high levels of PCBs and PCDFs were found on transformer and firefighters' uniforms. Personnel received comprehensive medical examinations, and the results were compared with preexposure values. Serum was analyzed for PCBs, PCDFs, and polychlorinated dibenzo-p-dioxins (PCDDs). Follow-up was conducted 9 mo later. Thirty-two of 58 (55%) firefighters reported initial symptoms, and 3 firefighters required brief medical leave. Pulmonary functions, exercise performance, serum liver functions, and serum lipid profiles were normal or unchanged from preexposure baselines. Serum PCBs averaged 2.92 ± 1.96 ppb (range = 1.9-11.0 ppb). Five (8%) had serum PCBs that were greater than or equal to 6 ppb. Eight (73%) had a significant decrease (p = .05) in serum PCB level at the time of follow-up. Serum toxic equivalency (TEQ [1998 World Health Organization]) for total PCDDs and PCDFs averaged 39.0 ± 21.5 (n = 48). Eighteen (38%) had elevated TEQs (i.e., > 40). All firefighters had no short-term heath effects. Modern firefighting uniforms are not meant to replace HAZMAT suits, but these uniforms provide protection from this chemical exposure for most firefighters.

Kendall, N. (2005). International Review of Methods and Systems Used to Measure and Monitor Occupational Disease and Injury, National Occupational Health and Safety Advisory Committee. 3**:** 148.

Summary
This report provides a comprehensive international evidence-based review of methods and systems used to measure occupational disease and injury and assess the ability of surveillance systems to measure changes in work methods and organization.

Krishnan, G., M. Felini, et al. (2003). "Occupation and Adult Gliomas in the San Francisco Bay Area." Journal of Occupational and Environmental Medicine 45(6): 639-647.

Abstract
The etiology of gliomas is not well understood. Some jobs might involve sustained and elevated exposures to carcinogens. This study compares lifetime job histories of 879 glioma cases diagnosed between August 1991 to April 1994 and May 1997 to August 1999 in the San Francisco Bay Area and 864 controls. Logistic analyses compared longest and ever held occupations of 1 year or more for all astrocytic and nonastrocytic cases and controls overall with adjustment for age, gender, and ethnicity and separately for men and women. Two-fold or higher or statistically significant elevated odds ratios were found overall and in men among those with longest held occupations, as firefighters, physicians, material moving equipment operators, and janitors; such elevated odds ratios were also observed for longest-held occupations among male motor vehicle operators and personal service workers and female messengers, legal/social service workers, electronic equipment operators, painters, and food processors. Odds ratios of 0.50 or less, but not statistically significant, were found for those with longest held jobs as writers/journalists, biological scientists, paper workers, mechanics, chemists, and photographers/photoprocessors. This study supports previously observed occupational associations and is one of the few studies with sufficient numbers to separately analyze occupations by gender.

Lee, D. J., L. E. Fleming, et al. (2004). "Risk of Hospitalization Among Firefighters: The National Health Interview Survey, 1986-1994." American Journal of Public Health 94: 1938-1939.

Abstract
This study assessed the risk of hospitalization among firefighters. Data were derived from a nationally representative sample of 235 897 employed men from the National Health Interview Survey. Firefighters aged 30 to 39 years were at significantly increased risk for hospitalization relative to other employed men in the same age group (odds ratio = 1.93; 95% confidence interval=1.21, 3.09). Findings from this study and others support the call for longitudinal studies to monitor the health of this high-risk occupational group.

LeMasters, G. K., A. M. Genaidy, et al. (2006). "Cancer Risk Among Firefighters: A Review and Meta-analysis of 32 Studies." Journal of Occupational and Environmental Medicine 48(11): 1189-1202.

Abstract
Objective: The objective of this study was to review 32 studies on firefighters and to quantitatively and qualitatively determine the cancer risk using a meta-analysis.
Methods: A comprehensive search of computerized databases and bibliographies from identified articles was performed. Three criteria used to assess the probable, possible, or unlikely risk for 21 cancers included pattern of meta-relative risks, study type, and heterogeneity testing.
Results: The findings indicated that firefighters had a probable cancer risk for multiple myeloma with a summary risk estimate (SRE) of 1.53 and 95% confidence interval (CI) of 1.21-1.94, non-Hodgkin lymphoma (SRE = 1.51, 95% CI = 1.31-1.73), and prostate (SRE = 1.28; 95% CI = 1.15-1.43). Testicular cancer was upgraded to probable because it

had the highest summary risk estimate (SRE = 2.02; 95% CI =1.30-3.13). Eight additional cancers were listed as having a “possible” association with firefighting. *Conclusions:* Our results confirm previous findings of an elevated metarelative risk for multiple myeloma among firefighters. In addition, a probable association with non-Hodgkin lymphoma, prostate, and testicular cancer was demonstrated.

Leonard, S. S., V. Castranova, et al. (2007). "Particle size-dependent radical generation from wildland fire smoke." Toxicology 236: 103-113.

Abstract

Firefighting, along with construction, mining and agriculture, ranks among the most dangerous occupations. In addition, the work environment of firefighters is unlike that of any other occupation, not only because of the obvious physical hazards but also due to the respiratory and systemic health hazards of smoke inhalation resulting from combustion. A significant amount of research has been devoted to studying municipal firefighters; however, these studies may not be useful in wildland firefighter exposures, because the two work environments are so different. Not only are wildland firefighters exposed to different combustion products, but their exposure profiles are different. The combustion products wildland firefighters are exposed to can vary greatly in characteristics due to the type and amount of material being burned, soil conditions, temperature and exposure time. Smoke inhalation is one of the greatest concerns for firefighter health and it has been shown that the smoke consists of a large number of particles. These smoke particles contain intermediates of hydrogen, carbon and oxygen free radicals, which may pose a potential health risk. Our investigation looked into the involvement of free radicals in smoke toxicity and the relationship between particle size and radical generation. Samples were collected in discrete aerodynamic particle sizes from a wildfire in Alaska, preserved and then shipped to our laboratory for analysis. Electron spin resonance was used to measure carbon-centered as well as hydroxyl radicals produced by a Fenton-like reaction with wildfire smoke. Further study of reactive oxygen species was conducted using analysis of cellular H2O2 generation, lipid peroxidation of cellular membranes and DNA damage. Results demonstrate that coarse size range particles contained more carbon radicals per unit mass than the ultrafine particles; however, the ultrafine particles generated more •OH radicals in the acellular Fenton-like reaction. The ultrafine particles also caused significant increases in H2O2 production by monocytes and lipid peroxidation. All particle sizes showed the ability to cause DNA damage. These results indicate that the radical generation and the damage caused by them is not only a function of surface area but is also influenced by changing chemical and other characteristics due to particle size.

Ma, F., L. E. Fleming, et al. (2006). "Cancer Incidence in Florida Professional Firefighters, 1981 to 1999." Journal of Occupational and Environmental Medicine 48(9): 883-888.

Abstract

Objective: The objective of this study was to examine the cancer risk associated with firefighting.
Methods: Standardized incidence ratio analysis (SIR) was used to determine the relative cancer risk for firefighters as compared with the Florida general population.
Results: Among 34,796 male (413,022 person-years) and 2,017 female (18,843 person-years) firefighters, 970 male and 52 female cases of cancer were identified. Male

firefighters had significantly increased incidence rates of bladder (SIR = 1.29; 95% confidence interval = 1.01-1.62), testicular (1.60; 1.20 -2.09), and thyroid cancers (1.77; 1.08 -2.73). Female firefighters had significantly increased incidence rates of overall cancer (1.63; 1.22-2.14), cervical (5.24; 2.93- 8.65), and thyroid cancer (3.97; 1.45- 8.65) and Hodgkin disease (6.25; 1.26 -18.26).
Conclusions: Firefighting may be associated with an increased risk of selected site-specific cancers in males and females, including an overall increased cancer risk in female firefighters.

Ma, F., L. E. Fleming, et al. (2005). "Mortality in Florida Professional Firefighters, 1972-1999." American Journal of Industrial Medicine 47: 509-517.

Abstract
Background: Exposure to occupational hazards among firefighters may lead to increased mortality from cancer, lung, or heart disease.
Methods: Age- and gender-adjusted mortality rates of 34,796 male and 2,017 female Florida professional firefighters between 1972 and 1999 were compared with the Florida general population.
Results: One thousand four hundred eleven male and 38 female firefighter deaths with known causes were identified. In male firefighters, mortality due to all causes and most nonmalignant diseases was significantly less than expected. There was no excess overall mortality from cancer, but excesses existed for male breast cancer [standardized mortality ratio (SMR=7.41; 95% confidence interval (CI): 1.99-18.96) and thyroid cancer (SMR=4.82; 95% CI: 1.30-12.34)]. Mortality from bladder cancer was increased and approached statistical significance (SMR=1.79; 95% CI: 0.98-3.00). Firefighters certified between 1972 and 1976 had excess mortality from bladder cancer (SMR=1.95; 95% CI: 1.04-3.33). Female firefighters had similar morality patterns to Florida women except for atherosclerotic heart disease (SMR=3.85; 95% CI: 1.66-7.58).
Conclusions: Excess mortality risk from bladder cancer may be related to occupational exposure during firefighting. The thyroid cancer and breast cancer risk in males, as well as the excess risk of cardiovascular disease mortality noted in females warrant further investigation.

Rothman, N., A. Correa-Villasenor, et al. (1993). "Contribution of Occupation and Diet to White Blood Cell Polycyclic Aromatic Hydrocarbon-DNA Adducts in Wildland Firefighters." Cancer Epidemiology, Biomarkers & Prevention 2: 343-347.

Abstract
Wildland (forest) firefighters are exposed to a wide range of carcinogenic polycyclic aromatic hydrocarbons (PAH) in forest fire smoke. PAH undergo metabolic adivation and can subsequently bind to DNA. In this study, we investigated the association between occupational and dietary PAH exposures and the formation of WBC PAH-DNA adduds in a population of wildland firefighters. An enzyme-linked immunosorbent assay using an antiserum elicited against benzo(a)pyrene-modified DNA was used to measure PAH-DNA adduds in WBC obtained from 47 California firefighters at two time points, early and late in the 1988 forest fire season. PAH-DNA adduct levels were not associated with cumulative hours of recent firefighting activity. However, firefighters who consumed charbroiled food within the previous week had elevated PAH-DNA adduct levels, which were related to frequency of charbroiled food intake. These findings suggest that dietary

sources of PAH contribute to PAH-DNA adduct levels in peripheral WBC and should be evaluated when using this assay to assess occupational and environmental PAH exposure.

Wagner, N. L., J. Berger, et al. (2006). "Mortality and life expectancy of professional fire fighters in Hamburg, Germany: a cohort study 1950-2000." Environmental Health: A Global Access Science Source 5(27).

Abstract

Background: The healthy worker effect may hide adverse health effects in hazardous jobs, especially those where physical fitness is required. Fire fighters may serve as a good example because they sometimes are severely exposed to hazardous substances while on the other hand their physical fitness and their strong health surveillance by far exceeds that of comparable persons from the general population.

Methods: To study this effect a historic cohort study was conducted to assess mortality and life expectancy of professional fire fighters of the City of Hamburg, Germany. Fire departments and trade unions questioned the validity of existing studies from outside Germany because of specific differences in the professional career. No mortality study had been conducted so far in Germany and only few in Europe. Information on all active and retired fire fighters was extracted from personnel records. To assure completeness of data the cohort was restricted to all fire fighters being active on January 1, 1950 or later. Follow up of the cohort ended on June 30th 2000. Vital status was assessed by personnel records, pension fund records and the German residence registries. Mortality of fire fighters was compared to mortality of the Hamburg and German male population by means of standardized mortality ratios. Life expectancy was calculated using life table analysis. Multivariate proportional hazard models were used to assess the effect of seniority, time from first employment, and other occupational characteristics on mortality.

Results: The cohort consists of 4640 fire fighters accumulating 111796 person years. Vital status could be determined for 98.2% of the cohort. By the end of follow up 1052 person were deceased. Standardized Mortality Ratio (SMR) for the total cohort was 0.79 (95% CI, 0.74-0.84) compared to Hamburg reference data and 0.78 (95% CI, 0.74-0.83) compared to National German reference data. Conditional life expectancy of a 30 year old fire fighter was 45.3 years as compared to 42.9 year of a German male in normal population. Job tasks, rank status and early retirement negatively influenced mortality. For fire fighters with comparably short duration of employment the mortality advantage diminished with longer time since first employment. SMR of persons who retired early was 1.25 (95% CI, 1.13-1.60) in reference to the general German population and the SMR of 1.71 (1.18-2.50) in the multivariate regression model.

Conclusion: A strong healthy worker effect was observed for the cohort, which diminished with longer time since first employment for fire fighters with shorter duration of employment, as expected. The negative effects on mortality of job tasks, rank status and in particular early retirement indicate the presence of undetermined and specific risks related to occupational hazards of fire fighters.

Class 2 Documents

Aronson, K. J., J. Siemiatycki, et al. (1996). "Occupational Risk Factors for Prostate Cancer: Results from a Case-Control Study in Montreal, Quebec, Canada." American Journal of Epidemiology 143(4): 363-373.

Abstract
A population-based case-control study of cancer and occupation was carried out in Montreal, Canada. Between 1979 and 1986, 449 pathologically confirmed cases of prostate cancer were interviewed, as well as 1,550 cancer controls and 533 population controls. Job histories were evaluated by a team of chemist/hygienists using a checklist of 294 workplace chemicals. After preliminary evaluation, 17 occupations, 11 industries, and 27 substances were selected for multivariate logistic regression analyses to estimate the odds ratio between each occupational circumstance and prostate cancer with control for potential confounders. There was moderate support for risk due to the following occupations: electrical power workers, water transport workers, aircraft fabricators, metal product fabricators, structural metal erectors, and railway transport workers. The following substances exhibited moderately strong associations: metallic dust, liquid fuel combustion products, lubricating oils and greases, and polyaromatic hydrocarbons from coal. While the population attributable risk, estimated at between 12% and 2 1% for these occupational exposures, may be an overestimate due to our method of analysis, even if the true attributable fraction were in the range of 5-10%, this represents an important public health issue.

Bolstad-Johnson, D. M., J. L. Burgess, et al. (2000). "Characterization of Firefighter Exposures During Fire Overhaul." American Industrial Hygiene Association Journal 61(5): 636-641.

Abstract
Previous studies have characterized firefighter exposures during fire suppression. However, minimal information is available regarding firefighter exposures during overhaul, when firefighters look for hidden fire inside attics, ceilings, and walls, often without respiratory protection. A comprehensive air monitoring study was conducted to characterize City of Phoenix firefighter exposures during the overhaul phase of 25 structure fires. Personal samples were collected for aldehydes; benzene; toluene; ethyl benzene; xylene; hydrochloric acid; polynuclear aromatic hydrocarbons (PNA); respirable dust; and hydrogen cyanide (HCN). Gas analyzers were employed to continuously monitor carbon monoxide (CO), HCN, nitrogen dioxide (NO2), and sulfur dioxide (SO2). Area samples were collected for asbestos, metals (Cd, Cr, Pb), and total dust. During overhaul the following exceeded published ceiling values: acrolein (American Conference of Governmental Industrial Hygienists [ACGIHT] 0.1 ppm) at 1 fire; CO (National Institute for Occupational Safety and Health [NIOSH] 200 ppm) at 5 fires; formaldehyde (NIOSH 0.1 ppm) at 22 fires; and glutaraldehyde (ACGIH 0.05 ppm) at 5 fires. In addition, the following exceeded published short-term exposure limit values: benzene (NIOSH 1 ppm) at two fires, NO2 (NIOSH 1 ppm) at two fires, and SO2 (ACGIH 5 ppm) at five fires. On an additive effects basis, PNA concentrations exceeded the NIOSH recommended exposure limits (0.1 mg/M3) for coal tar pitch volatiles at two fires. Maximum concentrations of other sampled substances were below their respective permissible exposure limits. Initial 10-min average CO concentrations did not predict concentrations of other products of combustion. The results indicate that firefighters

should use respiratory protection during overhaul. In addition, these findings suggest that CO should not be used as an indicator gas for other contaminants found in this atmosphere.

Burgess, J. L., M. L. Witten, et al. (2003). "Serum Pneumoproteins: A Cross-Sectional Comparison of Firefighters and Police." American Journal of Industrial Medicine 44: 246-253.

Abstract
Background: Serum pneumoproteins provide a measure of the permeability of the lower respiratory tract, and have shown promise as a biomarker of acute and chronic exposure to respiratory toxicants.
Methods: To evaluate the effects of chronic occupational smoke exposure, 105 firefighters were compared with 44 police controls in a cross-sectional study using spirometry, diffusing capacity of the lung, serum Clara cell protein (CC16), and serum surfactant associated protein A (SP-A) measurements.
Results: There were no significant differences in age, gender, height, spirometry (FVC and FEV1), and diffusing capacity between the two groups. Serum SP A was lower in firefighters (260.1+/-121.2 mg/L) than police (316.0+/-151.4 mg/L, P=0.019). Serum CC16 was also lower in firefighters (8.39+/-3.11 mg/L) than police (10.56+/-4.20 mg/L, P<0.001), although this difference lost statistical significance when adjusted for confounders.
Conclusions: Firefighters have lower serum concentrations of SP-A than do police. Although the clinical significance of this finding is presently unknown, SP-A deserves further study as a biomarker of toxic exposure to the lower respiratory tract.

Houser, A. N., B. A. Jackson, et al. (2004). Emergency Responder Injuries and Fatalities an Analysis of Surveillance Data, RAND Corporation**:** 114.

Summary
This report was supported by the National Institute for Occupational Safety and Health (NIOSH) and the National Personal Protective Technology Laboratory (NPPTL). The NPPTL asked the RAND Science and Technology Policy Institute to review available databases that offer to provide disease, injury, and fatality data pertinent to emergency response functions and the role of personal protective technology.

McGregor, D. (2007). Risk of Cancer of the Colon and Rectum in Firemen. Chemical Substances and Biological Agents Studies and Research Projects. Report R-516**:** 32.

Summary
This report discussed the colon and rectal cancer risks seen in firemen. The author discusses general characteristics of the firemen and what exposures they deal with. He notes the possible risk factors that are associated with firefighting. He reports a literature review of epidemiological studies done on firefighting and cancer risks.

Moore-Merrell, L., S. McDonald, et al. (2006). Contributing Factors to Firefighter Line-of-Duty Death in the United States, IAFF.

Abstract
Objective: The objective of this study was to analyze retrospective data from the years 2000-2005 (six years) to identify and quantify the major factors that contribute to

firefighter line-of-duty death (LODD) in the United States. The identified contributing factors were to be examined for frequency of occurrence and clustering with other factors. Results are to be used to develop risk management programs for fire departments.
Methods: A retrospective study was conducted using data compiled from six years of verified firefighter LODD from four reputable industry sources. Sources include the National Fire Protection Association (NFPA), the National Institute for Occupational Safety and Health (NIOSH), the United States Fire Administration (USFA) and the International Association of Fire Fighters (IAFF). For each LODD, factors contributing to the death were recorded from federal investigations and eyewitness reports. The contributing factors were then analyzed for frequency of occurrence and clustering with other factors. Factors mentioned in less than 5% of the LODD cases were excluded from the cluster analysis. Factors and clusters were stratified according to department type, age of firefighter, scene type, population density of the jurisdiction (proxy for department size) and census region.
Results: There were 644 cases with sufficient information to be included in the study. Frequency analysis revealed that the dominant contributing factors to LODD are health/fitness/wellness (53.88%), personal protective equipment (19.41%) and human error (19.1%). Cluster analysis was performed revealing contributing factors frequently occurring together. Four main clusters were identified with these contributing factors. Cluster 1 included incident command, training, communications, standard operating procedures, and pre-incident planning. Cluster 2 included vehicles, personal protective equipment, equipment failure, and human error. Cluster 3 included privately owned vehicles, accidental, and civilian error. Cluster 4 included company staffing, operating guidelines and health/fitness/wellness. Cluster 4 alone (regardless of other clusters) was shown to be responsible for more than 44.72% of all firefighter on duty deaths during the years studied. Cluster 4 in conjunction with other clusters was shown to be responsible for an additional 16% of all firefighter line-of-duty deaths during the years studied.
Conclusions: Ninety-seven and one half percent of all firefighter LODD occurring between the years of 2000-2005 are attributable to an identifiable cluster of contributing factors. Approximately half of all firefighter LODD that occurred between these years are attributable to a cluster of three factors that are under the direct control of the individual firefighter and chief officers. The information revealed in this study imposes a considerable burden on decision makers and fire service leaders as well as firefighters themselves. It offers substantial guidance for shaping local fire department policy decisions and operational priorities.

Sjogren, B. and G. Johanson (2006). "RE: Mortality in Florida Professional Firefighters, 1972-1999." American Journal of Industrial Medicine 49: 138-140.

Summary

Letter to the Editor. This article is in response to the original report on the mortality of Florida professional firefighters during 1972-1999. The authors stress that there are multiple confounding factors that need to be address in order to come to a solid conclusion about the study results. They also suggest that the study authors account for gender differences in the data analysis.

Stang, A., K.-H. Jockel, et al. (2003). "Firefighting and Risk of Testicular Cancer: Results from a German Population-Based Case-Control Study." American Journal of Industrial Medicine 43: 291-294.

Abstract
Background: There is some evidence of an elevated risk for testicular cancer among firefighters.
Methods: We performed a population-based case-control study including 269 testicular cancer cases and 797 controls matching on age and region with a special focus on occupational exposures. Job tasks were coded according to the International Standard Classification of Occupations (ISCO 68). We used conditional logistic regression to calculate odds ratios (OR).
Results: Three controls (0.4%) and four cases (1.5%) ever worked as firefighters. Firefighters showed an increased odds of testicular cancer in the matched evaluation (OR=4.3, 95% confidence interval (95% CI) 0.7-30.5). The adjustment for a history of cryptorchidism or family history of testicular cancer did not alter our results.
Conclusion: Although the association between firefighting and testicular cancer risk is based on only small numbers of exposed subjects in our study, the finding is consistent with a recent cohort study from New Zealand. Occupational hazards experienced by firefighters may increase the risk of testicular cancer.

Vos, A. J. B. M. D., A. Cook, et al. (2006). "Effect of Protective Filters on Fire Fighter Respiratory Health During Simulated Bushfire Smoke Exposure." American Journal of Industrial Medicine 49: 740-750.

Abstract
Background: Bushfire fighters are potentially subject to risks from bushfire smoke. Although many different protective masks and filters are available, it is not clear which is the most effective from a health and safety perspective. The effect of protective filters on the respiratory health of Western Australian urban career fire fighters under controlled simulated conditions is investigated.
Methods: Sixty-four healthy Fire and Emergency Services Authority of Western Australia (FESA) urban career fire fighters were subjected to controlled simulated bushfire smoke in an open smoke chamber for 15 min. The fire fighters were allocated one of the three types of protective filters: particulate only (P), particulate/organic vapor (POV), and a particulate/organic vapor/formaldehyde (POVF) filter using a double-blind randomized procedure. Personal air sampling inside the fire fighters' masks, spirometry, oximetry, and self-reported symptom data were collected at baseline and at two time intervals after the smoke exposure.
Results: A significant decline in oxygen saturation was seen immediately after exposure, however, the decline was small and no significant relationships could be established between this and the type of filter used. A significantly higher number of participants in the Pand POV filter groups self-reported an increase in coughing, wheezing, and shortness of breath compared to the POVF group. Air sampling demonstrated a significantly higher level of formaldehyde and acrolein inside the masks fitted with P filters compared to POV and POVF filters.

Conclusions: Testing the effectiveness of P, POV, and POVF filters under controlled conditions has demonstrated that the POVF filter provides statistically significant better protection for the fire fighters' airways in a simulated bushfire exposure chamber.

Zeegers, M. P. A., I. H. M. Friesema, et al. (2004). "A Prospective Study of Occupation and Prostate Cancer Risk." Journal of Occupational and Environmental Medicine 46(3): 271-279.

Abstract

A wide variety of occupations has been associated with prostate cancer in previous retrospective studies. Most attention has been paid to farming, metal working, and the rubber industry. Today, these results cannot be affirmed with confidence, because many associations could be influenced by recall bias, have been inconsistent, or have not been confirmed satisfactory in subsequent studies. This study was conducted to investigate and confirm these important associations in a large prospective cohort study. The authors conducted a prospective cohort study among 58,279 men. In September 1986, the cohort members (55-69 years) completed a self-administered questionnaire on potential cancer risk factors, including job history. Related job codes were clustered in professional groups. These predefined clusters were investigated in 3 time windows: 1) profession ever performed, 2) longest profession ever held, and 3) last profession held at baseline. Follow up for incident prostate cancer was established by linkage to cancer registries until December 1993. A case-cohort approach was used based on 830 cases and 1525 subcohort members. To minimize false-positive results, 99% confidence intervals (99% CI) were calculated. Although moderately decreased prostate cancer risks were found for electricians, farmers, firefighters, woodworkers, textile workers, butchers, salesmen, teachers, and clerical workers, none of the relative risks (RR) were found to be statistically significant. For road transporters, metal workers, and managers, no association with prostate cancer risk was found. Although the RR for railway workers, mechanics, welders, chemists, painters, and cooks was moderately increased, these estimates were not statistically significant. For men who reported to have ever worked in the rubber industry, we found a substantially increased prostate cancer risk, but not statistically significant (RR, 4.18; 99% CI = 0.22- 80.45). For policemen, we found a substantial and marginally statistically significant increased prostate cancer risk, especially for those who reported working as a policeman for most of their occupational life (RR, 3.91; 99% CI = 1.14 -13.42) or as the last profession held at baseline (RR, 4.00; 99% CI = 1.19 -13.37). Most of the previously investigated associations between occupation and prostate cancer risk could not be confirmed with confidence in this prospective study. The lack of statistical significance for rubber workers could be caused by the scarcity of rubber workers in this cohort and subsequent lack of power. The results for policemen were substantial and statistically significant, although a conservative value for significance level was used.

Class 3 Documents

(2005). Tab 3: Feedback from Fire Sector Stakeholders. Toronto, Ontario Ministry of Labour.

Summary

This webpage shows highlighted summaries and comments provided by the stakeholders of firefighter claims handled by the Workplace Safety Insurance Board in Toronto.

(2008). Bill would study rates of cancer among R.I. firefighters. The Providence Journal. Providence.

Summary
This newspaper article discusses a recent bill passed by the Rhode Island legislation to provide funds for a research study to investigate cancer rates among Rhode Island firefighters.

(FEMA), Federal Emergency Management Agency (2008). U.S. Fire Administration Emerging Health and Safety Issues in the Volunteer Fire Service**:** 35.

Summary
This report produced by the Federal Emergency Management Agency highlights the recent health and safety concerns in regarding volunteer firefighters. They discuss the risks involves, specific health conditions seen in the firefighters, health habits, best practices, and general exposure hazards.

Brown, N. J. and S. M. Snedeker (2008). BCERF Alert for Women Firefighters Chemical Exposures in Your Workplace and Breast Cancer Risk C. U. S. I. f. C. C. Research, Cornell Program on Breast Cancer and Environmental Risk Factors (BCERF).

Summary
This pamphlet emphasizes the firefighting biochemical hazards that female firefighters are exposed to in the line of duty.

Chiefs, IAFF Connecticut Professional Fire Fighters and Fire Chiefs. The Fire Service Response Fire Fighter Cancer, Heart Emergency and Infectious Disease Protections Connecticut Needs HB 5629 Support HB 5629**:** 9.

Summary
This report serves to show information describing occupational risk factors, cancers affecting firefighters, and other state statutes all in support of firefighter cancer presumption laws in Connecticut.

Elliot, D. L., L. Goldberg, et al. (2004). "The PHLAME Firefighters' Study: Feasibility and Findings." American Journal of Epidemiology 28(1): 13-23.

Abstract
Objective: To assess efficacy of 2 worksite health promotion interventions.
Methods: Randomly assign 3 fire stations to (a) team based curriculum, (b) individual counselor meetings, and (c) control.
Results: Both interventions were feasible and acceptable, and they resulted in significant reductions in LDL cholesterol. The team approach significantly increased coworker cohesion, personal exercise habits, and coworkers' healthy behaviors. The one-on-one strategy significantly increased dietary self-monitoring, decreased fat intake, and reduced depressed feelings.
Conclusions: Although both interventions promoted healthy behaviors, specific outcomes differed and reflected their conceptual underpinnings. The team-based curriculum is innovative and may enlist influences not accessed with individual formats.

Fahy, R. F., P. LeBlanc, et al. (2008). Firefighter Fatalities 2007. NFPA Journal. July/August: 74-83.

Summary
This report is a collection of data from 2007 on all firefighter fatalities in the US that resulted from injuries or illnesses that occurred while on duty.

Farr, D. (2007). 2007 Regular Legislative Session Fiscal Analysis of Proposed Legislation: Workers Compensation cancer coverage for firefighters. SB 560. Oregon Legislative Fiscal Office.

Summary
This is a note prepared by the Oregon Legislative Fiscal Office citing information to support adding specific cancers to their firefighter presumption. The note discusses the impact of the cancer presumption on workers' compensation.

Fighters, International Association of Fire Fighters (2000). 2000 Death and Injury Survey, IAFF**:** 12.

Summary
This report is a collection of data from the 2000 IAFF Annual Death and Injury Survey demonstrating the dangers to firefighters. The survey results point out the importance of protecting the health and safety of firefighters and emergency medical personnel.

Forgue, J. M. (1992). "Respiratory Protection for Fire Fighters." Professional Safety 11: 37-40.

Summary
This article discusses the importance of respiratory protection for fire fighters while on duty. This study bases its recommendations on past scientific studies which indicate that fire fighters had an increased risk of cancer and other health ailments. This study outlines the use of protective fire equipment.

Lazzer, R. D. (2008). Cancer claims costing city. The Hamilton Spectator. Hamilton.

Summary
This newspaper article discusses the financial burden of cancer presumption and workers' compensation on the cities/municipalities.

McGregor, D. B. (2005). Risk of Urinary Bladder Tumours in Firemen. Studies and Research Projects Report. Montreal**:** 28.

Summary
This report investigates the increased cancer risk of urinary/bladder tumors and occupational exposure to chemicals, toxins, and other substances. This report evaluated several scientific studies that were done on elevated cancer risk and firefighters.

Mulady, K. and C. McNerthney (2008). Cancer takes heavy toll on Seattle firefighters. Seattle Post-Intelligencer. Seattle.

Summary
This newspaper article cites personal stories of Seattle firefighters who are dealing with cancer. The article reports recent numbers of cancer cases diagnosed among the firefighters.

National League of Cities and Risk Information Sharing Consortium (2006). NLC-RISC Disease/Illness Presumption Survey Results, NLC-RISC: 7.

Summary
This report discusses the results from a survey that was done to collect information on state presumption laws around the country.

Palm Beach County Fire Rescue (2007). Firefighters and Cancer.

Summary
This statement represents the viewpoint of the Palm Beach County Fire Department and their support of cancer presumption for firefighters. The note discusses their position, the evidence they found, and the legislative language for the bill.

Panel, Industrial Disease Standards Panel (Occupational Disease) (1994). Report to the Workers' Compensation Board on Cardiovascular Disease and Cancer Among Firefighters. Toronto, IDSP.

Summary
The Industrial Disease Standards Panel set out to investigate possible industrial diseases, making findings as to whether a probable connection exists between a disease and an industrial process, trade or occupational in Ontario, create, develop and revise criteria for the evaluation of claims respecting industrial diseases, and to advise on eligibility rules regarding compensation for claims.

Prevention, Centers for Disease Control and Prevention and American Medical Association (2006). "Fatalities Among Volunteer and Career Firefighters - United States, 1994-2004." Morbidity and Mortality Weekly Report

55: 453-455.

Summary
This report investigates the fatalities among volunteer and career firefighters in the US during a ten year period. The article reports causes of injury and illness among the firefighter fatalities.

Racco, M. G. (2007). Report to Minister Peters on the Treatment of Firefighter Cancer Claims by the Workplace Safety and Insurance Board, Workplace Safety and Insurance Board.

Summary
This report reviews the process for considering firefighter cancer claims under workers' compensation legislation in Canadian provinces that have presumptive legislation, reviews an inventory of relevant scientific literature which considers the link between certain cancers and firefighting, and offers feedback from fire sector stakeholders on the treatment of firefighter cancer claims by the Workplace Safety and Insurance Board.

Roberts, S. (2008) More states passing firefighter comp laws. Business Insurance.

Summary
This report comments on how many states have incorporated some type of presumptive disability statutes for firefighters.

Sack, J., J. Allan, et al. (2002). Was firefighter's brain cancer an "occupational disease"? Lancaster's Firefighters/Fires Services Employment Law News. 18**:** 1-3.

Summary
This commentary investigates a firefighter's claim case that his brain cancer was caused by his employment as a fire fighter.

Tagg, B. (2007). 2007 Budget Briefing Note WSIB Occupational Disease Claim Liability for Fire Services. Toronto.

Summary
The briefing note discusses the changes made to the Workers Safety and Insurance Board handling of claims, there is an increased amount of approvals and cost increases in the budget. The note also highlights key budget information and costs.

Walker, J. (2007). Study: Firefighters face higher cancer rate. The Stamford Times**:** 3.

Summary
This newspaper article discusses a study done by the University of Cincinnati that has determined that firefighters are at a greater risk of developing cancer and that their protective equipment is insufficient for protecting them against cancer-causing agents.

Class 4 Documents

(2008). Public Policy Report Special Benefits Mandates: Unnecessary, Unjustified and Unaffordable, Connecticut Conference of Municipalities**:** 9.

Summary
This report is a summary of the potential fiscal impact and ramifications of cancer on firefighters as well as verification of medical studies done on cancer and firefighters.

Butler, N. (2007). Australia fire station cancer cases prompt inquiry, Australian Broadcasting Corporation.

Summary
This is an online newspaper article citing cancer cases among one particular fire department in the Atherton Fire Station in Australia. The cluster of cases has prompted an investigation as to the cause.

Jenkins, N. and K. Gillenwater (2008). Fewer volunteering for fire, rescue. The Seattle Times. Seattle.

Summary
This newspaper article discusses the problem that there are fewer volunteer firefighters and emergency personnel available for fire and rescue.

King, J. K. (2003). Job Related Cancers in Firefighters. Dissertation, Fire School of Staff And Command.

Abstract
Firefighters are dying at an alarming rate and it’s not just from heat and building collapses but also from a silent killer, Cancer. The Detroit Fire Department has historically embraced bravado that has brought about too many widows and bagpipe ceremonies. The perception of a good firefighter should not be based on their tolerance to

smoke while carrying out their duties, but the avoidance of it. A survey of both old and young firefighters, active and retired, revealed that attitudes have not changed, but research shows that our environmental dangers have.

This research paper will answer what Cancer is, where it comes from, what body systems are affected by its insidious mutant cellular growth and how to avoid the unnecessary risk factors associated with the disease. Through an increased awareness of the information presented, hopefully firefighters will use precaution in the manner in which they approach the fire ground in an effort to minimize the contact with the silent, deadly killer, Cancer.

CANCER COSTS

(2008). Cancer Patients Are Up Against Lifetime Insurance Limit. The Record. Bergen County.

Summary

This newspaper article discusses the financial concerns of cancer patients who have reached their medical insurance limit for care.

Ackers, F., C. Groves, et al. (2006). Maryland 2006 Hospital Discharge Data from General Hospitals for Maryland Residents with Cancer Diagnoses, Center for Cancer Surveillance and Control Maryland Department of Health and Mental Hygiene.

Summary

This report discusses the numbers of patients who were discharged from the Maryland hospitals who were diagnosed with cancer. These patients are followed by the Maryland Center of Cancer Surveillance and Control to complete medical records.

Agency, E. P. (2007). Cost of Illness Handbook, Environmental Protection Agency.

Summary

This report discusses individual cancers, rates of cancer seen in the general population and in specific occupations. The report highlights risk factors, populations most at risk, costs of diagnosis, treatment, and maintenance.

Avritscher, E. B. C., C. D. Cooksley, et al. (2006). "Clinical Model of Lifetime Cost of Treating Bladder Cancer and Associated Complications." Urology 68: 549-553.

Abstract

Objectives: To estimate the lifetime cost of bladder cancer and the contribution of complications to the total costs.

Methods: We reviewed the medical records of a retrospective cohort of 208 patients with bladder cancer who registered at our comprehensive cancer center from 1991 to 1999. We multiplied the number of resources used during management of bladder cancer by their unit charges. We converted charges into costs using the Medicare cost-to-charge ratio and inflated these to 2005 U.S. dollars. We estimated future costs by creating two extreme hypothetical scenarios. In the best-case scenario, we assumed patients with superficial disease developed recurrences at the cohort's mean rate and that patients with muscle-invasive disease were disease free after definitive therapy. Survival was based on the U.S. life expectancy in both cases. In the worst-case scenario, we assumed patients

with superficial disease developed muscle-invasive disease and that all patients subsequently died of bladder cancer.

Results: The average cost of bladder cancer was $65,158 among the cohort patients. Sixty percent of this cost ($39,393) was associated with surveillance and treatment of recurrences, and 30% ($19,811) was attributable to complications. The lifetime cost of bladder cancer was lower for the worst-case scenario ($99,270) than for the best-case scenario ($120,684). However, a greater proportion of the costs were attributable to complications with the worst-case scenario (43%, $42,290) compared with the best (28%, $34,169).

Conclusions: The management of bladder cancer and its associated complications results in a major economic burden. More cost-effective surveillance strategies and approaches for preventing complications are crucial to minimizing the disease's clinical and economic consequences.

Bach, P. B. (2007). "Costs of Cancer Care: A View From the Centers for Medicare & Medicaid Services." Journal of Clinical Oncology 25(2): 187-190.

Abstract

Fee-for-service Medicare pays for a very substantial portion of all cancer care delivered in the United States. By virtue of its size and visibility, its payment policies at times also influence those of other health care payers. As a result, Medicare affects both the overall economics and the incentive structures of oncology care. Three aspects of how Medicare finances cancer care are particularly germane to the issue of costs. First, Medicare finances all aspects of cancer care in independent payment units, paying separately for physician services, laboratory tests, procedures, imaging, radiation, drug administration, and drugs. Second, Medicare is currently managing and monitoring a very substantial overhaul in payment for cancer care, which aims to reduce or eliminate incentives that have favored aggressive and costly treatments in clinical situations where alternative therapeutic approaches might have been equivalent or preferable. Third, Medicare is trying to increase the focus on care quality and transparency, as improved efficiency and greater value is needed if costs of care are to be contained. Understanding these three aspects of cancer care financing can help clarify what Medicare is capable of doing to control the rising costs that are occurring in cancer today.

Barnett, A., H. Birnbaum, et al. (2000). "The Costs of Cancer to a Major Employer in the United States: A Case-Control Analysis." The American Journal of Managed Care 6(11): 1243-1251.

Abstract

Background: Detailed data will be increasingly important in determining the cost of cancer care in the managed care setting.

Objectives: To estimate the full cost of cancer to a major employer in the United States and to determine the nature of the expenditures. Study Design: Analysis of medical, pharmaceutical, and disability claims data from 1995 to 1997 for a major employer with more than 100,000 employees.

Methods: The cost of cancer is determined on a per-patient and per-employee basis. Based on a case-control method, cancer patients are matched to individuals with no record of cancer diagnosis or treatment. The incremental cost per employee and the percentage of total healthcare expenditures for cancer are quantified.

Results: Approximately $224 per active employee, or 6.5% of the corporation's total healthcare costs, was spent on incremental care for cancer patients in 1997. Medical conditions not directly related to cancer account for approximately half the total excess expenditures for patients with cancer. On average, annual healthcare and disability costs for persons with cancer were approximately 5 times higher than for their counterparts without cancer.

Conclusions: The costs of cancer care are a substantial proportion of healthcare costs for employers. When the full cost of cancer is included in a cost-benefit analysis, expenditures for programs to reduce the risk of cancer in the working population may be justified. Expenditures to reduce the incidence and severity of conditions indirectly associated with cancer may also reduce overall employer healthcare expenses.

Brown, M. L. (1990). "The National Economic Burden of Cancer: An Update." Journal of National Cancer Institute 82: 1811-1814.

Summary

The article highlights the cost of preventive, diagnostic, and treatment services related to cancer. The report also shows the economic losses due to lost productivity because of illness-related disability. The report also shows the full impact on the national economic output.

Brown, M. L., J. Lipscomb, et al. (2001). "The Burden of Illness of Cancer: Economic Cost and Quality of Life." Annual Reviews of Public Health 22: 91-113.

Abstract

Cancer is a major public health issue and represents a significant burden of disease. In this chapter, we analyze the main measures of burden of disease as relate to cancer. Specifically, we review incidence and mortality, years of life lost from cancer, and cancer prevalence. We also discuss the economic burden of cancer, including cost of illness, phase-specific and long-term costs, and indirect costs. We then examine the impact of cancer on health-related quality of life as measured in global terms (disability-adjusted life years and quality-adjusted life years) and using evaluation oriented applications of health-related quality of life scales. Throughout, we note the relative strengths and weaknesses of the various approaches to measuring the burden of cancer as well as the methodologic challenges that persist in burden-of-illness research. We conclude with a discussion of the research agenda to improve our understanding of the burden of cancer and of illness more generally.

Brown, M. L., G. F. Riley, et al. (1999). "Obtaining Long-Term Disease Specific Costs of Care: Application to Medicare Enrollees Diagnosed with Colorectal Cancer." Medical Care 37(12): 1249-1259.

Abstract

Objectives: This study develops estimates of long-term, cancer-related treatment cost using a modeling approach and data from the SEER- Medicare linked database. The method is demonstrated for colorectal cancer.

Methods: Data on Medicare payments were obtained for colorectal cancer patients for the years 1990 to 1994 from the SEER-Medicare linked database. Claims payment data for control subjects were obtained for Medicare enrollees without cancer residing in the same areas as patients. Estimates of long-term cost (<25 years following the date of diagnosis)

were obtained by combining treatment/phase- specific cost estimates with estimates of long- term survival from SEER. Treatment phases were defined as initial care, terminal care, and continuing care. Cancer-related estimates for each phase were obtained by subtracting costs for control subjects from the observed costs for cancer patients, matching on age group, gender, and registry area. Estimates of long-term cost < 11 years obtained by this method were compared with 11-year estimates obtained by application of the Kaplan-Meier sample aver- age (KMSA) method.
Results: The mean initial-phase cancer-related cost was approximately $18,000 but was higher among patients with more advanced cancer. The mean continuing-phase cancer-related cost was $1,500 per year and declined with increasing age, but was higher on an annual basis among persons with later stages of cancer and shorter survival time. The mean terminal-phase cancer-related cost was $15,000 and declined with both age at death and more advanced stage at diagnosis. After the phase-specific estimates were combined, the average long-term cancer-related cost was $33,700 ($31,300 at 3% discount rate) for colon cancer compared with $36,500 ($33,800 at 3% discount rate) for cancer of the rectum. This represented about half of the total long-term cost for Medicare enrollees diagnosed with this disease. Long-term cost was highest for Stage III cancer and lowest for in situ cancer. Eleven-year cancer-related costs estimated by the KMSA method were similar to estimates using the phase-based approach.
Conclusions: This paper demonstrates that valid estimates of cancer-related long-term cost can be obtained from administrative claims data linked to incidence cancer registry data.

Brown, M. L., G. F. Riley, et al. (2002). "Estimating Health Care Costs Related to Cancer Treatment From SEER-Medicare Data." Medical Care 40(8): 104-117.

Abstract
Background: Cancer-specific medical care costs are used by health service researchers, medical decision analysts, and health care policymakers. The SEER-Medicare database is a unique data resource that makes it possible to derive incidence- and prevalence-based estimates of cancer-related medical care costs by site and stage of disease, by treatment approach, and for age and gender strata for individuals older than 65 years.
Objectives: This paper describes the cost related data available in the SEER-Medicare database, and discusses techniques and methods that have been used to derive various cost estimates from these data. The limitations of SEER-Medicare data as a source of cost estimates are also discussed.
Results: Examples of cost estimates for colorectal and breast cancer derived from SEER Medicare are presented, including estimates of incidence-based cost (average cost per patient) by the initial, terminal, and continuing care phases of cancer treatment. Estimates of cancer-related treatment costs, costs by type of treatment, and long term costs are presented, as are prevalence-based costs (aggregate Medicare and national expenditures) by cancer type.

Chang, S., S. R. Long, et al. (2006). "Burden of Pancreatic Cancer and Disease Progression: Economic Analysis in the US." Oncology 70: 71-80.

Abstract
Objectives: The few studies that have estimated the costs of pancreatic cancer were limited by small sample sizes, geography or patient age range. Using a large nationwide

claims database, this study examines the cost of pancreatic cancer beginning with initial diagnosis and the additional costs when disease progresses.
Methods: A retrospective cohort study was conducted using a claims database of 3 million individuals covered by large US employers. The study population consisted of patients newly diagnosed with pancreatic cancer in 1999-2000 and a demographically matched control group. Utilization and costs were summarized as monthly means. Changes in cancer severity and treatment over time were used to approximate disease progression and its associated costs.
Results: The study included 412 pancreatic cancer patients and 1,236 controls. The mean follow-up time was 7.5 months. Regression-adjusted monthly costs attributable to pancreatic cancer were USD 7,279; over 60% resulted from hospitalizations. Patients with disease progression (over 50%) incurred an additional USD 15,143 per month compared to patients without disease progression.
Conclusion: Compared to patients without cancer, the costs of pancreatic cancer patients were substantial, especially when patients experienced disease progression. New therapies that prevent or delay disease progression could potentially offset the costs to patients, providers and society.

Du, W., D. Touchette, et al. (2000). "Cost Analysis of Pancreatic Carcinoma Treatment." Cancer 89(9): 1917-1924.

Abstract
Background: Pancreatic carcinoma is a major health issue and financial burden to society. To improve the quality and efficiency of care delivered, it is essential for health care providers to have a good understanding of the cost of treatment.
Methods: The authors examined the facility-based costs and survival of 103 patients with pancreatic carcinoma who were treated at the Karmanos Cancer Institute between January 1992 and September 1998. Longitudinal cost data for each patient were obtained, and from those data, 6-month, 1-year, and lifetime total treatment costs were calculated.
Results: The average 6-month, 1-year, and lifetime total treatment costs were $37,327, $42,218, and $48,803, respectively, and the median survival was 7 months. In univariate analyses, the disease stage at diagnosis was a highly significant predictor of total cost. Patients with metastatic disease had the lowest cost, and patients with resectable disease had the highest cost. In multivariate analyses controlling for disease stage, treatment strategies and dual insurance coverage were also important predictors of costs but patient age, race, and gender were not predictive. Disease stage also was highly predictive of survival. In a multivariate analysis controlling for disease stage, chemotherapy and radiation therapy were correlated with longer survival, whereas resection and palliative bypass surgery were not.
Conclusions: The costs of treating patients with pancreatic carcinoma are considerable, even though survival duration typically is short. Disease stage was the most dominating factor determining costs and survival. After controlling for disease stage, chemotherapy, surgery, and dual insurance coverage were also significantly associated with higher cost of care. However, in survival analyses, only chemotherapy and radiation therapy were associated with a significant increase in patient survival.

Fireman, B. H., C. P. Quesenberry, et al. (1997). "Cost of care for cancer in a health maintenance organization." Health Care Financing Review 18(4): 51-77.

Abstract

Estimates the costs of medical care for cancer patients at Kaiser Permanente (KP) in Northern California. Use of controls to determine utilization and costs attributable to cancer; Variability on the cost of medical care in relation to stage at diagnosis; Effects of demographic variables on cost of care.

Institute, National Cancer Institute (2007). "Cancer Trends Progress Report - 2007 Update Costs in Cancer Care." Retrieved September 23, 2008.

Summary

This webpage shows the estimated costs of cancer care including diagnosis and treatment and total personal health spending for a list of cancers by specified year.

Kim, P. (2007). "Cost of Cancer Care: The Patient Perspective." Journal of Clinical Oncology 25(2): 228-232.

Abstract

The diagnosis of cancer, along with subsequent related care, imposes a number of burdens on patients-physical, emotional, and financial. The financial expenses incurred extend well beyond the cost of medication, surgery, and related treatments. While these important issues warrant attention, patients also need assistance dealing with the indirect costs of cancer care, such as transportation, child care, and lost wages. There is an urgent need to improve the current inconsistent-sometimes nonexistent-methods used to inform patients about costs of cancer care as well as to provide them with appropriate assistance managing the costs and overall burden of cancer. Health care providers, patient advocates, agencies, and insurers have the responsibility and opportunity to provide leadership in this process. Most importantly, limited ability to address any of the expenses brought on by cancer should not prevent any patient from receiving necessary care.

Lipscomb, J. (2008). "Estimating the Cost of Cancer Care in the United States: A Work Very Much in Progress." Journal of National Cancer Institute 100(9): 607-610.

Summary

This article highlights the considerations that need to be taken when estimating the total cost of cancer care in the United States. It discusses resources used (SEER-Medicare data), intervention programs, different models and approaches, and different analyses that are used to come up with estimates.

Maroun, J., E. Ng, et al. (2003). "Lifetime costs of colon and rectal cancer management in Canada." Chronic Diseases in Canada 24(4).

Abstract

Colorectal cancer is the second leading cause of cancer-related mortality among Canadians. We derived the direct health care costs associated with the lifetime management of an estimated 16,856 patients with a diagnosis of colon and rectal cancer in Canada in 2000. Information on diagnostic approaches, treatment algorithms, follow-up and care at disease progression was obtained from various databases and was integrated into Statistics Canada's Population Health Model (POHEM) to estimate

lifetime costs. The average lifetime cost (in Canadian dollars) of managing patients with colorectal cancer ranged from $20,319 per case for TNM stage I colon cancer to $39,182 per case for stage III rectal cancer. The total lifetime treatment cost for the cohort of patients in 2000 was estimated to be over $333 million for colon and $187 million for rectal cancer. Hospitalization represented 65% and 61% of the lifetime costs of colon and rectal cancer respectively. Disease costing models can be important policy-relevant tools to assist in resource allocation. Our results highlight the importance of performing preoperative tests and staging in an ambulatory care setting, where possible, to achieve optimal cost efficiencies. Similarly, terminal care might be delivered more efficiently in the home environment or in palliative care units.

Max, W. (2002). The Costs of Gender-Specific Cancers in California. Abstract. California Department of Health Services/UC Davis.

Summary
This abstract discusses the costs of male and female specific cancers and overall costs to California hospitals.

Max, W. (2003). The Cost of Breast Cancer in California. Abstract. California Breast Cancer Research Program.

Summary
This abstract discusses the costs of breast cancer in women in California.

Meropol, N. J. and K. A. Schulman (2007). "Cost of Cancer Care: Issues and Implications." Journal of Clinical Oncology 25(2): 180-186.

Abstract
Medical technology is increasingly costly in most fields of clinical medicine. Oncology has not been spared from issues related to cost, in part resulting from the tremendous scientific progress that has lead to new tools for diagnosis, treatment, and follow-up of our patients. The increasing cost of health care in general (and cancer care in particular) raises complex questions related to its effects on our economy and the citizens of our society. This article reviews the macroeconomic principles and individual behaviors that govern medical spending, and examines how cost disproportionately affects various populations. Our overall goal is to frame debate about health policy concerns that influence the clinical practice of oncology.

Newhouse, J. P. (1992). "Medical Care Costs: How Much Welfare Loss?" Journal of Economic Perspectives 6(3): 3-21.

Summary
This research article discusses the implications of increasing medical care costs, age, increased insurance costs, increased income, supplier-demand, productivity, and hospitalizations on welfare status and the larger impact on the US economy.

Ng, E., J. A. Maroun, et al. (2001). Estimating the Lifetime Cost of Treating Colon (C) and Rectal (R) Cancer in Canada. 20.

Abstract
Diagnostic, treatment and follow-up care algorithms were developed for all phases and stages of C and R. Chart reviews, national administrative file for hospitalization, and a

nation-wide survey of oncologists were used to estimate resource utilization and costs. Based on these preliminary estimates, an average lifetime cost per patient for cases diagnosed of the disease in 2000 in Canada was calculated (in 1996 Cdn $) from the perspective of the government as payer in a universal health care system using the Population Health Model (POHEM). Our data on C show an increase in cost by stage. This is principally due to an increased use of initial treatment, active care, and most importantly, terminal care in more advanced stages. The results for R are slightly different and will be included in the presentation. Stage III R has the highest average cost, due to more frequent use of radiotherapy. This model will permit evaluation of the introduction of new management strategies for colorectal cancer.

Riley, G. F., A. L. Potosky, et al. (1995). "Medicare Payments from Diagnosis to Death for Elderly Cancer Patients by Stage at Diagnosis." Medical Care 33(8): 828-841.

Abstract
Although extensive resources go to cancer care, national population-based data on the costs of such care at the patient level have been unavailable. Medicare payments subsequent to diagnosis of cancer for elderly enrollees with five common cancers were estimated using tumor registry data from the Surveillance, Epidemiology, and End Results Program linked to Medicare claims from 1984 to 1990. The time between diagnosis and death was divided into four phases corresponding to the clinical course of solid tumors, average payments for each phase were estimated (including payments for services not related to cancer), then phase-specific payment data were aggregated. Average payments by phase varied among cancer sites, especially in the initial care phase, where payments were highest for lung and colorectal cancers ($17,500 in 1990 dollars) and lowest for female breast cancer ($8,913). Total Medicare payments from diagnosis to death were highest for persons with bladder cancer ($57,629) and lowest for those with lung cancer ($29,184). Low payments for persons with lung cancer corresponded to brief survival times. Persons diagnosed at earlier stages incurred higher total payments between diagnosis and death than those diagnosed at later stages, reflecting their longer survival. This implies that early detection may increase total Medicare expenditures by extending beneficiaries' lives. However, Medicare payments per year of survival were lower for earlier stages. Data on Medicare payments subsequent to diagnosis of cancer are useful for identifying the cost implications of differences in treatment patterns by demographic characteristics, geography, and delivery systems; comparing the financial impact of alternative therapies; evaluating the long-term cost impacts of screening and prevention programs; and risk-adjusting payments to health plans.

Svatek, R. S., J. J. Lee, et al. (2006). "The Cost of Prostate Cancer Chemoprevention: A Decision Analysis Model." Cancer Epidemiology Biomarkers & Prevention 15: 1485-1489.

Abstract
Background: The Prostate Cancer Prevention Trial found reduced prostate cancer prevalence for men treated with finasteride. The public health cost of wide-scale chemoprevention is unclear. We developed a model to help clarify the cost effectiveness of public use of prostate cancer-preventive agents.
Methods: A Markov decision analysis model was designed to determine the lifetime prostate health-related costs, beginning at the age of 50 years, for men treated with

finasteride compared with placebo. Model assumptions were based on data from the Prostate Cancer Prevention Trial, a literature review of survival and progression rates for patients treated with radical prostatectomy, and costs associated with prostate cancer disease states.
Results: Chemoprevention with finasteride resulted in a gain of 13.7 life years per 1,000 men at a cost of $704,000 per life year saved (LYS). However, if finasteride is assumed to not increase the incidence of high-grade tumors, it renders a gain of 21.4 life years per 1,000 men at a cost of $434,000 per LYS; finasteride must cost $15 monthly to reach $100,000 per LYS. When applied to a population at higher risk (lifetime prevalence of 30%) for developing prostate cancer, the cost of finasteride must be reduced from its current cost ($62/mo) to <$15 per month for the cost effectiveness to fall below $50,000 per LYS.
Conclusions: Given the natural history of treated prostate cancer, implementation of chemoprevention would require an inexpensive medication with substantial cancer risk reduction to be cost effective. Targeting populations at higher risk for developing prostate cancer, however, allows for considerable flexibility in the medication cost to make prostate cancer chemoprevention a more attainable goal.

Woodward, R. M., M. L. Brown, et al. (2007). "The Value of Medical Interventions for Lung Cancer in the Elderly." Cancer 110: 2511-2518.

Abstract
Background: Lung cancer is the leading source of cancer mortality and spending. However, the value of spending on the treatment of lung cancer has not been conclusively demonstrated. The authors evaluated the value of medical care between 1983 and 1997 for nonsmall cell lung cancer in the elderly US population.
Methods: The authors used Surveillance, Epidemiology, and End Results (SEER) data to calculate life expectancy after diagnosis over the period 1983 to 1997. Direct costs for nonsmall cell lung cancer detection and treatment were determined by using Part A and Part B reimbursements from the Continuous Medicare History Sample File (CMHSF) data. The CMHSF and SEER data were linked to calculate lifetime treatment costs over the time period of interest.
Results: Life expectancy improved minimally, with an average increase of approximately 0.60 months. Total lifetime lung cancer spending rose by approximately $20,157 per patient in real, i.e., adjusted for inflation, 2000 dollars from the early 1980s to the mid-1990s, for a cost effectiveness ratio of $403,142 per life year (LY). The cost-effectiveness ratio was $143,614 for localized cancer, $145,861 for regional cancer, and $1,190,322 for metastatic cancer.
Conclusions: The cost-effectiveness ratio for nonsmall cell lung cancer was higher than traditional thresholds used to define cost-effective care. The most favorable results were for persons diagnosed with early stage cancer. These results suggested caution when encouraging more intensive care for lung cancer patients without first considering the tradeoffs with the costs of this therapy and its potential effects on mortality and/or quality of life.

Yabroff, K. R., J. L. Warren, et al. (2007). "Costs of cancer care in the USA: a descriptive review." Nature Clinical Practice Oncology 4(11): 643-656.

Abstract
Although many studies assessing the cost of cancer care have been conducted in the US, to date, these studies and the underlying methods used to estimate costs have not been reviewed systematically. We conducted a descriptive review of the published literature on the cost of cancer care in the US, and identified 60 papers published between 1995 and 2006 pertinent to our study. We found heterogeneity across the studies in terms of the settings, populations studied, measurement of costs, and study methods. We also identified limitations in the generalizability of findings, the misclassification of patient groups and costs, and concerns with study methods. Among studies that reported costs of cancer care in multiple phases of care and for multiple tumor sites, costs were generally highest in the initial year following diagnosis and the last year of life, and lower in the continuing phase (i.e. the period between the initial and last year of life phases), following a ‘u-shaped’ curve. Within phase of care, costs for lung and colorectal cancer care were generally higher than those for breast and prostate cancer care, however, the long-term or lifetime costs for each type of cancer were more similar, reflecting the differences in survival and costs in each phase between the different disease types.

Yabroff, R. (2008). Costs associated with cancer care. Presentation, Fourth Biennial Cancer Survivorship Research Conference, Atlanta, GA. June 19, 2008.

Summary
This is a powerpoint presentation made by Yabroff on the costs associated with cancer care and the factors that influence rising costs.

OTHER

9/11 Articles

Edelman, P., J. Osterloh, et al. (2003). "Biomonitoring of Chemical Exposure among New York City Firefighters Responding to the World Trade Center Fire and Collapse." Environmental Health Perspectives 111(16): 1906-1911.

Abstract
The collapse of the World Trade Center (WTC) on 11 September 2001 exposed New York City firefighters to smoke and dust of unprecedented magnitude and duration. The chemicals and the concentrations produced from any fire are difficult to predict, but estimates of internal dose exposures can be assessed by the biological monitoring of blood and urine. We analyzed blood and urine specimens obtained from 321 firefighters responding to the WTC fires and collapse for 110 potentially fire-related chemicals. Controls consisted of 47 firefighters not present at the WTC. Sampling occurred 3 weeks after 11 September, while fires were still burning. When reference or background ranges were available, most chemical concentrations were found to be generally low and not outside these ranges. Compared with controls, the exposed firefighters showed significant differences in adjusted geometric means for six of the chemicals and significantly greater detection rates for an additional three. Arrival time was a significant predictor variable

for four chemicals. Special Operations Command firefighters ($n = 95$), compared with other responding WTC firefighters ($n = 226$), had differences in concentrations or detection rate for 14 of the chemicals. Values for the Special Operations Command firefighters were also significantly different from the control group values for these same chemicals and for two additional chemicals. Generally, the chemical concentrations in the other firefighter group were not different from those of controls. Biomonitoring was used to characterize firefighter exposure at the WTC disaster. Although some of the chemicals analyzed showed statistically significant differences, these differences were generally small.

Fireman, E. M., Y. Lerman, et al. (2004). "Induced Sputum Assessment in New York City Firefighters Exposed to World Trade Center Dust." Environmental Health Perspectives 112(15): 1564-1569.

Abstract

New York City Firefighters (FDNY-FFs) were exposed to particulate matter and combustion/ pyrolysis products during and after the World Trade Center (WTC) collapse. Ten months after the collapse, induced sputum (IS) samples were obtained from 39 highly exposed FDNY-FFs (caught in the dust cloud during the collapse on 11 September 2001) and compared to controls to determine whether a unique pattern of inflammation and particulate matter deposition, compatible with WTC dust, was present. Control subjects were 12 Tel-Aviv, Israel, firefighters (TA-FFs) and 8 Israeli healthcare workers who were not exposed to WTC dust. All controls volunteered for this study, had never smoked, and did not have respiratory illness. IS was processed by conventional methods. Retrieved cells were differentially counted, and metalloproteinase-9 (MMP-9), particle size distribution (PSD), and mineral composition were measured. Differential cell counts of FDNY-FF IS differed from those of health care worker controls ($p < 0.05$) but not from those of TA-FFs. Percentages of neutrophils and eosinophils increased with greater intensity of WTC exposure (< 10 workdays or ≥ 10 workdays; neutrophils $p = 0.046$; eosinophils $p = 0.038$). MMP-9 levels positively correlated to neutrophil counts ($p = 0.002$; $r = 0.449$). Particles were larger and more irregularly shaped in FDNY-FFs (1–50 µm; zinc, mercury, gold, tin, silver) than in TA-FFs (1–10 µm; silica, clays). PSD was similar to that of WTC dust samples. In conclusion, IS from highly exposed FDNY-FFs demonstrated inflammation, PSD, and particle composition that was different from nonexposed controls and consistent with WTC dust exposure.

Landrigan, P. J., P. J. Lioy, et al. (2004). "Health and Environmental Consequences of the World Trade Center Disaster." Environmental Health Perspectives 112(6): 731-739.

Abstract

The attack on the World Trade Center (WTC) created an acute environmental disaster of enormous magnitude. This study characterizes the environmental exposures resulting from destruction of the WTC and assesses their effects on health. Methods include ambient air sampling; analyses of outdoor and indoor settled dust; high-altitude imaging and modeling of the atmospheric plume; inhalation studies of WTC dust in mice; and clinical examinations, community surveys, and prospective epidemiologic studies of exposed populations. WTC dust was found to consist predominantly (95%) of coarse particles and contained pulverized cement, glass fibers, asbestos, lead, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and polychlorinated

furans and dioxins. Airborne particulate levels were highest immediately after the attack and declined thereafter. Particulate levels decreased sharply with distance from the WTC. Dust pH was highly alkaline (pH 9.0–11.0). Mice exposed to WTC dust showed only moderate pulmonary inflammation but marked bronchial hyperreactivity. Evaluation of 10,116 firefighters showed exposure-related increases in cough and bronchial hyperreactivity. Evaluation of 183 cleanup workers showed newonset cough (33%), wheeze (18%), and phlegm production (24%). Increased frequency of newonset cough, wheeze, and shortness of breath were also observed in community residents. Follow-up of 182 pregnant women who were either inside or near the WTC on 11 September showed a 2-fold increase in small-for-gestational-age (SGA) infants. In summary, environmental exposures after the WTC disaster were associated with significant adverse effects on health. The high alkalinity of WTC dust produced bronchial hyperreactivity, persistent cough, and increased risk of asthma. Plausible causes of the observed increase in SGA infants include maternal exposures to PAH and particulates. Future risk of mesothelioma may be increased, particularly among workers and volunteers exposed occupationally to asbestos. Continuing follow-up of all exposed populations is required to document the long-term consequences of the disaster.

Prezant, D. J., S. Levin, et al. (2008). "Upper and Lower Respiratory Diseases After Occupational and Environmental Disasters." Mount Sinai Journal of Medicine 75: 89-100.

Abstract
Respiratory consequences from occupational and environmental disasters are the result of inhalation exposures to chemicals, particulate matter (dusts and fibers) and/or the incomplete products of combustion that are often liberated during disasters such as fires, building collapses, explosions and volcanoes. Unfortunately, experience has shown that environmental controls and effective respiratory protection are often unavailable during the first days to week after a large-scale disaster. The English literature was reviewed using the key words–disaster and any of the following: respiratory disease, pulmonary, asthma, bronchitis, sinusitis, pulmonary fibrosis, or sarcoidosis. Respiratory health consequences after aerosolized exposures to high-concentrations of particulates and chemicals can be grouped into 4 major categories: 1) upper respiratory disease (chronic rhinosinusitis and reactive upper airways dysfunction syndrome), 2) lower respiratory diseases (reactive [lower] airways dysfunction syndrome, irritant-induced asthma, and chronic obstructive airways diseases), 3) parenchymal or interstitial lung diseases (sarcoidosis, pulmonary fibrosis, and bronchiolitis obliterans, and 4) cancers of the lung and pleura. This review describes several respiratory consequences of occupational and environmental disasters and uses the World Trade Center disaster to illustrate in detail the consequences of chronic upper and lower respiratory inflammation.

Prezant, D. J., M. Weiden, et al. (2002). "Cough and Bronchial Responsiveness in Firefighters at the World Trade Center Site." The New England Journal of Medicine 347(11): 806-815.

Abstract
Background: Workers from the Fire Department of New York City were exposed to a variety of inhaled materials during and after the collapse of the World Trade Center. We evaluated clinical features in a series of 332 firefighters in whom severe cough developed

after exposure and the prevalence and severity of bronchial hyperreactivity in firefighters without severe cough classified according to the level of exposure.
Methods: "World Trade Center cough" was defined as a persistent cough that developed after exposure to the site and was accompanied by respiratory symptoms severe enough to require medical leave for at least four weeks. Evaluation of exposed firefighters included completion of a standard questionnaire, spirometry, airway-responsiveness testing, and chest imaging.
Results: In the first six months after September 11, 2001, World Trade Center cough occurred in 128 of 1636 firefighters with a high level of exposure (8 percent), 187 of 6958 with a moderate level of exposure (3 percent), and 17 of 1320 with a low level of exposure (1 percent). In addition, 95 percent had symptoms of dyspnea, 87 percent had gastroesophageal reflux disease, and 54 percent had nasal congestion. Of those tested before treatment of World Trade Center cough, 63 percent of firefighters (149 of 237) had a response to a bronchodilator and 24 percent (9 of 37) had bronchial hyperreactivity. Chest radiographs were unchanged from precollapse findings in 319 of the 332 with World Trade Center cough. Among the cohort without severe cough, bronchial hyperreactivity was present in 77 firefighters with a high level of exposure (23 percent) and 26 with a moderate level of exposure (8 percent).
Conclusions: Intense, short-term exposure to materials generated during the collapse of the World Trade Center was associated with bronchial responsiveness and the development of cough. Clinical and physiological severity was related to the intensity of exposure.

Samet, J. M., A. S. Geyh, et al. (2007). "The Legacy of World Trade Center Dust." The New England Journal of Medicine 356(22): 2233-2236.

Summary
This article discusses the risks that were involved in the clean up of the World Trade Center and the possible long term effects.

Other Occupations

Finkelstein, M. M. (1998). "Cancer Incidence Among Ontario Police Officers." American Journal of Industrial Medicine 34: 157-162.

Abstract
The National Institute for Occupational Safety and Health (NIOSH) published a report in 1995 suggesting the possibility of increased incidence of testicular cancer, leukemia, and cancers of the brain, eye, and skin among police officers working with traffic radar. NIOSH recommended epidemiologic study of the issue. This report presents the results of a retrospective cohort cancer incidence study among 22,197 officers employed by 83 Ontario police departments. The standardized incidence ratio (SIR) for all tumor sites was 0.90 (95% confidence interval [CI] 5 0.83–0.98). There was an increased incidence of testicular cancer (SIR 5 1.3, 90%CI 5 0.9–1.8) and melanoma skin cancer (SIR 5 1.45, 90%CI 5 1.1–1.9). These anatomical sites might absorb energy from radar units, but at this time the author has no information about individual exposures to radar emissions, and it is not possible to draw etiologic conclusions. Nested case-control studies are planned to assess individual radar exposures.

Krstev, S., D. Baris, et al. (1998). "Risk for Prostate Cancer by Occupation and Industry: A 24-State Death Certificate Study." American Journal of Industrial Medicine 34: 413-420.

Abstract

Current knowledge of the etiology of prostate cancer is limited. Numerous studies have suggested that certain occupations and industries may be associated with the occurrence of prostate cancer. Information on occupation and industry on death certificates from 24 states gathered from 1984 to 1993 was used in case control study on prostate cancer. A total of 60,878 men with prostate cancer as underlying cause of death was selected and matched with controls who died of all other causes except cancer. Similar to the findings of our parallel large case control study of prostate cancer, we observed excess risks in some white-collar occupations, such as administrators, managers, teachers, engineers, and sales occupations. However, some blue-collar occupations, such as power plant operators and stationary engineers, brickmasons, machinery maintenance workers, airplane pilots, longshoreman, railroad industry workers, and other occupations with potential exposure to PAH also showed risk of excess prostate cancer. Risk was significantly decreased for blue-collar occupations, including farm workers, commercial fishermen, mechanics and repairers, structural metal workers, mining, printing, winding, dry cleaning, textile machine operators, cooks, bakers, and bartenders. Although we observed excess risks of prostate cancer among some low socioeconomic status (SES) occupations, the overall results suggest that the effects of higher SES cannot be ruled out in associations between occupational factors and the risk of prostate cancer.

Leigh, J. P. and T. R. Miller (1998). "Job-Related Diseases and Occupations Within a Large Workers' Compensation Data Set." American Journal of Industrial Medicine 33: 197-211.

Abstract

The objective of this report is to describe workers’ job-related diseases and the occupations associated with those diseases. The methods include aggregation and analysis of job-related disease and occupation data from the Bureau of Labor Statistics’ Supplementary Data System (SDS) for 1985 and 1986—the last years of data available with workers’ compensation categories: death, permanent total, permanent partial, and temporary total and partial. Diseases are ranked according to their contribution to the four workers’ compensation (WC) categories and also ranked within occupations according to the number of cases. Occupations are ranked according to their contribution to specific diseases within one of the four categories. The following diseases comprise the greatest numbers of deaths: heart attacks, asbestosis, silicosis, and stroke. Within the permanent total category, the diseases with the greatest contributions are heart attack, silicosis, strokes, and inflammation of the joints. For the permanent partial category, they are hearing loss, inflammation of joints, carpal tunnel syndrome, and heart attacks. For the temporary total and partial category, they are: inflammation of joints, carpal tunnel syndrome, dermatitis, and toxic poisoning. Hearing loss or inflammation of joints are associated with more than 300 occupations. Circulatory diseases comprise a larger share of job-related diseases than is generally acknowledged. Occupations contributing the most heart attack deaths are truck drivers, managers, janitors, supervisors, firefighters, and laborers. Ratios of numbers of deaths to numbers of disabilities are far higher for illnesses than injuries. Occupations that are consistent in their high ranking on most lists involving a variety of conditions include nonconstruction laborers, janitors and

construction laborers. The large SDS, though dated, provides a tentative national look at the broad spectrum of occupational diseases as defined by WC and the occupations associated with those diseases in 1985 and 1986. Some description of the spectrum of diseases encountered today is possible especially for occupations, such as those mentioned above for which employment has expanded in the 1990s.

Parent, M.-E. and J. Siemiatycki (2001). "Occupation and Prostate Cancer." Epidemiologic Reviews 23(1): 138-143.

Summary

This research article evaluates the risk of developing prostate cancer among several occupational groups.

Poirier, M. C. (1997). "DNA Adducts as Exposure Biomarkers and Indicators of Cancer Risk." Environmental Health Perspectives 105(4): 907-912.

Abstract

Quantitation of DNA adducts in human tissues has been achieved with highly sensitive techniques based on adduct radiolabeling, antisera specific for DNA adducts or modified DNA, and/or adduct structural characterization using chemical instrumentation. Combinations of these approaches now promise to elucidate specific adduct structures and provide detection limits in the range of 1 adduct/109 nucleotides. Documentation of human exposure and biologically effective dose (i.e., chemical bound to DNA) has been achieved for a wide variety of chemical carcinogens, including polycyclic aromatic hydrocarbons (PAHs), aromatic amines, heterocyclic amines, aflatoxins, nitrosamines, cancer chemotherapeutic agents, styrene, and malondialdehyde. Due to difficulties in exposure documentation, dosimetry has not been precise with most environmental and occupational exposures, even though increases in human blood cell DNA adduct levels may correlate approximately with dose. Perhaps more significant are observations that lowering exposure results in decreasing DNA adduct levels. DNA adduct dosimetry for environmental agents has been achieved with dietary contaminants. For example, blood cell polycyclic aromatic hydrocarbon-DNA adduct levels were shown to correlate with frequency of charbroiled meat consumption in California firefighters. In addition, in China urinary excretion of the aflatoxin B1-N7-guanine (AFB,-N7-G) adduct was shown to increase linearly with the aflatoxin content of ingested food. Assessment of DNA adduct formation as an indicator of human cancer risk requires a prospective nested case-control study design. This has been achieved in one investigation of hepatocellular carcinoma and urinary aflatoxin adducts using subjects followed by a Shanghai liver cancer registry. Individuals who excreted the AFB1-N7-G adduct had a 9.1-fold adjusted increased relative risk of hepatocellular carcinoma compared to individuals with no adducts. Future advances in this field will be dependent on chemical characterization of specific DNA adducts formed in human tissues, more precise molecular dosimetry, efforts to correlate DNA adducts with cancer risk, and elucidation of opportunities to reduce human DNA adduct levels.

Rates and Statistics

Branch, Cancer Epidemiology Services Public Health Services Branch. (2001). Probability of Developing Cancer for Selected Age Groups by Sex, 2001-2003 (New Jersey and U.S.), New Jersey Department of Health and Senior Services.

Summary
This report shows the probability of developing cancer by different age intervals in New Jersey compared to the US. This report highlights information collected from the New Jersey State Cancer Registry.

Foundation, Fire Fighter Cancer Foundation (2008). "U.S. Cancer and Presumptive Disease Legislation by State." Retrieved September 2, 2008.

Summary
This report indicates which states have presumption covered under their state laws.

Institute, National Cancer Institute (2008). The Nation's Investment in Cancer Research Connecting the Cancer Community An Annual Plan and Budget Proposal for FY 2009, US Department of Health and Human Services

National Institutes of Health**:** 39.
Summary
This report highlights the major cancer advances made and what areas need more attention. The proposed budget for 2009 emphasizes new research, more advanced technology, and better surveillance for cancer.

Institute, National Cancer Institute (2008). Table A-1 Number of Incidence Cases, 2001 - 2005

Table A-3 Number of Deaths, 2001-2005. SEER Cancer Statistics Review 1975-2005, National Cancer Institute.
Summary
These tables represent the number of new cancer cases and the number of deaths due to cancer during 2001-1005.

Institute, National cancer Institute (2008). Table I-1 Estimated New Cancer Cases and Deaths for 2008. SEER Cancer Statistics Review 1975-2005, National Cancer Institute.

Summary
This table displays the estimated number of new cancer cases and deaths for 2008.

Registry, Maryland Cancer (2000). Cancer in Maryland 2000 Incidence & Mortality Annual Report, Maryland Department of Health & Mental Hygiene.

Summary
This report discusses the cancer incidence and mortality among the residents in Maryland in 2000.

Society, American Cancer Society (2006). Cancer Facts & Figures 2006. Atlanta, American Cancer Society.

Summary
This is an annual report which highlights key cancer facts and statistics for 2006.

Society, American Cancer Society (2007). Cancer Facts and Figures 2007. Atlanta, American Cancer Society.

Summary
This is an annual report which highlights key cancer facts and statistics for 2007.

Society, American Cancer Society (2008). Cancer Facts & Figures 2008. Atlanta, American Cancer Society**:** 72.

Summary
This is an annual report which highlights key cancer facts and statistics for 2008.

Society, American Cancer Society (2008). "Lifetime Probability of Developing or Dying From Cancer." Retrieved September 11, 2008.

Summary
This report discusses the statistics behind the lifetime probability of developing or dying from particular cancers.

U.S. Cancer Statistics Working Group (2007). United States Cancer Statistics: 2004 Incidence and Mortality. Atlanta, U.S. Department of Health and Human Services

Centers for Disease Control and Prevention
National Cancer Institute**:** 684.
Summary
This report discusses the cancer incidence and mortality rates in the United States by state, gender, race, region, and other factors.

Miscellaneous

(1997). Michael J. Thomas, Melanie Thomas, Savanna Raine Rogers v James City County Fire Department. 1647-96-4: 1-7.

Summary
This is a court case in which the wife of Michael J. Thomas sought compensation from cancer presumption. The court case also discusses a custody dispute.

(2007). Measure assumes cancer, fire link. The Colorado Springs Gazette. Colorado Springs.

Summary
This newspaper article discusses the implications of linking firefighting to elevated cancer risks among firefighters.

Adams, J. (2003). Scheets v. ADA Fire Department. D. The Court of Civil Appeals of the State of Oklahoma. 99271: 4.

Summary
This is a court case in which the defendant claims cancer presumption for his brain cancer. The previous court order was sustained and the defendant was not given compensation.

Agee, J. G. S. (2002). Henrico County Division of Fire v Estate of William A. Woody. 1254-02-4: 1-9.

Summary
This is a court case in which William A. Woody claims cancer presumption for his cancer. Defendant was not given compensation.

Atwater, S. J. (2008). Senate Bill 2314**:** 3.

Summary
Senator Atwater proposed a legislative bill for cancer presumption in Florida.

Board, Law Enforcement Officers' and Fire Fighters' Plan 2 Retirement Board (2005). Presumptive Medical Conditions for Female Fire Fighters. T. Valencia**:** 8.

Summary
This report is in support of creating cancer presumption for female firefighters. The report includes information on available research results, presumptive coverage in nearby regions, and presumptions in other state legislation.

Board, Michigan Environmental Science Board (1998). Fire Fighter and Cancer Investigation Panel Meeting Summary. Howell.

Summary
This report highlights the hazardous exposures, risks, personal protective equipment, and cancers associated with firefighting that were discussed in a meeting with the Michigan Environmental Science Board.

Board, Michigan Environmental Science Board (1999). Evaluation of the Risk of Cancer among Fire Fighters.

Summary
The meeting report discusses the available cancer research results pertaining to firefighting and cancer as well as determined a level of cancer risk taking into account other factors such as smoking, duration and frequency of exposure, hazardous materials, and use of personal protective equipment.

Board, Michigan Environmental Science Board (1999). Fire Fighter and Cancer Investigation Panel Meeting Summary. Brighton.

Summary
The meeting report highlights expert opinions made by doctors to discuss the exposure of firefighting and cancer risks.

Chiang, J. (2007). City of Los Angeles Revised Audit Report Firefighter's Cancer Presumption Program Chapter 1568, Statutes of 1982 July 1, 2000 through June 30, 2003. Los Angeles**:** 16.

Summary
This report is an audit done on Los Angeles to categorize how much funding was spent on workers' compensation for firefighters.

Chiang, J. (2007). City of San Diego Audit Report Firefighter's Cancer Presumption Program Chapter 1568, Statutes of 1982, July 1, 2001, through June 30, 2005. San Diego.

Summary
This report is an audit done on San Diego to categorize how much funding was spent on workers' compensation for firefighters.

Chiang, J. (2007). Los Angeles County Audit Report Firefighters' Cancer Presumption Program Chapter 1568, Statutes of 1982 July 1, 2002, through June 30, 2005. Los Angeles**:** 11.

Summary
This report is an audit done on Los Angeles to categorize how much funding was spent on workers' compensation for firefighters.

Council, NORA Public Safety Sub Council (2008). National Occupational Research Agenda (NORA), NORA Public Safety Sub-Sector Council.

Summary
This report discusses National Occupational Research Agenda on safety considerations for hazardous occupations.

Firefighters, California Professional Firefighters (2007). "Firefighter Presumptions." Retrieved August 13, 2008.

Summary
This webpage outlines the firefighter presumptions for California as part of the labor code for workers' compensation.

Guidotti, T. Evaluating causality for occupational cancers: The example of firefighters. Occupational Medicine. 2007:57(7); 466-471.

Abstract
Background: The evaluation of causality in cancers associated with firefighting presents problems common to other applications of occupational epidemiology in adjudication of individual claims for workers' compensation. A trend in Canada to establish legislated presumptions for compensation of firefighters created an opportunity to re-evaluate the literature applying medicolegal standards of certainty.
Objective: To evaluate causality in selected cancer categories for firefighters using the criteria applied in tort litigation and workers' compensation, which is based on the weight of evidence and which is required to take into account individual factors.
Methods: The epidemiological literature on cancer risk among firefighters was reviewed based on the weight of evidence rather than scientific certainty. Generalizable frameworks were formulated to define recurrent issues in assessing the evidence from epidemiological studies. The evidence for latency and for a threshold effect with duration of employment was also examined in order to provide practical guidelines.
Results: Presumption is justified for the following cancers: bladder, kidney, testicular and brain, and lung cancer among non-smokers. Non-Hodgkin lymphoma, leukaemia and myeloma (each as a class) not only present particular problems in assessment but also merit an assumption of presumption. Four analytical frameworks describe the problems in analysis encountered.
Discussion: The preponderance of evidence supports the presumption of causation for certain cancer, mostly rare. These frameworks are applicable to other problems of

adjudication that rest on interpretation of epidemiological data. The named cancers, taking into account the special assessment issues described by each framework, are supported by sufficient evidence to conclude that a presumption is warranted but not necessarily sufficient evidence to accept as proof by a scientific standard.

Harris Poll. Firefighters, Doctors and Nurses Top List as "Most Prestigious Occupations." Harris Interactive Inc. Poll #58, July 26, 2006.

Summary
This webpage lists the most prestigious occupations according to a poll taken by Harris Interactive Inc.

Honorable Charles P. Mirarchi, J. (2003). City of Philadelphia v. Workers' Compensation Appeal Board. 2653: 1-17.

Summary
This is a court case on cancer presumption. The court affirmed the city of Philadelphia's petitions to reevaluate the compensation given by workers' compensation for a firefighter who died of lung cancer.

Honorable Glenn Dill (1997). McDaniel v. North Dakota Workers Compensation Bureau. Supreme Court of State of North Dakota. 960383: 8.

Summary
This is a court case on cancer presumption for McDaniel who had bladder cancer. He was affirmed and given compensation.

Hopson, K. (2008) A Better Alternative to Prevention Ulcerative Colitis-Associated Colon Cancer.

Summary
This report discusses alternative methods that can be used to prevent colon cancer.

Igliozzi, J. J. (2008). Caring for Firefighters and Protecting Taxpayers: A Fully Informed Perspective, Igliozzi Responds to Providence Journal Editorial. Providence Journal. Providence, Providence City Council.

Summary
This is a press release giving information about the health care costs of protecting firefighters and how much the taxpayers contribute to that cost.

International Association of Fire Chiefs. America's Fire Service: An Open Letter to Congress from the President of the International Association of Fire Chiefs.

Summary
This is the letter sent to Congress on behalf of the President of the International Association of Fire Chiefs in regards to the services of firefighters, fire safety, fire protection, need for funding, need for more trained firefighters, and fire prevention and education.

International Association of Firefighters/International Association of Fire Chiefs. Joint Labor Management Wellness-Fitness Initiative (3rd Edition). 2008. Washington, DC: International Association of Firefighters.

Summary
This report highlights the efforts of the Joint Labor Management Wellness-Fitness Initiative to raise awareness of firefighter health concerns and to commit to better health regimens for the firefighters.

Lawrence-Turner, J. (2008). Firefighters twice as likely to get cancer, studies say. The Tacoma News. Tacoma.

Summary
This is a newspaper article discussing the risk of developing cancer in Seattle based firefighters. The article highlights several personal stories of firefighters and their cancer hospitalizations.

Law Enforcement Officers' and Fire Fighters' Plan 2 Retirement Board (2005). Presumptive medical conditions for female firefighters initial consideration, Washington Law Enforcement Officers' and Firefighters' Plan 2 Retirement Board**:** 1-8.

Summary
This report is in support of creating cancer presumption for female firefighters. The report includes initial information on available research results, presumptive coverage in nearby regions, and presumptions in other state legislation.

Levy, B. S., A. Robbins, et al. (1983). Occupational Health: Recognizing and Preventing Work-Related Disease. Boston, Little, Brown, and Company.

Summary
This book covers key elements of maintaining health in several different occupations with a special emphasis on prevention.

Lynch, R. M. and M. S. Henifin (1998). "Causation in Occupational Disease: Balancing Epidemiology, Law and Manufacturer Conduct." Health, Safety & Environment 259(Summer 1998): 259-270.

Summary

This article discusses several possibilities of causation of occupational disease. They discuss epidemiological methods used to assess risk, determine what is written in legislation, and compare the information to what the manufacturer of products used in different occupations state.

Melhorn, J. M. and W. E. Ackerman, Eds. (2007). Guides to the Evaluation of Disease and Injury Causation, American Medical Association Press.

Summary
This book highlights assessment of disease and injury to determine probable cause.

National Fire Protection Association. 2007. U.S. Fire Department Profile Through 2006.

Summary
This report is a summary of the United States Fire Services characterizations during 2006.

National Volunteer Fire Council. Fact Sheet. 2008.

Summary
This fact sheet discusses the major problems facing fire services in regards to retention and recruitment, cost of training and equipment, and services of volunteers.

National Volunteer Fire Council. Health and Wellness Guide for Volunteer Fire and Emergency Services. 2008. Washington, DC: National Volunteer Fire Council.

Summary
This report emphasizes good health and wellness guidelines for volunteer firefighters and emergency services personnel.

National Volunteer Fire Council. In pursuit of fire fighter safety and health: An introductory guide to standards, regulations, and resources. National Volunteer Fire Council Foundation.

Summary
This report highlights safety measures to be taken to protect firefighters and their health. The report also discusses specific standards, rules and regulations, and resources available to understand the prevention methods to disease and injury.

National Volunteer Fire Council. NFVC, Johns Hopkins Research Project Receives FEMA Grant. June 25, 2008.

Summary
This webpage highlights the new grant received by Johns Hopkins School of Public Health to study the health and habits of firefighters to investigate potential causes of disease in this population.

National Volunteer Fire Council and United States Fire Administration. Retention & Recruitment for the Volunteer Emergency Services: Challenges & Solutions. 2007.

Summary
This report focuses on the retention and recruitment efforts for volunteer emergency services personnel.

Reporter, California Workers' Compensation Appeals Board (2005). "Presumption of Compensability - Labor Code & Sect; 5402." Retrieved August 13, 2008.

Summary
This webpage provides information about the labor codes for workers' compensation that directly correlate to cancer presumption for California.

Reuter, D. (2002). Arizona Mayor Leads Fight for "Presumptive Cancer" Bill. U.S. Mayor Newspaper. Washington, DC, The United States Conference of Mayors.

Summary

This newspaper articles discusses an Arizona Mayor who supports funding for cancer presumption research studies to be conducted.

Simon, M. and B. Francis, Eds. (1998). The Dissertation Cookbook: From Soup to Nuts - A Practical Guide to Start and Complete Your Dissertation. Dubuque, Kendall/Hunt Publishing Company.

Summary

This book provides guidelines to preparing and writing a dissertation quality report.

Smith, J. J. (2002). 2 No. 112 In the Matter of Emil Albano, Appellant, v. Board of Trustees of New York City Fire Department, Article 2 Pension Fund, Respondent. 2 No. 112.

Summary

This is a court case about cancer presumption for a defendant with testicular cancer. The court held that there was not sufficient evidence to uphold his claim.

VandeWalle, C. J. (2001). Wanstrom v. North Dakota Workers Compensation Bureau. 2001 ND 21, 20000187.

Summary

This is a court case about cancer presumption for a defendant with lung disease. The court held that the rebuttal was not sufficient and the defendant's claim should be upheld.

Ward, E. M., P. A. Schulte, et al. (2003). "Priorities for Development of Research Methods in Occupational Cancer." Environmental Health Perspectives 111(1): 1-12.

Abstract

Occupational cancer research methods was identified in 1996 as 1 of 21 priority research areas in the National Occupational Research Agenda (NORA). To implement NORA, teams of experts from various sectors were formed and given the charge to further define research needs and develop strategies to enhance or augment research in each priority area. This article is a product of that process. Focus on occupational cancer research methods is important both because occupational factors play a significant role in a number of cancers, resulting in significant morbidity and mortality, and also because occupational cohorts (because of higher exposure levels) often provide unique opportunities to evaluate health effects of environmental toxicants and understand the carcinogenic process in humans. Despite an explosion of new methods for cancer research in general, these have not been widely applied to occupational cancer research. In this article we identify needs and gaps in occupational cancer research methods in four broad areas: identification of occupational carcinogens, design of epidemiologic studies, risk assessment, and primary and secondary prevention. Progress in occupational cancer will require interdisciplinary research involving epidemiologists, industrial hygienists, toxicologists, and molecular biologists.

Westly, S. (2006). City of Santa Monica Audit Report Firefighters' Cancer Presumption Program Chapter 1568, Statutes of 1982 July 1, 2001 through June 30, 2004. Santa Monica.

Summary
This is an audit report on workers' compensation claims in Santa Monica pertaining to cancer presumption.

Westly, S. (2006). City of Torrance Audit Report Firefighters Cancer Presumption Program Chapter 1568, Statutes of 1982 July 1, 2001, through June 30, 2004. Torrance.

Summary
This is an audit report on workers' compensation claims in Torrance pertaining to cancer presumption.