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On behalf of the Professional Fire Fighters of Montana

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Good morning, I am Dr. Gayatri Reddy, an Occupational and Environmental Medicine Resident at the Johns Hopkins University Bloomberg School of Public Health. I am here today at the request of the International Association of Fire Fighters (IAFF) on behalf of the Professional Fire Fighters of Montana.

I would like to start by briefly telling you about the IAFF and my involvement with this organization. The IAFF is an international union that is affiliated with the AFL-CIO and the Canadian Labour Congress and currently represents almost 300,000 paid professional fire service employees in the United States and Canada. The IAFF has been actively involved in improving the health and safety of fire fighters for more than 90 years. This is a critical activity for a workforce in which fatalities and early retirement due to work-related disease occur regularly. I am currently on rotation as the resident doctor at IAFF. I am already beginning to appreciate the great voluntary risks these individuals take in order to save and benefit the lives of others.

This morning I will discuss four important topics about fire fighter occupational health:

1. **Occupational Cancer Risk and it Impact**
2. **Occupational Risk of Infectious Disease**
3. **Occupational Risk of Cardiac Disease**
4. **Occupational Risk of Respiratory Disease**

In this testimony, you will see a number of recurring themes regarding fire fighter exposures, risks and research challenges in the assessment of these exposures and risks.

The proposed legislative change in workers' compensation, in front of us, based on the presumption that fire fighters are at greater risk for certain diseases, can make a dramatic difference in the lives of fire fighters who develop these diseases during their careers.

1. Occupational Cancer Risk

Fire fighters are exposed to a wide range of cancer-causing chemicals in their work. This results in an increased cancer risk for fire fighters, which is commonly underestimated due to several challenges inherent in fire fighter research, such as exposure assessment.

Occupational Exposures of Fire Fighters

In the vast majority of US workplaces, occupational exposure levels have greatly declined in the past 2-3 decades. Improved workplace conditions can be attributed to many factors including governmental occupational safety and health agencies, legislation, union efforts, training programs for occupational health professionals, and good business practices such as trying to keep highly skilled workers healthy and working. As I went on plant tours, as part of my Johns Hopkins residency coursework, it was difficult to find a worker exposed to significant hazards because so much manufacturing is now automated and enclosed. These manufacturers have adopted the highest level of hazard exposure controls to ensure that their workforce remains healthy and productive.

Unfortunately, fire fighters have not benefited from this overall improvement. They are still entering uncontrolled, hazardous environments regularly. Fire fighters, unlike most workers in this country, have little information about the range of exposures they encounter in each fire they respond to. Nevertheless, they save lives and reduce property damage without regard for the hazards to their health that they may sustain. **However, studies of the chemicals contained within the smoke that fire fighters commonly encounter during fire suppression and overhaul activities has clearly documented reason for concern about these exposures. Smoke is a complex mixture of cancer causing chemicals from**

combustion of all the various products in modern fires. We all know that cigarette smoke causes cancer. However, smoke from the combustion of at least three other products, specifically wood, coal and diesel fuel, are also considered probable or known carcinogens. Occupational health experts rely on the International Agency for Research on Cancer (IARC) to categorize chemicals for their potential to cause cancer in humans. Studies have revealed that fire fighters are commonly exposed to numerous agents that IARC considers Group 1, which are known to cause cancer in humans. Examples include asbestos, benzene, benzo[a]pyrene, formaldehyde, 1,3-butadiene and soot, the exposure that causes cancer in chimney sweeps.[i] Fire fighters are also exposed to Group 2A probable human carcinogens such as diesel engine exhaust and combustion products of wood. In addition, thousands of new synthetic chemicals are produced annually, making it impossible to study the toxic properties of each one, let alone the toxic properties of their combustion products.

A Harvard study that examined levels of a number of air contaminants at more than 200 structural fires provides an excellent example of the **uncontrolled, hazardous nature of fire fighter exposures.**[ii] In that study, the carcinogen, benzene was detected in 92% of samples; half were over 1 part per million (ppm), which is the current Occupational Safety and Health Administration (OSHA) permissible exposure level. Approximately 5% of the samples were above 10 ppm benzene which is 10 times the current OSHA limit. One study reported benzene levels more than 200 times the OSHA limit.[iii] Evidence of the large number of chemicals that can be present in smoke is provided by a study that reported more than 70 different chemicals in smoke from monitored fire scenes regardless of whether synthetic materials were a major part of the materials burned.[iv]

Further adding to the risk is the fact that **the only available form of protection for fire fighters is also the least effective of the established workplace controls for exposure reduction.** Personal protective equipment, such as respirators and turn-out gear, is last in what we call the hierarchy of controls, far inferior to such remedies as substitution with a safer chemical, enclosure of the hazard, and ventilation. Why is this? Because this equipment does not completely eliminate exposure and if exposure is high, as commonly occurs in fire fighting, worker exposures, even with use of such equipment, will be high as well.

Fire Fighter Cancer Risk

Given the uncontrolled exposures to carcinogens that fire fighters regularly encounter, many studies to examine the risk for cancer in firefighters have been conducted. Statistically

significant elevations in various cancers have been reported in different studies using a range of research approaches. The results of many such studies have been summarized in a recent report by LeMasters and colleagues.[v] This study is a meta-analysis, which is a research technique used to combine many smaller studies. The advantage of this is that research with more participants is better able to detect true increases in risk. Results combining all data in 32 studies of fire fighters for 20 different cancer types are presented in Table 5 of the LeMasters report. Notably, **risks for 10 types of cancer (50%) were significantly increased in fire fighters and risks for the other 10 were increased but did not reach statistical significance.**

Reasons for Underestimation of Fire Fighter Cancer Risk in Existing Research

LeMasters and colleagues concluded that fire fighters had a "probable" increased cancer risk for four cancers and a "possible" increased risk for 8 others.[1] Does this mean that only four cancers are really due to occupation in fire fighters? Furthermore, the 32 individual studies included in the LeMasters meta-analysis did not all reach the same conclusions about which cancers fire fighters have an increased risk of developing. **If the exposures are so high and poorly controlled, why aren't all the studies consistent in showing greatly increased cancer rates? The answer is that there are several major challenges in accurately studying risk in fire fighters and ALL result in underestimation of risk.**

The first challenge is exposure assessment. In controlled manufacturing settings, air monitoring is performed to calculate routine exposures. There is no way to do that for fire fighters. As a result, many studies simply list exposure on a yes/no basis, based on occupation as a fire fighter. In an effort to better estimate actual carcinogen dose, some studies use years spent as a fire fighter. However, do exposures encountered during 20 years as a fire fighter in a quiet residential area result in the same cancer risk as 20 years in an urban industrial fire station? Probably not. What about number of runs? Again, combustion products in fires differ and fires involving industrial settings and/or synthetic products are likely to entail higher carcinogen exposures. What is the effect of this "misclassification" where high risk fire fighters may end up classified in the low risk group and/or the risk group is diluted by fire fighters with less true carcinogen exposure or fire fighters may even end up in the control

[1] Testicular cancer was considered probable in their final assessment although listed as possible in Table 5.

group in studies that use longest held occupations? Underestimation of true risk. This makes it appear that fire fighters are not at risk for cancer.

The next challenge is the healthy worker effect. In order to perform the physically demanding work involved in fire fighting, workers must enter the workforce very fit and continue to exercise and watch their diet to control weight and maintain physical ability in their fire fighting careers. This is evident in the LeMasters study, in which, overall, fire fighters have a 10% less risk of dying at a given age than the rest of us. How does the overall good health of fire fighters affect the outcome of cancer research in this workforce? Again, the risk is underestimated because their risk starts out below the general population to which they are compared. As a result, when a study finds firefighters to have *any* increase in cancer rates relative to the general population it is unsettling.

Further, the small numbers of fire fighters affected by individual cancers decrease the ability to detect increases in risk. Fire fighters comprise a relatively small occupational group and the large number of different cancers to be considered makes this a huge challenge.

Overall, given the challenges in this body of research, the likelihood is strongly AGAINST observing risk in firefighters. Thus, it is clear that fire fighters are at risk for many cancers not just the four listed as "probable" by LeMasters and co-workers.

Impact of Workers' Compensation For Fire Fighters Who Develop Occupationally Related Cancer

Despite these hazards, as public servants, fire fighters willingly take on the burden of danger for all of us. **Yet when they are diagnosed with cancer as a result of their job, they face a system that is stacked against them.** In the absence of presumptive legislation, the fire fighter with cancer has to shoulder the burden of proving that his or her cancer is work-related. The fire fighter has to find legal counsel to help with the process and a health care provider who understands the complex causation issues for work-related disease which is much more challenging than for injuries. Sometimes they are even asked to identify the exact exposure that caused their cancer which is clearly impossible. In addition, cancer diagnosis and treatment can be an arduous, protracted process which can take many months or longer when

surgery, chemotherapy, or radiation is needed. When these occupationally-induced cancers are not covered by workers compensation, fire fighters must use up precious leave time and may have to use personal savings in order to cover medical costs after the insurance maximum is met. Workplace accommodations are very difficult for cancer patients when the work is as physically demanding as fire fighting. It's true that whether it's health insurance or workers compensation, someone in the system has to pay the costs. But these **additional burdens should not be placed on fire fighters when they develop cancers that studies have shown are clearly a result of their occupation**.

Several reasons are commonly presented against presumptive cancer legislation. One, is the concept of the slippery slope, if we do this for one occupation we will have to do this for all. As I have shown in my initial discussion on fire fighter exposures, there are dramatic differences between their exposures and the rest of the US workforce. These differences make presumptive legislation uniquely applicable to fire fighters. Another important point is that presumption of cancer is rebuttable and if an individual fire fighter has non-occupational risk factors that outweigh their occupational risks, workers' compensation will still be denied.

In summary, air monitoring clearly documents that fire fighters are exposed to carcinogens in their work environment. We also know that the personal protective equipment used by fire fighters is the least effective of established workplace controls. Data also clearly show that fire fighters are at increased risk of developing and dying from cancer. For a number of reasons, the risks are likely substantially higher than the studies report. We also know that the current workers' compensation system places an enormous burden on individual fire fighters who develop cancer.

Presumption of cancer in fire fighters is finally becoming accepted throughout the country. Currently, more than 25 states in the United States have legislation now in effect that presumes that if a fire fighter develops cancer it is occupationally induced and other states are currently considering such legislation. It is time that Montana joins these other states throughout the country and enacts legislation to help fire fighters who develop work-related cancers.

2. Occupational Risk of Infectious Disease Exposures

Since many fire fighters are also first responders/emergency response personnel, they are at risk for exposure to blood-borne and aerosolized infectious diseases.[vi] Uncontrolled, chaotic settings that may involve sharp surfaces, the possible presence of large volumes of blood and other body fluids, the need to perform urgent, invasive procedures, and combative or excited victims all further increase fire fighter exposure to these infectious diseases. Although viral blood-borne pathogen infections, such as hepatitis B and C viruses and human immunodeficiency virus (HIV) infections, are of greatest concern, fire fighters are also at risk of being exposed to diseases spread by aerosols, included tuberculosis, meningococcal disease and diptheria. Even methicillin-resistant Staphylococcus aureus, which used to be an organism confined to hospitals and other health care institutions, is becoming an issue for fire fighters due to its dramatic rise in community settings where fire fighters are often the first responders.[vii] The fire fighters may be exposed by way of needle sticks, eye splashes, through mucous membranes, through inhalation and through both non-intact and intact skin.[viii] Also, in terms of uncontrolled settings, fire fighter involvement in bioterrorism response places them at increased risk not only for the usual suspects of pathogens, but also for covert and novel bacterial and viral agents, such multi-drug resistant tuberculosis, disseminated in unexpected ways. [ix]

Although a set of established guidelines, known as universal precautions, includes some engineered solutions, such as safer needle and syringe devices, it mostly emphasizes the use of barrier personal protective equipment in the form of gowns, gloves, respirators, goggles and face shields. Again, this is the **least effective of established workplace controls for exposure reduction and much less foolproof than isolation, ventilation and other engineered controls.**

Therefore, fire fighters are at a significantly increased risk for infectious disease exposures while being provided with the lowest level of exposure control.

3.Occupational Risk of Cardiac Disease

Fire fighters are exposed to many hazards that increase risk for cardiovascular disease and death from heart attack. These include exposure to chemicals in smoke that reduce oxygen in the body (asphyxiants), such as carbon monoxide; the extreme physical demands of fire

suppression; heat stress from fire and protective equipment; shift work; and psychological stress.

Air monitoring of smoke at fire scenes indicates that carbon monoxide is present at most fires.[x] Carbon monoxide is inhaled and absorbed into the blood stream where it binds to red blood cells which are then unable to carry oxygen to the body. Though fire fighters wear breathing apparatus while fighting fires, they still have inhalational exposures, especially during the overhaul period, when existing structures are destroyed after the fire has been put out. Blood tests on fire fighters have demonstrated an elevated level of carboxyhemoglobin, a marker for carbon monoxide exposure.[x] In addition to carbon monoxide, other exposures affecting the cardiovascular system include hydrogen cyanide, which is also an asphyxiant, and arsenic. Chemicals that irritate the lungs, decreasing lung function and reducing oxygen entry into the body are also present in smoke.

The increased physical demands of fire fighting also negatively affect the heart. A fire fighter's heart rate may increase dramatically after the alarm for a fire sounds.[x] The heart rate can remain elevated for the entire fire fighting operation. Fire fighting involves stressful and strenuous physical activity that is made more difficult by the 45 to 65 pounds of protective clothing and breathing apparatus a fire fighter wears. These factors together may cause the fire fighter to work with a sustained, elevated heart rate for several hours at a time, placing an unusual burden on the heart.

Noise is a physical stressor that is also well known to cause increased blood pressure which is a risk factor for heart attack.

Psychological stress is a risk factor for cardiovascular disease. Studies have found physiologic evidence of stress in active-duty firefighters as measured through catecholamine excretion.[xi,xii]

In order to respond to emergent situations 24 hours a day, shift work is a part of the job description. There is substantial epidemiologic evidence that shift work is associated with an increased risk of obesity, diabetes, and cardiovascular disease.[xiii xiv, xv] The most common effect of chronic shift work is shortened and/or disturbed sleep.[xvi] Additionally, blood levels of certain biologic markers *associated as risk factors for cardiovascular disease* are elevated in shift workers (and others with disturbed sleep) when compared to control groups. These markers include: homocysteine,[xvii] C-reactive protein,[xviii,xix] and total cholesterol level.[xx]

Night-time shift work promotes *circadian stress*, which was defined by Puttonen and colleagues as "the physiological, behavioral, and psychosocial consequences related to the disturbances of the human circadian rhythm (eg the sleep–wakefulness rhythm)"[xiv]. Their review of the literature focused on three pathways leading from shift work (circadian stress) to cardiovascular disease: psychosocial stresses, behavioral stresses, and physiological stresses. The overarching conclusion by the authors of this review was that the three pathways act in an interrelated manner to directly contribute to the disease processes of atherosclerosis, metabolic syndrome, and type II diabetes, all abnormal states that increase risk for cardiovascular disease. [xiv]

Research into cardiovascular disease risk in fire fighters is difficult due to the healthy worker effect. In order to perform the physically demanding work involved in fire fighting, workers must enter the workforce very fit and continue to exercise and watch their diet to control weight and maintain physical ability in their fire fighting careers. Cigarette smoking precludes employment as a fire fighter in an increasing number of fire departments. Fire fighters who become unfit

because of illness are removed from the workplace or reassigned to other duties. Fire fighters therefore tend to be healthier than the general population overall. Thus, when studies compare fire fighters to the general population, the problem of cardiovascular disease in fire fighters tends to be underestimated. A recent re-analysis of 23 mortality studies that adjusted for the healthy worker effect found that four studies, which previously showed no increased association between fire fighting and cardiovascular mortality, did in fact show a link between heart disease and fire fighting.[xxi] The author concluded that overall, "there is strong evidence of an increased risk of death overall from heart disease among firefighters." A 2006 study by investigators at the Centers for Disease Control (CDC) examining 1,141 U.S. fire fighters who died while on duty during 1994-2004, found sudden cardiac death as the leading cause of on duty death among career firefighters.[xxii] Research in fire fighters indicates a substantially increased risk of death from heart disease for strenuous activities such as fire suppression.[xxiii]

In conclusion, occupation as a fire fighter is associated with an increased risk of heart attack. The strain placed on the heart by this unique combination of occupational factors is unlike that of any other workforce.

4. Occupational Risk of Respiratory Disease

As noted previously, fire fighters are exposed to several different substances in uncontrolled environments during the course of their duty. Some of the substances reported, including carbon dioxide, carbon monoxide and hydrogen cyanide, are known asphyxiants that deprive the body of oxygen. Other exposures may include inhalations of ammonia, chlorine, nitrogen dioxide and phosgene gases that can result in upper airway irritation or even severe lower airway acute respiratory distress syndrome (ARDS). Smoke and its combustion products are a complex mixture and its composition is dependent upon the material that is being burned, the temperature of combustion and the amount of oxygen present. [xxiv] Firefighters have the greatest occupational risk, as a group, for smoke inhalation and its complications.[xxiv] They are exposed to known carcinogens such as asbestos which, in addition to cancer, is known to cause an interstitial lung disease known as asbestosis. I am only naming a few of the many known respiratory toxicants to which fire fighters may be exposed. Then, there is also the physical hazard of airway thermal burns that result in airway obstruction and severe respiratory distress. The point being is that fire fighters can be exposed to some very dangerous respiratory hazards.

Many studies indicate the presence of acute pulmonary dysfunction in fire fighters. These include significant hypoxemia, acute decline in lung function, increased airway hyperreactivity and bronchospasm. [xxv]
There is a growing body of literature about the respiratory effects from the recent World Trade Center disaster. After massive exposure to the dust and particulates from that disaster, there have been reports of continued cough, airway hyperreactivity and Reactive Airways Dysfunction Syndrome(RADS) among fire fighters.[xxvi]

Conclusion

Fire fighters have significantly elevated risks of developing cancer and heart and lung disease as well as contracting infectious diseases. Although it is difficult to control their workplace environment and engineer out all their hazards, compensation for illnesses acquired during the course of their demanding profession will help ease their burden.

Thank you for your time and consideration.

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