The long term health effects on firefighters that fail to properly decontaminate following exposures to fire smoke.

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Author Note
This paper was prepared for Fire Dynamics Spring 2017 semester at the University of Cincinnati, administered by Adjunct Professor Brad French.
Certification Statement

I hereby certify that this paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

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Date: February 25, 2017
Abstract

Through the use of historical data and recent studies it has been shown that firefighters have an increased risk of many cancers and illnesses that are job related. The source of many of these illnesses is the fire smoke they are exposed to on an almost daily basis. Research has also shown the fire fuels burning in structure fires today as compared to thirty years ago have changed drastically. This change has affected the rate at which a fire develops, but also the toxic gases being produced during the combustion process. While efforts have been made over the years to provide them protective equipment there are gaps with this equipment as well as a need for added awareness to the dangers they face. There are continued efforts to research and improve upon this equipment, but there are procedural and behavioral processes that can employed now. It is believed that if firefighters were to decontaminate their personal protective equipment and uniforms followed by showering immediately after a fire they would reduce the risk of developing many of the illnesses and cancers that have been on the rise.
# Table of Contents

Certification Statement .................................................................................................................. 2

Abstract ......................................................................................................................................... 3

Table of Contents .......................................................................................................................... 4

Introduction ...................................................................................................................................... 5

Background and Significance ......................................................................................................... 5

Literature Review ........................................................................................................................... 6

Procedures ...................................................................................................................................... 8

Results ........................................................................................................................................... 9

Discussion ...................................................................................................................................... 10

Recommendations .......................................................................................................................... 11

Reference List ................................................................................................................................. 13
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**Introduction**

Firefighters are exposed to countless dangerous scenarios over a given career, and quite often in a single day. Aside from the physical rigors and dangers that take a toll on their bodies much like an athlete, firefighters have both short and long term health concerns associated with the job. The short term concerns typically are the ones that they are most concerned about because of the relevancy to where they are in life. Firefighters that suffer knee, shoulder, back and various other injuries are concerned about the whether the next pay check will be in the bank so that they can provide for their families. Most people, firefighters included do not think or plan for the future like they should, whether it is retirement, college, or their health. Firefighters need to better understand the long term implications to the exposure to fire smoke and how it relates to the health issues the fire service is continuing to see on the rise. Fire smoke has both acute health effects during the time of exposure to smoke while on scene of a fire, and also chronic exposures to the gases and particulates on the gear, uniforms, equipment, and apparatus they are continually reintroduced to call after call. By looking at both historical data and new research being conducted the fire service has an opportunity to correct a growing problem and greatly improve the long term health of firefighters.

**Background and Significance**

Firefighters continue have an increase in job related illnesses, injuries, and deaths (InterAgency Board, 2016). As professionals these firefighters must continue to use science and
Failure to properly decontaminate following exposures to smoke

Krusen 6

technology to better understand their occupational risks not only from a tactical perspective, but from a physiological one as well. During the course of the Fire Dynamics class the students learn the benefits to understanding the science behind how fire burns and what factors determine its rate and growth. Understanding how fire behaves and dynamics that exist make those tasked with fighting the fires better at their job, but equally understanding the science and how it affects our bodies will hopefully improve our life expectancy and quality of life long after we leave the profession. It has been identified through various studies and research by the National Institute for Standards and Technology (NIST), National Institute for Occupational Safety and Health (NIOSH), National Institute of Environmental Health Sciences, and the Center for Disease Control (CDC) that fire smoke and the gases associated with it are extremely toxic (Gavin P. Horn, 2016). Therefore, by reducing the amount of time firefighters are exposed to these products the better the chances are of them not developing an illness or job related cancer.

**Literature Review**

For this paper there were a number of significant resources and pieces of literature that were reviewed. In the past 10 years there has been a growing emphasis on learning more about what is causing the increase in firefighter illnesses and injuries, and while many of these studies are ongoing they are starting to provide alarming information while providing initial recommendations to the fire service. The InterAgency Board (IAB) made a list of recommendations and in order to reduce the number of cancer incidences and mortality among fire fighters, fire departments must implement cancer prevention approaches through the use of personal protective equipment, education and training, and improved procedures as well as wellness/fitness programs (InterAgency Board, 2016). Additionally, the interim report for the
Cardiovascular & Chemical Exposure Risks in Modern Firefighting study conducted last year at the Illinois Fire Service Institute in conjunction with NIOSH looked at several issues, but one major issue was the toxic exposures associated with firefighting. While this recent study showed the dangers of the modern fire load it also examined the historical data of exposures dating back to 1975 (Gavin P. Horn, 2016).

There are growing numbers of researchers and firefighters that are concerned about the long term health effects and are starting to get involved with organizations such as the Firefighter Cancer Support Network (FCSN). Organizations such as FCSN are providing the support network to assist those affected by cancer as well as providing education to all firefighters in hopes to protect firefighters and prevent any further cases (Briese, 2013). By having strong advocates the fire service is pressuring the manufacturers of personal protective equipment and clothing to provide equipment to better protect the firefighters against things such as fire smoke (Department of Homeland Security, 2016). The fire services peers that sit on the various National Fire Protection Agency (NFPA) Committees are working to ensure that firefighters have the appropriate PPE to protect ourselves, but also the appropriate equipment to care for and maintain the things they currently have. (NFPA, 2015). By developing stronger standards such as NFPA 1851- Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting to ensure firefighters have clean gear that is providing the best protection possible the fire service has a voice (National Fire Protection Agency, 2014). To ensure the highest level of protection is being afforded to firefighters Executive Director Casey Grant with Fire Protection Research Foundation said in a press release about a research project that aims to determine if current methods are sufficient for removing
toxins from firefighters’ personal protective equipment over the next three years. “The ultimate goal of this project is to find out whether existing practices are truly removing those contaminants from PPE so we can better protect firefighters from related risks.” (Safety and Health Magazine, 2015).

**Procedures**

For the purpose of this paper several research papers, studies, and articles were reviewed for common findings on the contamination of firefighters and their personal protective equipment to fire smoke as it relates to the long term health effects in firefighters. There was historical data such as that found in the 2013 article *Mortality and cancer incidence in a pooled cohort of US firefighters from San Francisco, Chicago and Philadelphia (1950– 2009)* that brought to light the increased rates of cancer and in the end showed evidence of relation between firefighters and cancers. Firefighters in this study were shown to have a risk 2.2 times greater than other males not in the fire service of developing testicular cancer (Robert D Daniels, 2013). There are also a number of studies that have been recently conducted, but because so much of this information is initial data each study completed opens the door to several additional studies. The 2014 study conducted in Illinois by NIST, NIOSH, and the CDC identified that exposure to the known contaminants in smoke lead to cancers and other illnesses, and that firefighters exhibit a higher rate of these issues that the general population. The study also goes on to say that there are still a number of gaps and a need for additional work to learn more.

NIST is also looking into conducting additional research on the firefighting ensemble to better understand its limitations. The thermal protection of the gear, the lifetime, and the
Failure to properly decontaminate following exposures to smoke

abration resistance are key issues being examined, but it would be ideal if they could also add in the protection limitations to fire gases that firefighters are commonly exposed to. This is not an unlikely addition to the research based on their own findings during the recent study completed in Illinois. While the personal protective equipment firefighters wear has limitations NIST points out the true limitations of the gear are not fully known (National Institute of Standards and Technology, 2011).

Results

In reviewing these pieces of literature there many commonalities that relate to the toxicants in the fires. As discussed throughout the Fire Dynamics course modern fires are fueled by homes filled with so many synthetic products as compared to the natural fiber furnishings found in legacy construction. These same toxicants are transferred to and later found on the firefighter’s turnout gear and even their uniform and body. Based on research it has been identified that respiratory protection alone will not limit the exposure to these toxicants, but that dermal absorption is also a known route into the body (Gavin P. Horn, 2016). These toxicants are being accounted for on the scene and studied for possible connections to illnesses and injuries to those exposed. As more is learned of these risks the illnesses, injuries, and unfortunately the deaths of firefighters are being linked to these exposures as was done in the 2013 study of nearly 30,000 firefighters in San Francisco, Chicago, and Philadelphia (Robert D Daniels, 2013).

Since cancer awareness is growing the manufacturers of personal protective equipment are listening to new ways to better protect firefighters. One recent study determined that flash
hoods were an area that allowed a high concentration of particulate to easily make contact his the firefighters skins (Jeffrey O. Stull, 2015). Thyroid cancer is one of many cancers that firefighters have experienced an increased rate of, and because of this studies such as Jeffrey Stull’s were conducted. Following the study Manufacturers started looking into ways to provide a more suitable product to fill the gap in protection and out of this the particulate resistant hood was developed. The hood provides the same thermal protection as a conventional flash hood and also incorporates a barrier in between two thermal layers to help block the particulate from passing through (National Fire Protection Association, 2017).

**Discussion**

The author of this paper feels the recent studies as well as the historical ones have begun to open the eyes of the fire service. The studies are on the right track of learning more information that will be used to educate firefighters on how to better prevent an exposure to smoke and more importantly how to decontaminate following an exposure. As pointed out in the study from Illinois there was no significant data supporting wet decontamination versus dry decontamination during the post fire phase. This leads us to believe that alternative methods will need to be developed in the future to address this concern. In the meantime, the fire service is taking charge and not waiting on the manufacturers to determine this method. Departments are starting to place self-contained breathing apparatus (SCBA) in outside compartments to avoid continual exposure while riding in the cab. During a recent trip to Miami this author learned that the Miami Fire-Rescue Department in Miami, Florida has two apparatus in production that will contain negative pressure cabs to help exhaust any airborne contaminates. These little things all add up to hopefully lower the numbers firefighters affected by cancer and other illnesses.
The IAB recommends that fire departments investigate issues affecting PPE effectiveness in reducing exposure to carcinogens in order to better protect their firefighters (InterAgency Board, 2016). It is imperative that firefighters wash their contaminated gear following exposures, but additionally more needs to be researched as to how clean is clean. The question should be asked, is one wash sufficient or perhaps is a second wash necessary. Asking these questions will force the industry, including the manufacturers to conduct tests because NFPA should be incorporating these same concerns in future updates.

**Recommendations**

It is not fully known what all the long term health effects on firefighters are, but as more information is learned the fire service is starting to understand that failing to properly decontaminate following exposures to fire smoke is not helping. This includes not only the PPE worn into the fire, but also the uniform being worn underneath the PPE and the washing their bodies. While the on scene decontamination of firefighters PPE using a wet decontamination did not show a dramatic difference than the gear that was allowed to off gas in a dry decontamination method, decontamination in general is necessary. The PPE continued to off gas after the firefighters exited the structure showing the need decontamination. The firefighters uniform or clothing also becomes contaminated with the gases and particulates so it is also recommended that the clothes be removed and washed. Finally, the firefighters need to attempt to shower in an effort to remove particulates that may have deposited onto their skin and hair (C. Stuart Baxter, 2010). Addressing the long term effects to the exposure to fire smoke will help achieve the reduction of fire and life safety risk through preparedness, prevention and mitigation;
which is the first goal of the United States Fire Administrations (USFA) five strategic goals (US Fire Administration, 2014). It is recommended that the fire service and its advocates continue to research fires and better understand the products that are burning. This will not only make firefighters better at their job, but also safer doing it.

Firefighters and fire departments alike must embrace the messages delivered by those that came before us and by those affected by cancer and other illnesses. By paying attention to the past the fire can likely change the future and the FCSN is one of several organizations that are trying to educate firefighters on how to prevent cancer.
Failure to properly decontaminate following exposures to smoke

Reference List


Failure to properly decontaminate following exposures to smoke


