

**Cancer in the Fire Service: The Effects of Wearing Contaminated
Personal Protective Equipment**

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CERTIFICATION STATEMENT

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ABSTRACT

The problem this study investigated was the potential risk and effects from being exposed to contaminated personal protective equipment (PPE). The purpose of this project was to provide research based information to aid in developing a plan of action for the Violet Township Fire Department (VTFD), impact policies and procedures regarding safe practices in maintaining Personal Protective Equipment, and reduce the risk of exposure to hazardous toxins and carcinogens.

Four research questions were examined throughout the course of this project using a descriptive research method. The first question sought to determine what evidence existed that confirmed the link between exposure to carcinogens at fire scenes and the risks of exposure from wearing contaminated PPE. Additionally, the research investigated what the national and/or state guidelines were for cleaning contaminated PPE. The third question asked what the current practices were in other departments to track the occurrence of cancer in their firefighters. The final question asked how departments track exposure to contaminants.

Procedurally, the research design consisted of three surveys. The groups polled were the Metropolitan Emergency Communications Center (MECC) district, the Ohio Fire Chiefs, and the firefighters working for the VTFD.

The results determined that there is a cancer risk to firefighters through exposure to carcinogens on or in contaminated PPE. Additionally, many departments properly care for their PPE but little is being done to track an individual firefighter's exposure to smoke, soot, and toxic substances or track any cancer diagnoses. Primary recommendations suggest increased education regarding cancer prevention for firefighters along with implementation and strict

adherence of exposure tracking documentation. Also recommended are dermatologic screenings during annual physical exams in addition to all firefighters being issued a secondary set of PPE.

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INTRODUCTION

Statement of the Problem

Cancer is a very real threat, and it can no longer be ignored within the Violet Township Fire Department (VTFD). This reality hit the VTFD very personally during the spring of 2013. One of Violet's career firefighters was in the process of beginning his retirement when he was diagnosed with bladder cancer. There is no way of proving whether or not this cancer was related to his career as a firefighter, but this event sparked the interest of this researcher in delving deeper into the topic of elevated cancer risk in firefighters. This cancer diagnosis created great concern within the VTFD, and former Chief John Eisel conducted an informal poll to assess the rate of cancer within the VTFD firefighters. There was a high level of participation in this poll, and the results were very concerning. Out of forty-seven career firefighters within the VTFD, fourteen reported having had some variation of cancer within their careers. Therefore, over twenty-seven percent of the VTFD has come into personal contact with cancer, and that number could potentially be even higher. The information that will be gathered during this research will be used to provide information, educate about the risks of cancer, and develop new, safer practices for protecting Violet Township's firefighters from cancer.

The problems this study will address are the potential risk and effects from being exposed to contaminated personal protective equipment (PPE).

Purpose of the Study

The purpose of this study is to provide research based information to aid in developing a plan of action for the VTFD. The plan will impact policies and procedures regarding safe

practices in maintaining Personal Protective Equipment, and reduce the risk of exposure to hazardous toxins and carcinogens.

Research Questions

The research questions this study investigated using descriptive research are:

1. What evidence exists that confirms the link between exposure to carcinogens at fire scenes and the risk of exposure from wearing contaminated PPE?
2. What are the national and/or state guidelines for cleaning contaminated PPE?
3. What are current practices in other departments to track the occurrence of cancer in their firefighters?
4. How do departments track exposure to contaminants?

BACKGROUND AND SIGNIFICANCE

Today's firefighters are comprehensively trained in all aspects of firefighting to include fire suppression, rescue, hazardous materials handling, and emergency medical services (EMS). Firefighters, however, are not thoroughly trained to fight the silent killer, cancer. Although firefighters are well versed in the necessary skills to succeed at their jobs, they have not been adequately trained and educated on how to avoid becoming exposed to toxic levels of cancer-causing agents called carcinogens. This failure could possibly lead to a career-ending health event, or the worst-case scenario, death.

“The media blitz surrounding firefighter death, injury and disability has certainly heightened our awareness of the acute causes of firefighter morbidity and mortality. Virtually unspoken about, however, are deaths and career-ending conditions caused by chronic diseases, like cancer” (Kistner, 2009). The awareness of cancer in the fire service is rapidly on the rise, but

it is necessary to do more than solely be aware of the threat that cancer poses. It is imperative that action be taken through education, procedural changes, and new policies in order to protect the firefighters who put their lives on the line to protect so many others.

The cancer awareness in the VTFD was heightened after a recent retiree was diagnosed with bladder cancer in 2013. This brought the harsh reality of cancer to Violet Township. It led the department to question the current practices that were in place for cancer prevention and many procedures were found lacking. This cancer diagnosis opened the door for others to come forth and the administration in the VTFD realized that this diagnosis was not an isolated cancer event. Other individuals within the department have had various forms of cancer, with the most predominant being skin cancer. After looking into this matter further, it was found that age and years of service did not have a linear correlation to cancer occurrence.

As a result of the cancer diagnoses within the VTFD, procedures and standard operating guidelines have been implemented to promote anti-cancer behaviors while on the job and also in the personal lives of the department's employees. Cancer education has been a focus and the VTFD is now very proactive in their approach to cancer and what must be done to keep the department's employees safe.

The potential impact this study could have on the VTFD is to educate the VTFD firefighters that cancer is a very real threat for all firefighters as well as creating procedures to mitigate the possible effects of carcinogen exposure.

LITERATURE REVIEW

A review of literature related to the exposure and effects of toxins and carcinogenic substances provided the basis for this research. These substances have proven relationships

showing the increase of certain cancers found in those who have worked for the fire service. The goal of this research is to break down the historical and traditional perceptions that wearing dirty personal protective equipment (PPE) is the sign of an experienced and veteran firefighter and educate on the risks of continuing with these hazardous practices (Willing, 2014). Traditionally within the fire service, the mark of an experienced firefighter was gauged by how dirty their gear appeared. The conclusion was drawn that if your bunker gear was clean, then you had not been fighting much real fire lately. This can no longer be seen as a badge of honor (Willing, 2014). What has been learned through recent research is that firefighters are exposed to a wide variety of toxins and carcinogens, and steps must be taken to reduce this type of exposure. Through wearing dirty turnout gear, firefighters are elevating their risk of contracting one or several of the known cancers that are more predominant amongst firefighters (Rivero, 2014).

While at work, firefighters are exposed to a variety of hazardous substances both at the fire scene and at the firehouse. After conducting a large meta-analysis of 32 cancer studies, LeMasters et al. (2006), stated that firefighters are exposed to various mixtures of particulates, gases, mists, fumes of an organic and/or inorganic nature, and pyrolysis products. Some of the specific potential exposures found on the fire scene included metals such as lead, antimony, cadmium, and uranium. Other exposures included chemical substances such as acrolein, benzene, methylene chloride, polycyclic aromatic hydrocarbons (PAHs), perchlorethylene, toluene, trichloroethylene, trichlorophenol, xylene, and formaldehydes. Lastly, firefighters are exposed to minerals such as asbestos, crystalline and noncrystalline silica, silicates, and various gases that may have acute toxic effects. Furthermore, according to LeMasters et al. (2006), exposures can occur not only on the fire scene but also in the firehouse through the presence of

complex mixtures that comprise diesel exhaust, particularly if the trucks are run in closed houses without adequate outside venting.

Based on the numerous toxic agents that firefighters come into contact with, links have been established showing an elevated risk of certain cancers amongst firefighters. The LeMasters et al. (2006) study divided the cancer risk levels into three categories: probable, possible, and unlikely. The data gathered from the LeMasters et al. (2006) meta-analysis was pulled from various studies that included firefighters with at least one year in service. The cancers that fell under the “probable” category were multiple myeloma, Non-Hodgkin lymphoma, and prostate cancers with a recommendation within the study to elevate testicular cancer to a probable likelihood. The cancer with a “possible” elevated risk included testicular, skin, malignant melanoma, brain, rectum, buccal cavity and pharynx, stomach, colon, and leukemia. All other types of cancer fall under the “unlikely” category (LeMasters et al., 2006). The meta-analysis study concluded that cancers falling into the risk category containing a high probability might be related to the direct effect associated with exposures to complex mixtures, the routes of delivery to target organs, and the indirect effects associated with the modulation of biochemical or physiologic pathways (LeMasters et al., 2006).

An additional, more recent, study researching cancer in firefighters agreed with many of the LeMasters et al. (2006) findings but listed some varying differences. The LeMasters et al. (2006) study was a cohort of 32 studies while the aforementioned study was conducted using data from firefighters working in departments in San Francisco, Chicago, and Philadelphia during the years of 1950-2009. According to Daniels et al. (2013), their findings were consistent with the LeMasters et al. (2006) study but several exceptions were noted. Daniels et al. (2013) found little evidence of excess cancers of the testes, brain, and lymphohematopoietic systems.

This evidence is contrary to what the LeMasters et al. (2006) study published. Daniels et al. (2013) also observed decreases in many non-malignant diseases that suggest improved health in firefighters compared with the general population. They attribute this to the health requirements necessary for entering and remaining in the fire service. Even though Daniels et al. (2013) feels that many firefighters have an improved health level, evidence still suggests an increase in overall cancer mortality and incidence. Another variation between the LeMasters et al. (2006) study and the Daniels et al. (2013) study is that Daniels et al. (2013) mentions that additional factors such as diet, obesity, physical activity, tobacco use, and alcohol consumption can potentially link to cancer risk beyond the danger of solely being exposed to toxins and carcinogens.

In addition to the cancers listed in the LeMasters et al. (2006) and the Daniels et al. (2013) studies, the Fire Cancer Support Network has compiled a list of frequently occurring cancers in the fire service. The following is a list of the ten most significant cancers and their associated risk factors (FCSN, 2013):

- Testicular cancer (2.02 times greater risk)
- Multiple myeloma (1.53 times greater risk)
- Non-Hodgkin's lymphoma (1.51 times greater risk)
- Skin cancer (1.39 times greater risk)
- Prostate cancer (1.28 times greater risk)
- Malignant melanoma (1.31 times greater risk)
- Brain cancer (1.31 times greater risk)
- Colon cancer (1.21 times greater risk)
- Leukemia (1.14 times greater risk)
- Breast cancer in women (preliminary study results from the San Francisco Fire Department)

This published list that details the increased cancer risk provides very concerning information and many current firefighters are unaware of the dangers that cancer poses to them.

Everyday at work, firefighters are exposed to many toxic substances. These toxins and carcinogens can be absorbed through the lungs or through dermal contact. Soot is a major cause of concern because after a fire scene, firefighters carry soot back with them on their faces, hands, and under their gear. LeMasters says soot is a group-one carcinogen, a top cancer-causing agent, that gets sucked into the body through the skin, particularly when firefighters sweat and their pores open (Bach, 2008). According to research presented by Baxter, toxic gases found in soot are carbon dioxide, carbon monoxide, hydrogen sulfide, and methane. When these chemicals are present in smoke and soot, they dissolve in oil, *not* water, and they are absorbed into the skin very quickly. Skin absorption varies with anatomical region, and as mentioned previously, absorption increases with temperature. Baxter also gives percentages on the increased level of absorption in key areas: scalp, 25 percent increase; forehead, 43 percent increase; jaw, 93 percent increase; and scrotum, 300 percent increase in absorption (Baxter, 2012). According to the Firefighter Cancer Support Network (FCSN), following the lungs, the skin is the body's second largest organ in area and it is highly absorptive. Some areas of skin are more permeable than others, specifically the face, the angle of the jaw, the neck and throat and the groin. Skin's permeability increases with temperature and for every five degrees of increase in skin temperature, absorption increases 400 percent (FCSN, 2013).

Personal Protective Equipment (PPE) plays a critical role in protecting firefighters from various hazards while they are at work. This gear, however, does have its limitations. PPE does not protect from fine particulate matter containing toxins and carcinogens. The FCSN states that the most permeable piece of PPE is the hood. Hoods are designed to protect the head and neck from heat, but they are not designed to stop skin absorption through the forehead, angle of the jaw, the neck, and throat (FCSN, 2013). Going into even greater detail, Dr. Baxter and the

University of Cincinnati, conducted chemical tests on firefighter's gloves, hoods, and coats for chemical compounds. Found in the PPE were plasticizers which cause testicular and prostate cancers and interfere with reproduction and development in animals. Alkyl phenols (plastic additives) also interfere with reproduction and development and polycyclic aromatic hydrocarbons (PAHs) caused lung and skin cancer in experimental animals (Baxter, 2012).

Turnout gear has several barrier layers of protection while a hood is composed of one or two layers of permeable fabric. It does not contain any type of moisture barrier, therefore, smoke, contaminants, and liquids are able to penetrate through the hood and come into contact with the skin (Lucas, 2015). The National Institute for Occupational Safety and Health (NIOSH) conducted a study utilizing controlled structure burns in order to determine what, if any, contaminants were being absorbed through firefighters skin and into their bodies. Each day samples of air, breath, urine, and wipes from skin were collected at various times during the burn. The firefighters were to work one controlled structure burn per day for the span of three days. The tests being conducted were designed to look for levels of polycyclic aromatic hydrocarbons (PAHs) and aromatic hydrocarbons in the air during firefighting. Tests also examined levels of PAHs on the firefighters' skin before and after firefighting in addition to checking the levels of PAHs and aromatic hydrocarbons in the firefighters' blood and urine before and after firefighting. The following list highlights some of the test results:

- PAH levels in the air were consistent with levels of other burn tests but several burns produced PAH levels that were higher than the occupational exposure limit.

- PAH levels remained above the occupational exposure limit during overhaul. This is a concern because some firefighters do not wear their self contained breathing apparatus (SCBAs) during overhaul.
- Aromatic hydrocarbons were at levels nearly 30 times the occupational exposure limit during burns. Benzene was the primary substance found.
- PAH levels on firefighter's necks were higher after just fighting the fires. This suggests that the PAHs came from the fires. No PAHs were detected in other areas of the skin outside of the neck.
- Levels of PAHs excreted in urine three hours post fire were higher than those excreted prior to or just after firefighting suggesting that PAHs enter the firefighters' bodies through their skin.
- Benzene was measured on firefighters' breath at a higher level after firefighting. No benzene was detected in urine. This suggests that the level of aromatic hydrocarbons entering the firefighters' bodies was low.

The study also noted that turnout gear would off-gas aromatic hydrocarbons, such as benzene, toluene, xylene, and styrene, into the air for at least twenty-five minutes or longer after the fire fighting was completed. These findings provide more conclusive evidence that turnout gear is subject to contamination. This contamination elevates firefighter's risk for coming into contact with carcinogens (Fent, Eisenberg, Evans, Sammons, 2013).

The link between dermal absorption through PPE shortcomings is cause of great concern because it is something that has not been historically recognized in the fire service. As stated by the FCSN, although most fire departments are responding to fewer fires than in the past, the

amount of exposure time has increased due to the limited number of available firefighters, either due to budget cuts, staffing reductions, or the availability of volunteers. Today's fires grow at a much more rapid rate than yesterday's fires all the while exposing firefighters to significantly increased concentrations of highly carcinogenic agents. Today, residential fires have more in common with hazmat events than old-fashioned house fires. Today's homes utilize many plastics and synthetics in building materials and furnishings as opposed to older homes that contained primarily wood, cotton, and wool. Commercial and vehicle fires have highly concentrated toxins and dumpster fires contain completely unknown substances and toxins (FCSN, 2013).

With the statistics that have been presented linking cancer to firefighters, some recommendations have been provided by the FCSN for immediate and long-term steps for post exposure protocol. Some of the recommendations are as follows (FCSN, 2013):

1. Use SCBA from initial attack to finish of overhaul.
2. Do gross field decontamination of PPE to remove as much soot and particulates as possible.
3. Use Wet-Naps or baby wipes to remove as much soot as possible from head, neck, jaw, throat, underarms, and hands immediately and while still on the scene.
4. Change your clothes and wash them immediately after a fire.
5. Shower thoroughly after a fire.
6. Change your PPE, gloves, hood, and helmet immediately after a fire.
7. Do not take contaminated clothes or PPE home or store it in your vehicle.
8. Decontaminate fire apparatus interiors after fires.
9. Keep bunker gear out of living and sleeping quarters.
10. Stop using tobacco products.
11. Use sunscreen or sun block.

Some of these recommendations may seem rather simple, but it is in the best interest of everyone involved to decrease the impact of cancer through proactive and aggressive approaches to reduce the amount of exposure to carcinogens.

With the toxic substances that Dr. Baxter, the University of Cincinnati, and NIOSH found present in personal protective equipment, it is even more important to follow smart practices regarding the storage, cleaning, and maintenance of PPE. Document 1851 published by the National Fire Protection Agency (NFPA), is the standard on selection, care, and maintenance of protective ensembles for structural fire fighting and proximity fire fighting. This document is the absolute guide that all fire departments must comply with regarding PPE. However, it provides only minimum guidelines that are sometimes contrary to the recommendations presented by many of the cancer researchers. NFPA 1851 states that after any incident involving the soiling of PPE, the gear should receive light cleaning which involves brushing the material of any dried substances, rinsing the gear with a hose, or isolated spot cleaning. This type of cleaning specified by NFPA 1851 does not take the garment out of service. The NFPA also states that advanced cleaning should be done twice a year according to manufacturer specifications. Advanced cleaning involves disassembling the individual components of the garment for thorough cleansing. By definition, advanced cleaning involves washing the garments with a cleaning solution by hand, machine, or contract cleaning and it will take the garment out of service temporarily. While these are all good practices, the research being done in conjunction with cancer risk in the fire service indicates that these practices are not sufficient (NFPA, 2014). A direct quote from the article written by Bach (2008) most appropriately sums up the hazards of wearing dirty PPE and not exercising good hygiene after coming into contact with soot and chemicals. "We are concerned that though firefighters may have respiratory protection, they really aren't getting adequate protection from absorption of these compounds through their skin," says LeMasters. "A lot of firefighters have told me that they come back from fires covered in soot. Often times they are too tired to shower. They will just fall into their beds and go to sleep."

She says many firefighters have only one set of gear. And when they respond to a second alarm before their protective clothing is washed, they are slipping back into contaminated clothes. "We have to make sure that firefighters remove all the soot from their body as soon as possible," LeMasters says. "And we can afford to buy firefighters two sets of turn-out gear to go out and fight these fires. All firehouses have to make the investment in the health of their firefighters by making some relatively simple changes" (Bach, 2008).

Additionally, NFPA 1851 gives specifics for the storage of PPE. The gear is to be stored in a well-ventilated, dark room away from any source of UV light. If a dark room is not available, a storage bag is recommended. The primary goal is to avoid UV light contamination. According to the FCSN, the storage of PPE can be a very significant issue for volunteer fire departments. Many times volunteers carry their PPE in their vehicles. This method of transportation facilitates the off-gassing of toxins and carcinogens especially when environmental heating occurs. Regardless of whether the fire department is comprised of volunteers or career firefighters, PPE should not be carried in personal vehicles. Ideally, PPE should be transported on the fire apparatus in sealed duffle bags or large, sealed, "Rubbermaid-style" tubs and then only transported back to the fire station for washing, cleaning, and decontamination (FCSN, 2013).

Currently, NFPA 1851 is the only official document that covers how to clean, store, repair, and track PPE. The NFPA 1851 document is *only* a guideline, however, and no official tracking or monitoring is conducted outside of the internal department.

The study of cancer risk amongst firefighters is relatively recent in scope. Difficulties have arisen during these studies due to the lack of exposure reporting that is conducted by fire

departments. The study conducted by Daniels et al. (2013) utilized morbidity statistics due to the lack of exposure reporting. According to the FCSN, many departments across the country have some basic form of exposure reporting but it needs to be refined in order to create a good tracking database. At this time, there are no national guidelines for the collection and reporting of exposures to toxins, carcinogens, or tumor-producing agents. Exposure reporting guidelines exist for hazmat incidents, but guidelines need to be developed and implemented for exposure to chemicals, toxins, and carcinogens from incidents other than those covered by traditional hazmat guidelines. The International Association of Firefighters (IAFF) has started a voluntary tracking program with the hopes of national implementation for firefighter cancer tracking. At this time, only union members and their families can register data on the IAFF website. Although this is a step in the right direction for cancer tracking, it represents only a small population of firefighters throughout the United States. However, in Queensland, Australia, a statewide electronic cancer registry for firefighters has existed since 1995. This registry has proven to be very beneficial when conducting cancer studies in firefighters. In 2007, an increase in brain cancer was noted within the Queensland Fire and Rescue Service and they were able to utilize this cancer database to research the issue (Glass et al., 2009). Due to the variant latency period between exposure to toxins and carcinogens, and the actual cancer diagnosis, it is even more important to have a good record of what individual firefighters have come into contact with during their time in the fire service (FCSN, 2013).

The literature review suggests that further studies need to be conducted within the fire service to gauge the level of cancer awareness and safety practices with regard to cancer prevention. How often is PPE cleaned and what cleaning methods are utilized? How many active firefighters have already suffered from a cancer diagnosis? Are adequate methods in place

to track potential exposure to carcinogens? Although the literature review strongly suggests that cancer is a growing issue and risk for the fire service, it is now necessary to delve into finding answers to these questions at a department and regional level. Finding answers to these questions is what has influenced the design of this research project in order to help the VTFD, and potentially other fire departments, make adaptations to their current policies in order to reduce the amount of potential cancer amongst their firefighters.

PROCEDURES

The research design consisted of three different sections. The first section was the largest survey targeting departments within the Metropolitan Emergency Communications Center (MECC) district, which includes the VTFD. This survey focused on collecting data regarding cancer incidence in those departments, PPE cleaning, and exposure tracking systems. The second survey polled the Ohio Fire Chiefs, reaching a geographically broader audience, and looked into the existence of exposure tracking systems throughout the State of Ohio. The third section was an internal survey of the firefighters working for the VTFD. This survey looked at the level of cancer incidence within the VTFD and a follow-up personal survey was conducted with willing participants.

The literature review provided the motivation for the questions that were asked in the surveys. Throughout the literature review, many of the studies were very broad in scope and the goal of this research project was to collect data that would be more applicable to the VTFD. In order to collect this information, it was deemed useful to look at data gathered from the state of Ohio. To amass the most pertinent data, surveys were conducted in a tiered system where each survey group became narrower in scope.

The MECC district is made up of six different departments. These departments are from the same geographic region and are of similar size and scope to the VTFD. The total survey pool was 385 firefighters. The departments that fell into the MECC district are the Violet Township Fire Department, Truro Township Fire Department, Jefferson Township Fire Department, the City of Whitehall Fire Department, Mifflin Township Fire Department, and Plain Township Fire Department. An online survey utilizing the Google Document survey tool was the chosen method of data collection and the questions asked in the survey related to all three research questions. The goal of this survey method was to pull a cross section of information from the MECC region and compare it to national data and statistics.

The second survey was sent out to 590 fire departments throughout the State of Ohio. This survey was sent to Ohio Fire Chiefs, or department heads, and it was briefer in scope, focusing only on methods of tracking exposure. This survey was conducted utilizing the survey tool within Google Documents.

The final segment consisted of a survey through Google Documents aimed at pinpointing individuals within the VTFD that have had some form of cancer. Surveys were sent out to 85 individuals throughout the department. Based on the information retrieved from this survey, individual interviews were conducted with those members of the VTFD were willing to participate. This helped isolate the cancer issues within the VTFD and compare it to the national average.

Definition of Terms

- Carcinogen: A substance capable of causing cancer in living tissue.

- FCSN: Fire Cancer Support Network. A group whose goal is to provide timely assistance to all fire service members and their families in the event of cancer diagnosis. The FCSN also provides awareness to fire service members and their families about the importance of cancer prevention and screening by coordinating educational opportunities with various health programs.
- IAFF: International Association of Fire Fighters. The IAFF represents more than 300,000 full-time professional fire fighters and paramedics in more than 3,100 affiliates. IAFF members protect more than 85 percent of the population in communities throughout the United States and Canada.
- MECC: Metropolitan Emergency Communications Center. A dispatch center that covers six departments on the east side of Columbus, OH. Along with the dispatch communication, the MECC sets standards for EMS and fire protocols.
- Meta-Analysis: A quantitative statistical analysis of several separate but similar experiments or studies in order to test the pooled data for statistical significance.
- NFPA: National Fire Protection Association. NFPA is an association that delivers information and knowledge through more than 300 consensus codes and standards, research, training, education, outreach and advocacy.
- NFPA 1851: National Fire Protection Association Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting.
- Polycyclic aromatic hydrocarbons (PAHs): PAHs are a group of organic contaminants that form from the incomplete combustion of hydrocarbons, such as coal and gasoline.

PAHs are an environmental concern because they are toxic to aquatic life and because several are suspected human carcinogens.

- PPE: Personal Protective Equipment. PPE is designed to protect firefighters from serious injuries or illnesses resulting from contact with chemical, radiological, physical, electrical, mechanical or other hazards. It covers a variety of devices and garments such as respirators, turnout gear, gloves, blankets and gas masks.
- Turnout Gear: A term that is synonymous with PPE. Turnout gear consists of any equipment that a firefighter wears for protective purposes such as a helmet, hood, coat, pants, gloves, and boots.
- UV: Ultraviolet rays are described as rays of light that cannot be seen by the naked eye.
- VTFD: The Violet Township Fire Department provides professional emergency medical and fire service utilizing a combination of full time, part time, and volunteer firefighters. The Violet Township Fire Department responds to more than 5000 fire and emergency runs each year. Our service area is approximately 41 square miles located in northwest Fairfield county (OH), with a population of more than 39,000 residence.

Limitations of the Study

- This study was designed to benefit the Violet Township Fire Department. The study results may not accurately portray other fire departments in different areas of the country.
- This study primarily focused on the risk of cancer to firefighters through wearing contaminated PPE. It did not take into account cancer risk and or diagnosis due to family history of cancer or lifestyle preferences of those who participated in the survey.

RESULTS

Three surveys were sent out to various groups. The first survey was sent to the MECC agencies and consisted of 22 questions that identified the level of cancer awareness among the MECC members. Additionally, the study looked at analyzing department practices for PPE cleaning and storage along with researching exposure-tracking methods. This survey was sent to 382 firefighters and 98 responded with a survey participation rate of 25.7%. The second survey was sent to the Ohio Fire Chiefs and asked 4 questions based on exposure tracking. Five hundred and ninety surveys were distributed and 170 responses were received with a participation rate of 28.8%. The third and final survey was an internal survey of the VTFD firefighters that consisted of 7 questions that primarily looked at personal cancer diagnoses. Out of the 75 surveys sent out, 20 VTFD members responded bringing the participation rate of the third survey to 26.7%. This internal survey did not support any of the Research Questions, however, it contained useful data reflecting the significance of cancer awareness in the VTFD.

The first research question sought to explore the link between exposure to carcinogens at fire scenes and the risk of exposure from wearing contaminated PPE. This question was answered based on information described in the Literature Review. The studies of Baxter (2012), Daniels et al. (2013), FCSN (2013), and LeMasters et al. (2006) support the relationship of an increased risk of carcinogen exposure as well as an increased cancer risk from contact with contaminated PPE.

The second research question sought to define the national and/or state guidelines for cleaning contaminated PPE. The Literature Review determined that NFPA 1851 is the sole guideline for PPE care, maintenance, and storage. The survey sent to the MECC agencies questioned participants on PPE cleaning and storage. The survey results supported that the

MECC group is abiding by and exceeding NFPA 1851 standards. Out of the 98 firefighters who responded to the survey, 83 (84.7%) stated they wash their gear after every fire, 5 (5.1%) wash their gear every six months, and the remaining 10 (10.2%) listed "Other" as their response. A follow-up question asked if they felt gear should be washed after every fire. Ninety-seven (99%) firefighters selected "Yes" and 1 (1%) firefighter responded "No". The survey also asked the MECC Agencies how their gear was cleaned. The results showed 97 (99%) of the firefighters polled use a commercial extractor and follow the NFPA 1851 guidelines. The remaining 1 (1%) indicated they utilize a contract-cleaning agency.

A third survey question for the MECC agencies polled the firefighters on what items of PPE they clean following a fire. The survey participants noted their coat, pants, and hood were washed 100% of the time. They reported their gloves were only washed 93.9% of the time, helmets were washed with a regularity of 66.3%, and boots were cleaned 54.1% of the time. The article of PPE receiving the least amount of cleaning was the helmet liner with a 53.1% occurrence (See Appendix 1).

The third and fourth research questions asked if departments had a practice in place for tracking potential exposure to contaminants and cancer occurrences in their firefighters. This research question was posed and answered through the survey that was sent to the Ohio Fire Chiefs as well as from information presented from the FCSN, listed in the literature review. The survey asked the Ohio Fire Chiefs if their departments had a current exposure tracking system in place. Out of the 170 responses, 104 (61.2%) stated they currently had a system, while 66 (38.8%) did not. The majority of the departments who utilized a tracking system kept a paper database 50 (75.8%) followed by an online database 25 (37.9%). The Ohio Fire Chiefs were also questioned on where exposure records were kept. Thirty-two (48.5%) departments store the

records in the firefighter's personnel file, 18 (27.3%) are kept in a medical file, and "Other" was the remaining 21 (31.8%) (See Appendix 2).

DISCUSSION

Cancer is not an unknown entity to the majority of the general public. Most people at some point in their lives have been affected by cancer whether it was a relative, co-worker, friend, or they may have only known of someone dealing with cancer. The same could be said of the fire service. Many firefighters have known a co-worker or someone from a neighboring department who has battled cancer. The scary reality is that research has shown and is continuing to show that there is a very real correlation between cancer and the fire profession. The topic of cancer in the fire service has been elevated to the national stage of media attention and a great deal of concerning information has been presented over the last five years.

In two of the surveys, the MECC group and the VTFD were polled on personal experiences with cancer (See Figure 1). Out of 118 individuals that chose to respond to the survey, 14 shared that they have had various forms of skin cancers and melanomas along with one report of thyroid cancer and once diagnosis of Hodgkin's Lymphoma. Referring back to the studies denoted in the literature review, these survey results mirror the results found in the LeMasters et al. (2006) study. LeMasters found that Non-Hodgkin's Lymphoma was categorized as a "probable" cancer risk while skin and malignant melanoma were "possible" risks (LeMasters et al., 2006). The survey results are also relevant to the list compiled by the FCSN of frequently occurring cancers in the fire service. The FCSN stated that firefighters are at a 1.51 greater risk for Non-Hodgkin's Lymphoma, 1.39 greater risk for skin cancer, and 1.31 greater risk for malignant melanoma (FCSN, 2013). Although, the MECC and VTFD surveys

were small in scale, these surveys do show similar results to the large-scale study completed by LeMasters.

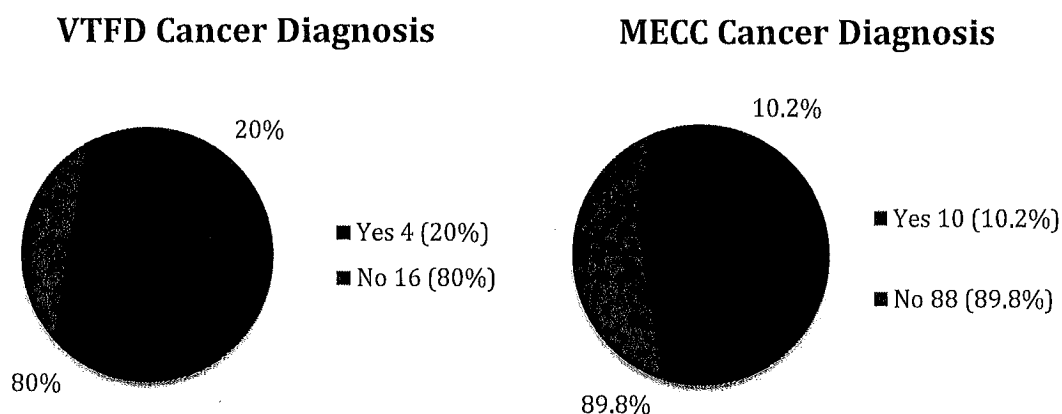


Figure 1. Cancer Results

In the surveys of the MECC group and the Ohio Fire Chiefs, each group was asked if their departments had an exposure tracking system in place. Based on the survey responses, significant deficiencies were noted (See Figure 2). Less than half of those surveyed had exposure tracking systems in place within their departments. Throughout the course of research for this research project, it was found that there is a substantial lack of exposure reporting in the fire service. For example, the LeMasters and Daniels studies utilized morbidity statistics instead of exposure documentation to back the research findings (LeMaster et al., 2006; Daniels, 2013). The FCSN states that there is no national reporting database for firefighters (FCSN, 2013). Information drawn from exposure records would provide beneficial information to determine cancer risk factors for firefighters. With this knowledge, individual departments, firefighters, and researchers could be more aware of the hazardous substances and exposures that are relevant to fire ground operations and have a detailed history on every firefighter. Therefore, in the event of a cancer diagnosis, referencing the exposure records could provide assistance towards medical

benefits.

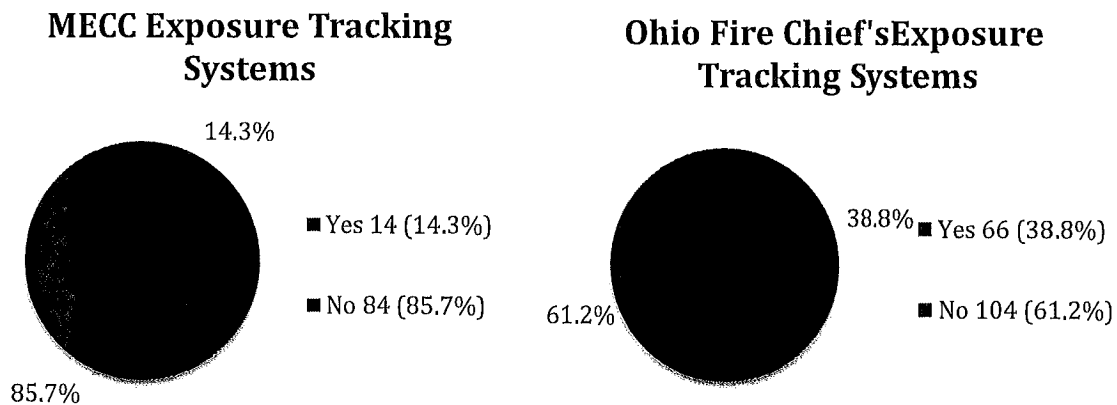


Figure 2. Exposure Tracking Survey Results

On a more positive note, the MECC survey showed a high level of awareness of the topic of cancer in the fire service. Of the 98 respondents, 90 (91.8%) were “aware” and 8 (8.2%) were “somewhat aware” that firefighters are at a higher risk for developing certain cancers. Although the awareness of cancer is high, the behavior patterns do not always reflect that the firefighters truly understand that they are at a higher risk for cancer. Based on the survey responses to the question of what articles of gear get cleaned, the respondents do an excellent job cleaning the pants, coats, hoods, and gloves (See Appendix 1, Figure D). The articles that lack regular cleaning attention are the helmet, helmet liner, and boots. From information presented in the literature review, Baxter’s research outlined the increased percentages of dermal absorption based on temperature as well as his findings that coats, hoods, and gloves contained cancer causing chemicals post contamination (Baxter, 2012). Although Baxter’s research did not include the testing of helmets, helmet liners, and boots, it would reasonable to say that all contaminated or dirty gear poses a risk for potential dermal absorption.

RECOMMENDATIONS

Recommendations for reducing potential cancer causing risks that will guide the Violet Township Fire Department to an increased level of cancer awareness and prevention.

- *Continue cancer awareness and education within the VTFD.* The VTFD began a cancer outreach partnership with the Ohio State University Occupational Health Department. This partnership has provided cancer awareness over the past two years in the form of quarterly training events and educational seminars. The VTFD, along with Truro Township Fire Department and the City of Worthington Fire Department, has an additional opportunity to participate in joint cancer research through the James Cancer Hospital in Columbus, OH. These partnerships provide a great opportunity for the VTFD to continue to educate about cancer awareness and prevention.
- *Ensure compliance with the eleven FCSN recommended cancer practices (FCSN, 2013).* The FCSN guidelines have been briefly discussed within the VTFD but the recommended practices need to become documented in our department policies.
- *Improve current exposure tracking methods.* The current exposure form needs to be reevaluated for validity, necessary adjustments made, and determine the best method of exposure record keeping whether it be paper format or online.
- *Reevaluate NFPA 1851 and the compliance to these standards within the department.* The current gear cleaning practices within the VTFD need to be assessed to ensure that current practices follow NFPA 1851 guidelines. One potential course of action is to weigh the effectiveness of utilizing an independent service provider versus in-house turnout gear care and inspections.

- *Implement a second set of turnout gear for all firefighters.* Through the literature review, a second set of turnout gear was listed as being an effective method of reducing firefighter exposure to contaminants. A cost analysis is necessary to ensure proper budgeting for future gear acquisition as well as development of a gear implementation program.
- *Initiate a hood exchange program.* A hood exchange program would allow firefighters access to clean hoods upon returning from an event where there was potential contamination. An excess of hoods would always ensure that clean hoods are available.
- *Enforce wearing of the full PPE complement for all fire ground operations.* Update the fire ground policy to reflect this change from current policy.
- *Diesel particulate capturing device.* Analyze current station design for effectiveness of current diesel removal system. Explore options for enhancement of the current system and research any costs associated with system upgrades.
- *Annual dermatology appointments.* The VTFD currently provides annual physicals to all department members. Based on the statistics regarding the high risk of skin cancer in firefighters, encourage the department to add a dermatology exam to the current annual physical.

Although cancer awareness is on the rise in the fire service, a cultural change has to be accepted in order to truly make an aggressive step in reducing cancer risk for firefighters. New cancer studies conducted on firefighters have increased rapidly over the last year and the cancer statistics are truly scary. Many firefighters may feel as though these statistics do not apply to them because they are young and healthy. That mentality must essentially change in order for the future generation of the fire service to develop and succeed. The practice of wearing

contaminated fire gear to show an individual's level of experience must change in order to continue the rich history and tradition of an honored profession.

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APPENDIX 1 – MECC AGENCY PPE CARE AND MAINTENANCE

Figure A. How often does your gear get cleaned?

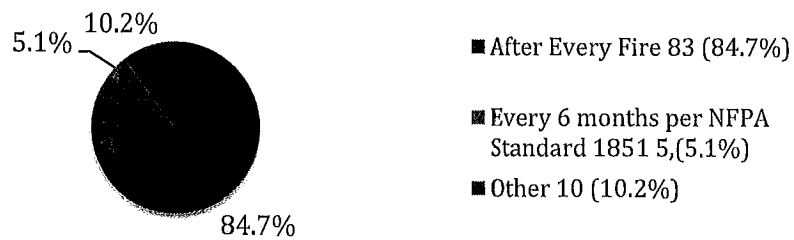


Figure B. Do you feel that gear should be washed after a fire?



Figure C. What cleaning method do you use to wash your gear?

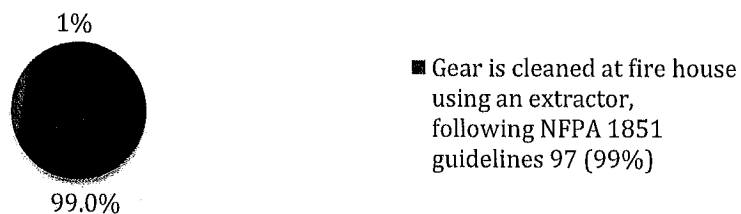
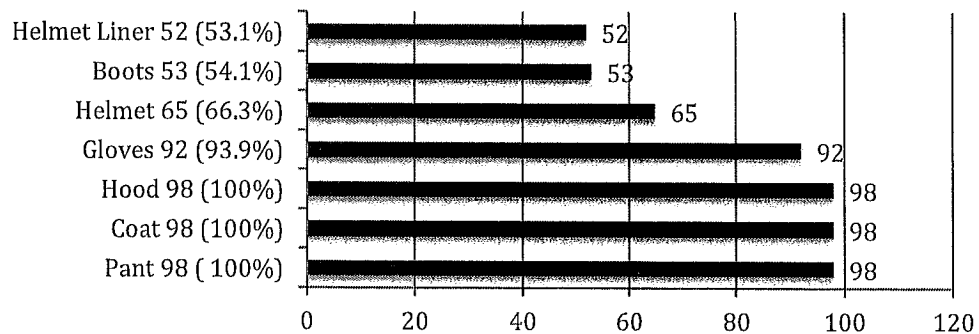


Figure D. When you clean your gear, what items get cleaned?



APPENDIX 2 – OHIO FIRE CHIEF EXPOSURE TRACKING

Figure A. Does your department have any kind of exposure tracking system in place?

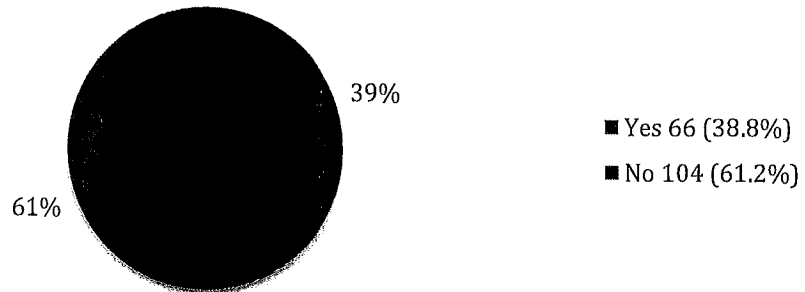


Figure B. What kind of tracking system does your department utilize?

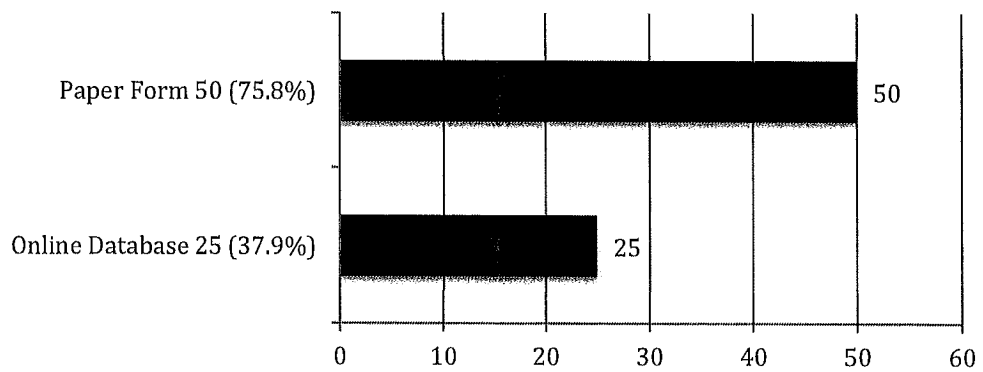
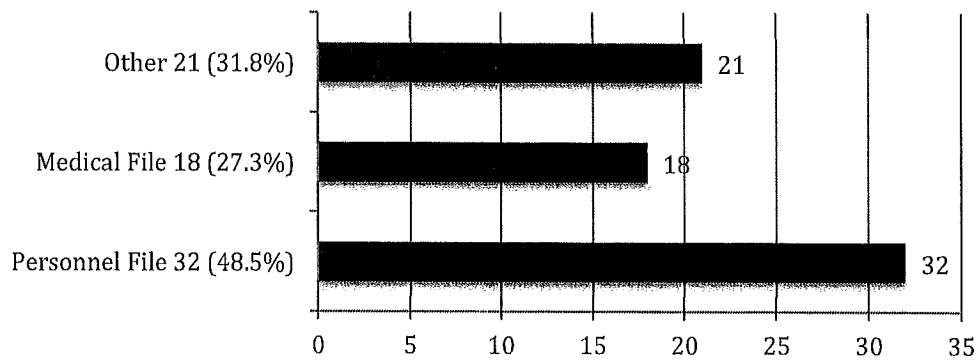


Figure C. Where are your department's exposure records kept?



APPENDIX 3 – VTFD INTERNAL CANCER SURVEY

- 1. How old are you?**
- 2. What is your gender?**
 - Male
 - Female
- 3. How many years have you worked in the fire service?**
 - 1-5
 - 6-10
 - 11-15
 - 16-20
 - 21-25
 - 26-30
 - More than 30 years
- 4. Have you ever had a cancer diagnosis since entering the fire service?**

This does include any type of skin cancer.

 - Yes
 - No
- 5. If you have had a confirmed cancer diagnosis, what type(s) were you diagnosed with?**
- 6. Have you had any subsequent cancer occurrences or relapses?**
 - Yes
 - No
- 7. Would you be willing to respond to a follow-up interview? If so, please share your name.**

This could be conducted in person or via phone call. All information will be kept confidential.

APPENDIX 4 – CANCER SURVEY FOR MECC AGENCIES**General Information**

- 1. How many years of service do you have in the fire service?**
 - 1-5 years
 - 6-10 years
 - 11-15 years
 - 16-20 years
 - 21-25 years
 - 26-30
 - More than 30 years of fire service

- 2. What is your gender?**
 - Male
 - Female

Cancer Awareness

- 3. What is your level of awareness that firefighters are at a higher risk for contracting cancer?**
 - Aware
 - Somewhat aware
 - Not at all aware

- 4. Has your department made mention of the growing concern of firefighter cancer?**
 - Yes
 - No

- 5. Has your department provided any cancer awareness education?**
 - Yes
 - No

- 6. Have you ever been diagnosed with any type of cancer since entering the fire service?**
 - Yes
 - No

- 7. Please share what type of cancer you were diagnosed with.**

- 8. During your annual department physical, are any of the following items done?**
Please select all answers that apply
 - General physical exam
 - PSA test (prostate screening)
 - Dermatology testing
 - My department does not offer an annual physical exam

APPENDIX 4 (CONTINUED) – CANCER SURVEY FOR MECC AGENCIES**9. Post fire exposure, do you do any of the following actions?**

Please select all answers that apply

- Use baby wipes to remove soot from body
- Shower upon returning to quarters
- Decontaminate truck cab
- Switch to a second set of turn out gear

10. Are you aware that Ohio has a Firefighter Cancer Support Network (FCSN)?

- Yes
- No

PPE Cleaning and Storage**11. How many sets of issued gear do you have?**

- 1 set
- 2 sets
- More than 2 sets

12. How often does your gear get cleaned?

- After every fire
- Every 6 months per NFPA standard 1851
- Other:

13. Do you feel that gear should be washed after a fire?

- Yes
- No

14. What cleaning method do you use to wash your gear?

- Gear is cleaned at fire house with residential washing machine
- Gear is cleaned at fire house using an extractor, following NFPA 1851 guidelines
- Gear is cleaned through a contract cleaning service
- Gear is washed at home

15. When you clean your gear, what items get cleaned?

Please select all items that apply.

- Pant
- Coat
- Gloves
- Helmet
- Helmet Liner
- Hood
- Boots

APPENDIX 4 (CONTINUED) – CANCER SURVEY FOR MECC AGENCIES**16. Where is your gear currently stored?**

- Apparatus Bay
- Designated gear room/locker
- Personal Vehicle
- Other:

Exposure Tracking**17. Are you aware that the IAFF has an electronic cancer reporting system for their members and immediate families?**

- Yes
- No

18. Have you ever used the IAFF online electronic reporting system?

- Yes
- No

19. Does your department have any kind of exposure tracking system in place? For example, are you able to log events where you have come into contact with fire, smoke, and/or soot?

- Yes
- No

20. What kind of tracking system does your department utilize?

Please select all answers that apply.

- Online database
- Paper form
- Other:

21. Do you consistently fill out your exposure log?

- Yes
- No

22. Where are your exposure records kept?

Please select all answers that apply.

- Personnel file
- Medical file
- Other:

APPENDIX 5 – OHIO FIRE CHIEFS' EXPOSURE TRACKING SURVEY

- 1. Does your department have any kind of exposure tracking system in place? For example, are you able to log events where you have come into contact with fire, smoke, and/or soot?**
 - Yes
 - No

- 2. What kind of tracking system does your department utilize?**

Please select all answers that apply.

 - Online database
 - Paper form
 - Other:

- 3. Where are your department's exposure records kept?**

Please select all answers that apply.

 - Personnel file
 - Medical file
 - Other:

- 4. Are you aware that the IAFF has an electronic cancer reporting system for their members and immediate families?**
 - Yes
 - No