Cancer Rates in Children of Kitsap County Firefighters

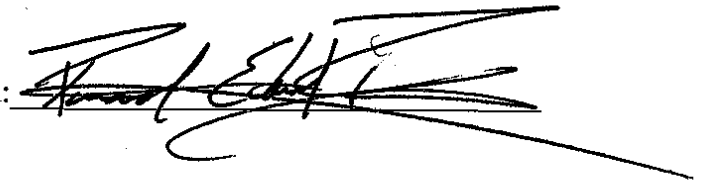
Ronald E. Powers

South Kitsap Fire Rescue

Port Orchard, Washington

CERTIFICATION STATEMENT

I hereby certify that this paper constitutes my own product, that where 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.

Signed: 

Abstract

The problem was in Kitsap County children of local firefighters have been diagnosed with cancer. The purpose of this research is to determine if cancer rates are higher for children of career firefighters in Kitsap County. This applied research project (ARP) utilized a combination of quantitative and descriptive methodology to answer the following four research questions: (a) What is the probability for children to be diagnosed with cancer? (b) What is the probability for children of career firefighters in Kitsap County to be diagnosed with cancer? (c) What are the potential causes of increased risk of cancer for children of firefighters? (d) What recommendations should be implemented to address the problem? A literature review was used to establish a foundation for the subject matter. The quantitative methodology was used to answer the first two research questions. The descriptive methodology included an organizational case example conducted with a firefighter's family whose child was diagnosed with cancer, as well as personal interviews with chief officers from each of the six departments in Kitsap County. Through this research it was determined that there is a 0.0179% chance a child will be diagnosed with cancer in the U.S. whereas a child of a Kitsap County (KC) career firefighter has a 0.49% chance of getting cancer. This probability is 27.4 times higher than that of the general population of children. The potential solution to decrease the risk for children of Kitsap County firefighters includes implementing a countywide wellness task force and training programs, as well as policies and systems to help mitigate exposures.

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Cancer Rates in Children of Firefighters in Kitsap County

Over the last nine years, three children of Kitsap County career firefighters have been diagnosed with cancer. There are 306 career firefighters, working with an additional 172 volunteer firefighters within Kitsap County. There are no reported cases of cancer among the volunteers' children.

The problem is children of local firefighters have been diagnosed with cancer. The purpose of this research is to determine if cancer rates are higher for children of career firefighters in Kitsap County.

This applied research project (ARP) utilizes a combination of quantitative and descriptive methodology to answer the following four research questions: (a) What is the probability for children to be diagnosed with cancer? (b) What is the probability for children of career firefighters in Kitsap County to be diagnosed with cancer? (c) What are the potential causes of increased risk of cancer for children of firefighters? (d) What recommendations should be implemented to address the problem?

Cancer is one of the most frightening terms in the human language. Cancer is considered a "death sentence" as well as a long road through a medical maze of test, medications, treatment, and recovery (Ortiz, 2012, p. 11). Cancer creates an intellectual, emotional, physical, and financial burden on the families and patients of those affected (Anonymous, personal communication, January 23, 2015).

One local firefighter explained the war on cancer to his son with these words:

> I told C that there is two different types of cancer. There's cancer that you can beat and cure and there's cancer that you cannot. Your type of cancer, they can cure. But, it's

> going to be a fight. It's going to be *your* [emphasis added] fight. (Anonymous, personal communication, January 23, 2015)

This research project focuses on a risk reduction strategy for the local Kitsap County firefighter community in an effort to bring awareness, to identify potential causes, and to offer reasonable and practical solutions.

Background and Significance

Kitsap County is composed of six fire districts serving a total population of 253,968 including 59,993 under the age of 20 (United States Census Bureau, 2013). These six departments are comprised of 478 firefighters of which 306 are full-time career staff and 172 are volunteer staff (Appendix A). Three children of Kitsap County career staff members, all under 18 years old, have been diagnosed with cancer (Anonymous, personal communication, December 19, 2013). In 2005, one of the children was diagnosed with hepatoblastoma (Anonymous, personal communication, January 28, 2015). In 2008, a second child was diagnosed with Acute Lymphoblastic Leukemia (ALL; Anonymous, personal communication, January 5, 2015). Finally, in 2011, another child was diagnosed with a non-Hodgkin's lymphoma known as Burkitts (Anonymous, personal communication, January 23, 2015).

Over the last 41 years, the fire service has taken great strides to understand, implement safety programs, and pass comprehensive presumptive legislation that recognizes the carcinogenic risk factors associated with the profession (Abrams, 1974; IAFF Firefighters, 2015). Based on a 2013 NIOSH report, firefighters are 1.47 (brain/nervous system) to 2.43 (esophagus) times more likely to develop various forms of cancer (Daniels, et al., 2013). Presumptive law coverage for cancer now exists in 33 states (IAFF Firefighters, 2015).

The US Census Bureau estimates there are 72 million children under the age of 18 in the United States (United States Census Bureau, 2014). Surveillance, epidemiology, and end results program (SEER; n.d.) indicates there are 17.9 incidents of cancer for every 100k children (ages 0-19). These statistics set a baseline indicating approximately 1.79 children (through age 19) out of 10,000 will be diagnosed with cancer.

This is an extremely sensitive subject and many fire service members have lost colleagues, friends and family members to this tragic disease. The very thought of dangers associated with the profession being extended to one's children will "undermine the protective cocoon of the person" (Small, 2003, p. 52). When a child is diagnosed, it is a catastrophic blow to those who care for and love the child (American Cancer Society, 2015a).

Applied Research Project Linkage and Goals

In an effort for the researcher to contribute to the fire service literature, it was determined that within the collection of 7000 published ARP's, no work had been conducted regarding this problem (observation, May 25, 2014).

***Significance to organization*.** This applied research project (ARP) is designed to support South Kitsap Fire and Rescue (SKFR) organizational effectiveness through:

- Supporting the mission defined as, "To prevent the loss of life and property resulting from fire, medical emergencies, and other disasters while continually striving to meet the future needs of the citizens, *in a climate which supports and maintain District personnel in a quality environment [emphasis added]*." (South Kitsap Fire, 2010, p. 1)

Executive Analysis of Community Risk Reduction (EACRR) course content. Support the EACRR primary course goal defined as:

- Empower the Executive Fire Officer (EFO) with the ability to lead community risk reduction in a strategic manner. (Federal Emergency Management Agency [FEMA], 2012, p. 1-7)

- Cancer diagnoses in children is a significant public health concern because of the tremendous physical and emotional stress placed on the child and family, as well as the significant impact on health, economic, and social welfare systems. (Badham, 2009, p. 9)

***U.S. Fire Administration's [USFA] strategic goals*.** Uphold the *USFA Strategic Plan* by supporting:

- Goal 1: Reduce the risk at the local level through prevention and mitigation.

- The objective of strategic initiative number one is stated as, “Encourage the State, local, and tribal adoption of risk reduction, prevention, mitigation, and safety strategies.” (United States Fire Administration [USFA], 2010, p. 13, 18)

Literature Review

This section reviews the literature relevant to this applied research project. Several concepts were reviewed including: cancer, carcinogens, exposure routes, personal protective clothing, childhood cancer, and preventative measures. The objective of the literature review is to establish a foundation for the subject matter that would assist the researcher in answering the following four research questions: (a) What is the probability for children to be diagnosed with cancer? (b) What is the probability for children of career firefighters in Kitsap County to be diagnosed with cancer? (c) What are the potential causes of increased risk of cancer for children of firefighters? (d) What recommendations should be implemented to address the problem?

Over the last 41 years, the fire service has taken great strides to understand, implement safety programs and pass comprehensive presumptive legislation that recognizes the carcinogen risk factors associated with the profession (Abrams, 1974). Based on a 2013 NIOSH report, firefighters are 1.47 (brain/nervous system) to 2.43 (esophagus) times more likely to develop various forms of cancer (Daniels, et al., 2013). Presumptive law coverage for cancer now exists in 33 states (IAFF Firefighters, 2015).

Epidemiology of Cancer

Cancer is one of the most frightening terms in the human language. Cancer is considered a “death sentence” as well as a long road through a medical maze of tests, medications, treatment, and recovery (Ortiz, 2012, p. 11).

The body is a complex organism composed of cells, which are continually dividing and recreating. The programming of cell reproduction is contained in the DNA. Zimmer (2013)

shares that researchers and scientist have calculated that the human body is composed of 37.2 trillion cells. Paulson (2007) explains how these cells reproduce:

> The cell division cycle is usually divided into four distinct phases, G1 (gap 1), S (synthesis), G2 (gap2) and M (mitosis) phases (Sherr and Roberts, 1999). Gap phases allow cells time to grow and double their mass of proteins and organelles in order to replicate their DNA and divide. DNA duplication occurs during S phase, which requires 10-12 hours and occupies about half of the cell cycle time in most mammalian cells. After S phase, chromosome segregation and cell division occur in M phase, which requires less than an hour in most mammalian cells. (p. 5)

Deoxyribonucleic acid (DNA) is defined as an acid that holds the genetic information for cells (DNA, 2015). All the cells in the body contain the same DNA sequence (Essex, et al., 2013, p. 59, 71). Xu (1999) explains that certain DNA are an easier target for carcinogens and these are considered, "mutation hot spots" (p. 7).

Cancer is a disease in which abnormal cells divide in a chaotic, out-of-control fashion and then invade surrounding tissues. As these abnormal cells grow, the mutations create new cells that are not needed, and old cells do not die when they should. These extra cells invade surrounding tissue, and can form a mass called a tumor (National Cancer Institute, 2014a).

Carcinogens

A carcinogen is defined as a material that is known to cause cancer (National Cancer Institute, n.d.). Several governmental agencies provide comprehensive analysis and reporting of known and suspected carcinogens including: Environmental Protection Agency (EPA), Center for Disease Control (CDC), Occupational Safety and Health (OSHA), and the National Institute of Occupational Safety and Health (NIIOSH).

The published list of probable carcinogens includes 138 different substances (Centers for Disease Control and Prevention [CDC], 2015). Some are well known terms such as asbestos, chloroform, wood dust and diesel fumes. All of the listed carcinogens pose a significant risk to the safety of firefighters. Several studies have found the following chemicals associated with increased cancer rates of firefighters:

- Polycyclic aromatic hydrocarbons (PAHs) are environmental and occupational carcinogens that are produced by the incomplete combustion of organic material, such as from the burning of tobacco, coal, and petroleum products. (Clark, 2008)

- Benzene [is] a chemical that is used widely by the chemical industry, and is also found in tobacco smoke, vehicle emissions, and gasoline fumes. Exposure to benzene may increase the risk of developing leukemia. (National Cancer Institute, 2014b)

- Di(2ethylhexyl)phthalate (DEHP) are primarily used as plasticizers in PVC products. DEHP is a constituent of infant toys, indoor constructions, food packaging products, and biomedical devices. DEHP is not chemically bound to the polymer and, therefore, is readily released into the environment – despite its relatively low vapor pressure and low water solubility. (Pflieger-Bruss, Schuppe, & Schill, 2004, p. 341)

Brandt-Rauf, Fallon Jr., Tarantini, Idema, and Andrews (1988) followed two stations over the course of nine days in 1986, and collected samples during 14 fires. Their findings concluded that the most prevalent chemical found was carbon monoxide. However, the second most prevalent chemical was benzene. "NIOSH and OSHA propose an exposure level of 1ppm, while the study found risk factors of 10-50 ppm. Sulphur dioxide, hydrogen cyanide, formaldehyde, and hydrogen chloride were all detected at or above the acceptable time thresholds established by NIOSH and OSHA" (p. 609).

Benzene is a carcinogen that is eventually metabolized in the liver and possibly the bone marrow. Current research suggests that as benzene is metabolized it forms into the "reactive intermediates and metabolites […and then] travel in the blood to the bone marrow where they are oxidized" (Badham, 2009, pp. 19-25). It is during this reaction that DNA mutation can occur

(Bauer, et al., 2003). This reaction is conditional upon a specific enzyme that has the ability to detoxify and "reduce the oxidative stress" (Smith, et al., 2001, para. 1).

Charles (2010) makes it clear that firefighters underestimate the threat of carcinogens as they are not seen and often not measured (p. 20). Single source exposures are often tested in laboratory settings, however, it is important to note that a firefighter will not normally be exposed to a single source; rather, it will be a complex exposure on the emergency scene (Osika, 2010, p. 6).

Avenues of Exposure

The three routes of exposure to toxins and carcinogens are inhalation, ingestion, and dermal absorption (Kim, 2006). Dermal and inhalation exposures secondary to firefighting are considered two of the significant routes for carcinogens. These exposure routes are complicated by elevated temperatures as well as the "unpredictable nature of fires" (Alexander, 2012, p. 1). Charles (2010) also affirms that the exposure to "petrochemicals and aromatic hydrocarbons" (p. 9) poses a danger to firefighters in his research on *Keeping Our Firefighters Safe From Toxins and Carcinogens*. Charles (2010) further explains that firefighters are exposed to known toxins and provides a case history of a member in his organization who died prematurely secondary to a documented line-of-duty death related to cancer (p. 8).

Dermal.

Paulson (2007) describes the anatomy and physiology of the skin and the potential dermal exposure route:

> The skin is composed of two major compartments that are separated by a basement membrane. The compartment under the basement membrane is called the dermis, a dense connective tissue layer that plays a supportive role in skin function. The compartment

> lying above the basement membrane is called the epidermis. The epidermis consists of several layers of keratinocytes: the innermost basal layer to the outermost stratum corneum. The keratinocyte is the predominant cell type in the skin epidermis. The function of keratinocytes includes formation of a mechanical barrier, defense against pathogens and other noxious agents from the outside, and preventing water loss. (p. 22)

How chemicals are absorbed and to what depth is a critical step in determining the risk. Whether these chemicals evaporate, penetrate deeper into the dermis, or absorbed and metabolize and then dispersed to other tissues are critical factors into the damage that will occur (Xing, 2008, p. 52). It is difficult to measure the amount of chemical the skin has absorbed secondary to an epidermal exposure. As the skin is exposed, both local and systemic reactions may occur. One note of specific interest is the point that, "Some absorbed compound may also transfer back to the skin and evaporate back into the surrounding air" (Kim, 2006, pp. 7, 29).

Inhalation.

Particulate matter (PM) is a combination of solid particles and liquid droplets that can be found in the surrounding air. PM, including smoke can only be seen due to their size and color. However, it is the smaller PM that can only been with a microscope that can permeate deeply into the alveoli that poses the greatest exposure risk secondary to inhalation (Environmental Protection Agency, 2013). Smoke is a complex mixture of particulate matter and super heated gases (Kulig, 1991, p. 369).

Ingestion.

The Merriam-Webster dictionary defines ingestion as "the taking of material (as food) into the digestive system" (Ingestion, 2015). As material is ingested, it is moved through the digestive tract (alimentary canal), which is one continuous tube with two openings: the mouth

and anus. Material passing through the cavity does not "technically enter the body until it is absorbed through the walls of the digestive tract and passes into blood or lymphatic vessels" (CliffsNotes, n.d.).

Increased Childhood Vulnerability

The human body is composed of trillions of cells. These cells undergo a normal process of growth, division, creation of new cells, and death in a systematic way. This entire process is completed more quickly during the childhood phase of life, which allows the person to grow (American Cancer Society, 2014). Children are more susceptible to hazards due to several factors:

- Larger body surface area in relation to weight.
- Different body composition.
- Rapid growth, during which chemicals may affect growth or become incorporated into tissue.
- Functionally immature organs and body systems.
- Immature immune system.
- Inadvertently contaminated living quarters. (Canadians for a Safe Learning Environment, 2009)

Although cancer in children is rare, it is the leading cause of death by disease past infancy among children in the United States (National Cancer Institute, 2014b). Childhood cancers make up less than 1% of all cancers diagnosed each year. More than 80% of children diagnosed with cancer will survive. This is significant improvement over the last 40 years, when the survival rate was 58% (American Cancer Society, 2015b). Environmental causes of childhood cancer have been difficult to identify, partly because cancer in children is rare, and

partly because it is difficult to determine what children might have been exposed to early in their development" (National Cancer Institute, 2014a).

"Cancer diagnoses in children is a significant public health concern because of the tremendous physical and emotional stress placed on the child and their family, as well as the significant impact on health, economic, and social welfare systems" (Badham, 2009, p. 9). Ortiz (2012) explains the picture of family dealing with cancer in children:

> The process of childhood cancer can vary, but once diagnosed, the child usually spends a few days to several weeks in the hospital for various tests. When a cancer treatment is selected, the child may undergo surgery and most likely will receive radiation and/or chemotherapy treatments. These treatments have toxic effects on the body and most children experience physical discomfort and psychological strain. The treatment routine may be visiting the hospital as an outpatient and receiving medication for a couple of hours. Other cancer treatments may require them to be admitted to the hospital for weeks or months at a time. The treatment of cancer does not necessarily stop after remission; it is ongoing and can influence overall functioning of the individual. It is important to recognize the biological consequences of treatment because it can lead to overwhelming distress and disturb psychosocial development of the survivor. (pp. 19, 25)

Leukemia.

Leukemia is the most common form of cancer in children, accounting for 30% of children affected with cancer. The two most common forms of leukemia are acute lymphocytic leukemia (ALL) and acute myelogenous leukemia (AML); both will grow and spread rapidly without treatment (American Cancer Society, 2015c).

Under most situations, cancer cells will form a tumor. These tumors will replace and impede upon healthy tissue. Leukemia, however, is a cancer that does not form a tumor and instead affects the blood and organs, which then circulate to other tissues and organs where they grow. Specifically, leukemia originates in the bone marrow, which is where the blood cells are developed. As cancer cells grow, they will impede the growth of healthy blood cells. These unhealthy cells then circulate throughout the body (Ortiz, 2012, p. 20). Badham (2009) gives a description of leukemia:

> Leukemias are cancers originating in blood or bone marrow and are generally characterized by an abnormal proliferation of white blood cells. The term "leukemia" includes a variety of neoplasms that are broadly divided into two large categories based on the rapidity of blood cell proliferation (acute or chronic) and the specific hematopoietic lineage involved (lymphoblastic or myelogenous). Acute leukemias display a very rapid increase in the number of immature blood cells in the bone marrow. As a result, the bone marrow becomes crowded and the production of other healthy blood cells is hindered. As the bone marrow becomes crowded, the malignant cells can overflow into the blood stream and spread to other organs. (p. 8)

Preventative Measures

The *Fundamentals of Fire Fighter Skills* is considered a baseline textbook for new recruits and seasoned veterans regarding the core knowledge of fire department operations. In explaining the care of PPE the following comment is made: "PPE that has been badly soiled by exposure to smoke, other products of combustion, petroleum products, or other contaminants needs to be cleaned as soon as possible" (Deforge-Kling, 2014, p. 51).

The National Fire Protection Agency (NFPA) provides the standards that many departments use to create their local policies and procedures. NFPA 1851 gives this practical advice:

> Extra caution should be practiced to avoid exposing children to soiled protective equipment[…] Children are less likely to wash off any dirt they might pick up from handling ensembles or ensemble elements. Departments should consider dedicating PPE solely for use at public education events to minimize public exposure to soils and contaminants. (National Fire Protection Agency, 2014, p. 33)

Charles (2010) concisely makes the case that,

> What we have failed to educate and train them in is to how not to become exposed to toxic substances and known carcinogens, so that they do not suffer career ending injury, or worse, die prematurely. As fire service leaders, we have trained firefighters to properly wear personal protective clothing (PPE) including their self-contained breathing apparatus (SCBA). However, we have only trained them to wear the SCBA in the presence of smoke and fire. Unfortunately, we don't train them to recognize the real danger of carcinogens found in the atmosphere. (p. 6)

Alexander (2012) noted that inspections of gear and regular cleaning as mandated by organizational policy are not consistently performed. In fact, "soiled turnout gear may still be viewed as a 'badge of honor' and there may be some reluctance to have a favorite set of gear cleaned or inspected if that might lead to the gear being replaced" (p. 46). Eskierka (2014) found that only "16% of firefighters in the Saint Paul Fire Department regularly cleaned their gear after every fire" (p. 7). This is further explained by the "portrayal, intended to denote bravery and

generate respect[…]a needless obsession among firefighter into looking the part of the hero by wearing burnt helmets and soot covered turnout gear" (p. 7).

After conducting tests on thirteen different turnout gear samples, Alexander (2012) determined that most of the gear was contaminated with a variety of chemicals. These chemicals included benzo(a)prene and DEHP, both of which are classified as "probable human carcinogens by the US EPA" (p. 51). Further, DEHP was found on every sample of the protective clothing that was tested (p. 44).

Cross contamination of gear was also suspected as part of the problem in Alexander's (2012) study. For instance, facepieces may have been cleaned per guidelines, but not secured in proper storage bags (p. 49).

Alexander (2012) also documented two significant areas of interest related to gloves and hoods:

> [G]loves are removed first when exiting the fireground. As a result, contamination may be transferred from the helmet, hood, coat, pants and boots to the firefighter's hands when protective clothing is doffed, resulting in dermal exposure. The wearing of cotton undergloves or glove liners[…]reduced PAH contamination on firefighters hands by 80%. (p. 53)

> Hoods are important protective gear to prevent dermal exposure because they are worn in close contact with the firefighter's skin. In particular, they are worn next to some of the most permeable skin in the human body. According to the work of Feldmann and Maibach on regional differences in skin permeability, only the skin of the scrotum is more permeable than that of the jaw angle, forehead and scalp (Feldmann & Maibach, 1967). Hoods become contaminated during fire events, and, if not washed, continue to

expose firefighters whenever they are worn, donned or doffed. Hoods should be laundered following fire response. (pp. 53-55)

Rodriguez-Diaz (2005) conducted a survey and discovered that PPE was only used 57% of the time when in response to “always wears PPE” (p. 17). Eskierka (2014) documented the far-reaching denial of a problem related to PPE at the Saint Paul Fire Department:

- Respondent number 44, “Surveys are a joke. Your cancer task force is a joke.”
- Respondent number 8, “The guys won't clean their gear, they want to look salty.”
- Respondent number 7, “Please, no more policies!”
- Respondent number 4, “We are adults and are able to wash our own clothes without a written policy.”
- Respondent number 66, “The department tries to be big brother too often instead of worrying about department priorities.”
- Respondent number 76, “Conducting cleanliness inspections could lead to disciplinary events and we all know discipline is an agenda of our leadership.” (pp. 29-31)

The Honolulu Fire Department has a comprehensive PPE policy that identifies several important points in regards to the transport and storage of PPE:

- Soiled or contaminated ensemble elements shall be removed from service, placed in an airtight container and transported to the nearest HFD station outfitted with an extractor. Prior arrangements shall be made with the captain on duty. Transporting personnel will conduct all cleaning while at the station.
- Soiled or contaminated ensemble and elements and personal clothing shall not be brought into the home, washed in home laundries, or washed in public laundries. Arrangements should be made by the company commanders in consultation with the IC at the scene or his/her designee to wash all contaminated personal clothing at Department extractors and properly dry them before taking them home again.
- At no time shall department personnel transport or store soiled or contaminated ensembles or ensemble elements in department living areas, personal vehicles, or personal place of residence. At no time shall department personnel unnecessarily expose themselves, family, other department personnel, or the public to ensembles and ensemble elements that have been soiled or contaminated. (Kealoha, 2011, pp. 97-98)

Occupational Safety & Health Administration [OSHA] (2013) broadly defines a hazardous waste as a "[D]isease causing agent which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly or indirectly[…]will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation…in such person or their offspring." In addition to comprehensive training, safety and health, and decontamination program, OSHA places the burden on the employers to "[A]ssure that employees shower at the end of their work shift and when leaving the waste site" (OSHA, 2013). Alexander (2012) also noted that the "[F]requent washing of gear and of the skin is recommended to reduce dermal exposures" (p. 56).

Literature Review Conclusion

Cancer is a devastating disease (Badham, 2009; Ortiz, 2012). Firefighters are routinely exposed to known carcinogens through two predominant pathways: dermal and inhalation (Brandt-Rauf, et al., 1988; Charles, 2010; IAFF 2015; Kulig 1991). The dermal pathway is perhaps the most difficult to protect against, and firefighters routinely underestimate the toxicity from byproducts of combustion during fire ground operations and in the decontamination of their PPE (Kim 2006; Paulson 2007; Xing 2008).

Due to firefighters' exposure to carcinogens, the children of firefighters are at a potentially higher exposure risk than the normal population. This can include cross contamination through dermal contact, and personnel protective equipment cleanliness and storage (American Cancer Society, 2014; Canadians for a Safe Learning Environment, 2009; OSHA, 2013; Paulson, 2007). Childhood cancer rates are currently documented at 1.79 per 10,000 children in the United States, with leukemia being diagnosed 30% of the time (American Cancer Society, 2015c; SEER, n.d.). Benzene is a strongly suspected carcinogen that is linked to

leukemia and has been documented as the second most prevalent fire ground chemical toxin (Brandt-Rauf, et al., 1988; National Cancer Institute, 2014b).

Although numerous studies have been published regarding exposure and the importance of decontamination, firefighters still cling to hazardous materials-stained PPE as a "badge of honor" (Alexander, 2012; Daniels, et al., 2013; Eskierka, 2014). This culture must be changed and Eskierka (2014) defines what is necessary:

> [N]ew organizational norms are necessitating a change in behavior requiring many recognized symbolic elements to be eliminated from the firefighting environment. This has led to the development of cognitive dissonance within firefighters who respond to these emotional conflicts through a combination of defense mechanisms. These may take the form of either a denial of the issue of carcinogenic particulates in smoke, an attempt to minimize carcinogenic dangers, or a fatalistic attitude that nothing can be done about the situation. (p. 29)

Procedures

This applied research project (ARP) utilized a combination of quantitative and descriptive methodology to answer the following four research questions: (a) What is the probability for children to be diagnosed with cancer? (b) What is the probability for children of career firefighters in Kitsap County to be diagnosed with cancer? (c) What are the potential causes of increased risk of cancer for children of firefighters? (d) What recommendations should be implemented to address the problem?

The quantitative methodology was used to answer the first two research questions. The descriptive methodology included an organizational case example conducted with a firefighter's

family whose child was diagnosed with cancer as well as personal interviews with chief officers from each of the six departments in Kitsap County.

Background and Approval

The research project began at the National Fire Academy's (NFA's) Learning Resource Center (LRC) while attending Executive Analysis of Community Risk Reduction (EACRR), the second course of the Executive Fire Officer Program (EFOP) in May 2014. Accessing the electronic search engine WorldCat, the initial keywords of cancer, carcinogen and children were used to identify the previous work that has been done in this field of study. It was determined that of the collection of 7000 published ARP's, no work had been published regarding this problem (observation, May 25, 2014).

During this phase, the researcher began to consider the relevancy to the course content and the seriousness of the problem for the fire service community. A review confirmed there was relevancy to the relationship of the problem and the content of the EACRR course goals, relationship to the *United States Fire Administration (2010) Strategic Plan: Fiscal Years 2010-2014 Operational Goals,* and finally, the significance to the fire service community.

The ARP proposal document was completed and submitted electronically to the assigned evaluator. Correspondence regarding suggested revisions to the projects purpose statement, research methodology, and research questions were considered (J. Heim, personal communication, May 28, 2014).

A comprehensive literature review continued and was expanded through alumni access of Embry Riddle Aeronautical University's (ERAU) Hunt online library. Alumni status was granted, as the researcher is a graduate of ERAU's Master of Science Leadership (M.S.L.) program. Within the Hunt library, utilizing EAGLEsearch, the keywords were expanded to

include: skin, children, benzene, and personal protective equipment. The search was refined through the use of content type to include journal articles, dissertations and theses, and further narrowed through publication dates within the last ten years. The researcher attempted to use the most currently published research when options were available (Powers, 2014, p. 43).

Development and Procedures

The literature review was used to establish a foundation for the subject matter. Once the literature review was complete, the researcher was prepared to start the internal research within Kitsap County. A personal interview to support questions with a chief officer from each organization was created (Appendix A). The interview was created to facilitate the research and ensure all representatives were asked the same questions. The developed interview was conducted via phone calls to each of the six chief officers from the departments. Results of the six interviews are contained (Appendix A).

Once the interview questions were completed in draft form, it was sent to two individuals to confirm that the questions and statements were not ambiguous and contained relevant information that matched the research project. Minimal editing to the questions was completed through the course of feedback. The six departments and their representatives included:

- Bainbridge Island Fire Department (BIFD); Assistant Chief (A/C) J. Moravec
- Bremerton Fire Department (BFD); Battalion Chief (B/C) P. McGanney
- Central Kitsap Fire & Rescue (CKFR); Deputy Chief (D/C) J. Lavato
- North Kitsap Fire & Rescue (NKFR); Battalion Chief (B/C) R. Lagranduer
- Poulsbo Fire Department (PSD); Battalion Chief (B/C) B. Peterson
- South Kitsap Fire & Rescue (SKFR); Battalion Chief (B/C) D. Richards

Finally, an organizational case example was conducted with a firefighter's family whose child was diagnosed with cancer (American Psychological Association, 2012). The family was chosen as one of the two families whom the researcher has a working relationship with (out of the three cases in Kitsap County). This was proposed to the parents under voluntary conditions with the premise to tell their story in their own words. There were no questions developed other than the open ended invitation above. An informed consent was created for the personal interview, which was signed and retained by the researcher (Appendix B).

Ethical consideration regarding the case study included anonymity and protection of medical records. The participants were open to sharing all details, including names. However, these were omitted, as they were unnecessary to accomplish the purpose of the research project. In addition, some of the information is available through blogs, but these were also omitted to protect the participants' privacy. The researcher did not establish a relationship or approval through an ethics board as part of this research process.

The case example was scheduled at a location and time convenient for the parents. The informed consent was produced and the researcher confirmed voluntary participation and received the signed consent. The researcher explained how the answers would be used in the research project and assured anonymity for the interviewees. The researcher requested permission to record the interview, and explained the purpose of recording as verifying all quoted material for the project to ensure accuracy. The interview took approximately sixty minutes to complete. All quotes used in the project by the participants were confirmed for accuracy via the recorded sessions. All consent forms, notes, and transcribed audio recordings, were retained by the researcher (Powers, 2014, p. 49).

The researcher used an online tutoring community to access subject matter experts in mathematics, statistics and probability through InstaEDU. Both tutors requested to keep their last names anonymous. The researcher has retained the message dialogues. The first contact was with Sami S. and the researcher requested assistance in understanding the answers to probability questions one and two (Appendix C). The second contact was with Lee W. who assisted with answering the confidence interval and Z score (Appendices D and E).

The 612 children of KC firefighters were sampled, and the number of children who developed cancer was recorded. To determine rates of cancer incidence in children in the general population, the American Cancer Society (2015c) was consulted. A 99% confidence interval was extrapolated from the data using the equations in appendix D (Anonymous, January 30, 2015).

Limitations

Volunteer firefighters were not included in the study of Kitsap County firefighters. There are no known cases of KC volunteers' children being diagnosed with cancer, as well as no reports from the six fire districts (Appendix A).

Factors such as environmental hazards that may be specific to Kitsap County, which may increase the likelihood of all Kitsap County children having a higher probability of cancer, were not considered. The researcher attempted to locate statistics to define how many children in Kitsap County have cancer; however, the researcher was not able to locate the total number of incidences isolated to children in Kitsap County. It is possible that Kitsap County has a higher incidence of cancer rates in children for the entire population.

Gathering information on the total number of children of career firefighters yielded results that included some of the following variables for each agency: some included step and

foster children, others did not; the requested age range was through 26 years old, as this was the easiest way to gather data via children still on parents' insurance records.

In addition, the cancer statistics gathered to determine the 1.79 to 10,000 cases nationwide were limited to a filter with children through age 19 (SEER, n.d.). The number of children across the United States was filtered with children through age 18 (United States Census Bureau, 2015). Thus, three different ages were used to define children: 18, 19 and 26.

The three children were diagnosed in 2005, 2008, and 2011. Exact figures of how many career firefighters were on staff at that time, along with how many children at that time, was not factored. The numbers that were used for both career firefighters and number of children of career firefighters are based on the time of this report.

Definitions

Alveoli: A small air-containing compartment of the lungs in which the bronchioles terminate and from which respiratory gases are exchanged with the pulmonary capillaries (Merriam-Webster, 2015).

Cancer: A disease where abnormal cells divide in a chaotic, out-of-control fashion and then invade surrounding tissues (National Cancer Institute, 2014a).

Carcinogen: A material that is known to cause cancer (National Cancer Institute, n.d.).

Confidence Interval: A group of continuous or discrete adjacent values that is used to estimate a statistical parameter (as a mean or variance) and that tends to include the true value of the parameter a predetermined proportion of the time if the process of finding the group of values is repeated a number of times (Merriam-Webster, 2015).

Cross-Contamination: The transfer of contamination from one item to another or to the environment (NFPA 1851, 2014, p. 9).

Deoxyribonucleic A**cid** (**DNA**)**:** An acid that holds the genetic information for cells (Merriam-Webster, 2015).

Ingestion: The taking of material (as food) into the digestive system (Merriam-Webster, 2015).

Leukemia: Cancers originating in blood or bone marrow and are generally characterized by an abnormal proliferation of white blood cells (Badham, 2009, p. 8).

Oncology: The study and treatment of cancer and tumors (Merriam-Webster, 2015).

Particulate Matter (**PM**)**:** A combination of solid particles and liquid droplets that can be found in the surrounding air (Kulig, 1991, p. 369).

Procedures Summary

The researcher attempted to add credibility to the ARP through utilizing a combination of quantitative and descriptive methodology to answer the four research questions. A review confirmed there was relevancy to the relationship of the problem and the content of the EACRR course goals, relationship to the *United States Fire Administration (2010) Strategic Plan: Fiscal Years 2010-2014 Operational Goals,* and finally, the significance to the fire service community. It was also determined that of the collection of 7000 published ARP's, no work had been published regarding this problem (observation, May 25, 2014).

The literature review was used to establish a foundation for the subject matter. Once the literature review was complete, the researcher was prepared to start the internal research within Kitsap County. A personal interview to support questions with a chief officer from each organization was created (Appendix A). An organizational case example was conducted with a firefighter's family whose child was diagnosed with cancer. For assistance with quantitative

methodology, the researcher used an online tutoring community to access subject matter experts in mathematics, statistics and probability.

Results

This section reviews the findings of the research project on children of local career firefighters being diagnosed with cancer. This applied research project (ARP) utilized a combination of quantitative and descriptive methodology to answer the following four research questions: (a) What is the probability for children to be diagnosed with cancer? (b) What is the probability for children of career firefighters in Kitsap County to be diagnosed with cancer? (c) What are the potential causes of increased risk of cancer for children of firefighters? (d) What recommendations should be implemented to address the problem?

To begin, the researcher attempted to gain insight into the depth of the problem within the community of Kitsap County firefighters. It was reported that there were three cases of children diagnosed with cancer (Anonymous, personal communication, December 19, 2013).

Specific Answers to Research Questions

To answer the first research question the US Census Bureau was utilized to determine that there are 72 million children under the age of 18 in the United States (United States Census Bureau, 2014). Surveillance, epidemiology, and end results program (SEER; n.d.) reports there are 17.9 incidents of cancer for every 100k children (ages 0-19). These statistics set a baseline indicating approximately 1.79 children out of 10,000 (through age 19) will be diagnosed with cancer. Through this research it was determined that there is a 0.0179% chance children will be diagnosed with cancer in the United States (Appendix C).

The second research question was calculated with the assistance of several subject matter experts in the field of mathematics, statistics and probability. A child of a Kitsap County career

firefighter has a 0.49% chance of getting cancer. This probability is 27.4 times higher than that of the general population of children. Put another way, a child of a Kitsap County firefighter is 27 times more likely to be diagnosed with cancer than a child in the general population of children (Appendix C). Based on a hypothesis test at the 1% significance level, it would be virtually impossible for three children of Kitsap County career firefighters to be diagnosed with cancer if the KC sample is truly representative of the population (Anonymous, personal communication, January 30, 2015; Appendix E).

Understanding the potential causes of increased risk of cancer for children of Kitsap County career firefighters was gained through chief officers of the six fire districts in Kitsap County. Several discoveries were made:

- Of primary concern is the lack of established policies as well as organizational norms that would ensure a secondary full decontamination (showering/personal hygiene) process after all fire events. One agency does require showering, personnel are then required to load the hose and put the engine back in service, which now creates a cross contamination.

- A member showering at the conclusion of their shift was also deficient. All six chiefs reported mixed result ranging from, “no” to, “most everyone showers before they go home.” Again, there are no established policies or organizational norms to support this important process.

- Five of the agencies reported that members who “float to other stations” routinely carry their PPE in their personal vehicles.

- Only one agency clearly articulated that members do not bring uniforms home.

- Only one agency has NFPA compliant medical exams, however, these are scheduled once every five years.

- Five of the agencies stated varied results to routine visits by family members. The results were also on two extremes ranging from, “very seldom” to some family members that “visit daily.”

- Only one agency mentioned the monitoring of indoor air quality as a part of the overall wellness plan.

- Only one agency mentioned the installation of walk-off track pads that hat pull contaminants off the boots as you travel through the bay to [living] quarters. (Appendix A)

The final research question, *what recommendations should be implemented to address the problem* was also identified in the interview with the representatives of the six fire districts in Kitsap County. Each agency identified different solutions:

- Installation of idle reduction devices so that can automatically shut down engines, thus reducing carcinogen exposure to diesel fumes on the scene.
- Make a concentrated effort to buy low volatile soaps and other station cleaning supplies.
- Conduct routine sampling of air on the compressor units (more often then standards).
- Management and labor engaging in conversations to implement mandatory annual physicals for the responders.
- Health and wellness committees taking an active role in the education of the personnel. (Appendix A)

Personal Interview

A personal interview was conducted with a chief officer from each of the six departments within Kitsap County (Appendix A). Each of the six representatives is a senior officer at the battalion chief level or above.

Through this interview it was determined that the total number of career firefighters in Kitsap County is 306, and the total number of children of the 306 firefighters is 612. Of the 612 children, there are three known cases of cancer (Appendix A).

Each department reported an increased level of awareness over the last 5-10 years to the risk of toxins and carcinogens secondary to the profession. All six departments have installed diesel exhaust capture systems in their apparatus bays, as well as at least one PPE specialized cleaning extractor to decontaminate gear. All six departments also have loaner PPE, or issue a second set of PPE for their responders.

In addition, the 2014 edition of the Washington Administrative Code (WAC) 296-305 which governs fire department operations has had a direct affect including gross-decontamination procedures on the fire ground, with all six agencies reporting compliance. Four of the six departments also specifically said that they now require SCBA's to be worn during overhaul operations.

Regarding showering after a fire event, all six chiefs reported differing results:

- NKFR stated that there is no policy, but generally, everyone does.
- BIFD also stated there is no policy, but in practice all do once cleanup is done.
- SKFR stated that a secondary decontamination [showers] is completed back at the station.
- CKFR stated there was no policy or standard practice regarding post-fire showering.
- Poulsbo stated there is no policy, but they push all personnel to shower before reloading hose [putting the unit back into service].
- BFD used the strongest terms, in stating that it is not mandatory, but crews do not go back in service until they get cleaned up. (Appendix A)

Regarding showering at the end of shift, all six chiefs reported a mixed result ranging from, "no" to, "most everyone showers before they go home." This was similar to the results of taking uniforms and PPE home from "no uniforms taken home" to personnel routinely carrying their PPE and uniforms as they work at different stations (Appendix A).

In answering the question *how often families visit stations* the results were also on two extremes ranging from, "very seldom" to some family members that "visit daily" (Appendix A).

Finally, with the open-ended question of, "Anything else to add or consider regarding this research topic?" it became evident that Poulsbo is actively addressing the broad issue regarding the dangers of toxins and potential carcinogens. B/C Peterson stated they have implemented several strategies including:

- The fleet manager has installed idle reduction on emergency apparatus to decrease diesel exhaust emission on the emergency scene.
- Attempt to buy low volatile soaps and cleansers for use around the station.
- Air monitoring conducted in the stations to ensure standards are met (the station is next to a state highway, and it was determined that quality inside is better than quality outside).
- Routing air sampling of breathing apparatus (more often than standards require).
- Walk-off track pads installed at entry points between apparatus bays and quarters to pull contaminants off boots. (B. Peterson, personal communication, January 23, 2015)

Quantitative Results

Kitsap County is composed of six fire districts serving a total population of 253,968 including 59,993 under the age of 20 (United States Census Bureau, 2013). These six departments are comprised of 478 firefighters of which 306 are full-time career staff and 172 are volunteer staff (Appendix A). The total number of children of the 306 career firefighters is 612. Of the 612 children, there are three known cases of cancer (Appendix A).

The US Census Bureau estimates there are 72 million children under the age of 18 in the United States (United States Census Bureau, 2014). Surveillance, epidemiology, and end results program (SEER; n.d.) reports there are 17.9 incidents of cancer for every 100k children (ages 0-19). These statistics set a baseline indicating approximately 1.79 children (through age 19) out of 10,000 has cancer. In contrast, one out of every 204 children of a Kitsap County career firefighter has cancer. Through this research it was determined that there is a 0.0179% chance children will be diagnosed with cancer in the U.S. The chance that a child of a KC career firefighter will get cancer is 0.49% (Appendix C).

Statistically, if only one of the 612 Kitsap firefighters children were diagnosed with cancer, it would be 9.3 times higher then the general population of children. However, the

chance of three of the 612 firefighters children being diagnosed with cancer is 27.4 times higher than the general population of children. Put another way, a child of a Kitsap County firefighter is 27 times more likely to be diagnosed with cancer than the general population of children (Appendix C).

The KC data yields a confidence interval for the population proportion of [0.0035, 0.0063]. "If Kitsap County kids are 'normal' we would be 99% confident that the national proportion of cancer cases would be between 0.0035 and 0.0063" (Anonymous, personal communication, January 30, 2015). Since the population proportion of 0.000179 is nowhere near this interval, it would be virtually impossible for three children of Kitsap County career firefighters to be diagnosed with cancer (Anonymous, personal communication, January 30, 2015; Appendix D).

Another way to evaluate the statistical improbability of three of the 612 children getting cancer is to consider the Z score. When calculated this score indicates that the KC firefighters children are eight standard errors above the normal population. "If Kitsap County kids are 'normal,' the probability of three (or more) out of 612 having cancer is 1.10(10)^-18. Therefore the Kitsap County kids must NOT be 'normal'!" (Anonymous, personal communication, January 30, 2015; Appendix E).

Organizational Case Example

An organizational case example was conducted with a firefighter's family whose child was diagnosed with cancer on the premise to tell their story in their own words. The participants of the interview were assigned codes F (father), M (mother), and C (child diagnosed with cancer; not present during the interview) to maintain anonymity for this report.

The interview was started and framed by the researcher wanting to hear *their story in their own words* and began with, “How did it start?” M began to share,

> We were outside playing badminton and C was feeling a cramp in his stomach. He had been feeling a cramp in his stomach for a little while, but at the time he was playing basketball, baseball, and soccer. We equated it to: you must have done something in sports. Finally he said, “I really don’t feel good and I’m going to go lay down on the couch.”
>
> I came back at about 8:30 and he was lying there with the bowl and towel and I thought that was strange. C felt something and said, “dad is this normal?” F gets up to check him and felt something hard in his stomach and F thought maybe it was appendicitis.

The father decided to take him into the local hospital to get checked, and the mother was insistent on going with them. M continued, “This is 9:00 on a Wednesday night. I can tell you, April 13 on a Wednesday night.” The event regarding the day, date, time and location was etched into the parent’s memories.

The father continued,

> I convinced them to get the CT, and they came back and said, “CT looks fine.” I went over and started pushing on his stomach and I go, “No, it’s right here” and I take his fingers, literally take his fingers and then you see a puzzled look on the doctors face.

At this point the doctor decided to send the CT scan to a nearby children’s hospital. “Well, they missed a grapefruit-size tumor” was how F described the second hospitals opinion. Within 12 hours the oncologist and staff at the children’s hospital were presenting the parents

with options to move forward, including a simple biopsy or surgery to remove the mass and attempt to repair the damaged organs.

The oncologist recommended going in and removing the mass, which the parents agreed to. F stated bluntly, “I want it out.” After the surgery, the surgeon reported to the family that they were able to get the whole mass out, and repair the damaged organs. Although the medical staff did not have conclusive evidence on the cancer’s stage, it was reported to the family that it was probably end stage cancer (stage IV).

For the family, this was a message of doom. M then expressed the pain of the event as she watched her son “[H]e was shut down. That was definitely the hardest part. C wouldn’t say anything, because he knew in his heart that he was going to die.”

M continued to express how the family processed the news, “That first day was pretty dark. I just remember being overpowered. Everything was gray. Everything was dark. I think we were both really, really angry with God. We told him how angry we were.” M shared the struggle she had with her faith, and a sense of relief and peace that came once she worked through that struggle.

Good news returned from the New York lab that the cancer was not stage IV. From there, the father describes the litany of test: CT scans, PET scans, bone-marrow test, spinal tap, and a [intravenous (IV) access] port installed in his arm. Chemotherapy would be delayed two weeks until the best protocol was established and a treatment plan was in place as well recovery from the surgery. C’s recovery was inspiring as F describes the strength of his son, “He’s a tough kid. He only had one pain pill the entire time. He didn’t want anything else. But he was shut down and withdrawn. He’s a processor and smart kid. He was internalizing a lot of things.”

F bought a camping blow-up mattress and simply said, “I camped out in his room. Sometimes he would come crawl up on the camping mattress with me.” A specialist on the East Coast had developed a protocol for C’s cancer with a 90% success rate. F asked the staff, “90% treatment rate or 90% cure rate?” The answer was cure. “I was ecstatic about that.”

F explained the dichotomy between his role as a firefighter and his role as a bystander, “We’re immune and numb to a lot of different scenarios. We always have that ability to figure things out and adapt. I don’t get frazzled very easily. We solve peoples problems.” He spent countless hours researching details on his son’s condition. He wanted to be the best advocate he could. But, that research and advocacy played a heavy toll as it clashed with his primary role of being a dad, “I think it hurt me in some circumstances more than it helped…I had to let that go. I was exhausted.”

But, the family was only 2 weeks into their long battle with this war. F describes the next hurdle,

> I told C that there is two different types of cancer. There’s cancer that you can beat and cure and there’s cancer that you cannot. Your type of cancer, they can cure. But, it’s going to be a fight. It’s going to be *your* [emphasis added] fight.
>
> I remember them coming in with full PPE, bringing in the chemo treatment. Gloves, goggles, gown, splashguard. I’m watching them hanging the bag then you watch them dump that crap into your son, when they wouldn’t even touch it with their bare hands. That killed me. That’s the best we got? That was hard.
>
> You’re up in the cancer ward, watching sick, sick kids walking around. They’re all walking around smiling. No hair, skinny, emaciated. You’re watching your healthy kid, at that point…but you’re seeing ‘that’s what my kid is going to look like in two

months'. It's really hard to process all that information at once. You're watching them pour all that poison into your kid, to kill the good cells and the bad.

M brought it back to the current moment,

That's what we deal with three years later today. The last visit that we had…they gave us this huge binder of 'these are all the medicines we gave to your son, and these are all the side effects that could happen.'

Hair came out in clumps one day during a hard study session as C attempted to keep up with his schoolwork around the kitchen table. F and C got their heads shaved. M shared, "I think that was hard for him. He did not like attention being drawn to himself." One month later, F's earlier concerns are now facing him as he explains, "That's the final thing. He lost his hair, his eyebrows, he full-on looked like a cancer kid; skinny and bald."

The family also started to see the financial cost of the cancer treatment. M gave an overview: "Just for three months, it was close to $150,000." F shared struggles he watched others have, "Bill should be with his daughter, but he's working a side job besides the fire department just to try to make do."

C recently had an echocardiogram, as the drugs given three years before could affect his heart. M described the daily fears, "If he gets a bloody nose your mind goes, 'is something wrong?' We feel like we are on egg shells constantly."

The family is at a different place today. F describes it, "He'll ask, 'dad, you want to go play catch?' Even if I don't feel like it, I go play catch." They are three and half years out from the Wednesday, April 13th night. C is spending the night at a friend's house. The parents can laugh a little, even as they reflect the dark times. (Anonymous, personal communication, January 23, 2015)

Unexpected Findings

One of the three children of the Kitsap County career firefighters was diagnosed with Acute Lymphoblastic Leukemia, which is a cancer that affects the blood. The second child was diagnosed with non-Hodgkin lymphoma called Burkitts, which affects the blood (Anonymous, personal communication, December 19, 2013). The third child was diagnosed with hepatoblastomam, which is a cancer of the liver (Anonymous, personal communication, January 28, 2015). The liver is the primary organ that filters the blood. Thus, two of the children were diagnosed with cancer that affects the blood, and the third with a cancer that affects the filtering of the blood. In a related way, all three children were diagnosed with cancers directly or indirectly affecting the blood.

Summary of Results Section

Cancer creates an intellectual, emotional, physical, and financial burden on the families and patients of those affected (Anonymous, personal communication, January 23, 2015). In the United States, 17.9 out of 10,000 children have been diagnosed with cancer (United States Census Bureau, 2014). Three children of career firefighters out of 612 have been diagnosed with cancer (Anonymous, personal communication, December 19, 2013). A child of a Kitsap County career firefighter has a 0.49% chance of getting cancer. The chance of three of the 612 Kitsap County firefighters children being diagnosed with cancer is 27.4 times higher than the general population of children (Anonymous, personal communication, January 29, 2015).

Several potential causes of increased risk to children of firefighters of Kitsap County have been identified including: members failure to shower at the conclusion of fires and the end of their shifts; transporting PPE and uniforms in personal vehicles and to their residences; routine visits to the fire stations by family members; and a lack of organizational policies and norms that

support health and wellness programs including physicals, education, and systems to reduce potential exposures (Appendix A).

Solutions to the reduce the potential risk to the children of firefighters include: idle reduction devices to decrease exposure to diesel fumes; purchasing low volatile cleaning supplies; additional sampling of SCBA compressor units; and cooperation between management and labor in developing an annual wellness physical protocol (Appendix A).

Discussion

The results of this ARP along with the subject matter contained within the literature review allowed the researcher insight into the problem of local career firefighter's children being diagnosed with cancer. This applied research project has confirmed that there is a 0.0179% chance children will be diagnosed with cancer in the U.S., whereas a child of a Kitsap County career firefighter has a 0.49% chance of getting cancer.

Statistically, if only one of the 612 Kitsap firefighters children were diagnosed with cancer, it would be 9.3 times higher then the general population of children. However, the chance of three of the 612 firefighters children being diagnosed with cancer is 27.4 times higher than the general population of children. Put another way, a child of a Kitsap County firefighter is 27 times more likely to be diagnosed with cancer than the general population (Appendix C).

Cancer

Cancer is one of the most frightening terms in the human language. Cancer is considered a "death sentence" as well as the long road through a medical maze of test, medications, treatment, and recovery (Ortiz, 2012, p. 11). Cancer creates an intellectual, emotional, physical, and financial burden on the families and patients of those affected (Anonymous, personal communication, January 23, 2015).

Cancer is a disease where abnormal cells divide in a chaotic, out-of-control fashion and then invade surrounding tissues. As these abnormal cells grow, the mutations create new cells when they are not needed, and old cells do not die when they should. These extra cells invade surrounding tissue and can form a mass called a tumor (National Cancer Institute, 2014a). Although cancer in children is rare, it is the leading cause of death by disease past infancy among children in the United States (National Cancer Institute, 2014b).

The journey from the start to being a "survivor" is akin to a live nightmare for the victims and loved ones. M describes it like this: "That first day was pretty dark. I just remember being overpowered. Everything was gray. Everything was dark. I think we were both really, really angry with God. We told him how angry we were" (personal communication, January 23, 2015). Describing her son, M said, "[He was] shut down. That was definitely the hardest part. C wouldn't say anything, because he knew in his heart that he was going to die" (personal communication, January 23, 2015). Even three years later, the parents still worry, "If he gets a bloody nose your mind goes, 'is something wrong?' We feel like we are on egg shells constantly" (Anonymous, personal communication, January 23, 2015).

Environmental causes of childhood cancer have been difficult to identify, partly because cancer in children is rare, and partly because it is difficult to determine what children might have been exposed to early in their development" (National Cancer Institute, 2014b). However, benzene is a strongly suspected carcinogen that is linked to leukemia and has been documented as the second most prevalent fire ground chemical toxin (Brandt-Rauf, et al., 1988; National Cancer Institute, 2014c).

Children

Although cancer in children is rare, it is the leading cause of death by disease past infancy among children in the United States (National Cancer Institute, 2014b). Childhood cancers make up less than 1% of all cancers diagnosed each year. Around 10,000 children in the United States (under the age of 15) will be diagnosed with cancer in 2015. More than 80% of children diagnosed with cancer will survive. This is significant improvement over the last 40 years, when the survival rate was 58% (American Cancer Society, 2015b). Environmental causes of childhood cancer have been difficult to identify, partly because cancer in children is rare, and partly because it is difficult to determine what children might have been exposed to early in their development" (National Cancer Institute, 2014a).

Leukemia is the most common form of cancer in children, accounting for 30% of children affected with cancer. The two most common forms of leukemia are acute lymphocytic leukemia (ALL) and acute myelogenous leukemia (AML); both will grow and spread rapidly without treatment (American Cancer Society, 2015c).

Children are more susceptible to hazards due to several factors:

- Larger body surface area in relation to weight.
- Different body composition
- Rapid growth, during which chemicals may affect growth or become incorporated into tissue.
- Functionally immature organs and body systems.
- Immature immune system.
- Inadvertently contaminated living quarters. (Canadians for a Safe Learning Environment, 2009)

Exposure

Firefighters are at increased risk to exposures to toxins and more importantly, carcinogens (Abrams, 1974). Although firefighters may be exposed to an isolated chemical, they are more often exposed to a complex exposure on the emergency scene (Osika, 2010, p. 6). This exposure consists of a complex mixture of particulate matter and super heated gases (Kulig, 1991, p. 369). Several studies have found the following chemicals associated to increased cancer rates of firefighters: Polycyclic aromatic hydrocarbons (PAHs), benzene, and Di(2ethylhexyl)phthalate (DEHP; Clark, 2008; Pflieger-Bruss, et al., 2004). Other chemicals such as, asbestos, chloroform, wood dust and diesel fumes are also listed as probable carcinogens with the CDC (Centers for Disease Control and Prevention, 2015). Unfortunately, firefighters underestimate the threat to carcinogens as they are not seen and often not measured (Clark, 2008, p. 20).

The three routes of exposure to toxins and carcinogens are inhalation, ingestion, and dermal absorption (Kim, 2006). Dermal and inhalation exposures secondary to firefighting are considered two of the significant routes for carcinogens. These exposure routes are complicated by elevated temperatures as well as the "unpredictable nature of fires" (Alexander, 2012, p. 1).

It has been determined that PPE used in fireground operations are contaminated with a variety of chemicals. These chemicals included benzo(a)prene and DEHP, both of which are classified as "probable human carcinogens by the US EPA" (Alexander, 2012, p. 51). Although numerous studies have been published regarding exposure and the importance of decontamination, firefighters still cling to hazardous materials stained PPE as a "badge of honor" (Alexander, 2012; Daniels, et al., 2013; Eskierka, 2014).

KC firefighters have implemented some strategies to mitigate their exposures to these carcinogens. All six departments have installed diesel exhaust capture systems in their apparatus bays, as well as at least one PPE specialized cleaning extractor to decontaminate gear. All six departments also have loaner PPE, or issue a second set of PPE for their responders (Appendix A).

In addition, the 2014 edition of the Washington Administrative Code (WAC) 296-305 which governs fire department operations has had a direct effect including gross-decontamination procedures on the fire ground, with all six reporting compliance. Four of the six departments also said that they now require SCBA's to be worn during overhaul operations.

Cross Contamination

Alexander (2012) documented two examples of cross contamination. The first is when facepieces are cleaned per guidelines, but not secured in proper storage bags. The second regarding gloves:

> [G]loves are removed first when exiting the fireground. As a result, contamination may be transferred from the helmet, hood, coat, pants and boots to the firefighter's hands when protective clothing is doffed, resulting in dermal exposure. The wearing of cotton undergloves or glove liners…reduced PAH contamination on firefighters hands by 80%. (p. 53)

Kim (2006) described a potential cross contamination after a dermal exposure as "some absorbed compound may also transfer back to the skin and evaporate back into the surrounding air" (Kim, 2006, pp. 7, 29). Due to firefighters' exposure to carcinogens, the children of firefighters are at a potentially higher exposure risk than the normal population. This can include cross contamination through dermal contact, personnel protective equipment cleanliness and

storage, and time spent at the fire station (American Cancer Society, 2014; Canadians for a Safe Learning Environment, 2009; OSHA, 2013; Paulson, 2007).

The risk to KC firefighters has identified several possible cross-contamination routes:

- Of primary concern is the lack of established policies as well as organizational norms that would ensure a secondary full decontamination (showering/personal hygiene) process after all fire events. Although one agency does require showering, personnel are then required to load hose and put the engine back in service, which now creates a cross contamination potential (Appendix A).

- When asked if members of their departments showered at the end of their duty shift, all six agencies reported mixed results ranging from, “no” to, “most everyone showers before they go home.” Again, there are no established policies or organizational norms to support this important process.

- Five of the agencies reported that members who “float to other stations” routinely carry their PPE in their personal vehicles.

- Only one agency clearly articulated that members do not bring uniforms home.

- Five of the agencies stated varied levels of results to routine visits by family members. The results were also on two extremes ranging from, “very seldom” to some family members that “visit daily.”

- Only one agency mentioned the installation of walk-off track pads that hat pull contaminants off the boots as the firefighter travels through the bay to the living quarters. (Appendix A)

Reducing Risk

Each of the six KC agencies identified different solutions to reduce the risk to carcinogen exposures:

- Installation of idle reduction devices so that can automatically shut down engines, thus reducing carcinogen exposure to diesel fumes on the scene.

- Make a concentrated effort to buy low volatile soaps and other station cleaning supplies.

- Conduct routine sampling of air on the compressor units (more often than standards).

- Management and labor engaging in conversations to implement mandatory annual physicals for the responders.

- Health and wellness committees taking an active role in the education of the personnel.

The baseline training for firefighters is contained in the *Fundamentals of Fire Fighter Skills* textbook. In explaining the care of PPE the comment is made that "PPE that has been badly soiled by exposure to smoke, other products of combustion, petroleum products, or other contaminants needs to be cleaned as soon as possible" (Deforge-Kling, 2014, p. 51). The researcher was unable to determine the threshold for KC firefighters to consider their gear "badly soiled", however, all KC departments indicated they have at least one PPE specialized cleaning extractor to decontaminate gear (Appendix A).

The Honolulu Fire Department has a comprehensive PPE policy that identifies several important points in regards to the transport and storage of PPE:

- Soiled or contaminated ensemble elements shall be removed from service, placed in an airtight container and transported to the nearest HFD station outfitted with an extractor. Prior arrangements shall be made with the captain on duty. Transporting personnel will conduct all cleaning while at the station.

- Soiled or contaminated ensemble and elements and personal clothing shall not be brought into the home, washed in home laundries, or washed in public laundries. Arrangements should be made by the company commanders in consultation with the IC at the scene or his/her designee to wash all contaminated personal clothing at Department extractors and properly dry them before taking them home again.

- At no time shall department personnel transport or store soiled or contaminated ensembles or ensemble elements in department living areas, personal vehicles, or personal place of residence. At no time shall department personnel unnecessarily expose themselves, family, other department personnel, or the public to ensembles and ensemble elements that have been soiled or contaminated. (Kealoha, 2011, pp. 97-98)

Changing the mindset from "responding to a fire" to "responding to a haz-mat scene" will allow the safety benefits of OSHA to encourage post-event personal hygiene. OSHA (2013) broadly defines a hazardous waste as a,

> [D]isease causing agent which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly or indirectly[…]will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation[…]in such person or their offspring.

In addition to comprehensive training, safety and health, and decontamination program, OSHA (2013) places the burden on the employers to "[A]ssure that employees shower at the end of their work shift and when leaving the waste site." Alexander (2012) also noted that the "frequent washing of gear and of the skin is recommended to reduce dermal exposures" (p. 56). It was found in the survey of the six Kitsap departments had mixed result ranging from, "no" to, "most everyone showers before they go home." (Appendix A). Again, there are no established policies or organizational norms to support this important process (Appendix A).

Most importantly the culture must be changed, as currently the KC firefighters are not fully embracing a culture of safety. Eskierka (2014) defines what is necessary:

> [N]ew organizational norms are necessitating a change in behavior requiring many recognized symbolic elements to be eliminated from the firefighting environment. This has led to the development of cognitive dissonance within firefighters who respond to these emotional conflicts through a combination of defense mechanisms. These may take the form of either a denial of the issue of carcinogenic particulates in smoke, an attempt to minimize carcinogenic dangers, or a fatalistic attitude that nothing can be done about the situation. (p. 29)

Community Risk Reduction Implications

The Kistap County firefighters have failed to fully embrace a culture of safety, specifically regarding the personal and cross-contamination risk associated with toxins and

carcinogens. The norms demonstrated through failure to shower after exposures and at the end of shift, transporting PPE in vehicles while in non-closed containers (gear bags), and routine visits to the stations by family members are surface level indications of this culture (Appendix A). The "badge of honor" (Alexander, 2012) associated with contaminated clothing, and the "fatalistic attitude that nothing can be done about the situation" are also indications of a wider spread problem (Eskierka, 2014).

The researcher is hopeful that organizations with the resources to explore the problem further and identify the depth and scope as well as casual and correlated analysis will conduct in-depth studies. At a minimum, all firefighters should take caution to recognize that on-the-job risk can potentially become at-home risk and due regard should be exercised.

Discussion Summary

Cancer creates an intellectual, emotional, physical, and financial burden on the families and patients of those affected (Anonymous, personal communication, January 23, 2015). Although cancer in children is rare, it is the leading cause of death by disease past infancy among children in the United States (National Cancer Institute, 2014b). Through this research it was determined that there is a 0.0179% chance a child will be diagnosed with cancer in the U.S. whereas a child of a Kitsap County (KC) career firefighter has a 0.49% chance of getting cancer. This probability is 27.4 times higher than that of the general population of children.

Firefighters are at increased risk to exposures to toxins and more importantly, carcinogens. Cross contamination from exposures is a documented reality (Abrams, 1974; Alexander, 2012; Canadians for a Safe Learning Environment, 2009; Kim, 2006; OSHA, 2013; Paulson, 2007). The fire service community leaders should consider changing the mindset from *responding to a fire* to *responding to a hazardous-materials scene.*

Recommendations

This applied research project assessed the problem of children of Kitsap County career firefighters being diagnosed with cancer. The project allowed the researcher to focus on several key areas of cancer risk including the history of cancer research with the profession, specific carcinogens, exposure routes, and increased childhood vulnerability.

The most compelling change that needs to take place is the fire service community should consider changing the mindset from *responding to a fire* to *responding to a hazardous-materials scene*. This single change has the potential to impact the culture and organizational norms in significant ways that will dramatically change how members frame their response.

Solutions to this problem are addressed through three focused efforts: (a) Forming joint labor-management health, safety and wellness task force within Kitsap County, (b) Implementing training programs to help educate members to the personal and family risk of toxins and carcinogens, and (c) Implement policies and systems that will help support the reduction to unnecessary risk.

Wellness Task Force

Each of the six agencies in Kitsap County has isolated ideas they have implemented to help reduce the risk to exposures. By forming a joint county team, the research and work being implemented in one organization could be shared and capitalized in neighboring jurisdictions. Shared cost for subject matter experts and nationally known instructors could provide immediate financial returns for the task force. Currently implemented programs could be shared and minimal staff resources would be needed to implement. Most importantly, by looking at this as a countywide problem instead of an isolated incident, the synergy of working together to solve a community-based problem could potentially yield better outcomes for the whole.

Training Programs

Each agency should consider ways to integrate exposure awareness and risk reduction strategies in every part of their training. All fireground practical and didactic training should have exposure training integrated into the teaching objectives. Using the OSHA guidelines for hazardous material events and transposing many of these practices to fireground training events would eventually transform the actions and hopefully, attitudes and behaviors of members on the fireground.

Implementing Policies and Systems

The six organizations should ensure that their policies match the expectations of the 2014 WAC 296-305 standards. In addition, fireground operational policies should take into consideration the OSHA requirements for hazardous materials scenes. Through policy adoption, organizations should also allocate funding to support the policies. For instance, authorizing overtime at the end of a shift, which includes a shower before going home, when normal duty time is not available will allow the senior leaders to demonstrate the organizational importance of exposure reduction. Systems such as airtight containers when transporting PPE in personally owned vehicles; walk-off track pads; and additional SCBA compressor and station air monitoring; are all systems that could help mitigate the risk to exposures.

Future Research and Readers Recommendations

- The researcher is hopeful that organizations with the resources to explore the problem further and identify the depth and scope as well as casual and correlated analysis will conduct in-depth studies.

- The unexpected findings of two of the firefighters children being diagnosed with cancer that affects the blood, and the third with a cancer that affects the filtering of the blood could be part of a larger research project. In addition, cancer rates in spouses may be considered to determine if the spouses or even families as a whole are at a higher risk compared to the nationwide average.

- At a minimum, all firefighters should take caution to recognize that on-the-job risk can potentially become at-home risk and due regard should be exercised.

Research Conclusion

Each of the six agencies in Kitsap County is doing good work to help improve the safety and wellness of their members in regards to exposures to toxins and carcinogens. However, there is still work to do, and the risk to the membership and potential risk to their families is too high to wait for another 41 years of research. Implementing a countywide wellness task force, training programs, as well as policies and systems to help mitigate exposures are solutions that are reasonable and can be started today.

Cancer is a devastating disease (Badham, 2009; Ortiz, 2012). There are no parents who want to learn through the trial of this disease that, “even if I don’t feel like it, I go play catch” (Anonymous, personal communication, January 23, 2015).

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Appendix A

CKFR
Deputy Chief Jay Lovato

How many line career (911 responders) are on your staff?
78
How many volunteer line staff members?
55
Do you know how many children of the members ½?
166
How many cases of cancer of these children?
1
Do you know what type of cancer?
u/k
What systems policies programs have been put in place over the last 5-10 years to help combat potential for exposure to toxins *and carcinogens…?*
Decon policy including extractor
How often do families visit FF in the station during their shifts?
One family every shift….between five stations….
Do FF carry their PPE and/or Uniforms home?
- most are laundering but not transferring stuff
- do have rovers and carrying and transporting between

Are showers mandatory after Fires? (next call?) Showers mandatory at end of shift?
- no….
- we do have mandatory in bunker gear before removing SCBA facepiece "gross decon"

Anything else to add or consider regarding this research topic?
May consider the Firefighter cancer network for information and additional research?

BFD:
Pat McGanny

How many line (911 responders) are on your staff?
48
How many volunteer line staff members?
0
Do you know how many children of the members ½?
89
How many cases of cancer of these children?
1
Do you know what type of cancer?
no
What systems policies programs have been put in place over the last 5-10 years to help combat potential for exposure to toxins and carcinogens…?
- diesel exhaust systems in all the stations.
- everyone has two sets of bunker gear and each station has an extractor

- policy change of wearing SCBA during overhaul…
- gross decon at the scene

How often do families visit FF in the station during their shifts?

- one shows up every day…
- on an average...once a week.

Do FF carry their PPE and/or Uniforms home?

- no ppe inside the living quarters at station
- no uniforms homes

Are showers mandatory after Fires? (next call?) Showers mandatory at end of shift?

- not mandatory, crews do not go back in service until they get cleaned up.
- 80% of the department takes a shower before going home

Anything else to add or consider regarding this research topic?

PFD / Poulsbo
Bruce Peterson

How many line (911 responders) are on your staff?
36
How many volunteer line staff members?
30
Do you know *how many children of the members ½?*
~ 72
H*ow many cases of cancer of these children?*
0
Do you know what type of cancer?
n/a
What systems policies programs have been *put in place over the last 5-10 years to help combat potential for exposure to toxins and carcinogens…?*

- follow state laws
- exhaust capture systems in stations
- had an extractor for 15 years….
- gears is laundered after all fires, have loaner sets during laundered.guys who float do have a second set.

How often do families visit FF in the station during their shifts?

- occasional visits, not a lot of families come in and hang around….
- very rare.

Do FF carry their PPE and/or Uniforms home?

- absolutely do not take any department issued stuff to launder at home…
- most have bags that pick up and move before
- if they move bunker gear they have a bag.

Are showers mandatory after Fires? (next call?) Showers *mandatory at end of shift?*

- run on call/fire you shower...pushed shower reload before hose….whenever possible get them into shower and into clean and dry clothes
- most everyone showers before they go home...
- no policy but the practice

Anything else to add or consider regarding this research topic?

- reduce exposure risk: fleet manager piloted idle reduction so can shut down unless reducing carcinogen exposure to diesel fumes on the scene.
- try to buy low volatile soaps, and stuff
- done air monitoring in stations to make sure no problem (figured out air outside is worse than air inside is better than outside: state highway outside
- air sampling in breathing apparatus
- walk off track pads, that pull contaminants off the boots as you travel through bay to quarters.

SKFR
Doug Richards

How many line (911 responders) are on your staff?
75
How many volunteer line staff members?
~40
Do you know how many children of the members ½?
183
How many cases of cancer of these children?
1
Do you know what type of cancer?

W*hat systems policies programs have been put in place over the last 5-10 years to help combat potential for exposure to toxins and carcinogens…?*

- annual wellness checks -
- awareness program during overhaul
- SCBA usage throughout overhaul
- 2nd bunker gears: every member has, bring dirty set in….(including hoods and gloves).
- extractor is 10 years old….plan to purchase second extractor…
- air monitoring for all aid units (at the scenes)
- 100% participation of all members through manufacturing online training course

How often do families visit FF in the station during their shifts?

- six stations- several per shift….between 20-30 a day.

Do FF carry their PPE and/or Uniforms home?

- policies in place to not take gear home.
- If they do carry, carried in supplied bunker gear bags

Are showers mandatory after Fires? (next call?) Showers mandatory at end of shift?

- gross decon required by policy at the scene
- secondary decon back at station

Anything else to add or consider regarding this research topic?
We recognize the value of cancer awareness….to the point of engaging with labor for mandatory physicals.

BIFD
Assistant Chief / Operations, Jared Moravec

How many line (911 responders) are on your staff?
33
How many volunteer line staff members?
~30

Do you know how many children of the members ½?
~50
How many cases of cancer of these children?
no
Do you know what type of cancer?
n/a
What systems policies programs have been put in place over the last 5-10 years to help combat potential for exposure to toxins and carcinogens…?

- changes to WAC over the last year raising bar.
- wearing SCBA during investigations.
- As a result of the WAC - zero tolerance in place as pertains to...if doing any type of overhaul going to have SCBA in place.
- Just implemented a significant health and wellness program, use as a screening tool for cancer, everyone gets a full NFPA compliant every 5 years, and in between blood draw and urinalysis
- new extractors through a grant; two of the three have extractors- the third one no space…
- exhaust removal systems through grant, 5-6 years ago and installed at all stations.
- stopped issuing second sets of gear to everyone….with the NFPA standard of replacement every ten years….we have a stash of spare gear crews can swap out as needed. Handful that do have a second set, but once that gear reaches its ten years, they will.

How often do families visit FF in the station during their shifts?
not sure.
Do FF carry their PPE and/or Uniforms home?

- some of the staff take PPE home in gear bags...because they live in close proximity and may respond off duty…
- Most of the folks keep their gear at the stations, but could not say how many bring home.

Are showers mandatory after Fires? (next call?) Showers mandatory at end of shift?

- not in policy, but practice all of the guys do once cleanup is done.
- end of shift not policy….50% of the crews will shower before they head home.

Anything else to add or consider regarding this research topic?
our health and wellness committee has taken an active role in educating our folks, and cancer prevention has been a big part of that...

NKFR
Rick Lagrandeur: B/C

How many line (911 responders) are on your staff?
36
How many volunteer line staff members?
~17
Total number of children of the members ½?
52
How many cases of cancer of these children?
0
Do you know what type of cancer?
na
What systems policies programs have been put in place over the last 5-10 years to help combat potential for exposure to toxins and carcinogens…?

- biggest thing we've done is exhaust systems in the bays….put poiot to point systems in every station.
- gross decon procedures, number of years ago just come back to station, now we do quick wash at the scene….
- only one station with extractor- everything goes in garbage sacks back at the station and B/C will drive to S84 (only station in district on sewer, rest are on septics). Got a new extractor 18 months ago, and can wash 12 sets of gear...

Over the course of a year how many times do families visit FF in the station during their shifts?
Experience is very seldom. But we had one who would visit daily….generally speaking pretty infrequent.
Do FF carry their PPE and/or Uniforms home?
No policy on that...discourage the use in any private vehicle, but guys get moved around due to staffing levels.
Are Showers mandatory after Fires? (next call?) Showers mandatory at end of shift?

- no policy that states have to shower but generally everyone does that.
- no on shower, probably about half of the guys get up and shower before the end of shift….some guys get up cup of coffee and hit the road
- Anything else to add or consider regarding this research topic?

Appendix B

INFORMED CONSENT:

Thank you for offering to participate in this study exploring cancer rates in children of firefigthers.

Informed consent is an important component of the survey process. The following information is provided for your information. You are encouraged to review the below information for reference.

Survey Participants: Participants for this interview have been selected based on their direct involvement in this issue.

Research Purpose: This research project is being conducted as part of the National Fire Academy's Executive Fire Officer Program. This applied research project is a requirement for the Executive Analysis of Community Risk Reduction second year course. This portion of the study will be using a one on one interviews to explore individual stories of the problem.

Research Process: Each participant will be asked to voluntarily participate in the interview process that will collect personal accounts of children of firefighters with cancer.

Confidentiality: Anonymity is preserved between participants, as participants do not have interaction with anyone except the researcher. Interaction with the researcher is through providing and receiving interview responses. Participant responses will remain completely anonymous in the research project. All participant documentation will be held in strict confidence. No one except the researcher will have access to the individual data.

Risks and Benefits to the Participant: There are no known psychological or physical risks to individuals who participate in this study.

Known Limitations: This is an isolated study within Kitsap County and will not necessarily quantify or qualify the potential depth of the problem.

Voluntary Participation: Participation is voluntary and participants are able to stop participation at any time, without penalty. There are no associated risks or consequences in withdrawing from the study at any point in the process.

Compensation: There is no compensation provided for individuals participating in this study.

Contact Information: The researcher conducting this study is Ron Powers, currently working as a shift battalion/duty chief with South Kitsap Fire & Rescue. A copy of the completed study and/or the applied research project will be available upon request.

Ron Powers
BC, SKFR
Personal Direct Line: [redacted]

Interview (printed name)_____

Interview (signature) _____

Appendix C

If 3 out of 612 kids in a sample size (KC firefighter child) get cancer then p=0.49% and general population is 1.79 out of 10000, p=0.0179% so 0.49/0.0179=27.4.

Appendix D

$p = \frac{1.79}{10{,}000}$

$\hat{p}_{KC} = \frac{3.}{612}$

$$z = \frac{\hat{p} - p_0}{SD(\hat{p})}$$

$$SD(\hat{p}) = \sqrt{\frac{p_0(1-p_0)}{n}}$$

99%

$$CI = \hat{p}_{KC} \pm 2.575\sqrt{\frac{p(1-p)}{n}}$$

95% CI

[0.0038, 0.0060]

.0049+2.575√(.0049(1−.0049)/612) = .0062924806

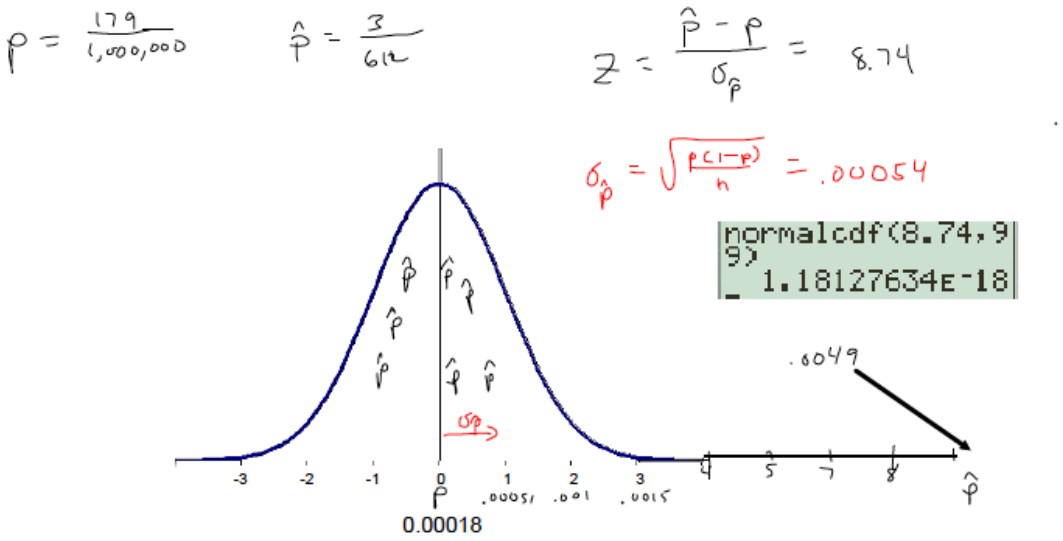
.0049−2.575√(.0049(1−.0049)/612) = .0035075194

99% CI

[.0035, .0063]

If KC county kids are "normal," we would be 99% confident that the national proportion of cancer cases would be between 0.0035 and 0.0063.

Appendix E



If KC county kids are "normal," the probability of 3 (or more) out of 612 having cancer is 1.18(10)^-18!!! Therefore the KC kids must NOT be "normal"!