The Importance of Firefighter Rehab on the Fire and Training Ground

By: Brian M. Novotny

Captain

Streetsboro Fire Department
9184 State Route 43
Streetsboro, OH 44241

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CERTIFICATION STATEMENT

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ABSTRACT

The Streetsboro Fire Department had numerous occasions of firefighters becoming overexerted on the training and fire-ground. The problem this study will address is, Streetsboro firefighters were not receiving proper rehabilitation while preforming extreme physical activities during those times. The purpose of this study was to provide research-based information to identify and describe methods to rehabilitate physically exhausted firefighters. Descriptive research was utilized to answer four research questions. What are the advantages and disadvantages of emergency incident rehabilitation? What methods can be employed to properly rehabilitate firefighters? How do comparable occupations perform rehabilitation? Are there any standards or current best practices for emergency incident rehabilitation?

The research was obtained from local Public Libraries, internet search and surveys were created to validate the need of emergency incident rehabilitation. The results had shown the initiation of rehabilitation will prevent injuries and a Line of Duty Death (LODD). The recommendations were to adopt an SOP/G's and establish a rehabilitation sector when emergency operations or training exercises pose a potential safety or health risk to their members.

TABLE OF CONTENTS

INTRODUCTION

The Streetsboro Fire Department have experienced situations where firefighters on the fire and training ground had to request a break from their assigned tasks due to fatigue. In these situations, there were no means to properly evaluate and rehabilitate those firefighters. Firefighters had exhibited signs and symptoms of overexertion and cardiovascular problems of chest pain, shortness of breath, weakness, dizziness, lightheadedness and required extended recovery time. The only means of evaluating those firefighters were to go on their own state of perceived readiness. The lack of appropriate medical examination on scene potentially placed the firefighters at risk of a life threating injury.

Firefighting is an inherently dangerous and physically demanding activity. During their duties, firefighters are exposed to several potentially life-threatening dangers, including burn injury, hazardous chemicals, asphyxiations, collapse, explosion, and entrapment. Despite these myriad dangers, it's the physiological consequences of firefighting that poses the greatest threat to Firefighters (Denise L. Smith J. P., 2010). Applied research will be needed to first understand the amount of physical stress the firefighter goes through while working on the fire scene. Then bring awareness to firefighters, because their perception of readiness while on the fire ground may be setting them up for injury or death.

The number one cause of injury and death to firefighters is due to overexertion. (Dodson, 2016). Statistics show there has been a decrease in firefighter injuries and deaths; however, when the statistics are tallied by how many injuries and deaths there are to firefighters per 1,000 fires, the numbers greatly increase. This is an alarming fact when there have been enormous strides in education on fire dynamics, technological advances in personal protective equipment

(PPE), and increases in situational awareness.

Underwriters Laboratories (UL) have tested fire dynamics between three modern day configurations against three legacy configurations, defined as furnishing in mid-20th century homes and building materials from between 1950 and 1970. The experiments revealed that the natural materials in the legacy rooms released energy more slowly than did the fast-burning, synthetic-furnished modern rooms, which leaves significantly less time for occupants to escape. The experiments also demonstrate to firefighters that in most cases, the fire has either transitioned to flashover prior to their arrival or has become ventilation-limited and is waiting for a ventilation opening to increase its burning rate. This difference has a substantial impact on occupant and firefighter safety and leads to faster fire propagation, shorter time to flashover, rapid changes in fire dynamics and shorter escape times. (Laboratories, 2012)

UL's research has discovered the fireground environment has become hotter, more toxic and increases in size at a frightening rate due to modern day synthetic furniture. Because of these changes in the fire dynamics, firefighters will be tested physically more than ever before. Research data was collected through descriptive research and surveys to identify the importance and methods to properly rehabilitate overexerted firefighters.

Statement of the Problem

The problem this study will address is Streetsboro firefighters are not receiving proper rehabilitation while on the fire and training ground.

Purpose of the Study

The purpose of this study is to provide research-based information to identify and describe methods to rehabilitate physically exhausted firefighters.

Research Questions

The following questions will be answered by using descriptive research:

1. What are the advantages and disadvantages of emergency incident rehabilitation?
2. What methods can be employed to properly rehabilitate firefighters?
3. How do comparable occupations perform rehabilitation?
4. Are there any standards or current best practices for emergency incident rehabilitation?

BACKGROUND AND SIGNIFICANCE

The Streetsboro Fire Department is in Portage County in northeast Ohio, between Akron and Cleveland. The city of Streetsboro is 25 square miles with a population of more than 16,000 residents. The city is made up of residential, commercial, manufacturing, industrial and rural areas. The city's tax base is largely supported by its three industrial parkways. The largest industrial/manufacturing business is L'Oréal which is over 750,000 square feet of office and distribution warehouse. The city has two main arteries of travel which run through it; Interstate 480 and the Ohio Turnpike. The Streetsboro Fire Department covers eight miles of Interstate 480 and 13 miles of the Ohio Turnpike which transports hazardous cargo.

The organization is a combination full and part-time department. There are 19 full-time members including the Chief. The department also consists of 23 part-time employees and an administrative assistant. There are three 24-hour rotating shifts, each consisting of five full-time employees and three part-time employees per shift. Three of the 19 full-time members are assigned to the Fire Prevention Bureau and work 40-hours a week Monday through Friday.

The department's initial response to working structure fires is a command vehicle, three-member engine company, two-member truck company and two-member ambulance crew. They

utilize a mutual aid box alarm system (MABAS) to acquire adequate personnel which is compliant with National Fire Protection Association (NFPA) 1710 *Standards for the organization and deployment of fire suppression operations*, Emergency Medical Operations, and Special Operation to the Public by Career Departments, which recommends 15-17 personal on an initial full alarm assignment.

According to their 2016 annual report, 78% of the call volume was EMS (emergency medical service) and 22% were fire related incidents. They respond to 2,500 calls a year which has been increasing each year. The department members participate on specialized teams within Portage County which include, Urban Search and Rescue (USAR), Portage County Fire Investigation Unit (PCFIU), Portage County Water Rescue Team (PCWRT) and the Portage County Hazmat Team (PCHT).

The Streetsboro Fire Department has had numerous incidents on the training and fire ground where crew members reported feeling fatigued, overexerted, dizzy and exhausted after completing an assignment or task. These members had no area of refuge to seek proper evaluation of vital signs, body core temperature or monitoring of fluid and fuel intake. There was no medical team to evaluate the members to ensure their safety of not succumbing to a heat-related illness or sudden cardiac event.

Complacency or failure to understand how quickly overexertion and cardiac arrest can happen can be a deadly mistake. Just as important, the Department must recognize the signs and symptoms of overexertion and heat-related illness and learn how to properly rehab themselves to prevent these occurrences.

While participating in a hose advancement training in extreme heat of the summer, a firefighter became overexerted with symptoms of heat exhaustion. He became dizzy, lightheaded

and showed signs of weakness after completing the drill. The next incident occurred during live fire training were a firefighter become overexerted and had chest pains with excessive weakness. Finally, during a working apartment fire, a firefighter became physically exhausted and could not complete his task while advancing a hose line up to the second floor. In all these cases there were no areas for these firefighters to be evaluated.

The literature unveiled that Firefighters will push themselves physically and mentally for the community they serve and risking their own life to save others. Firefighters must remember they can't take care of others if they don't take care of themselves. If they become unable to complete their tasks due to overexertion, they place themselves, their crew and the community in danger.

There is no current policy on when and how to properly rehabilitation firefighters within the Streetsboro Fire Department. The department does carry in their incident command vehicle and primary responding engine, cooling towels and a cooler filled with bottled water and Gatorade for hydration. However, there is no structured standard operating procedure (SOP) on when and how to formally initiate emergency incident rehabilitation.

Firefighters should not rely on their perceived comfort level regarding their physical ability to return to their next fire ground assignment or training ground task. "Like a professional athlete, firefighters need to maintain their individual diet needs to best support cell performance and their work-hardening efforts. Those who know how their bodies respond to stress and how to immediately address metabolic deficiencies perform better and help prevent injuries" (Dodson, 2016). Their prime objective should be to strive to make sure everyone returns home safely by hydrating, fueling and properly evaluating and monitoring vital signs while on an emergency incident or training ground. They should mirror the National Fallen Firefighters Foundations,

"Everyone Must Go Home" campaign by taking the necessary steps to prevent the possibility of a Line of Duty Death (LODD).

The potential impact this study could have on Streetsboro Fire Department is prevention of injuries or sudden cardiac arrest due to overexertion and heat-related injuries by the implementation of an emergency incident rehabilitation policy.

LITERATURE REVIEW

Firefighter rehabilitation is defined as the process of providing rest, rehydration, nourishment, and medical evaluation to responders who are involved in extended and/or extreme incident scene operations (USFA, 2008). Firefighting is a very demanding job which can push the body to its maximum physical and mental limits. From advancing hose lines, to search and rescue, ventilation, throwing ladders, and carrying heavy equipment in all types of extreme environments. Firefighters not only have to perform all those tasks effectively and efficiently, they must account for the increased weight of PPE (personal protective equipment) which weighs more than 75 pounds. These tasks, along with the added weight of their PPE, carrying equipment and tools for accomplishing those tasks can place the firefighter in danger of overexertion. Firefighting consumes only 10% of on-duty hours, yet virtually 50% of all firefighter deaths and 66% of the injuries happen on-scene (Mcevoy, 2008). Firefighting may cause a sudden cardiac event in vulnerable personnel. A Harvard research study cited by Skidmore College found firefighters only spend a short amount of their time in actual firefighting, a sizable percentage of their deaths happen quickly after firefighting operations (Denise L. Smith J. P., 2010). This study also showed firefighters are 136 times more likely to

have a sudden cardiac event after fire-ground operation than nonemergency activities around the station.

NFPA 1584 (2015) *Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises* states, fire department shall develop standard operating procedures/guidelines (SOP/Gs) that outline a systematic approach for the rehabilitation of members operating at incidents and training exercises. It further states each department is responsible for preplanning a rehabilitation program and training its members. The standard gives the responsibility of establishing emergency incident rehabilitation to the incident commander.

The NFPA is a global nonprofit organization, established in 1896, devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards. They create and maintain private, copyrighted standards and codes for usage and adoption by local governments. They acquire information on all firefighter fatalities in the U.S. which results from injuries or illness while a firefighter is on-duty. The NFPA reported there were 68,085 firefighter injuries in 2015. There had been a recent decline over the past few years; however, there was an increase of 7.5% compared to 2014. Overexertion was included in the number one type of injuries sustained on the fireground. Not only that, fireground injuries per 1,000 fires has remained relatively constant for the past 20 years (Quiros, 2017). These statistics are very concerning and there needs to be a change in the culture to improve firefighter safety.

According to the NFPA's report on Firefighter fatalities in the United States in 2017 there were 60 firefighters that died while on-duty. The research recorded the lowest number of firefighter line of duty deaths since 1977, when they started recording these events. Of those 60 deaths, 17 had occurred while firefighters were working on the fire-ground. In 2017, 29 sudden

cardiac deaths resulted with an onset while the victim was on-duty. This is the fourth time in the last six years that the toll has been below 30, but still accounts for almost half of the deaths while on-duty in 2017 (Rita F. Fahy, 2018). From 1977 through 1986 an average of 60 firefighters annually suffered sudden cardiac arrest while on-duty, which was 44.7% of the deaths during that time. The report makes a point to indicate the onset of cardiac symptoms that happened while the firefighters were on-duty and their deaths occurred suddenly or shortly after. According to the NFPA, cardiac related events accounted for 43% of the on-duty fatalities over the past 10 years. Overexertion, stress, and medical problems are by far the largest share of deaths. Of the 32 deaths in this category, 29 were classified as sudden cardiac deaths (usually heart attacks) and one a stroke (Rita F. Fahy, 2018).

This review will also examine how dehydration due to physical exertion and environmental conditions affects the physiological functions of the firefighter. The study will identify how to properly administer and detail the importance of establishing a rehabilitation sector on the fire and training ground. Emergency incident rehabilitation starts prior to the incident when the firefighters report to duty. They shall report to duty properly rested and hydrated to perform at peak performance. Section 4.3 Pre-Incident and Training Operations and 4.3.1* in (NFPA1584, 2015). It states members shall maintain proper hydration, nutrition, and diet to maintain normal body function. Dehydration can adversely affect the performance of firefighters and lead to serious injuries. (Zimmerman, 2012, p. 76) states, health and wellness are vital for firefighter safety and dehydration is one of the most crucial factors that need to be addressed on the fire scene.

(USFA, 2008) states the human body is made up of 60% water and normal body function is dependent on maintaining proper hydration to ensure proper hemostasis of the firefighter.

They define hydration as the amount of water contained by the body. The goal of hydration is to ensure the intake versus discharge is the same. The body loses water through four separate ways: in urine, stool, while exhaling and sweating. When the body sweats it also loses electrolytes essential for normal body function. Failure to maintain these levels may result in a decrease in muscle function and affects the hearts electrical system. The negative effects of the conduction system may cause a potentially deadly cardiac arrhythmia. Dehydration provokes changes in the blood volume, which affects the cardiovascular, thermoregulatory, metabolic and central nervous function as dehydration worsens (Larkin, 2017). The USFA states it is better if firefighters enter operation with an even or slightly positive water balance. This prevents them from quickly lapsing into a dehydration state during the initial stages of an incident.

When firefighters perform their tasks on the fire ground and start to exert themselves, their body core temperature starts to rise. The body increases blood flow to the skin and begins to sweat to reduce the increase in body core temperature. With continued physical exertion, the body produces more heat than the sweat can dissipate which stimulates the increase in body core temperature, heart rate and dehydration. A decrease in one percent of body weight due to dehydration can cause a danger to performance. Of all the physiological perturbations that can cause early fatigue during exercise, dehydration is arguably the most important, if only because the consequences are potentially life threatening (pointhealth.com, n.d.).

The physiological strain of firefighting affects every major body system. There is an increase in heart rate, blood pressure, body temperature, oxygen consumption, lactic acid, heat production and respiratory rate. The body has a decrease in stroke and plasma volumes which leads to hemoconcentration. Hemoconcentration causes a change in electrolytes and an increase in blood viscosity. (Denise L. Smith J. P., 2010)

The NFPA's number one cause of Line of Duty Death (LODD) is sudden cardiac arrest. (Rita F. Fahy, Paul R. LeBlanc,Joseph L. Molis, 2017) Within eighteen minutes of routine fire suppression based physical activity while donned in personal protective equipment (PPE) results in increased heart rate, core body temperature, and speed of clot formation; all contributing to or exacerbating a responder's underlying cardiovascular disease. The sudden formation of a clot in an artery supplying the heart results in a heart attack or ischemia leading to the development of a fatal heart arrhythmia. (Levitin, 2009) Dr. Levitin also states that cardiac deaths had occurred following fireground activities when the firefighter's level of physical exertion, metabolic rate, and heat stress levels were at their peak.

The current firefighting protective ensemble is heavy, thick, multilayered and it exacerbates the challenge of thermoregulation due to its limited permeability and insulative properties (Durand, 2006). The protective barrier of the gear also prevents the body from properly cooling itself. "Few occupations stress the human body to the degree that firefighters experience in hostile, working-fire environments" (Dodson, 2016). Dodson also compares the demands of firefighting to professional athletes and states "Firefighters are the only professional athlete who needs to achieve peak performance without warming up." (Dodson, 2016). Athletes that are either fully (e.g., fencers, motorsport drivers/riders) or partially (e.g., American football and ice hockey players) encapsulated by protective equipment/clothing are unable to fully modify skin surface heat loss via changes in sweating, since sweat evaporation is blunted by the properties of the clothing system (Morris, 2018).

The generation of internal body heat and the inability to dissipate heat are further compounded by the weight of the gear. Due to the nature of a firefighter's work and working conditions, it is inevitable that firefighters will increase their core body temperatures (Durand,

2006). In a study written in the Journal of Australian Strength and Conditioning, firefighters wearing full proper protective equipment had a significant increase in tympanic temperatures after they had completed a certain amount of exercise in a normal temperature atmosphere. The study also found a larger increase in body core temperature while performing the same exercise in a hotter atmosphere. This hypothesis is because the PPE worn by firefighters is designed to protect their body from external radiant heat and research has identified increasing metabolic demands when carrying heavier loads (Andrew Carlton, 2016).

In addition to the firefighter's gear, physical exertion and thermal stress also affects the firefighter by increasing their body core temperature into dangerous ranges. In contrast to exercise, environmental temperatures add significantly to heat stress on the body. In addition, heat loss through evaporation, convection, conduction, and radiation is dramatically reduced. Sweat is unable to evaporate effectively enough because PPE creates an environment in the air layer between the skin and the gear that has 100% humidity. Although PPE has a vapor barrier, heat loss by convention is limited (Denise L. Smith J. P., 2015). Medical literature on this varies; however, most agree that core temperatures above 101 degrees Fahrenheit or below 96 degrees Fahrenheit will start to affect physical performance including reduced mental alertness or decision-making capability (Dodson, 2016). A NASA study also concluded that when the temperature is 95° F for an extended period, people can make 60 mistakes per hour – without realizing it (Scott Gammons, 2009). This is very concerning when temperatures of a structure fire may reach 1,000 degrees which would accelerate the increase of body core temperature in addition to the physical stress, weight of the equipment and being encapsulated in PPE. (Durand, 2006) also acknowledges that intense heat strain may cause firefighters to suffer a loss of concentration, which then leads to accidents and injury. He also states it is very important to

reduce heat stress, so firefighters can make the quick decisions needed during fire ground activities.

Skidmore College in Saratoga Springs, NY completed a study on the effects of heat stress and dehydration on cardiovascular function. They stated several research reports indicate a high percentage of firefighters report to work or training in a dehydrated state. One study reported 31% of firefighters were seriously dehydrated, 46% were significantly dehydrated, 14% minimally dehydrated and only 9% were well-hydrated.

They tested 12 healthy firefighters which had undergone cardiovascular exercises in full firefighter PPE in four different environmental conditions. The first two conditions studied were in a normal hydration state, one with heat stress and one without. The next two tests were completed in a dehydrated state, one with heat stress and the other without. Evidence shows over 70% of firefighters are dehydrated when they arrive at work (Denise L. Smith J. P., 2015).

In the study's major recommendations, they stated to mitigate heat stress and dehydration firefighters need to.

- Receive an annual medical evaluation consistent with NFPA 1582, The Standard on Comprehensive Occupational Medical Program for Fire Departments guidelines, and performed by a physician familiar with the physiological demands of firefighting.
- Engage in regular physical exercise to improve thermoregulation, enhance cardiovascular function, improve work performance, and provide cardio protection.
- Ensure proper hydration before emergency operations.
- Adopt NFPA 1584 and ensure that incident rehabilitation is established for emergency incidents and training drills.

The study further states working in a dehydrated state puts firefighters an increased risk for heat injuries and increased thermal and cardiovascular strain. To ensure proper hydration, firefighters should monitor their hydration status by the color of their urine. If a firefighter is properly hydrated their urine should be pale or light yellow. Dark yellow urine is an indicator of dehydration. To maintain proper hydration, they should drink two to three liters per day of water, non-sugary, non-caffeinated and low-calorie fluids. They should replace fluids lost during exercise and training and avoid alcoholic beverages the night before reporting to duty.

Firefighters can find themselves in all types of environments and physical settings. These situations place them in compromising positions which increases their physical stress and leads to overexertion. Dodson states there are two types of environmental stressors which are ergonomic and thermal. Ergonomic stressors to firefighters are the physical setting, worker relationship to the setting and task requirements of the job. Thermal stressors can be divided into internal and external. External heating comes from the building's content on fire, which increases the environmental temperature. The internal heating increases from our metabolism, due to the physical exertion. Firefighters are called to work in many types of environments and the ergonomic stressors are endless. These stressors add to their physical exhaustion and lead to injuries.

Once on scene and firefighting assignments and tasks have been completed, rehabilitation continues with removing themselves from the environment they are in. Passive and active cooling are two strategies to begin the rehabilitation process. Passive cooling is when the firefighter removes themselves to an area away from the heat stressors of the incident. Some passive cooling techniques are lying under the shade of a tree, removing their personal protective equipment and resting to reduce their body core temperature. Active cooling is the use of

cooling towels, cooling vests and placing forearms in ice buckets to assist in lowering body core temperatures. Several studies have shown active cooling is best accomplished by placing the forearms in cold icy water or using cold, wet towels on the head and neck (Dodson, 2016).

NFPA 1584 (2015) addresses the need to assist firefighters in establishing an area and time to decompress, rest and rehydrate after specific allotted work times on the fire and training ground. Rehabilitation shall commence whenever emergency operations or training exercises pose a potential safety or health risk to members. The standard also recommends relief from environmental conditions and performing active and/or passive cooling or warming when required for the emergency type and temperature conditions, fluid, fuel and electrolyte replacement for longer duration incidents when required, medical monitoring, member accountability and release (Bladsoe, 2011). Further research points to using the consumption of self-contained breathing apparatus (SCBA) bottles as a benchmark of when a firefighter should have rehabbed due to the difficulty of keeping track of time on a dynamic incident. The USFA cites two guidelines from NFPA 1584 (2015) of when firefighters should seek rehabilitation. Guideline number one states, the crew must self-rehab (rest and hydrate) for 10 minutes following the use of one 30-minute SCBA bottle or after 20 minutes of intense work cycle without wearing an SCBA. Guideline number two states, members shall rest for a minimum of 20 minutes following the use of a second 30-minute or 45-minute self-contained breathing apparatus (SCBA) cylinder, a single 60-minute SCBA cylinder, or 40 minutes of intense work without SCBA.

After the benchmarks have been reached, the literature indicates the importance of being medically monitored with vital signs including body temperature. The reason for this, which the literature suggests, the firefighter should relax enough to regain energy with proper hydration

and nutrition to allow their vital signs and body temperature to return within normal limits to prevent injury. Firefighters whose initial assessment reveals present or pending injury or illness must receive a more thorough evaluation and treatment to minimize the change of their condition worsening (USFA, 2008). (Dodson, 2016) states the USFA utilizes the following criteria to determine the need for extended time in rehab following 20 minutes of rest, cooling and hydration:

- Pulse rate more than 120 beats per minute
- Body temperature above 100.5 degrees Fahrenheit
- Diastolic blood pressure above 90 mmgh
- Systolic blood pressure over 130 mmgh

Finally, after being medically cleared by the rehab officer, the research shows that emergency incident rehabilitation must continue through demobilizing and continuing upon return to the station. Firefighters must continue to hydrate, fuel, recover and report any signs or symptoms of overexertion. True recovery from an overly strenuous incident or emergency scene can take 24 hours (Dodson, 2016). The USFA recommends firefighters continue to drink up to 32oz of carbohydrates and electrolytes for two hours following the incident. They further state by maintaining a relatively clear and odor free urine is the best way to identify when their hydration is adequate.

In summary, the literature review reveals that rehab starts prior to, during and after the incident. Firefighters are placed into highly volatile situations with extreme internal and external temperatures. They must be ready to address these situations at a moment's notice,

which starts with being physically conditioned, properly fueled and hydrated prior to the incident. The literature from the NFPA and USFA are transparent on the importance of the implementation of an emergency incident rehabilitation policy and how it can reduce the risk of overexertion and sudden cardiac event which is the number one cause of injury and death to firefighters. This author believes the Streetsboro firefighters are placing themselves at increased risk of injury due to overexertion and cardiac arrest without a proper emergency incident rehabilitation policy in place.

PROCEDURES

The descriptive research method was used to acquire data to answer the four research questions. The research was obtained from books, internet sources, fire service articles and the utilization of firefighting national standards from the National Fire Protection Association (NFPA), United States Fire Administration (USFA), National Institute of Occupation and Health (NIOSH) and the National Fallen Firefighters Foundation (NFFF). Research information was also obtained from the Twinsburg Library which was able to access the Kent State Library Resource Center for articles related to physiological responses to firefighters to live fire training, investigate the effects of structural fire suppression on firefighter's hydration status and the impact of heat exposure on firefighter's work performance. Internet searches were done by using key terms of firefighter heat stress, overexertion and dehydration. Data was further obtained by listening to Fire Engineering's podcast on firefighter fitness and rehabilitation. The podcast referenced two research studies from Skidmore College First Responder Health and Safety Laboratories. Attended the Maryland Fire and Rescue Institutes Staff and Command class and was able to network with command officers from across the country on how they utilize emergency incident rehab and what standards they used to develop and implement their rehab

policies.

An internal survey was sent out to Department members and were asked ten questions on the topic of emergency incident rehabilitation. The reason for the survey was to research the need for the adoption of a formal emergency incident rehabilitation policy. The survey asks their opinions on the benefits of rehab, could they personally have benefited from rehab during working structure fires or on the training ground, do they believe rehab prevents injury or death, or is the status of our current emergency incident rehab adequate. Forty surveys were sent out and 20 were returned. The results of the survey can be found in Appendix A.

A second survey with 10 questions were sent out to 215 Ohio Fire Executive program alumni, current students, local and nationwide departments to obtain research on how they utilize rehabilitation, have they had an injury or illness that can be attributed to the lack of emergency incident rehabilitation, do they have a designated vehicle for rehabilitation and do they believe their department would benefit from an emergency incident rehabilitation policy. One hundred surveys were returned, and the results of the study can be found in Appendix B.

Definitions of terms

Hemoconcentration. An increase in the concentration of red blood cells as a result of a decrease in plasma volume or increase in red blood cells (Denise L. Smith J. P., 2010).

Perturbations. Is a slight change in the movement, quality or behavior of something, especially an unusual change.

Limitations of the study

1. In the study completed by Skidmore College, 12 firefighters in full personnel protective equipment were studied in a controlled laboratory on the effects of heat stress and dehydration on cardiovascular function. The study was unable to produce all the physical and psychological stressors which occur on the fireground.

RESULTS

Research question 1. What are the advantages and disadvantages of emergency incident rehabilitation?

The research data clearly states the main advantage of emergency rehabilitation will reduce the physiological stressors place on the body during the incident scene. Rehabilitation will reduce the cardiac strain, replace electrolytes, reduce body core temperature, increase plasma levels and decrease lethal arrythmias cause by dehydration. The reduction of the physical stressors will prevent the number one cause of firefighters LODD which is overexertion and a sudden cardiac event.

Disadvantages of emergency rehabilitation are shortages in staffing levels which will take away from firefighting operations. Dave Dodson states if breaks are unobtainable due to staffing levels, the Incident Commander needs to change the incident action plan to match their resources. When self-rehabilitation is required, and firefighters are not supervised, they may not take full advantage of the available resources to properly care for themselves. The bottom line is that we shouldn't rely on working firefighters to carry out the medical monitoring and care portion of self-rehab (Dodson, 2016).

Research question 2. What methods exist to properly rehabilitate firefighters?

The literature identifies self-rehab or sometimes called initial rehab as the most utilized method of rehabilitation. Primarily used at smaller incidents of short durations when resources are available. The self-rehab shall start after the firefighter had consumed their first SCBA (30 to 45minute bottle) or at the end of a 20-minute work cycle without a SCBA for at least 10 minutes. A firefighter should rest for 20 minutes after their second SCBA cylinder or after the use of a 1-hour SCBA cylinder (Dodson, 2016) . While self-rehabbing, a firefighter shall take relief from the environmental conditions, rest/recover, active/passive cooling or warming, rehydration and medical monitoring.

The second method identified through the research is formal rehab. Formal rehabilitation is established at large, complex incidents and when excessive physical demands are required lasting for longer than two hours. In a formal rehabilitation sector, firefighters should be in an area away from the immediate incident. NFPA 1584 commends relief from climatic conditions (2) Rest and recovery (3) Active and/or passive cooling or warming as needed for incident type and climate conditions (4) Rehydration (fluid replacement) (5) Calorie and electrolyte replacement, as appropriate, for longer duration incidents (6) Medical monitoring (7) Member accountability (8) Release. Members shall rest for a minimum of 20 minutes following the use of a second 30-minute or 45-minute self-contained breathing apparatus (SCBA) cylinder, a single 60-minute SCBA cylinder, or 40 minutes of intense work without SCBA (NFPA1584, 2015). The standard further states a supervisor may adjust the rest cycles due to the work or environment conditions. The personnel shall not return to fire or training ground if they feel they are not fully rested or if there is evidence of mental or physiological stress where it is unsafe to perform their duties.

Research question 3. How do comparable occupations perform rehab?

Gator-aid sports science institute states, if an athlete does not hydrate properly every day, dehydration can worsen and lead to performance issues. To prevent dehydration, especially in hot, humid conditions, athletes need to drink enough of the right fluids, before, during and after physical activity. To maximize an athlete's physical performance, athletes should drink 17 to 20 oz of water two to three hours before the event and then drink 7 to 10 oz, 10-20 min before the start. During the event, they should be drinking 28-40oz per hour of activity. Upon completion of the race they should drink enough water to replace weight loss from the event (Larkin, 2017). The Gator-aid Sports Science Institute recommends athletes follow these rules for hydrations before, during and after activity.

Before

- Take the time to acclimate to the heat during the first 2 weeks of practice.
- Schedule practice during cooler times of day.
- Athletes should hydrate throughout the day. Coaches and parents should teach athletes how to monitor their hydration levels by checking the volume, frequency, and color of their urine. If they are hydrated, their urine should look like lemonade. If their urine looks dark, like apple juice, they may need to drink more fluids.
- Coaches should encourage athletes to weigh in and out before and after practices to determine individual fluid losses

During

- Schedule and enforce frequent drink breaks and rest periods during physical activity.
- Remove protective padding and practice in T-shirts and shorts.
- Reduce intensity and/or length of training with high temperatures and/or humidity.
- When it comes to keeping athletes safe on the field, water may not be enough. While water is fundamental to the body, it does not hydrate as effectively as a properly formulated sports drink with sodium.
- Ask athletes to buddy up during practice with a teammate to monitor for warning signs of heat illness.
- Overexposure to high temperature and humidity can cause heat-related illnesses. The National Weather Service issues heat alerts when the daytime heat index (a combination of temperature and humidity) is 105° F or more, which can dramatically increase the risk of the most serious heat-related illnesses. At 80-105° F, fatigue and heat stroke are also possible with prolonged exposure. Athletes playing in the heat for long periods of time wearing protective padding are especially at risk.
- Be prepared by having an ice-filled tub ready for immersing a player in case of an emergency. Carry a cell phone on the field at all times. Know the precise address of the practice or game field and any specific directions required by EMS responders. Remember to cool first before trying to transport the athlete.

After

- Weigh athletes before and following practice as close to nude as they are comfortable and use the change in weight to determine fluid losses. Coaches should monitor athletes to ensure they replace every pound lost during practice with approximately 20 ounces of fluid.

Football players can be compared to endurance athletes and Firefighters due to the extreme physical exertion produced during the event. Pre-activity rehydration should be done in addition to hydration during and post-activity. Begin drinking 15 to 20 ounces two to three hours prior to activity and 7 to 10 ounces of water every 20 to 30 minutes during exercise. Additionally, athletes can monitor their urine color to ensure the hydration plan is adequate. A clear to light yellow urine color indicates adequate hydration, while a dark yellow or brown color indicates dehydration (Sundeen, 2017)

Construction workers are susceptible to overexertion as are firefighters. Due to the extreme environmental conditions to which they are exposed to while wearing heavy protective, non-breathable clothing or impermeable chemical protective clothing. OSHA requires them to create work/rest cycles, give the body an opportunity to get rid of excess heat, slow down the production of internal body heat, slow down the heart rate, and provide greater blood flow to the skin. Work/rest schedules are often based on 1-hour cycles and might call for a rest period of 15 minutes every hour during hot weather, but 45 minutes per hour when temperature and humidity are extreme. They shall remind workers to drink plenty of water every 15 to 20 minutes and drink about 4 cups of water every hour during the hottest periods. (United Department of Labor, n.d.)

Research question 4. What are the national recommended standards for emergency incident rehabilitation?

NFPA 1500 (*Standard on Fire Department Occupational Safety, Health and Wellness Program 2018)*, states personnel shall undergo rehabilitation in accordance with NFPA 1584. NFPA 1584 (*Recommended Practice on the Rehabilitation of Members Operating at Incident Scene Operations and Training Exercises*.) was distributed in January 2003 to initially support NFPA 1500 in the development of a rehab program for emergency incidents. NFPA 1584 was later adopted to become its own standard. The committee updated the standard to meet the current science of rehabilitation in 2008. They also intergraded NIMS (National Incident Management System) terminology, added an annex to display a standard SOP on preforming emergency incident rehab and provide information on how to identify and treat environmental emergencies. The standard also places the importance on Firefighters sustaining proper nutrition, hydration, and maintaining a healthy lifestyle prior to emergency incidents or training exercises. The 2015 version added the importance of post incident rehabilitation and identifies the difference between energy drinks from sports drinks and how they may affect the rehab process. It also stresses the importance of the firefighter to report any associated signs and symptoms of overexertion or heat related illness.

The literature reviewed identified over 50% of the firefighter line of duty deaths were a result of a preexisting medical conditions. NFPA 1582 *Comprehensive Occupational Medical Program for Fire Departments* 2018 took the initiative to assist firefighters to take a proactive approach in identifying those condition and taking the proper steps to alleviate and prevent them. The intent of this standard is to rehabilitate the firefighter and only limit them from performing those tasks where their injury or illness would affect the safety of themselves or other personnel.

The research also identified how important physical fitness and reporting to duty properly hydrated and nourished is when rehabilitation starts. NFPA 1583 *Health-Related Fitness Programs for Fire Department Members* was developed to focus on providing a firefighter with a comprehensive knowledge on maintaining a healthy lifestyle along with a fitness component. Firefighters who are physically sound will have less of a chance of being impaired during training and emergency operations and will be easier participants in the rehab operation (USFA, 2008).

The U.S. Fire Administration (USFA) created a publication with the IAFF properly titled Emergency Incident Rehabilitation. This document was created to offer suggestion, science and procedures to assist the fire service in developing a rehabilitation group.

The results of the internal survey to determine the need and evaluate the current state of rehabilitation within the department are as follows. The first question was asked if they felt rehabilitation was important. (100%) of the respondents felt rehabilitation was important. Reviewing the literature of the number one cause of line of duty deaths being overexertion, all the Streetsboro Firefighters surveyed felt rehab was necessary.

Question two asked if they ever felt overexerted on the fire/ training ground? (100%) surveyed had felt overexerted during these times. Signs and symptoms of cardiac distress or injury potential are difficulty breathing/ shortness of breath, chest pains, extreme fatigue/sluggishness, altered level of consciousness, dizziness, poor skin color and slurred speech (Dodson, 2016).

Question three stated, “Have you ever felt short of breath, chest pain, dizzy, lightheaded or nauseated during fireground operation?” (47.62%) of respondents felt these symptoms.

Question four ask if they felt the same symptoms on the training ground which (38.10%) experienced these symptoms.

Question five of the survey, “Do you believe monitoring vital signs were important?” Most of the respondents (47.62%) “agreed” verses (33.33%) who “strongly agreed”. Through the literature review, monitoring body core temperature was indicated as a vital sign; however, question six asked, “Do you believe body temperature should be taken in rehab?” (47.26%) of the respondent “agreed” and (38.10%) of them “strongly agreed”.

Question seven asked, “Do you believe emergency incident rehab could prevent injury or death?” (67.90%) respondents “strongly agree” to (38.10%) of them “agree”. Question eight queried, “Should emergency incident rehabilitation be required at all working structure fires?” (33.33%) of the respondents “strongly agreed” and (42.86%) of the respondents “agreed”.

Question nine of the survey, “Do you believe the Department could benefit from an emergency incident rehabilitation policy?” (94.24%) of the respondents said “yes” to (4.76%) of them said “no”. The final question number ten asked, “Do you believe the way we currently rehabilitate on emergency incidents is adequate?” (52.38%) of the respondents “disagree” and (28.57%) “neither agree” or “disagree”.

An external survey was sent out to local and nationwide fire departments for the purpose of determining the impact of emergency incident rehabilitation within their departments. The first question was “Has your department had an injury/illness due to the lack of emergency incident rehabilitation?” (31.03%) of the respondents said “yes” and (68.93%) of them said “no”.

Question two of the survey “In your opinion, would having an emergency incident rehabilitation sector prevent fatigue or overexertion?” Most of the respondents (34.48%) said, “a great deal” to (31.03%) of them stated “a lot”.

The fire department shall develop standard operating procedures/guidelines (SOP/Gs) that outline a systematic approach for the rehabilitation of members operating at incidents and training exercises (NFPA1584, 2015). Question three ask “Does your department have an emergency incident rehabilitation policy?” (62.07%) of the respondents said “yes” and (37.93%) said “no”.

Question four asked “Do you believe emergency incident rehabilitation should be implemented on all working fires?” (50%) of the respondents “agree” to (34.48%) who “strongly agreed”. Question five was then asked, “How often is emergency incident rehab used at working structures fires?” Most of the respondents (34.48%) stated “Sometimes”, to the next highest, (29.31%) who stated “usually”. Question six was asked “How often is emergency incident rehab used at large scale training’s?” (37.93%) responded “usually”, to the next highest of (24.14%) who said “sometimes”.

Question seven stated “Does your department have a specific vehicle designated for emergency incident rehab?” (70.69%) of the respondents stated, “no” to (29.31%) of them said “yes”.

Question eight asked “Does your department monitor vital signs during emergency incident rehabilitation?” Most of the respondents stated “never” (24.14%) to a tie of (22.41%) who responded “always” or “sometimes”. Question nine ask “Does your department monitor body core temperature during emergency incident rehab?” Most of the respondents stated (41.38%) “never” to the next highest (34.48%) who said “rarely”.

Question ten “Do you believe your department would benefit from an emergency incident rehab policy?” (46.55%) of the respondents “agreed” to the next highest (41.36%) of them who “strongly agreed”.

DISCUSSION

The Streetsboro Fire Department has no official rehabilitation policy. Rehabilitation should be part of any department's health and safety program, as a proper incident rehabilitation program can help reduce adverse events to the health of the firefighters operating at the scene. The goal of the rehabilitation sector is to let responders return to a state of readiness to operate safely during an incident. (DR. RAYMOND BASRI, 2010).

Observations have been made where Streetsboro firefighters could have benefited from being properly evaluated and hydrated in a formal rehabilitation sector. Research is needed to prevent a significant injury or avoid a LODD (line of duty death), due to sudden cardiac arrest within the department. A study completed by a Scotland cardiologist studied 19 firefighters while exposing them to extreme temperatures while attempting to remove a 176-pound mannequin from a two-story building. The results indicated an exaggerated normal physiological reaction. These reactions included an increase in blood clotting and a decrease in blood pressure due to dehydration. “This new study should encourage practitioners to perform additional studies-such as exercise stress testing, coronary artery calcium scans or echocardiography- to detect atherosclerosis or cardiac enlargement” (Amanda Hunter, et al., 2017).

The literature reviewed addresses how the physical demands of firefighting effects the body. The research further describes how the body responds to the physical demands. Next, the research addresses rehabilitation strategies and the criteria to evaluate the firefighter. Dave Dodson uses the acronym R.E.H.A.B to address the components while in rehab. R-rest, E-energy, nutrition, H-hydration, A-accommodate for weather, and B-bls monitoring and care. Finally, the literature describes the importance and best practices of continuing rehabilitation

upon return to quarters. The literature stressed to reduce the negative physiological stressor on the body. Firefighters should monitor their hydration status for up to 24 hours.

In reviewing the study results along with the review of the literature, one could submise how important emergency incident rehabilitation is to the fire service. The review of the internal survey indicated the current status of rehabilitation within the department is not adequate. The most concerning result of the survey was (100%) of the respondents stated they have felt overexerted on the fire or training ground. The results of the study had indicated from the external survey that (62%) of respondents have a rehab policy. However, only (34%) use it on working structure fires and (37%) use it on large scale incidents.

The review of the literature is very transparent of the severity of overexertion and the consequences which may arise. The study overwhelmingly stresses the importance of reporting to duty in peak physiological and mental state of readiness. The implications of the study are that the Streetsboro firefighters will strive to maintain physical fitness and maintain a proper diet and nutritional standards to increase performance. The adoption of a rehabilitation policy following NFPA 1584 (2015) will provide them a systematic approach to properly address their state of readiness while working on an emergency incident.

RECOMMENDATIONS

The problem identified at the Streetsboro Fire Department is personnel were not being properly rehabilitated on the fire and training ground. These incidents could have proven deadly for those firefighters. (NFPA1584, 2015) clearly defines, rehabilitation shall commence whenever emergency operations or training exercises pose a potential safety or health risk to members. The research identified through a departmental internal survey (100%) felt rehabilitation is important

and the current system of a rehabilitation was not adequate. The following recommendations are made to maintain the health and safety of the Streetsboro Fire Department personnel.

1. Develop an emergency incident rehabilitation policy in accordance with NFPA 1584 (2015).
2. Firefighters must be prepared for the physical, mental and environmental stressors they will endure. Participating in a physical fitness program daily will give them the ability to acclimate themselves to those condition which will allow them to recover and be able to return to their next assignment quicker. The Streetsboro Fire Department shall follow the NFPA 1583 (2015), Standard on Health-Related Fitness Programs for Firefighters.
3. The research project identified 50% of those that died in 2017 were caused by firefighters which had a preexisting cardiac condition. The Department shall follow NFPA 1582, Standard on Comprehensive Occupational Medical Program for Fire Departments, to identify and treat any protentional life threating condition.
4. The research study has identified how significant Firefighters need to be properly rested, hydrated and nourished when reporting for duty. To prevent the fatal physiological stressors caused by dehydration, Streetsboro members shall be trained on the proper methods of fueling and hydration before, during and after their shift.

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APPENDIX 1 – Internal Survey

Streetsboro Fire Department Rehab Survey

1. **Do you believe emergency incident rehab on the fireground and training ground is important and please explain why?**

    a. **Yes 100% No 0%**

2. **Have you ever felt overexerted on the fire or training ground?**

    a. **Yes 100% No 0%**

3. **Have you ever felt SOB, CP, Dizzy, Lightheaded or became Nauseated during fireground operation?**

    a. **Yes 47.62% No 52.38%**

4. **Have you ever felt SOB, CP, Dizzy, Lightheaded or became Nauseated on the training ground?**

    a. **Yes 38.10% No 61.90%**

5. **Do you believe monitoring vital signs is important in rehab?**

    a. **Strongly Agree 33.33%**

    b. **Agree 47.62%**

    c. **Neither agree or disagree 9.52%**

    d. **Disagree 9.52**

    e. **Strongly Disagree 0%**

6. **Do you believe body temperatures should be taken in rehab?**
    a. **Strongly Agree** **38.10%**
    b. **Agree** **47.62%**
    c. **Neither agree or disagree** **4.76%**
    d. **Disagree** **9.52%**
    e. **Strongly Disagree** **0%**
7. **Do you believe emergency incident rehab could prevent injury or death?**
    a. **Strongly Agree** **61.90%**
    b. **Agree** **38.10%**
    c. **Neither agree or disagree** **0%**
    d. **Disagree** **0%**
    e. **Strongly Disagree** **0%**
8. **Should emergency incident rehab be required at all working structure fires?**
    a. **Strongly Agree** **33.33%**
    b. **Agree** **42.86%**
    c. **Neither agree or disagree** **14.29%**
    d. **Disagree** **9.52%**
    e. **Strongly Disagree** **0%**
9. **Do you believe the Department could benefit from a emergency incident rehab policy?**
    a. **Yes** **94.24%** **No** **4.76%**

10. Do you believe the way we currently rehab on emergency incidents is adequate and please explain why?

a. Strongly Agree	**0%**
b. Agree	**0%**
c. Neither agree or disagree	**28.57%**
d. Disagree	**52.38%**
e. Strongly Disagree	**19.05%**

APPENDIX 2 – EXTERNAL SURVEY

Local and National Emergency Incident Rehab Survey

1. **Does your department have an emergency incident rehabilitation policy?**
    a. **Yes 61.00% No 39.00%**
2. **Has your Department had and injury or Illness that can be attributed to the lack of emergency incident rehabilitation?**
    a. **Yes 26.00% No 74.00%**
3. **In your opinion, would having an emergency incident rehab sector prevent fatigue or overexertion injures?**
    a. **A great deal 28.00%**
    b. **A lot 27.00%**
    c. **A moderate amount 28.00%**
    d. **A little 17.00%**
    e. **None at all 0%**
4. **Do you believe emergency incident rehab should be implemented on all working fires?**
    a. **Strongly Agree 35.00%**
    b. **Agree 46.00%**
    c. **Neither agree or disagree 13.00%**
    d. **Disagree 6.00%**
    e. **Strongly Disagree 0%**

5. **In your department, how often is emergency incident rehab used at working structure fires?**
    a. **Always** **12.00%**
    b. **Usually** **32.00%**
    c. **Sometimes** **33.00%**
    d. **Rarely** **22.00%**
    e. **Never** **1.00%**
6. **In your department, how often is emergency incident rehab used at large scale training's?**
    f. **Always** **23.00%**
    g. **Usually** **36.00%**
    h. **Sometimes** **22.00%**
    i. **Rarely** **12.00%**
    j. **Never** **7.00%**
7. **Does your department have a specific vehicle designated for emergency incident rehab?**
    k. **Yes** **23.00%** **No** **77.00%**
8. **Does your department monitor vital signs during emergency incident rehab?**
    l. **Always** **19.00%**
    m. **Usually** **20.00%**
    n. **Sometimes** **25.00%**
    o. **Rarely** **19.00%**
    p. **Never** **17.00%**

9. **Does your department monitor body core temperature during emergency incident rehab?**
    q. **Always** **6.00%**
    r. **Usually** **8.00%**
    s. **Sometimes** **9.00%**
    t. **Rarely** **33.00%**
    u. **Never** **44.00%**
10. **Do you believe your department would benefit from an emergency incident rehab policy?**
    v. **Strongly Agree** **37.00%**
    w. **Agree** **48.00%**
    x. **Neither agree or disagree** **14.00%**
    y. **Disagree** **1.00%**
    z. **Strongly Disagree** **0%**