AFTER DARK: ASSESSING HYDRATION AND GLUCOSE LEVELS DURING LATE NIGHT OPERATIONS

EXECUTIVE ANALYSIS OF FIRE SERVICE OPERATIONS IN EMERGENCY MANAGEMENT

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CERTIFICATION STATEMENT

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

Signed: _____
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Abstract

Provo Fire & Rescue has not evaluated the hydration or glucose levels on firefighters during late night operations. In addition, the department has not established the most effective method of providing fire ground rehabilitation. The result is arbitrary rehabilitation methods that may not meet the needs of firefighters operating late at night. This can result in decreased firefighter safety and performance.

The purpose of this Applied Research Project was to evaluate the physiological effects of late night operations on Provo firefighters. The project gathered data to answer these questions. First, what are the hematological effects of strenuous activities during late night operations? Second, do strenuous activities during late night operations create an increased risk to Provo Firefighters due to falling glucose levels and increased blood viscosity?
Third, what rehabilitation method provides the best short term and long term glucose and hydration replenishment in a firefighting scenario? And last, does rehabilitation improve firefighter efficiency and safety?

A process for evaluating the effects of late night operations was defined and collaborative partners were identified. An evaluation method using surveys, laboratory blood testing, analysis of vital signs, and other physiological indicators was set forth and a convenience sample of firefighters was obtained. In addition, additional research was completed on firefighter rehabilitation including the design of the rehabilitation regimens by a registered dietician. With the testing parameters defined, the convenience sample of 13 firefighters from Provo Fire & Rescue, and Orem Fire Department, participated in testing sessions at 0200 and 0400 hours.

The raw data was recorded, analyzed, and converted to a usable form. The data suggests that physical activity, in personal protective equipment, caused physiological changes in the test

subjects including weight loss, dehydration, increasing temperature, and shifts in blood chemistry. The data also suggests that a balanced diet, consisting of more complex carbohydrates and proteins provided a more stable nutritional platform for medium and long term firefighter rehabilitation.

The author recommends further study in both the physiological effects of firefighting activities and firefighter rehabilitation. The author further recommends a conscious shift in the role of rehab on the fire ground, identifying fluid replacement and nutritional supplements as a life safety issue.

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Introduction

Provo Fire & Rescue has not evaluated glucose and hydration levels of firefighters during late night operations, nor has it identified the most effective firefighter rehabilitation methods that may result in reduced efficiency and firefighter safety. The purpose of this Applied Research Project (ARP) is to evaluate the glucose and hydration levels of firefighters during late night operations and determine the most appropriate method of rehabilitation resulting in improved safety and performance.

The following are the research questions that will be addressed during the course of this applied research project:

1. What are the hematological effects of strenuous activity during late night operations?
2. Do strenuous activities during late night operations create an increased risk to Provo Firefighters due to falling glucose levels and increased blood viscosity?
3. What rehabilitation method provides the best short term and long term glucose and hydration replenishment in a firefighting scenario?
4. Does rehabilitation improve firefighter efficiency and safety?

This applied research project will be an evaluative project. The project will include the following:

1 A comprehensive literature review including fire service based journals and books, sports journals, and medical books and literature. In addition, the review will include interviews with physicians, dieticians, and allied health professionals.

2 An evaluation of glucose and hydration levels in firefighters during simulated late night operations on two separate occasions, including vital signs, weight, blood glucose levels and blood chemistry.

3 An evaluation of two different rehabilitation regimens after completion of the simulated operations.

4 A post-activity questionnaire completed by the test subjects.

5 A compilation of the data obtained during the simulated operations.

It should be noted here that the research has been completed under the supervision of Provo Fire & Rescue's EMS Coordinator Dale Maughan and the author. The author served as the safety officer during the testing process.

Background and Significance

Provo Fire & Rescue is a career department currently staffed by 72 firefighters. Provo operates four stations staffed with five personnel and one station that houses a paramedic rescue and is staffed by three paramedics. Two stations operate 55 foot Quint apparatus and two operate 105 foot Quints. Total staffing per day, with vacation and other leave factored in, averages 19 personnel, including the battalion chief. Provo Fire & Rescue responds to over 9,000 calls for service per year with approximately 85% being medical assists. The fire department covers a first due area of 42 square miles and provides fire suppression, emergency medical services, heavy rescue, and hazardous materials response. Provo has a full time population of approximately 114,000 residents and a day time population approaching 140,000. Provo is home to Brigham Young University, as well as a mix of residential, commercial, and manufacturing properties.

Provo Fire & Rescue provides mandatory annual physicals to department members. The physicals include vital signs, pulmonary function test, complete blood count, lipid profile, blood chemistry, vision test, hearing test, urinalysis, drug screening, and communicable disease screening (in compliance with state law). Additionally, male firefighters are given an annual

PSA blood test to detect prostate cancer and, after age 50, annual digital prostate exams. Female firefighters are offered pap smears and mammograms as a part of the city's wellness incentive. All firefighters over the age of 50 are given a stress test as the need is determined by the examining physician. Provo Fire & Rescue provides one and one-half hours each duty day for the firefighters to engage in physical conditioning programs. Each station is equipped with a treadmill, free weights, and other exercise equipment. Firefighters' fitness levels are evaluated annually using two separate testing procedures. In the spring, the firefighters are tested using the mile and one half run, push-ups, sit-ups, grip strength, and flexibility. In the fall, the firefighters are tested using the Combat Challenge®. The department provides certified fitness coordinators to assist in conditioning. Participation in the testing process is mandatory if hired after 1989, and carries incentives for successful completion. The current methodology for rehabilitation is determined by the on-duty battalion chief. Historically, rehab has consisted of various fruits, pastries, cookies, sandwiches, and prepared fast foods. Re-hydration has normally consisted of water, sports drinks, soft drinks, and hot drinks during the winter (hot chocolate, coffee). There is no policy for the implementation of a rehabilitation sector or what should be included in the rehabilitation procedures. In April 2005, Provo Fire & Rescue adopted a 48/96 work schedule. This new work schedule adds significance to rehabilitation and maintenance of high levels of physical and mental performance.

Provo Fire & Rescue has never experienced a line-of-duty fatality or significant cardiovascular incident during the performance of fire department operations. Nationally, cardiovascular events and heat stress incidents accounted for 66 of the 117 line of duty deaths or 56 percent of the total number of line of duty firefighter deaths in 2004 (USFA, 2005, pg. 15). In 2003, cardiovascular events and heat stress accounted for 2,380 injuries in the American fire

service (NFPA, 2006). While disturbing, these statistics are consistent with previous years' trends in the fire service. These trends compel each department to continue to evaluate and improve fitness levels and performance.

This ARP is consistent with two operational objectives of the United States Fire Administration. These are the reduction of loss of firefighters' lives and appropriate response in a timely manner to emerging issues (USFA, 2003, II-2). Ongoing evaluation of risk factors associated with the cardiovascular system during firefighting operations will eventually provide insight in how we, as the American Fire Service, can reduce those risks and improve survivability and fire ground performance.

This ARP is a natural fit for the Executive Analysis of Fire Service Operations in Emergency Management, because the first and most important role of a fire service incident commander is to ensure the safety of their firefighters. Understanding physiological factors that influence firefighter safety and performance must be factored into all decisions surrounding both short term and long term fire service operations.

> Food, fuel, and rest must be primary considerations in the mobilization of resources. No resource runs forever. Food, fuel, and rest require that a reserve force be in place for critical, limited, resources: this is particularly important if a large force is mobilized. Consideration of food, fuel, and rest will vary widely depending on emergency, weather, duration, and phase. (NFA, 2004, SM 4-33)

Some of these variables are a constant issue in Provo. Provo is located in the Great Basin of Utah. Provo has a high desert climate. While enjoying four seasons, the climate is dry and summer temperatures can get into the low 100s. These environmental features influence a firefighter's ability to remain hydrated and perform at optimal levels.

This ARP will evaluate how the blood glucose levels and hydration levels of Provo Firefighters are affected by late night operations, and evaluate rehabilitation methods used to maintain optimal performance.

Literature Review

The first area that must be considered when evaluating hydration and glucose levels during late night operations is the physiological effects on the cardiovascular system of strenuous activities. The cardiovascular system is comprised of three basic elements, the heart, blood vessels, and blood. Fox (1984) states that blood is composed of two elements, formed elements and plasma with formed elements comprising about 45% of the total blood volume and plasma, the liquid portion comprising 55 %. Plasma consists of water and dissolved solutes including sodium (Na+), potassium (K+), chloride (Cl-), and glucose. "In addition to Na+, plasma contains many other salts and ions as well as organic molecules. . ." (Fox, 1984, pg. 373). The components of the plasma that we need to evaluate include glucose, sodium, potassium, and chloride. McFarland (1982) indicates that glucose, a monosaccharide, is a simple sugar. It is created by the digestive processing of carbohydrates (CHO) through the gut and into the circulatory system and then it is stored by the liver. "Glucose . . . is the form which sugar circulates in the bloodstream and is oxidized by all body cells to provide energy for cellular metabolism" (McFarland, 1982, pg 284).

McFarland (1982) states that sodium is the principal extra cellular cation and is the most important electrolyte in the maintaining of the fluid balance in the body. "Because of the intricate relationship between sodium and water, sodium has a primary role in the distribution of body water" (McFarland, 1982, pg. 109). Potassium, on the other hand, is the principal intracellular cation. Sanders (2000) indicates that potassium is essential for muscle contractions,

enzyme actions, and the function of cellular membranes. McFarland (1982), states that potassium initiates and sustains muscular contractions in both cardiac and skeletal muscle. Chloride is the principal anion in the extracellular fluid and is closely tied to sodium.

> Chloride can help balance the level of anions in different fluid compartments. One example is the chloride shift that occurs between red blood cells and plasma as the blood level of carbon dioxide either increases or decreases (Tortora, 2000, pg. 962).

In addition to the basic electrolytes, sodium, potassium, and chloride, there are other laboratory values that help evaluate the effects of shifts in hydration on the body; they include the anion gap and Glomerular Filtration Rate (GFR). "The anion gap is a mathematical estimation of the difference between the number or measured cations (sodium and potassium), and measured anions (chloride and bicarbonate) in the serum" (McFarland, 1982, pg. 163). McFarland (1982) goes on to say that an increase in the anion gap occurs when hydrogen ions are added to body fluids. Increased levels of exertion, combined with anaerobic metabolism can create a lactic acidosis, which could be demonstrated by an increase in the anion gap. According to Tortora (2000) the Glomerular Filtration Rate is the amount of filtrate formed in the renal corpuscles of both kidneys. A filtration rate that is too high doesn't allow filtrates to reabsorb, while a GFR that is too low may inhibit the excretion of waste products through the kidneys.

Lab testing is done to identify changes in electrolyte levels as well as shifts in other metabolic processes. The results are then quantified into a range of values that are considered within normal limits.

With a very basic understanding of blood chemistry the question remains; how do fire fighting operations impact the blood and cardiovascular system? How do we, as an industry, get ourselves in trouble physiologically? "It is common for firefighters to lose two to six percent of

their body weight due to dehydration during physical stress in a hot environment" (Welch, 1999. pg. 16). Welch, (1999) goes on to say that dehydration with the loss of as little as two percent can lead to diminished performance and capacity. Firefighting, in and of itself, is physically demanding. Bonanno, (1996) states that firefighting is a mixture of anaerobic and aerobic work using most muscles of the body. Bonanno goes on to compare firefighting as "the equivalent to, in the exercise world, a body builder's workout" (Bonanno, 1996, pg. 4). Schamadan (1996) compares the body to a "constant temperature heat machine" requiring continual cooling. That cooling is accomplished through sweat evaporation. He goes on to indicate that efficient cooling requires a supply of water and certain electrolytes, free surface area to evaporate from, and air space to evaporate into. Firefighting gear reduces the amount of free air for evaporation. Eric Verfuss (2005) states:

> The problem is when we encase our firefighters in the "protective envelope", we hinder this process because we cover up the entire skin surface. This takes away the evaporative cooling, and the body temperature begins to rapidly rise. The environment inside of a firefighter's turnout gear becomes more humid, and less evaporation occurs (Verfuss, 2005, pg. 12).

When firefighters engage in strenuous activities, their hydration levels are affected by more than just their turn-outs. Insensible fluid loss occurs through the digestive system and breathing. These losses, when combined with sweating to cool the body, further reduce the body's ability to maintain an efficient fluid balance. Wright (2006) indicates that exercise causes fluid loss, not only from sweating, but also through the moisture in exhaled air. O'Connor (1996) adds that the body loses significant amounts of water from breathing compressed air. Since air is compressed by removing water vapor, breathing bottled air requires that the

firefighter's body replace some of the moisture prior to exhalation. This reduces the amount of water available for sweating.

As the firefighter continues to lose water, the fluid balance shift also causes a shift in some of the components of the blood. Electrolytes, particularly sodium, are lost from the body. Dickinson (2000) states, that when the sodium levels fall, due to excessive sweating, the proper function of skeletal muscles is inhibited. Heat cramps are a clinical manifestation of excessive sodium loss in a hot environment. Potassium, an element that has a very narrow range, can also cause problems for firefighters as they lose fluids due to sweating or insensible water loss. Dickinson (2000) speaks of the significant cardiovascular implications of potassium levels that are too high or too low. He says that excessive potassium levels, either too high or too low, can cause cardiac arrhythmias because the heart's electrical system loses its abilities to properly generate and conduct electrical impulses.

Firefighting operations do have hematological effects on the firefighter's body. Long term operations affect the fluid balance within the blood and the body. The loss of body fluid is exacerbated by personal protective equipment (PPE) including turn-outs and self-contained breathing apparatus (SCBA). Firefighting PPE, combined with strenuous activities, can overcome the body's ability to regulate temperature in the firefighter. As the firefighter continues to lose water through sweat and breathing, blood chemistry can, and does, begin to change. These changes can affect firefighter safety and performance.

What effect does firefighting have on glucose levels and the body's ability to effectively perfuse blood to the cells? With the loss of fluids, the body begins to compensate by increasing the heart rate to ensure proper perfusion throughout the body. Wright States:

> Unless fluid losses are replaced by drinks, sweating causes progressive depletion of circulating blood volume, leading to hypohydration (commonly called dehydration) and a thickening of the blood. This places a strain on the cardiovascular system, with a rise in heart rate in order to maintain adequate blood flow to exercising muscles and vital organs (Wright, 2006, pg 1).

Verfuss (2004) cites a study at the University of Illinois that showed the efficiency of the cardiovascular system actually decreased during exercise and physical exertion. This resulted in less blood and, as a result, oxygen being available to the cells. Verfuss (2004) correlates this to the increasing heart rate not allowing for an adequate preload, thereby, reducing the amount of blood being circulated. "The heart can also lose some of the force of the contractions as electrolyte levels change because of fluid shifts within the body" (Verfuss, 2004, pg. 43). O'Connor (1996) supports the concept of increasing blood viscosity by saying: "Severe water loss also puts added load on the cardiovascular system by increasing the viscosity of the blood and making it harder to pump" (O'Connor, 1996, pg. 20). The increasing loss of fluid also alters blood chemistry. Smith (2001) discusses changes in laboratory blood chemistry as a reflection of hemoconcentration that typically occurs as a result of fluid shifts during physical exertion. Smith, goes on to demonstrate that most of these changes will be corrected within ninety minutes if the test subject is adequately re-hydrated.

Blood glucose levels are of concern, during late night operations, because of the length of time since the firefighter last took in some form of nutrition. Verfuss (2004) addresses this issue by considering firefighters who respond to early morning calls. Verfuss reminds us that they may not have eaten since the evening before and so their blood glucose could already be at the lower end of normal. With physically strenuous activities, the firefighter's blood glucose levels

could drop dangerously low. "The body cannot store glucose except in the blood supply as an immediate but limited source of energy for intensive physical demands" (Verfuss, 2004 pg. 48). Smith (2001) found that during exertion, the firefighter subjects had an increase in their glucose level that can be attributed to hemoconcentration, and sympathetic nervous and hypothalamic pituitary adrenal activation. Smith noted that after ninety minutes of recovery, the subject's glucose decreased further and while the glucose levels were still within normal limits, thirty percent of the subjects were clinically hypoglycemic at the end of the recovery period. This is concerning to firefighters and fire officers as the signs and symptoms of hypoglycemia include weakness, nervousness, anxiety, sweating, and can progress to confusion and an altered or unconscious state.

In discussing fatigue and impaired performance, Wright states: "The two main factors influencing early fatigue and impaired performance (both physical and mental) in all types of sports and exercise are depletion of body levels of carbohydrate (CHO) and/or fluid" (Wright, 2006, pg. 2).

As identified in this review, there is a growing body of evidence showing that fluid loss during firefighting operations can lead to electrolyte shifts, alterations in blood chemistry, and a reduction in the efficiency and effectiveness of those operations. With more significant fluid loss, the cardiovascular system can become impaired and firefighter's health can be jeopardized. Since firefighting operations may continue for an extended period of time, how do fire service leaders protect the health and well being of their crews? Effective, on scene, rehabilitation is the answer.

"Excessive sweating and evaporation rob a rescuer's body of vital fluids. Dehydration then saps the body of its strength and misaligns vital signs like an unbalanced scale" (Heightman,

2000, pg. 8). Coyne, (2006) indicates that even mild dehydration of 1% of body weight can create a reduction in muscle performance and start to show symptoms. He further states that "thirst is a sign – too late – of dehydration, performance is already impaired" (Coyne, 2006, pg. 2). Implementing strategies that can preempt dehydration can be achieved simply by considering dehydration as a significant issue on the fire ground. Dickinson (2004) suggests placing re-hydration solutions, such as water or sports, drinks near the spare SCBA cylinders where they can be easily accessed while changing air bottles. Monitoring firefighter activities and setting predetermined limits on time in turnouts or number of air cylinders can improve firefighter productivity and safety. Klaene (2005) suggests that fire departments institute the "two cylinder" rule for establishing a rehabilitation sector. This sentiment is echoed in the guidance provided by the United States Fire Administration (USFA) in *Emergency Incident Rehabilitation* published in 1992. The USFA (1992) recommends one quart of fluid replenishment per hour with a 50-50 mix of water and a commercially prepared activity beverage. The fluid replacement solution should be served at about 40 degrees "because cool beverages are absorbed better than room temperatures or warm beverages" (Coyne, 2006, pg. 2).

Re-hydration of fire department personnel should be done carefully. There are risks associated with providing too much water and not balancing the need for electrolytes. Over-hydration can lead to a very dangerous condition known as hyponatremia.

> As over-hydration or "water intoxication" with a low blood sodium concentration can be accompanied by nausea, fatigue, confusion, and even seizures, it was in fact more of a risk to poor performance than dehydration (CPTIPS, 2005, pg. 1).

As stated by Welch (1999) "water has always been – and still is – an excellent source of hydration for activity of less than one hour" (Welch, 1999, pg.16). Another consideration when

responding to late night alarms is the firefighter's present level of hydration. Many firefighters respond to alarms already dehydrated due to inadequate or inappropriate fluid intake. Piepenburg (2006) advocates eight 8-ounce glasses of water per day for a person living a sedentary lifestyle and advocates four to eight quarts for runners. Firefighters fall in to the four to eight quart a day category, particularly when working in high heat, humidity, and in PPE. Verfuss (2005) enlightens us about the "coffee and soda that is prevalent in the fire house today." He further states that these are actually diuretics causing a fluid shift at the cellular level leading to dehydration. This means that firefighters could already start from behind in the fluid balance equation. Piepenburg (2006) suggests increasing water intake at a 1:1 ratio to counteract the diuretic effects of caffeinated and carbonated beverages or risk being already fluid challenged.

Fire administrators must begin to plan for nutritional replenishment for longer term fire ground operations. This may be more significant during late night operations as firefighters are further removed from their last oral nutrition. Late night operations complicate nutritional rehabilitation due to the limited number of options for food. Dickinson (2000) prefers simple carbohydrates as first line of carbohydrate replenishment due to the speed with which they metabolize. These can be found in commercially prepared drinks such as Gatorade®. For prolonged operations, Dickinson suggests providing food containing complex carbohydrates. The USFA (1992) suggests soups, broth, or stews because they are digested faster than sandwiches or prepared foods. D. L. Schofield, (personal communication February 12, 2006) a registered dietician (RD) and certified diabetic educator (CDE), suggests broth-based soups due to the vegetables with their complex carbohydrates and the proteins and fats for their longer lasting effects. Schofield continues that by adding crackers to the soups, broths, or stews, one could increase the carbohydrates for short and medium term energy. While some may consider

fruit juice as an acceptable alternative, Bonnano (1996) cautions against fruit juices for rehabilitation.

> Although fruit contains vital nutrients, in juice form it is a highly concentrated sugar in the form of fructose. It takes more than seven apples to make one 8 – glass of juice with no fiber to slow absorption. Glucose levels will go through the roof, followed by a large secretion of insulin to counteract it. This affects an initial burst of energy and a rapid crash, with no long-term energy and minimal glycogen replenishment (Bonanno, 1996, pg. 4).

This is called a rebound effect. While discussing some of the preliminary findings of this ARP, Dr. Robert Corniea (personal communication, February 27, 2006) indicated foods that are high in simple sugars such as cookies, doughnuts, soft drinks, and fruit juices can stimulate the pancreas to secrete more insulin, thinking the body has been fed, only to have a second "bonk". "Bonk" is a term used by distance runners and triatheletes to indicate a loss of energy, it also refers to hitting the wall.

The other significant reason for nutritional rehabilitation is to allow the body to replenish glycogen storage in the liver and muscle.

> The fuel used by the body for anaerobic work is glycogen, the storage form of carbohydrate stored in the liver and muscles. Dragging heavy hose lines, forcing doors, ventilating a roof or windows – all anaerobic activities can significantly deplete muscle glycogen stores and hinder the firefighter's ability to perform high level muscular exertion (Bonanno, 1996, pg. 4).

Bonanno (1996) goes further by identifying a window of opportunity immediately after significant exertion that will allow the replenishment of glycogen stores. If that window of

opportunity is missed, and carbohydrates are not available, "the firefighter's body will break down its own muscle tissue and convert it to blood sugar to satisfy energy and glycogen replenishment requirements" (Bonanno, 1996, pg. 4).

The final issue in hydration and glucose levels on the fire ground during late night operations is a cultural shift at Provo Fire & Rescue specifically, and in the fire service as a whole. After a working house fire several years ago, a battalion chief was heard to say "just because we have a fire doesn't mean we have to throw a party." This comment was made in response to a question about rehabilitation for the fire crews. Our department has come a long way since then. Each front line Quint has a refrigerator, or "environmentally controlled medication cabinet" stocked with water and Powerade™ this represents progress towards emergency incident rehabilitation. Sullivan (1999) identifies some of the key issues that must be addressed at the company, battalion, department, and fire service levels. He writes:

> If we apply that principle to . . . our own experience, the results will tell us the following:
>
> - Asking firefighters if they need a break is sure to result in a negative response.
> - Failure to plan for replacement crews will result in delayed rehabilitation or no rehabilitation at all.
> - The costs of not rehabilitating crews will have a significant negative impact on personnel and medical budgets.
> - Someone needs to assist the incident commander in managing rehab efforts.
> - Without strong leadership, effective rehab will not be accomplished (Sullivan, 1999, pg. 55).

The authors and experts that have been identified, during the literature review portion of this research, have helped to frame the issues relating to rehabilitation. They have identified

some of the areas that this research should address. How much fluid does an average fire fighter use during late night operations? Much of the reviewed materiel presented was for high temperature, and presumably daytime studies, but does the hour of the day affect fluid balance? Does conditioning play a role in individual responses to exertion? What signs and symptoms can be observed that speak to a shifting fluid and electrolyte balance? It is interesting that blood glucose may continue to fall even after the activity has stopped. Can that be replicated during late night operations? What type of rehab provides the best long term energy and nutritional support? Is there such a thing as bad rehab? Many of the references and interviews will be used to develop the research evaluating the hydration and glucose levels of Provo Firefighters during late night operations.

Procedures

After completing the literature review, discussions began to determine the best method of evaluating hydration and glucose levels during late night operations. It was determined that a standard form of simulated firefighting exertion would be completed by all test subjects. Blood testing would then be completed to quantify shifts in fluid and glucose levels. This concept was discussed with Dale Maughan RN, MS, Provo Fire & Rescue's EMS Coordinator and then presented to Chief Coy Porter, an Executive Fire Officer graduate. With the approval of the Chief, a testing protocol was identified and presented to the EMS Coordinator and to Dr. Robert Corniea, for evaluation. Suggested modifications were made regarding the number of tests to be conducted and the blood work to be drawn. Three testing sessions were originally proposed with start times at 2300, 0200, and 0400 hours. It was determined that reducing the test times to 0200 and 0400 would provide a more specific evaluation of what would typically be considered "late night operations". Blood testing, originally proposed as a Chem 20 and a Complete Blood

Count, was discussed and reduced to a Basic Metabolic Panel (BMP). Corniea (personal communication, Aug, 29, 2005) suggested that the BMP provided sufficient indicators to identify fluid shifts and evaluate glucose levels. The revised protocol was presented to Chief Porter and the testing process was approved to move forward. With the approval of the chief, the testing was done on duty, where possible, on the first night of the 48 hour tour.

The next step in the project was to identify an exercise that could replicate activities on the fire ground in a controlled environment. It was also preferable to be able to evaluate more than one test subject at a time. An inquiry was made to Ms. Kandi Negete, the manager at Gold's Gym, to see if the gym would be willing to participate as a collaborative partner. A copy of this inquiry is included in Appendix A. With their consent, it was determined that an elliptical cycle with arm bars would be the most appropriate machine to accomplish test objectives. This machine was preferable because it required both upper and lower body exertion; it had a setting that increased resistance and incline in a random order, and the foot pads were large enough to safely accommodate turn-out boots. It was determined that for the purpose of this evaluation, the test subjects would start at a resistance level of four and they would be required to maintain a range of 50 to 60 revolutions per minute. While the base level of resistance was set at four, the machine automatically changed the resistance level from 4 to 10 in a random sequence every 20 to 40 seconds. Use of the arm bars was also required.

A second inquiry was made to Laura Salazar, marketing director for Intermountain WorkMed in Orem, Utah, to see if they would also be interested in participating in this study as a collaborative partner. A copy of this inquiry is included in Appendix A. Intermountain WorkMed is an industrial and occupational health clinic that provides the annual physicals and treatment of work related injuries for Provo Fire & Rescue. They graciously accepted invitation

and provided blood testing supplies and covered the costs of the laboratory studies. They also provided Release of Medical Information Consent documents, labeling for blood tubes and laboratory requisitions. A sample of the Medical Information Consent is included in Appendix B.

With the arrangements made for blood testing and use of a gym, the focus shifted to identifying a group of volunteers to participate in the study. Volunteers were identified largely by word of mouth. This is a convenience sample, not a random sample. A breakdown of the sample will be explored later when discussing the results of this study. Twelve firefighters were identified from Provo Fire & Rescue, and one firefighter was brought in from the Orem Fire Department to provide a second data set for female firefighters. The addition of a second female firefighter provides a better statistical basis in data broken down by gender. Ultimately, the project included thirteen volunteer test subjects. Each of the test subjects was presently cleared for full duty and the majority of the test subjects had completed a full department physical within the past twelve months. Each test subject completed a short questionnaire prior to participating in the study, after which they were given an instruction sheet in preparation for the testing process. A copy of the test subject survey instruction sheet, schedule, and post-incident survey can be found in Appendix B. Due to the legal requirements surrounding medical information, a summary of test subjects by age and gender is provided in Appendix C. All other information, releases, original testing records, and original laboratory data were maintained in the custody of the author. Testing records, identifiable by test subject number are included in Appendix C.

The testing process consists of two testing events, one at 0200 and one at 0400 hours. There are two primary evaluations in each testing event, physiological changes during simulated

operations and the effectiveness of a specific rehabilitation regimen. Each of those evaluations will be discussed in detail.

The evaluation of physiological changes began at 2200 hours on the night before testing when the test subjects changed to a nothing by mouth (NPO) status. This was done to provide a common baseline for data.

Fifteen minutes before the testing was scheduled to begin, the test subjects were toned out of their station by dispatch. The station was then out of service until the completion of the testing process. When the test subjects arrived, at the gym, they were weighed in their physical fitness clothes and they had a tympanic temperature recorded. Vital signs including pulse, blood pressure (BP), respirations, and oxygen saturation (SaO2) were also recorded. An intravenous saline lock was started and the first of three serum separating blood tubes was drawn. The test subject then put on the remainder of their PPE and was weighed with dressed weight also being recorded. The test subject was taken to the elliptical cycle that had been set at a resistance level of four and on a random pattern. A 40 minute timer was started once the test subject was on air and on the machine. All other times are based on the timer. After 20 minutes on the machine, the test subjects' pulse, respirations, and SaO2 were taken and recorded. Air cylinders were replaced as needed, with the timer stopped. When the firefighters completed the 40 minutes on the elliptical cycle a second tympanic temperature was taken within one minute of leaving the machine. The temperature was recorded and the test subjects were helped out of their PPE. A second tube of blood was drawn. The test subject was then weighed for the second time and given a bottle of water. When the timer sounded, it was reset to 30 minutes from when the firefighter completed their time on the elliptical cycle at that time the firefighter obtained a blood glucose level using a One Touch® glucometer. After that the firefighter could, if desired, have a

sports drink. Then the testing process moved from the gym to the firefighter's station. The firefighter was then given one of the two rehab regimens. The firefighter can have as much, or as little rehab as desired. The servings are recorded and then a calorie count was recorded. Thirty minutes from the time rehab is completed the third, and final, tube of blood was drawn and the saline lock was removed and properly discarded. The test subject was allowed to return to bed and the station was placed back in service. When the firefighter awakened, a glucose level was taken, using the glucometer, and recorded. The same procedure was utilized for the 0400 hours testing.

The second phase of the testing was an evaluation of how the body reacted physiologically to different types of rehabilitation. Two rehabilitation regimens were developed with the assistance of Donna Schofield RD, CDE. The first routine known as the "sugar" routine included Lofthouse™ Frosted sugar cookies, Hostess™ Raspberry filled doughnuts, water, and if so desired, Powerade™ , a sports drink. This routine is high in simple sugars, fructose, dextrose, and sucrose but low in fiber and more complex carbohydrates such as starches. This routine has high fat and low protein content. A serving of this regimen provides 120 to 180 milligrams of sodium that will support sodium replacement. This routine was chosen because, historically, late night rehabilitation consisted of these types of items that are readily available to purchase at the stores that are open 24 hours. The specific items used in this routine were selected because they have the nutritional information broken down on the package that enables calorie counting and evaluation of nutritional components. To ensure a fair representation of the value of each of the regimens, the test subjects were divided with seven firefighters (54 percent) receiving the sugar regimen after the 0200 testing. The other six fire fighters (46 percent) received the soup regimen

after the 0200 testing. The regimens were reversed during the 0400 testing, a rehab log, showing the nutritional breakdown of each item, can be found in Appendix B.

The second rehabilitation regimen is referred to as the "soup" routine. This routine consisted of Campbell's™ Vegetable Beef Soup and Original Premium Saltine™ crackers. This USFA recommended routine, has a lower fat content. The carbohydrates in the soup are primarily starches, potatoes peas, and barley, with only two grams of simple sugars per serving. This routine provides some fiber and more protein than the "sugar" routine. Crackers were added to boost the complex carbohydrate levels of this routine. A rehab log showing the nutritional breakdown of each item can be found in Appendix B.

The drawing and handling of blood during this testing process was a significant portion of this project. To complete a BMP, the blood must be drawn into a serum separating blood tube. The sample then has to be labeled, and allowed to clot. Clotting usually takes about ten minutes after the draw. Once the blood is clotted, it has to be centrifuged to separate formed elements from the plasma. The centrifuge spins the blood at 3,500 rpm for seven minutes. The blood is then placed in a sample bag with the testing requisition and refrigerated until it can be transported to the lab for analysis. Each set of blood samples was delivered to the laboratory within two hours of the completion of testing. The following procedure was used to prevent spoiling the sample: Each test subject has a 20 gauge IV placed using an aseptic technique. A dry saline lock was attached and the first tube of blood was drawn. The saline lock was then flushed with 10 ml of 0.9 percent normal saline and clamped. On subsequent blood draws, the saline lock was first cleared by drawing out 7 ml of blood. This is done to prevent the saline from altering the laboratory results. That blood is discarded in the syringe in a sharps' container.

After the second tube is drawn, the line is again flushed and clamped. The same process is repeated for the third draw. When all of the samples have been obtained, the IV is removed.

The environmental conditions at the gym also factored into this study. It is impossible to replicate the heat of a fire in this environment. The temperature in the gym is regulated at 65 degrees and the relative humidity is < 20%. The Humiture Scale (USFA, 1992) shows the Humiture °F of 68 to 70 degrees. This factors in the ambient temperature, humidity, and adds ten degrees because the test subjects are wearing turnouts. This scale shows minimal risk of heat stress at this level.

Statistical Analysis

On completion of the testing process, the results were recorded, tabulated, and double checked. The data was then configured into a usable form. The pre-testing questionnaire and post-testing questionnaire were tabulated and double checked. The data was then evaluated and trends were noted for further review. The results were then analyzed and correlated with the findings of others. These results will be discussed in detail in the results and discussion section of this ARP.

Limitations

As with any other research, there are limitations that can affect the outcome of this project. First, it is assumed that the sample group is representative of the department as a whole. The age, health, and fitness of the sample group may have statistical variances from the department. A correlation of the sample group and the department as a whole will be presented in the results section of this project. Second, because the sample group volunteered it may indicate an increased willingness to participate in a physically challenging activity that may not be an accurate representation of the department as a whole. Third, the data assumes that all test

subjects understood and followed the instructions provided. Fourth, the data assumes that all samples were appropriately drawn, prepared, labeled, and analyzed. Fifth, the data assumes that all records and published findings are accurately recorded. Sixth, the data assumes that all questions were answered honestly. And seventh, the data assumes that all nutritional information provided by third parties is accurate.

Definition of Terms

Basic Metabolic Panel (BMP) – A laboratory test that analyzes the following items found in blood plasma: sodium, potassium, chloride, carbon dioxide, anion gap, glucose, blood urea nitrogen (BUN), creatinine, glomerular filtration rate (GFR), and calcium. Also known as a Chem. 7.

NPO – nothing per os, or nothing by mouth.

Bonk – a term that relates to "hitting the wall". Generally used by runners and triatheletes, it means the loss of energy or having no energy.

Body Mass Index (BMI) - is a mathematical formula that expresses the ratio of your weight to your height. (IHC, 2004 pg. 6) The formula is weight in pounds divided by height in inches times height in inches, times 703.

Cation – an ion with a positive charge. E.g. sodium (Na+)

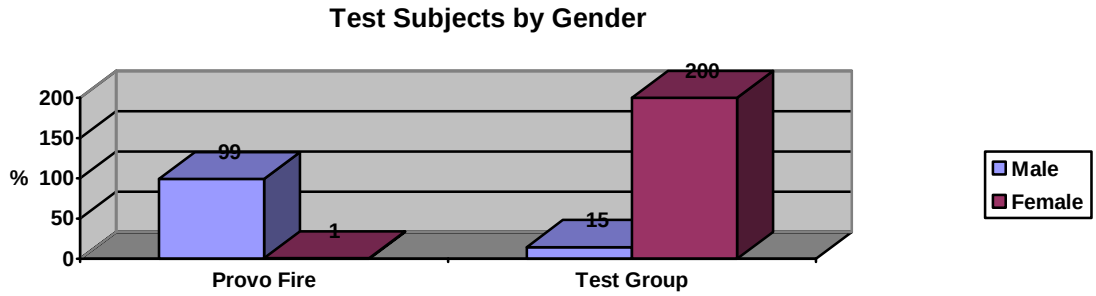
Anion – an ion with negative charge. E.g. chloride (Cl-)

Results

To begin to describe the results of this project it would be helpful to correlate the test volunteers to Provo Fire & Rescue. Of the 13 volunteers 11, or 85%, are firefighter/paramedics at Provo Fire & Rescue. Of the two remaining volunteers, one is a captain at Provo Fire & Rescue, and the other is a firefighter/paramedic for the Orem Fire Department. Males represent

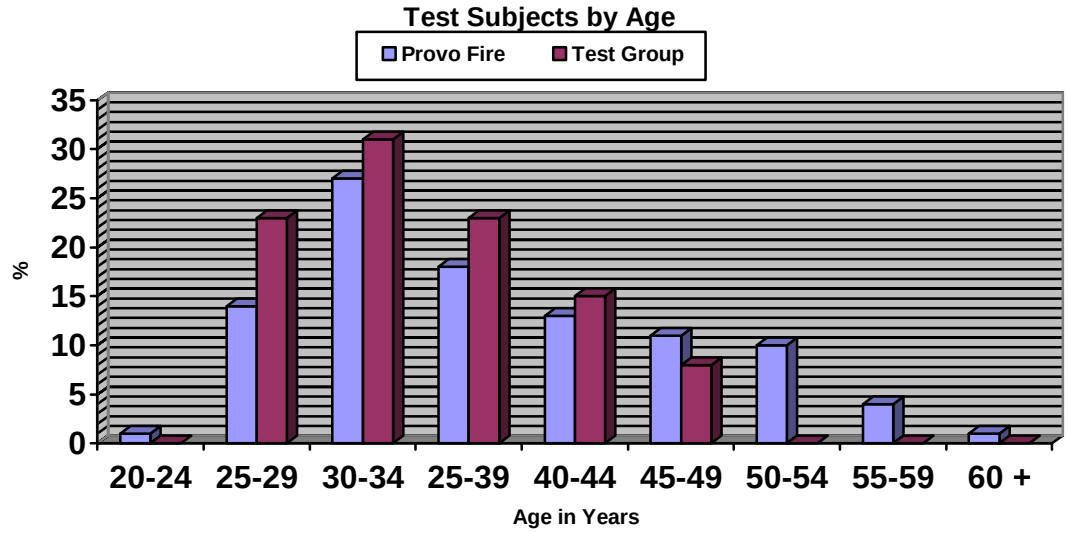
11 of the 13 volunteers, or 85% and females account for 16 %, or two of the volunteers. Figure 1 correlates the test group, by gender with Provo Fire & Rescue.

Figure 1 Test Subjects by Gender



The test group represents a reasonably diverse mixture of ages. Figure 2 correlates the test group by age group with Provo Fire & Rescue.

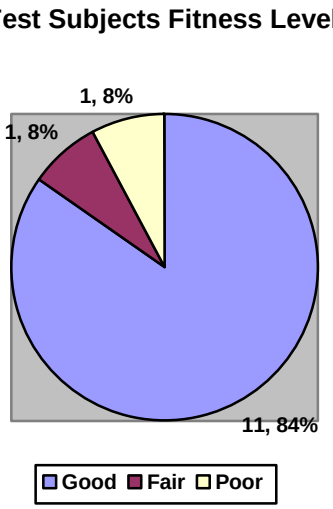
Figure 2 Test Subjects by Age



As demonstrated in Figure 2, the test group lacks representation from age group 50 and higher. That population represents 15% of the department, or 11 firefighters. Of those 11 firefighters, only three, four percent are still serving as line firefighters. The other 12 serve as chief officers, captains, and engineers. From a strenuous combat role, the sample is representative of the department as a whole. From a practical standpoint it, was important that

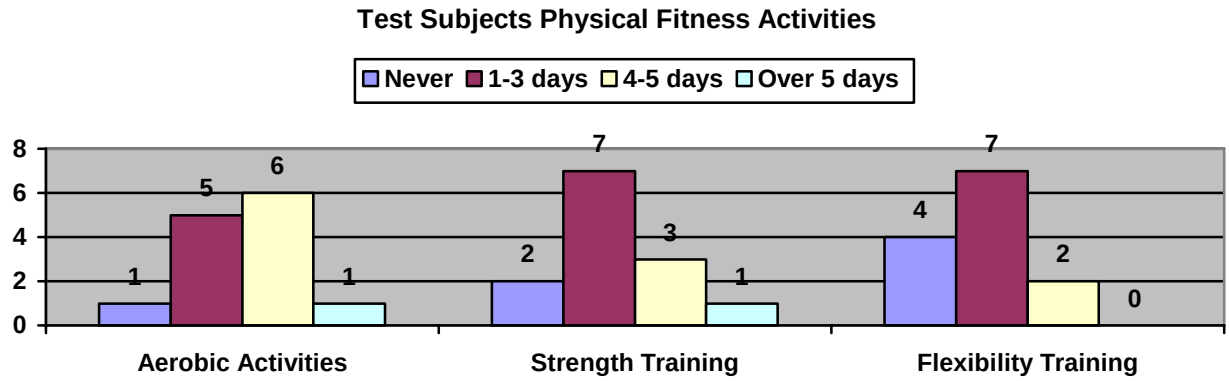
the sample represent the various fitness levels within the department. To determine the perceived fitness level of each test subject, a survey was compiled and presented to each volunteer prior to testing. Figure 3 shows the fitness levels identified by the test subjects.

Figure 3 Test Subjects Fitness Level



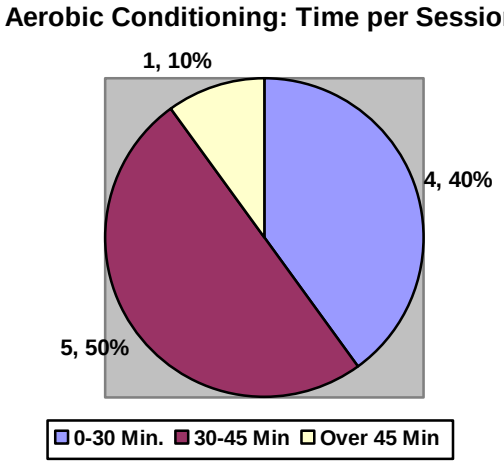
This evaluation of personal fitness was subjective. Test subjects hired after 1989 are required to participate in the departments' physical fitness testing. The physical fitness testing was completed this year by 11 of the 12 Provo firefighters or 91%. The test subject from the Orem Fire Department is in compliance that agencies' fitness standard. Although none of the test subjects identified themselves as being in excellent physical condition, several would be evaluated by their peers as being in excellent physical condition. Of the test subjects 11 had received a complete physical evaluation within the past 12 months. Two test subjects, 15%, stated that they hadn't received a physical. The survey then asks the test subjects what activities they participate in to maintain their fitness levels. The test subjects could choose from aerobic activities, strength training, and flexibility training. Figure 4 identifies the fitness activities that the sample group participates in.

Figure 4 Test Subjects Physical Fitness Activities



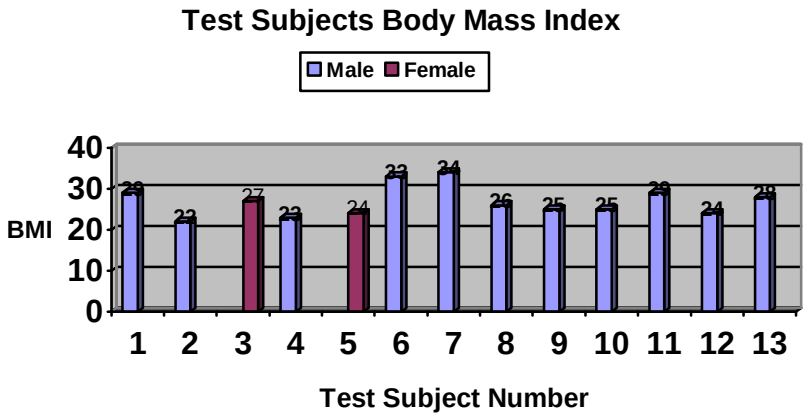
The test subjects were then asked how often long they participated in aerobic conditioning their responses are illustrated in Figure 5.

Figure 5 Aerobic Conditioning: Time per Session



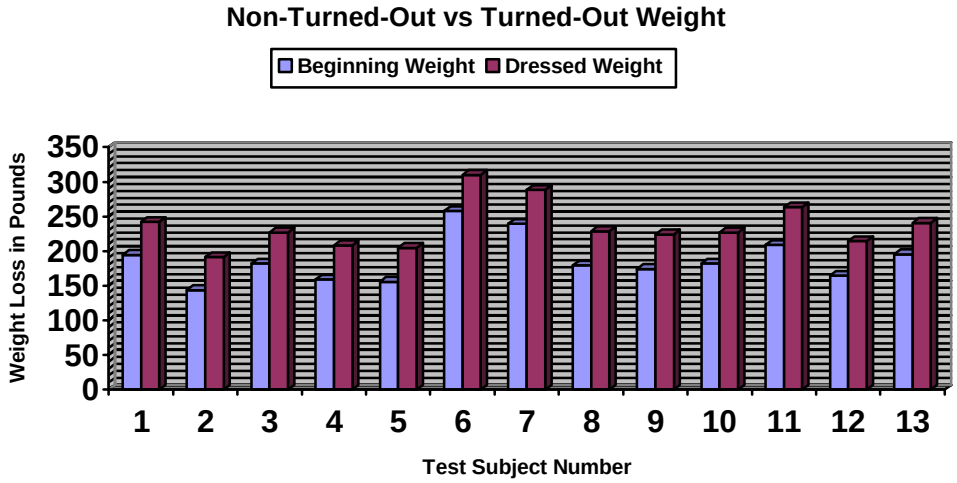
The last element that we evaluated, prior to beginning the testing process, was each test subject's Body Mass Index (BMI). Later in this section a correlation of changes in the anion gap based on the test subject BMI will be completed. Figure 6 shows the BMI range for our test subjects.

Figure 6 Test Subjects Body Mass Index



Once the testing process began, a determination was made about the amount of weight each added for this exercise and then that was calculated into a percentage of their initial weight obtained at the gym. This factors into the project because as firefighters the addition of full personal protective equipment and SCBA not only inhibits the body's ability to cool itself, it adds extra stress on the body because of the increased weight. Figure 7 shows how much additional weight was placed on each test subject.

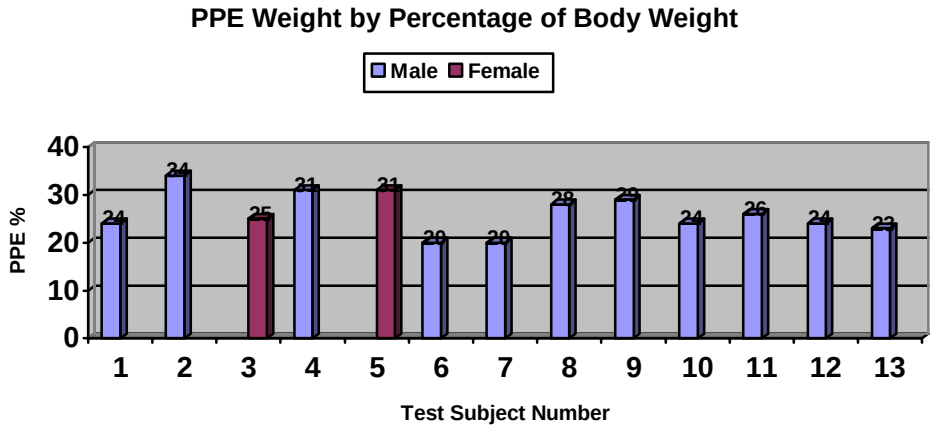
Figure 7 Non-Turned Out vs Turned Out Weight



The percentage of body weight increase due to the addition of turn-outs and SCBA is represented in Figure 8. This is significant because, although the turn-outs ranged from 49 to 52

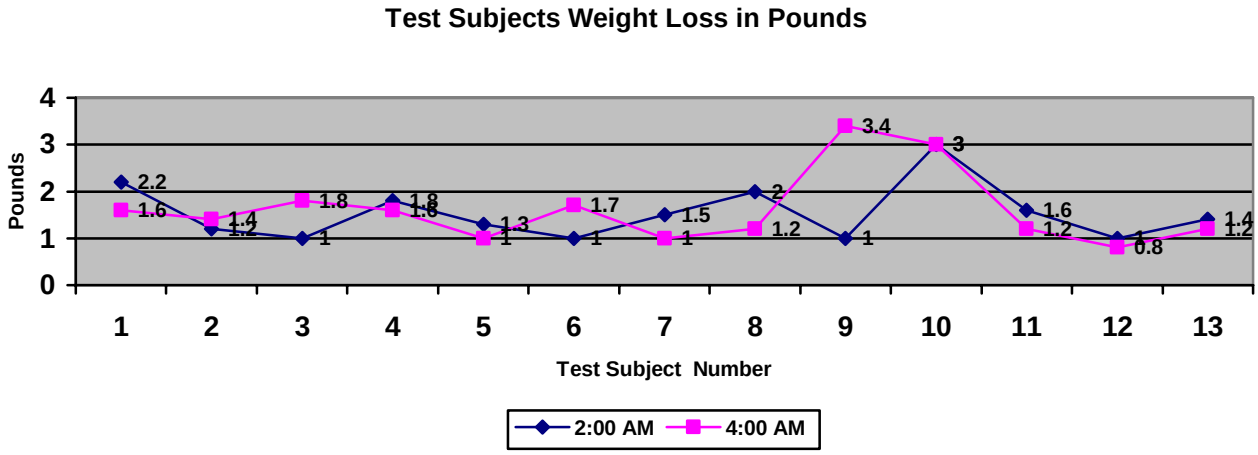
pounds, a five percent shift in the amount of weight being carried during strenuous activity would represent a marked increase in the amount of effort required to sustain that activity.

Figure 8 PPE Weight by Percentage of Body Weight



With the test subjects' backgrounds identified and correlated to Provo Fire & Rescue, it is necessary to review and analyze the results of the laboratory studies. The first tested area to be examined is the loss of body fluids through sweating. To effectively measure the loss of fluid through sweat, each test subject was weighed prior to getting into turn-outs and again after completing the exercise in the same clothes as the before weight. Figure 9 shows amount of weight loss for each test subject.

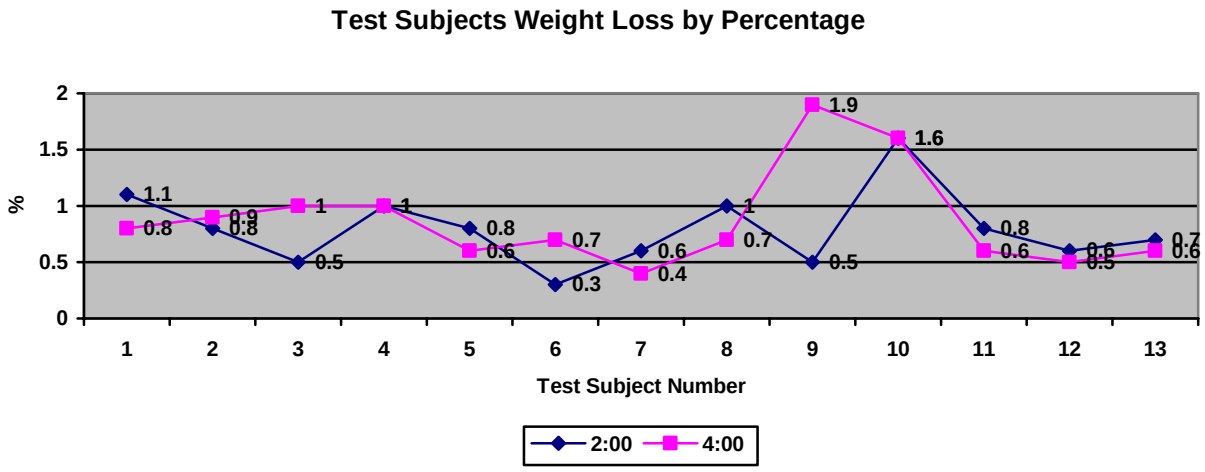
Figure 9 Test Subjects Weight Loss in Pounds



Overall the average weight loss in both testing sessions was 1.6 pounds (0.73 kg) per test

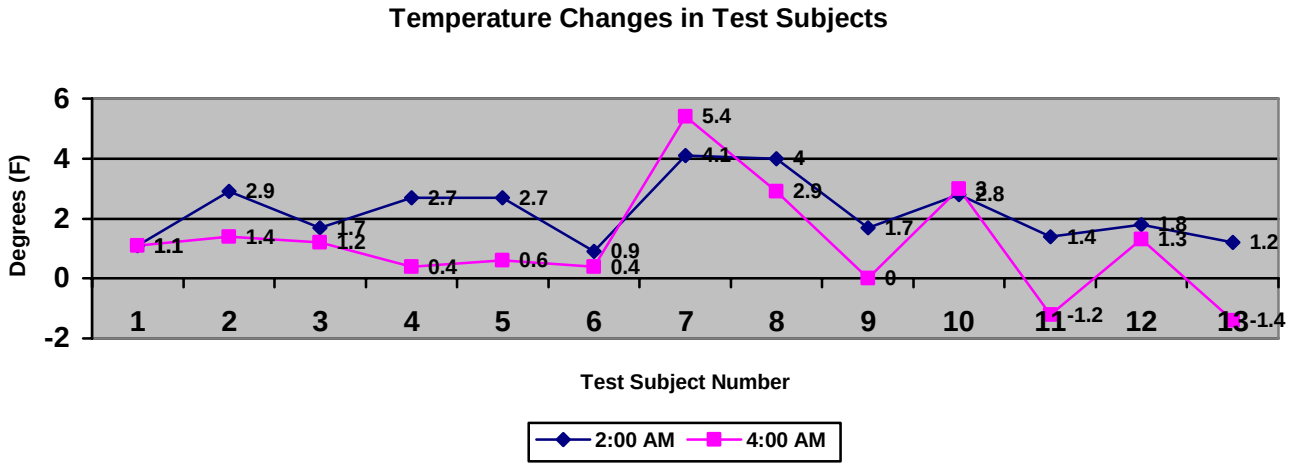
subject. It is important to remember that one kilogram (2.2 pounds) of weight loss equates to approximately one liter of fluid. The reality that heat stress can begin simply by wearing turn-outs and engaging in physically strenuous activities is supported by these findings. It is also significant to note, that these tests were conducted at a facility where the temperature is regulated at 65 degrees. Mild dehydration can begin with fluid loss of one percent of the total body weight. Figure 10 considers the percentage of body weight loss during the 40 minute exercise routine.

Figure 10 Test Subjects Weight Loss by Percentage



The shift in fluid balance also changes the effectiveness of the body's ability to maintain its temperature. Figure 11 illustrates the measured temperature changes in the test group. All temperatures were obtained using a tympanic thermometer.

Figure 11 Temperature Changes in Test Subjects

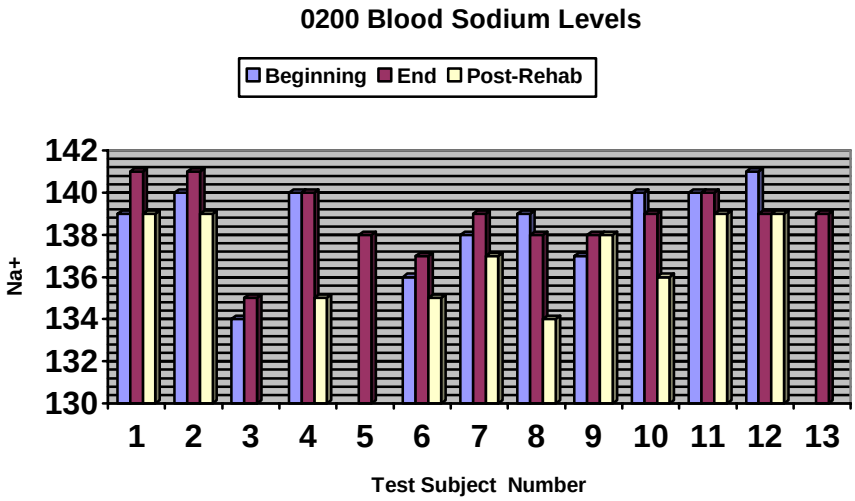


The temperature loss, recorded during the testing process, on test subject 11 and 13 was suspect. This reading could be accurate, however; it is probably more likely that the reading was not accurately obtained or recorded. Most significantly, test subjects 11 and 13 each lost weight during the exercise making it very unlikely that their core temperature dropped. Temperatures were obtained before the test subjects dressed in PPE and within one minute after they left the elliptical cycle. The increase in core temperature in the majority of the test group subjects indicates that when in full PPE the body's ability to cool itself is diminished. In higher temperature environments, it is likely that the ambient temperature combined with PPE substantially increases the risk for heat stress. Emphasis on early fluid maintenance could reduce the effects of the heat stress identified here.

The purpose of this study was to look at the hematological effects of late night operations. We have already identified dehydration as a significant event. Dehydration is a factor in thermoregulation, but how does it affect the blood? The next data to be evaluated consider the effects of the testing process on the blood chemistry. For reference purposes the range of normal values for laboratory samples at Utah Valley Regional Medical Center is included in Appendix C. There are three samples for each session of the testing process. The

beginning sample collected before any testing, the end sample when the test subject finished the work-out portion of the test, and the post-rehab sample that was collected after the test subject had been re-hydrated and fed. Sodium is the principal extracellular cation and where sodium goes, water follows. Figure 12 tracks the blood sodium levels obtained at the 0200 hours testing, and figure 13 illustrates the 0400 hours testing.

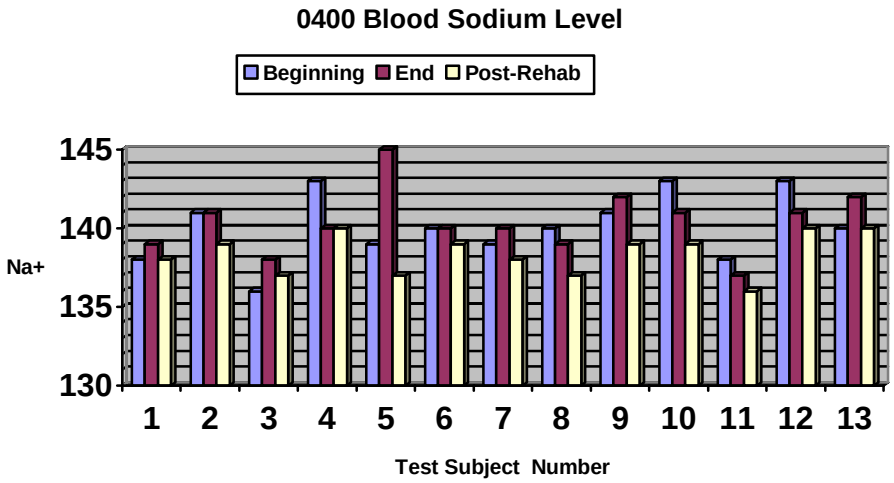
Figure 12 0200 Blood Sodium Levels



There are several items to note on Figure 12. First, three test subjects, test subjects three, five, and thirteen did not have three separate samples. A third tube of blood was not able to be drawn for testing on these three test subjects. Anecdotally, the second and third draws on all test subjects were more difficult. This could be in part because of an increase in blood viscosity due to dehydration and the small gauge catheter placed for the testing process. The first draw for test subjects five and thirteen were hemolyzed, making laboratory analysis impossible. The normal range for sodium in the blood is 137 - 146 mEq/liter. Four test subjects had sodium levels below the normal limits during the testing process. During the 0400 hours testing, all samples were obtained and processed by the laboratory. A slight increase in the sodium level was noted between the first and second draw in most cases. All sodium levels went down between the

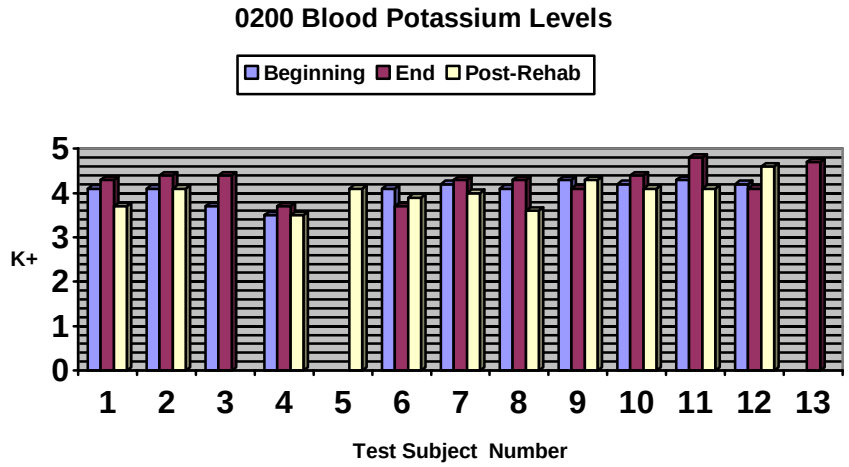
second and third blood draws after the test subject had been given fluid and nutrition. The third blood draw occurred 30 minutes after the test subject completed rehabilitation. These charts demonstrate the hemoconcentration discussed in other studies. That same hemoconcentration may represent an increase in blood viscosity that was observed during the testing, but not specifically tested for in the laboratory. Figure 13 shows the shifts in sodium levels during the 0400 hours testing process.

Figure 13 0400 Blood Sodium Levels



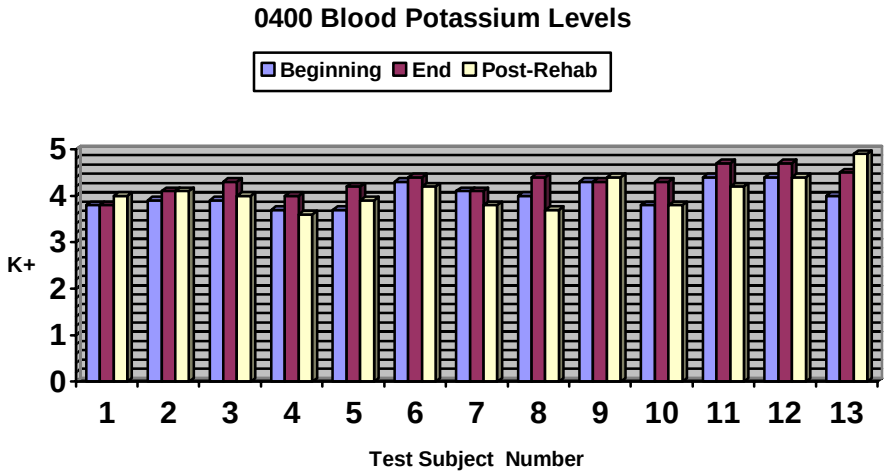
Potassium, with a normal range of 3.5-5.0 mEq/L, is also susceptible to hemoconcentration. Potassium, unlike sodium, has a very narrow range and the cardiac implications when the body has too much or too little potassium are significant. The shifts, if any, in potassium levels are shown in Figures 14 and 15.

Figure 14 0200 Blood Potassium Levels



As is the case for each of components of the blood testing, there are not three samples for test subjects, three, five, and thirteen.

Figure 15 0400 Blood Potassium Levels



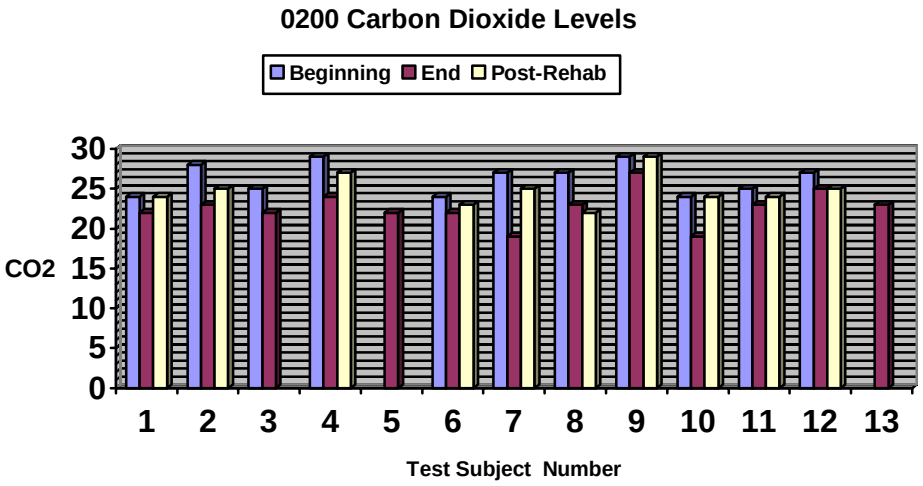
The shifts in potassium levels, generally higher from the beginning sample to the end of workout sample, show a slight increase. This can once, again be attributed to a loss of fluid in the blood and the resulting hemoconcentration. Unlike the sodium levels, no test subject's potassium left the normal range.

Similar shifts have been observed in the calcium and chloride levels of the blood. Each of these shifts can be explained by the hemoconcentraton of the blood secondary to fluid loss.

While each cation, sodium, potassium, and calcium showed a slight increase between the beginning and the end of the workout, the majority had resolved back to pre-work out values after rehab was completed. These results support the value of rehabilitation.

Two other lab results warrant discussion as a part of this project; they are the carbon dioxide levels (CO2) and the Anion Gap. The carbon dioxide level and the anion gap are significant because they both can indicate conditions that will result in a change in the acid base balance in the body. An increase in carbon dioxide can indicate that a person is not moving enough air resulting in a respiratory acidosis, while an increasing anion gap indicates an increase in hydrogen ions as a result of a metabolic acidosis, such as a build up of lactic acid. Figure 16 examines the blood carbon dioxide levels during the 0200 hour testing.

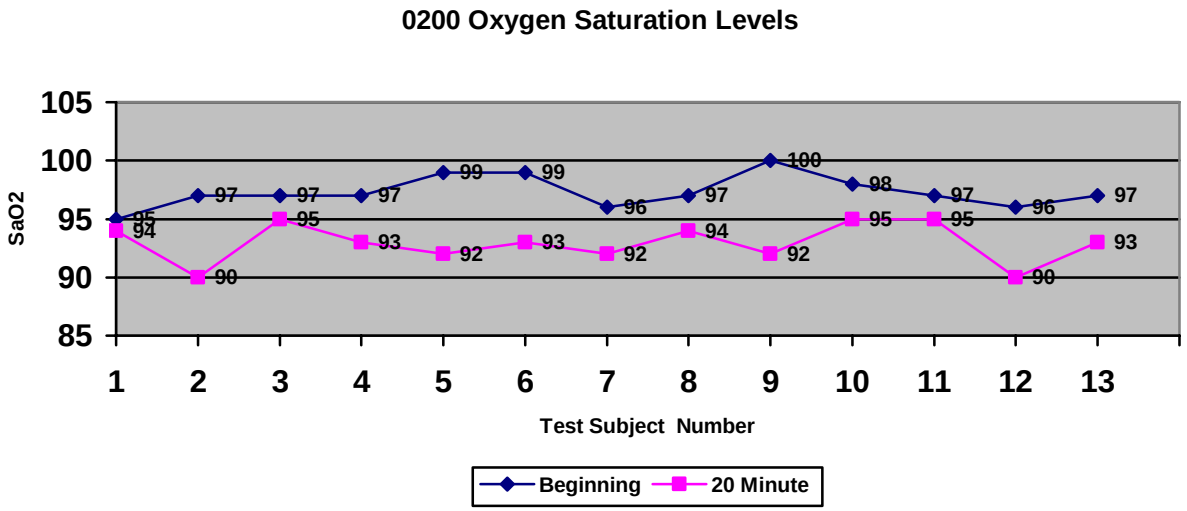
Figure 16 0200 Carbon Dioxide Levels



The data show a decrease in the carbon dioxide level in the blood during the work out. This could be due to increased rate of respiration because of the strenuous activity. What is interesting to note, is that when the body changes into an anaerobic metabolism, the respirations increase to support muscle activity and hyperventilation may become a problem. However, the body may not be as efficient when working under these conditions. Oxygenation at the cellular

level may be affected. Figure 17 shows the beginning oxygen saturation levels, and a repeat saturation level taken twenty minutes into the workout routine.

Figure 17 Oxygen Saturation Levels



The decreasing oxygen saturation when combined with physical activity can result in an oxygen deficit within the muscles. That deficit produces lactic acid. Increasing levels of acids within the blood stream are one cause of an increase in the anion gap. Figure 18 and 19 illustrates the shifting of the test subject's anion gap in response to exercise.

Figure 18 0200 Anion Gap Level

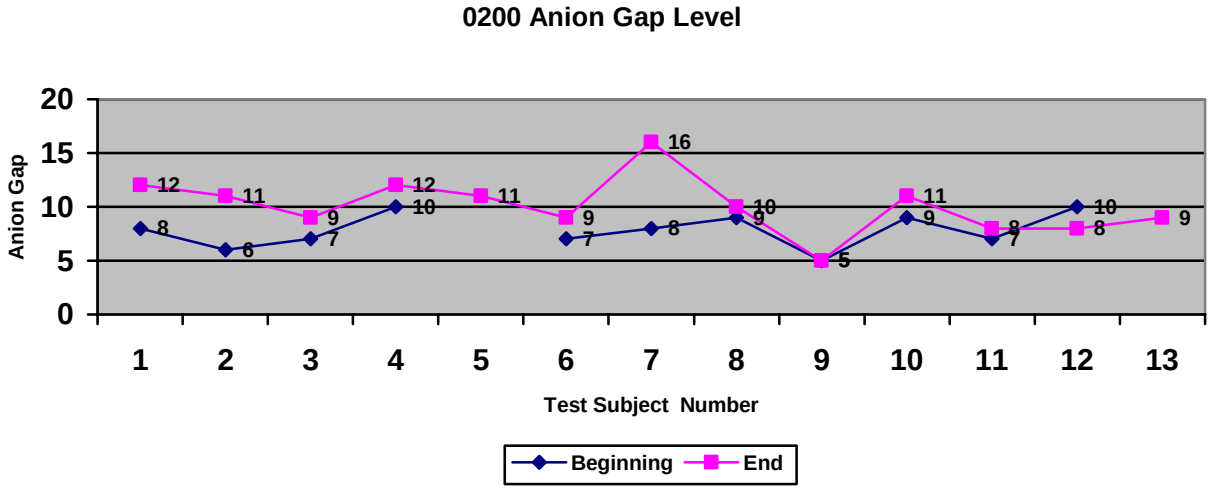
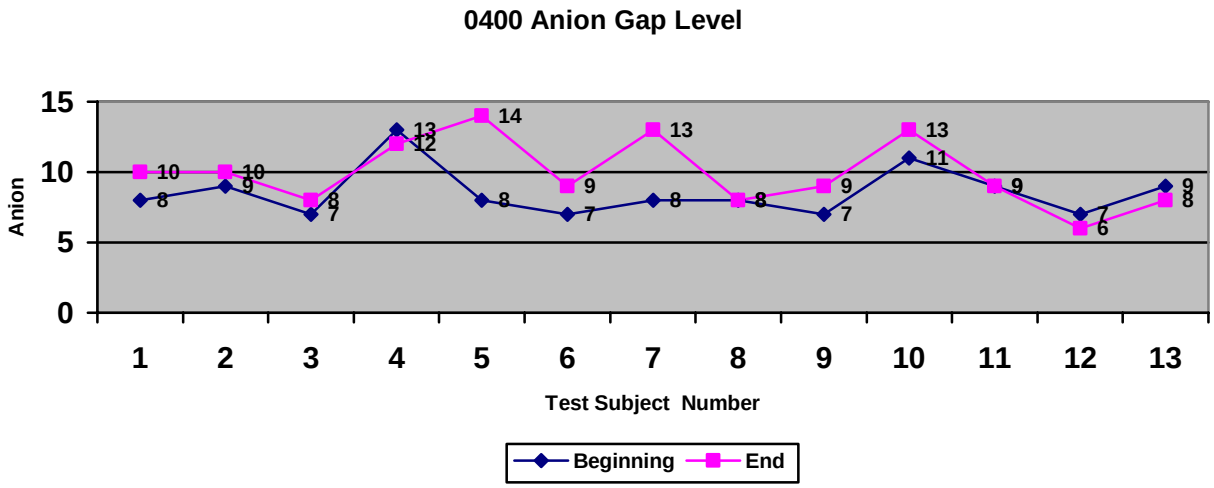
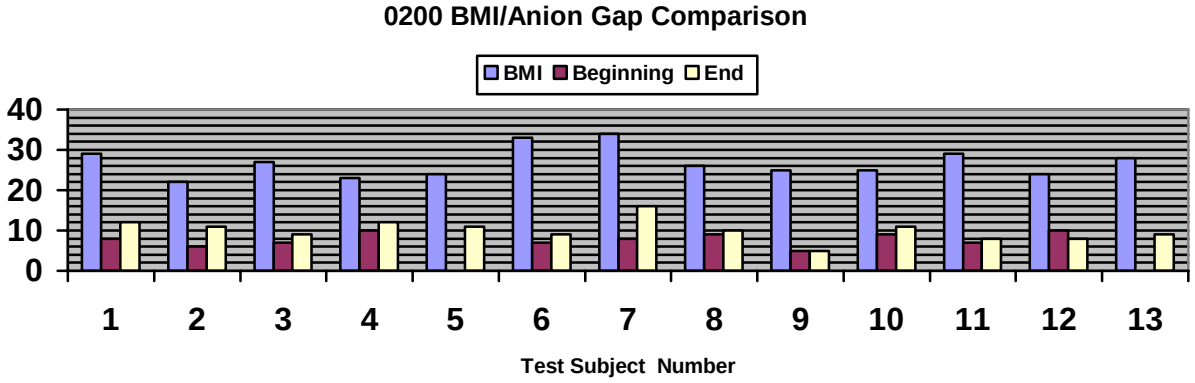


Figure 19 0400 Anion Gap Level



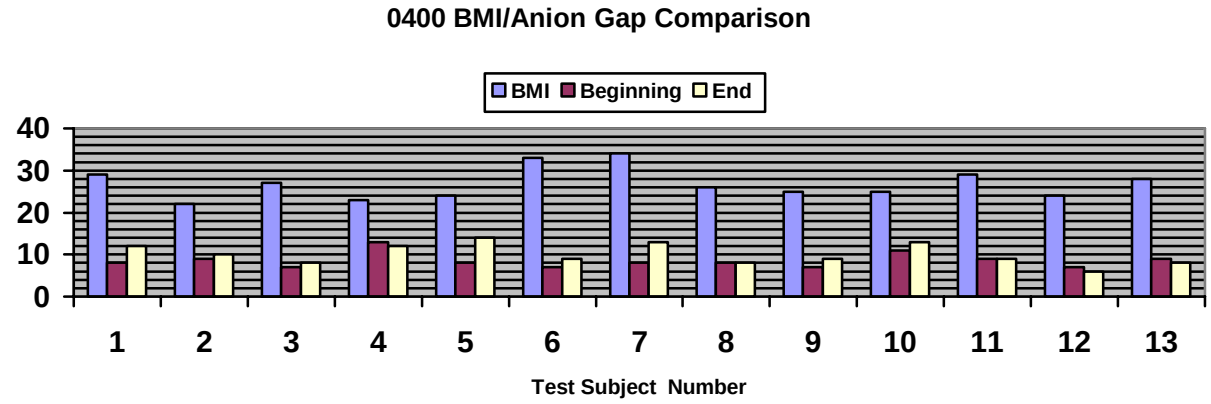
The increasing anion gap indicates a state of metabolic acidosis within the body. The most likely cause is lactic acidosis, caused by oxygen depletion in the muscles due to inadequate oxygen uptake and anaerobic metabolism. Aerobic fitness improves the body's ability to handle the stresses placed on it by strenuous activities. Because BMI is thought to be an indicator of physical fitness, although not specifically aerobic fitness, a comparison of the shifts in the anion gap to the test subject's BMI would prove useful. The use of BMI as an indicator of fitness levels is limited. Individuals, such as firefighters and professional athletes may have a high BMI due to the large muscle mass they possess. BMI only calculates height and weight. It does not calculate muscle mass or aerobic fitness. Using the data obtained during this research project, a correlation of BMI, to shifts in the anion gap was evaluated to see if there is a correlation between the two. Figure 20 shows the BMI to anion gap comparison at 0200.

Figure 20 0200 BMI/Anion Gap Comparison



During the 0200 hour testing, the largest shift in the anion gap occurred in test subject seven. Test subject seven had the highest BMI of any test subjects, however; a large shift was not detected in test subject six who had the second highest BMI. The only difference between the two test subjects is test subject six rated its physical fitness as good, while test subject seven rated their fitness level as poor. This finding supports the concept that the BMI is just one factor in evaluating overall health, particularly in firefighters.

Figure 21 0400 BMI/Anion Gap Comparison



A similar result is shown in the 0400 hour testing. In this case, the largest shift in the anion gap occurs in test subject five, who has a BMI of 24. Test subject seven showed the second largest shift during this test session. Test subject three, eight, eleven, and twelve have the

smallest shifts in the anion gap consistently across both testing session even though their BMI results ranged from 23 to 29.

The final laboratory value to be evaluated is the blood glucose levels. The first levels to be evaluated are the levels found during the physical activity portion of the testing process. Figure 22 graphs the pre-activity, post-activity, and post-hydration blood glucose levels during the 0200 hours test.

Figure 22 0200 Activity Blood Glucose Levels

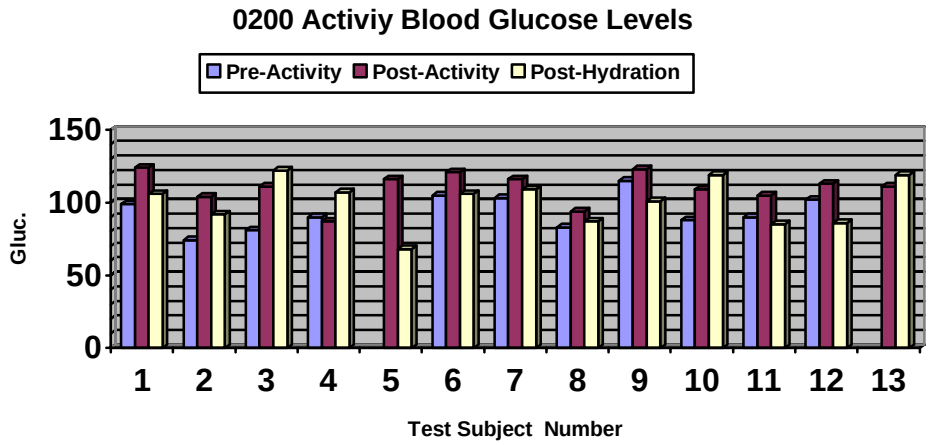
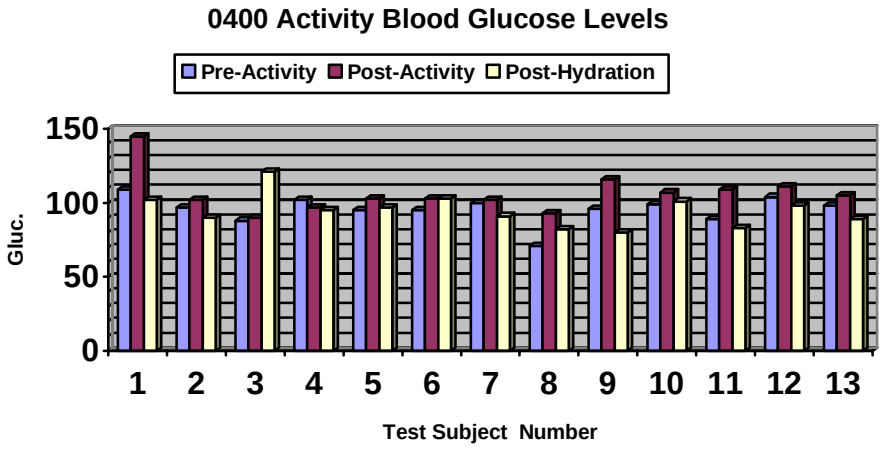


Figure 23 illustrates the blood glucose levels during the 0400 hours testing.

Figure 23 0400 Activity Blood Glucose Levels



As was the case in previous blood studies, each test subject showed a slight elevation in their blood glucose during the activity. This indicates hemoconcentration, due to the loss of fluid

in the blood stream. For the most part, the blood glucose levels returned to the pre-activity levels or lower with just the addition of water.

Once the activity portion of the testing was completed, the test subjects were taken back to the fire station and given a rehabilitation regimen to replace their lost fluid and calories. The next charts will break down the rehabilitation regimens to provide the basis for the post-rehabilitation blood glucose levels. With the assistance of a clinical dietician, two rehabilitation regimens were developed. The first regimen is a "sugar" regimen, while the second is the "soup" regimen. The items used in these regimens can be found at any grocery store, including those that are open 24 hours.

The sugar regimen consisted of doughnuts, cookies, water, and sports drinks if they wanted them. The nutritional breakdown of each of the regimens can be found in Appendix B. To better understand the nutritional values in the "sugar" regimen, carbohydrate (CHO) will be broken down into sugars that include sucrose, fructose, and dextrose, and CHO that includes starches and the more complex carbohydrates. Figure 24 shows the nutritional breakdown of the Lofthouse™ Frosted Sugar cookie used as part of the sugar rehabilitation regimen.

Figure 24 Nutritional Breakdown of Cookie By Calories

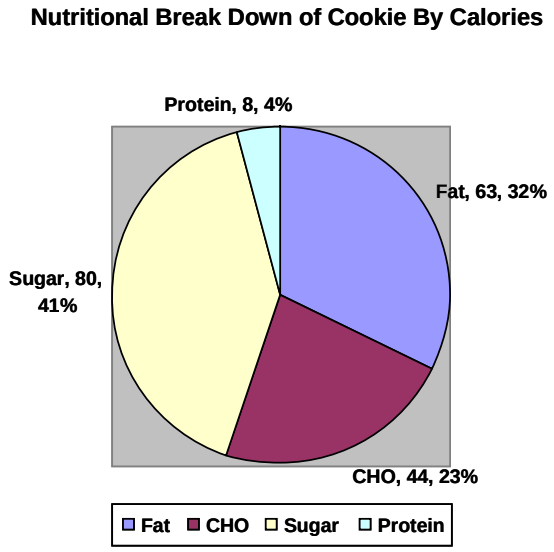
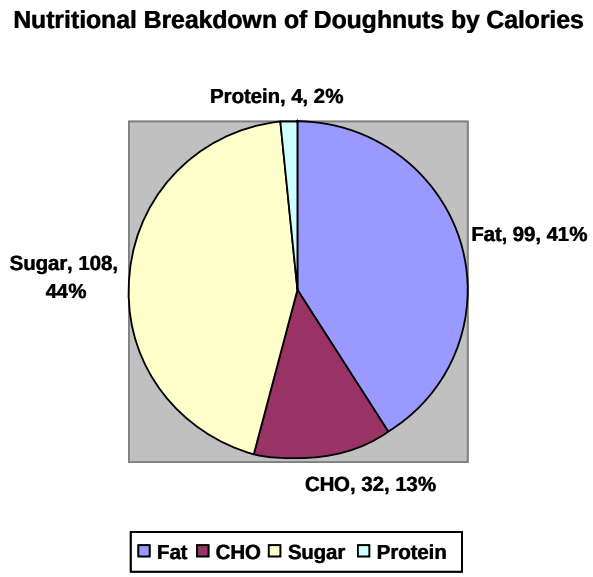


Figure 25 shows the nutritional breakdown of the Hostess™ Raspberry Filled doughnut used as a part of the sugar rehabilitation regimen.

Figure 25 Nutritional Breakdown of Doughnut by Calories



The preceding graphs illustrate that, in the sugar regimen, fat and simple sugars are the most significant components of the overall caloric intake. Simple sugars metabolize very

quickly providing a short term burst of energy, however the lack of protein and starches eliminate much of the medium and long term value of these items in a rehabilitation regimen.

The second rehabilitation regimen used soup and crackers as the nutritional elements. Figure 26 shows the nutritional breakdown of Campbell's™ Vegetable Beef Soup.

Figure 26 Nutritional Breakdown of Soup by Calorie

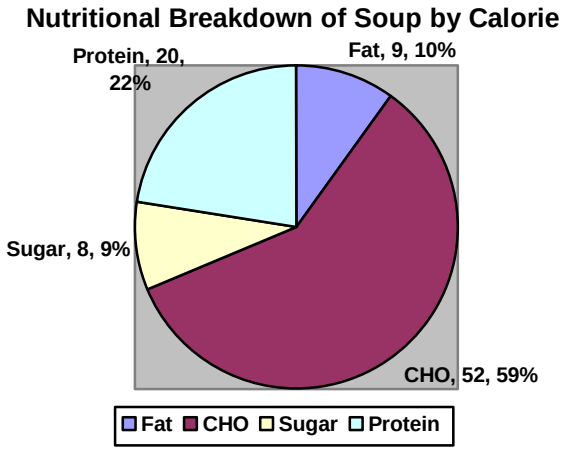
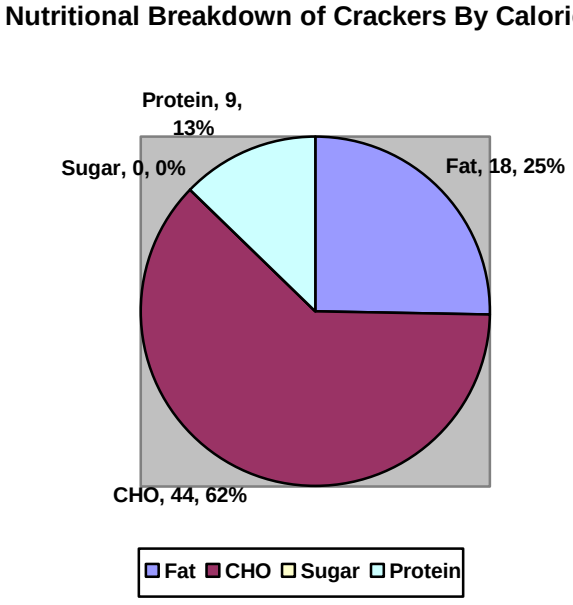


Figure 27 shows the nutritional breakdown of the Nabisco™ Original Premium Saltine Crackers.

Figure 27 Nutritional Breakdown of Crackers by Calorie



The soup routine provides a more balanced regimen because there is a mix of short term glucose in the form of sugars, a large amount of complex CHO for longer acting energy replacement, some fat for long acting energy replacement, and protein for muscle repair. The soup and crackers derive the bulk of its calories from complex carbohydrates found in the potatoes, barley, and peas and the starches found in the crackers.

The primary difference between the two rehabilitation regimens is the proportion of simple sugars and fats found in each. The second purpose of this ARP was to evaluate the two rehabilitation regimens and evaluate their effectiveness after strenuous activities. The sample group was split into two separate groups for rehabilitation. During the 0200 hours testing seven test subjects received the sugar regimen, and six received the soup. Figure 28 tracks the blood glucose levels obtained in the 0200 hours' test. The glucose levels are from 30 minutes post activity until the next morning, when the test subjects tested their blood with a glucometer and recorded the results.

Figure 28 Blood Glucose Levels: Sugar Regimen

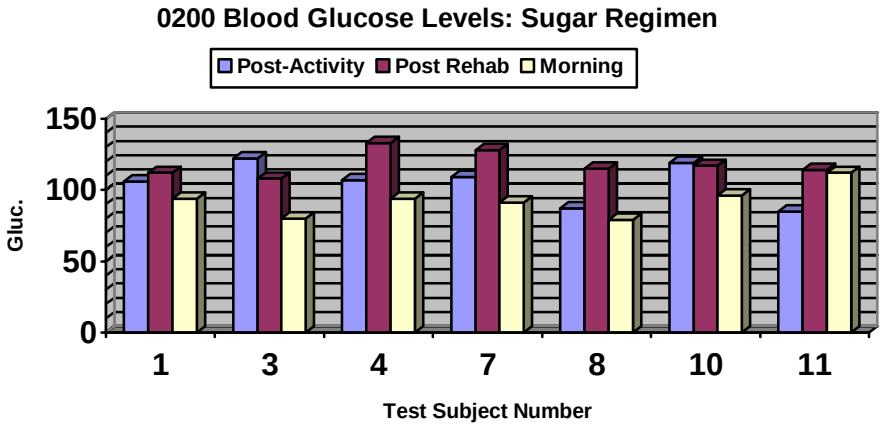
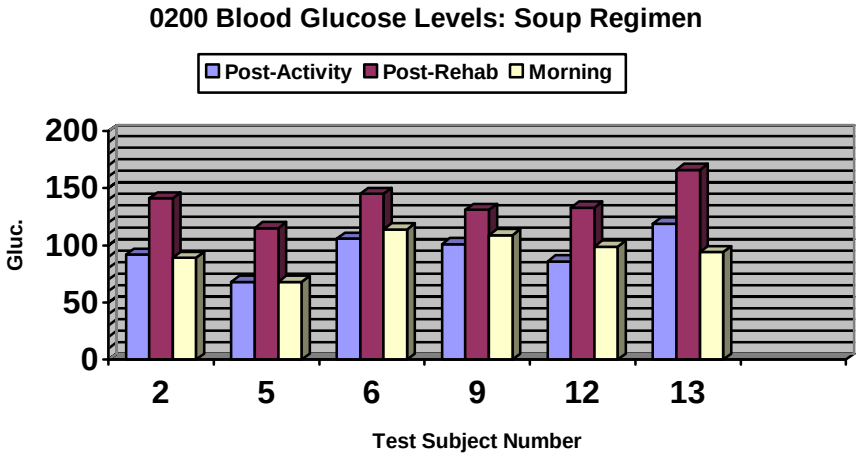


Figure 29 tracks the blood glucose levels during the rehabilitation of the 0200 hours test session by test subjects who had the soup regimen. The glucose levels are from 30 minutes post activity

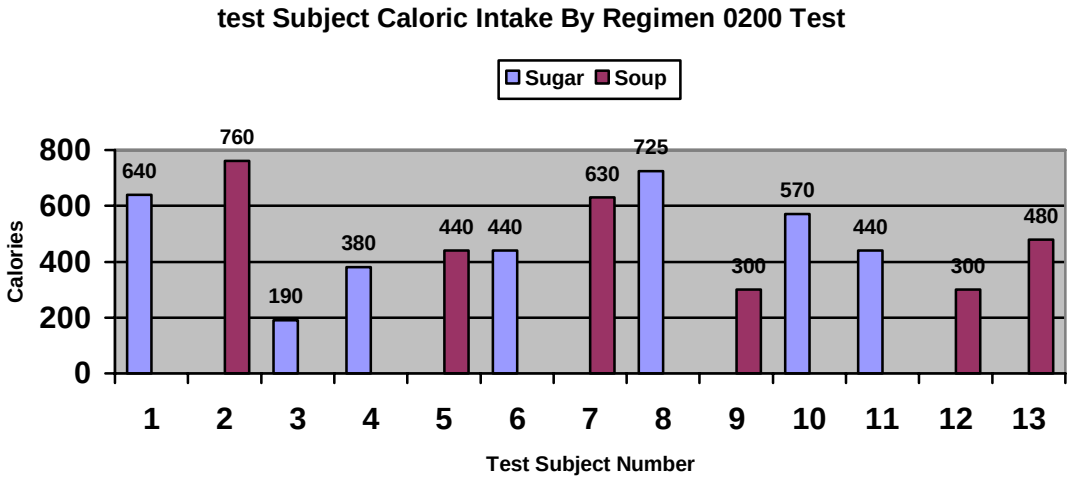
until the next morning when they obtained a blood glucose using a glucometer and recorded their results.

Figure 29 0400 Blood Glucose Levels: Soup Regimen



To give some perspective to Figures 28 and 29, Figure 30 illustrates the caloric intake of each of the test subjects during the 0200 hours' testing.

Figure 30 Test Subject Caloric Intake by Regimen 0200 Test



The next charts, figures 31 and 32, compares the post-rehabilitation glucose levels to the glucose levels obtained the morning following rehabilitation.

Figure 31 0200 Post Rehabilitation Blood Glucose Levels: Sugar Regimen

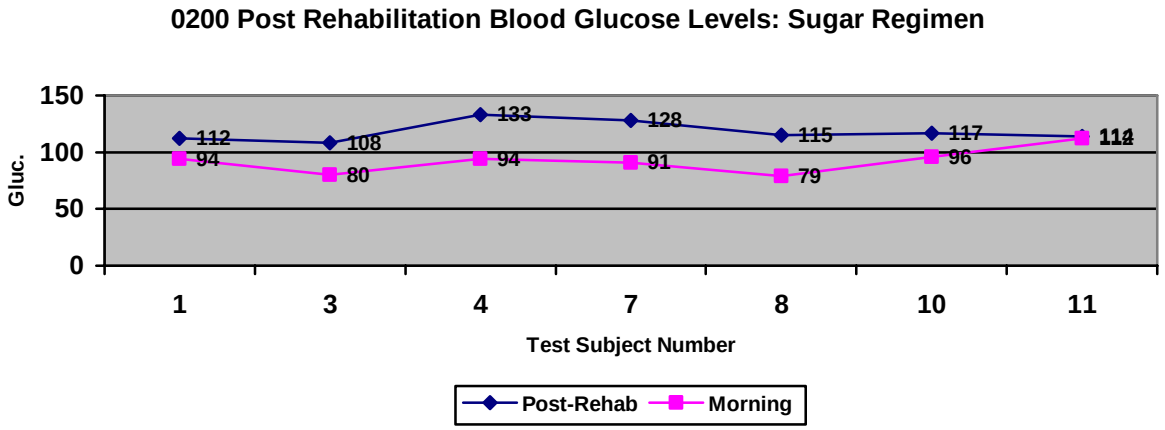
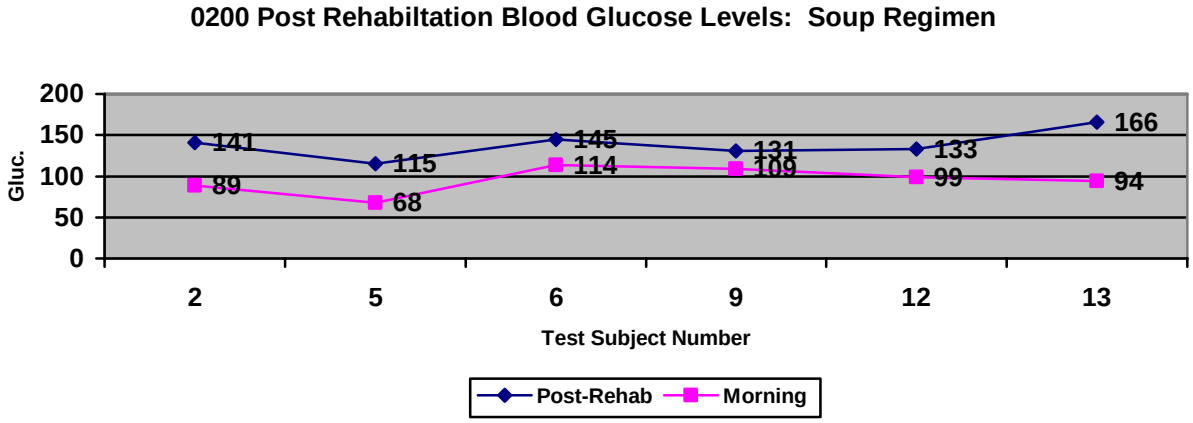


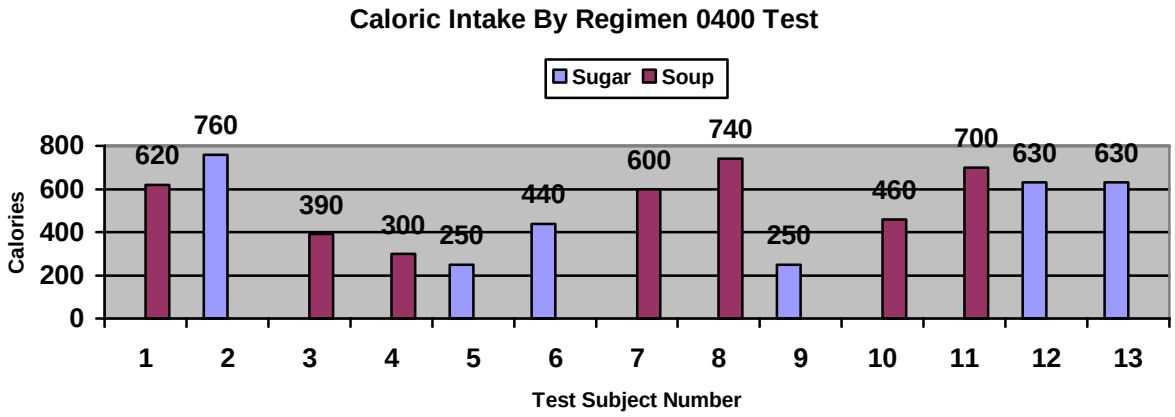
Figure 32 0200 Post-Rehabilitation Blood Glucose Levels: Soup Regimen



These charts show that in this testing period the blood glucose levels, for the most part parallel each other as the body responds to the elevated glucose levels and secretes insulin to bring those levels back in to the normal range. Test subject five is the closest to the bottom range for glucose with a blood glucose level of 68. The lower normal glucose limit is 60.

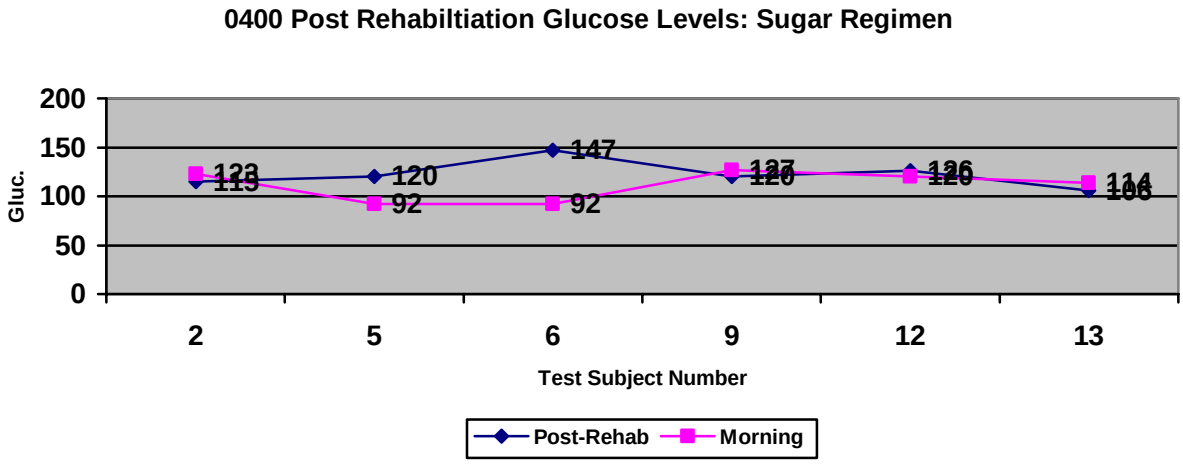
To evaluate the 0400 testing, figure 33 will show the caloric intake of each of the test subjects. For this testing session the rehabilitation regimens have been switched.

Figure 33 0400 Test Subject Caloric Intake by Regimen



Again, a comparison of the two regimens effect on the glucose levels in test subjects is indicated. Figure 34 shows the blood glucose comparison between the post rehabilitation test and the morning test done with a glucometer.

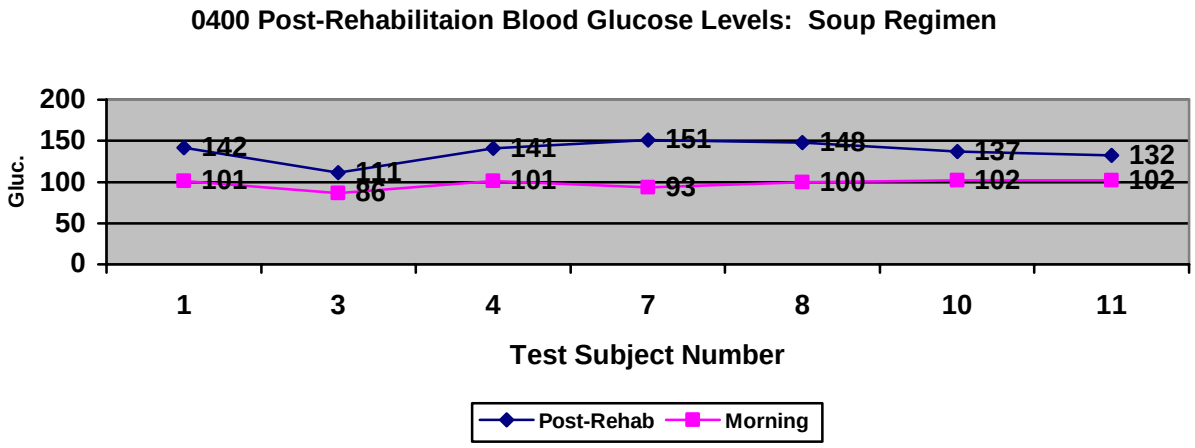
Figure 34 0400 Post-Rehabilitation Glucose Levels: Sugar Regimen



Test subject six provides an opportunity to see the rebound insulin effect. Test subject six's blood glucose level dropped 55 points between 0635 and 0930 after taking in 440 calories, of mostly sugar and fat. This effect represents the risks associated with high sugar foods and drinks in rehabilitation. Even though this person's blood glucose level is in the upper range of normal, test subject six's normal glucose levels are high in the 100-115 range, so a glucose level

of 92 represents a significant drop. Figure 35 graphs the test group that received the soup regimen during the 0400 hours test.

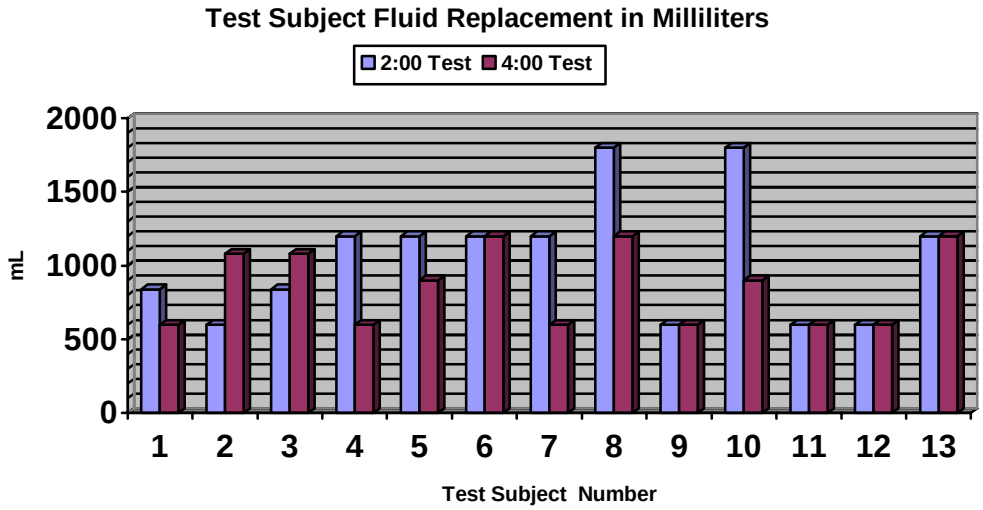
Figure 35 0400 Post-Rehabilitation Blood Glucose Levels: Soup Regimen



When evaluating both rehabilitation regimens using their nutritional breakdown and the test subject's blood glucose level, it appears that the soup and cracker routine provides a more stable nutritional platform, particularly for extended operations.

The final rehabilitation area to be examined is fluid replacement. Figure 36 represents the amount of fluid intake each test subject had during the two testing sessions.

Figure 36 Test Subject Fluid Replacement in Milliliters

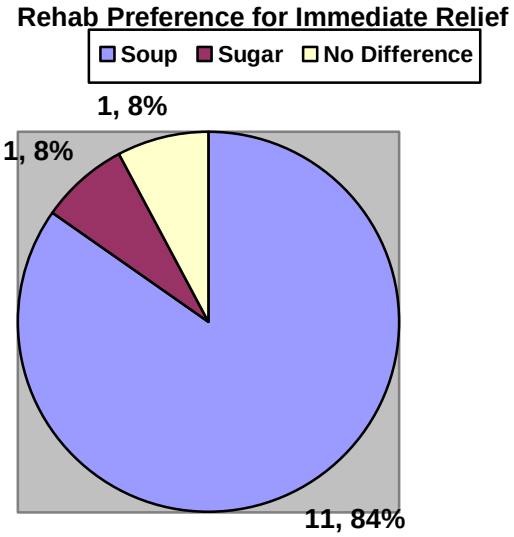


Using the data recorded during the testing sessions, the average weight loss during the activity

portion of this project was 1.6 pounds. That equals 730 milliliters of fluid. The data in Figure 36 show that some of the test subjects didn't replace the fluid they lost during this testing process.

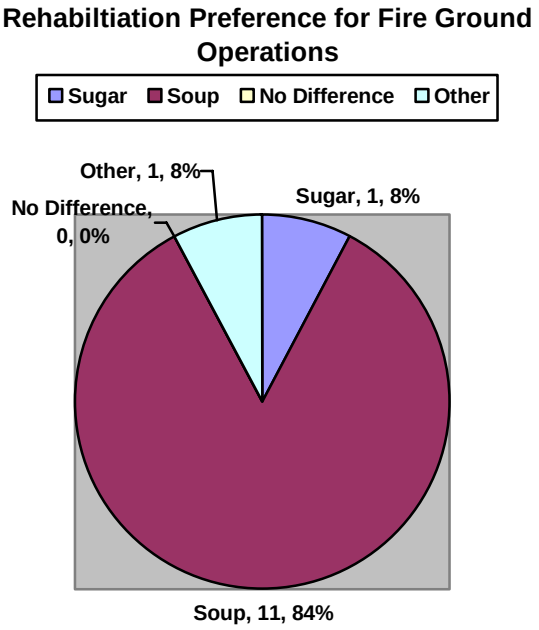
After the testing process was completed, each test subject was given a post-testing survey. The surveys were returned and the results tabulated. The first issues were related to physical complications due to the testing process. During the research portion of this project one test subject, eight percent, experienced nausea and lightheadedness. This test subject also experienced nausea after the activity portion was completed. It should be noted that this test subject began the testing process with a low sodium count secondary to attempting to pre-hydrate prior to the testing process. Other complications from the testing occurred in 32% of the test subjects. Two test subjects, 16%, experienced fatigue, although both attributed some of the fatigue to alarms that they responded to after the testing process. Two test subjects, 16%, also complained of joint and arm pain secondary to the exercise. And finally, 2 test subjects, 16%, complained of localized pain at the IV insertion site. Figure 37 shows the rehabilitation preference, based on the test subject surveys for immediate relief

Figure 37 Rehab Preference for Immediate Relief



The test subjects were asked which rehabilitation regimen provides the best long term results. All test subjects responded that the soup provided the best long term rehabilitation. The test subjects were also surveyed to determine what their preference would be for rehabilitation during fire ground operations. Figure 38 shows their responses.

Figure 38 Rehabilitation Preference Fire Ground Operations



Discussion

The results of this ARP have been evaluated, correlated with others findings and the implications for Provo Fire & Rescue analyzed. The ARP was designed to identify the effects of late night operations on blood chemistry. As firefighters became dehydrated, during the exercise portion of the study, it was anticipated that key indicators of shifts in blood chemistry could be identified by evaluating, before and after each testing session, the changes in sodium, potassium, carbon dioxide, anion gap, glucose and calcium. The shift in fluid balance because of sweating and other fluid losses is the first element of the study that will be considered. McFarland (1982) indicates that sodium is the principal extracellular cation and is the electrolyte responsible for

maintaining the fluid balance in the body. Therefore, sodium and fluid levels go hand in hand. Dickinson (2000) correlates loss of sodium, due to excessive sweating, as a factor in the inhibition of the function of skeletal muscles. Welch (1999) refers to a weight loss of two to six percent as common to firefighters during physically stressful work in a hot environment.

During the controlled setting of this project, the test subjects lost an average of 1.6 pounds. The study attributes this loss to sweat and insensible loss of fluids in breathing. A small percentage of weight loss could be the result of the calories burned to sustain the required level of performance for this study. This is a fairly accurate representation of the actual weight loss as other opportunities to lose weight through urination, defecation, and vomiting were limited. The test subjects were not allowed to use the restroom from the time they weighed in, until they weighed out after the exercise portion of the test. Pre- and post-test activity weights were obtained in the firefighters' physical fitness training clothes. There is the possibility that weight, in the form of sweat, continued to be carried in the clothing. As a result, that weight loss was not accurately recorded. The dressed weight, as opposed to a more accurate naked weight, was done because the scale is in a public place. The second variable is the ambient temperature where the study was conducted. The gym is regulated at a normal temperature of 65 degrees. Fire ground operations, particularly in burning structures, are conducted in areas with significantly higher ambient temperatures.

The next area that was evaluated was the hematological effects of the fluid shift caused by sweating. Dickinson (2000) discusses the cardiovascular implications of potassium levels that are too high or too low. Of particular concern, are arrhythmias that may occur because the electrical conduction system loses its ability to generate and conduct electrical impulses. Verfuss (2004) discusses the specific implications to the heart indicating that it can lose some of its force

of contractions because of the change in the electrolyte levels as fluid leaves the body. Smith (2001) linked changes in the blood chemistry to hemoconcentration that normally occurs as a result of the fluid shifts common during physical exertion. That hemoconcentration can normally be corrected with rehabilitation within about 90 minutes.

During the study, laboratory tests showed hemoconcentration of sodium, potassium, chloride, glucose, and calcium. The electrolyte shifts were corrected in all but two instances by hydration and nutrition. Two test subjects demonstrated lower than normal sodium levels during the last blood draw of the session. One test subject presented already dehydrated with a low sodium level before the testing began, and they did not return to a normal sodium level after the final blood draw. The test subject also had other signs and symptoms of dehydration, including a rapid pulse, nausea, and lightheadedness. After the third blood draw, the test subject still had a pulse over 100 and was still nauseated. This test subject was given small sips of a sports drink to balance both fluids and electrolytes and was monitored for the rest of the morning. The other test subject finished the testing process with a lower than normal sodium but no symptoms. That test subject attempted to pre-hydrate the evening before the testing process, and was possibly low on sodium due to dilution from their higher than normal water intake prior to testing. Fluid replacement in this test subjects' sodium returned to a level near their pre-activity level, but outside the normal range.

The implications for Provo Fire & Rescue regarding fluid and electrolyte replenishment, are primarily conditioning the firefighters and company officers to begin re-hydration earlier than previously anticipated. It is possible that rather than waiting for a firefighter to finish two air cylinders before they take off their mask and have a drink of water, it may be more appropriate to hand them a drink while their cylinder is being changed. Firefighters are normally

thirsty after their second bottle of air. Coyne (2006) indicates that thirst is too late of a sign regarding dehydration. Once thirsty, their performance is already impaired. Dickinson (2004) suggests the strategic placement of re-hydration solutions, by the spare air cylinders for easy access when changing air bottles. This suggestion is a good approach to providing firefighters with fluid; it also provides a physical reminder that they need to take on fluid. As an example, a company officer in Provo puts a small bottle of water in each of their firefighter's turn-out boots each summer. The water is not for them to drink, but rather a reminder that they are in their turn-outs, and they should come and get a cold drink when the call is over to stay hydrated. Klaene (2005) suggests that fire departments implement a two-cylinder rule for establishing a rehab sector.

An area that was identified during this study was not a primary focus of this study. However, the results, and implications for Provo Fire & Rescue are significant enough to be addressed as a part of this ARP. That is the relationship of fluid loss and PPE to temperature control. Schamadan (1996) relates the body to a "constant temperature heat machine" that requires constant cooling. For efficient cooling there must be an ample supply of water and electrolytes, free space to evaporate from, and free space to evaporate to. Firefighting gear inhibits the free space necessary for efficient evaporation. Verfuss (2005) states:

> The problem is when we encase our firefighters in the "protective envelope"; we hinder this process because we cover up the entire skin surface. This takes away the evaporative cooling, and the body temperature begins to rapidly rise. The environment inside of a firefighter's turnout gear becomes more humid, and less evaporation occurs (Verfuss, 2005, pg. 12).

In addition to turn-outs, the breathing apparatus rob the body of needed fluids. O'Connor (1996) indicates that because air is compressed by removing water vapors, breathing compressed air requires the body to replace moisture before exhaling. This reduces the amount of fluid available for sweating. This is insensible fluid loss. As the firefighter produces more sweat, the PPE becomes a more humid environment and loses its cooling efficiency. This results in elevated temperatures.

This study demonstrated that even in a temperature-controlled environment, like the gym, the PPE reduces the body's ability to cool itself. The majority of test subjects demonstrated temperature increases between 0.4 and 5 degrees (F). Three test subjects had temperature readings that showed no temperature gain. One test subject showed not gain, while two other test subjects recorded temperature losses, during the study. The findings of weight loss and vital signs tend to indicate these results were not correctly obtained, or incorrectly recorded. Fluid replacement and limitations on the amount of time a fire fighter can spend in PPE can avoid the risks of hyperthermia. The implication for this department is primarily the need for a reassessment of rehabilitation protocols.

The second purpose of this ARP was to determine whether strenuous activities during late night operations resulted in an increased risk, due to falling glucose levels and increasing blood viscosity. "Glucose . . . is the form which sugar circulates in the bloodstream and is oxidized by all body cells to provide energy for cellular metabolism" (McFarland, 1982, pg 284).

Late night operations may tax a firefighters glucose reserves because the last nutritional intake may have been be several hours ago. Verfuss (2004) discusses firefighters responding to early morning alarms. Because they may not have eaten since the evening before, their glucose levels could already be on the lower end of normal. For the most part, that was not the case in

this study. In the study, the beginning glucose level of the test subjects were in the middle to upper level of the normal limits with some test subjects being hyperglycemic. Two test subjects had an initial glucose of approximately 70 during the 0200 hours' testing. The initial glucose levels were actually higher during the 0400 hours' testing, and only one test subject was near 70.

Smith (2001), in a similar study, noticed that the firefighter's glucose levels continued to drop, even after the strenuous work stopped and after a 90 minute recovery time. This study only allowed a 30 minute period of time to re-hydrate the test subject prior to obtaining a blood glucose reading. The results in this study showed a slight increase in the blood glucose level from the initial blood draw, to the blood drawn immediately after the test subject stopped the physical activity. Smith (2001) attributes this increase to hemoconcentration. After the second blood draw the test subject was given water for fluid replacement, and sent to an area to rest for 30 minutes. After 30 minutes the test subject had a blood glucose taken. The blood sugar levels showed some decrease, although not as significant as Smith (2001) indicated. This may be due to the decreased time allowed for re-hydration prior to obtaining the blood glucose reading.

The next item to be evaluated was whether or not there is an increase in blood viscosity due to fluid loss during late night operations. Smith (2001) indicates that changes in blood chemistry are most likely a reflection of hemoconcentration that typically occurs because of fluid shifts within the body. That hemoconcentration occurs because the body is losing fluid through sweat and insensibly, through breathing. Wright (2006) noted that sweating causes a depletion of the circulating blood volume that leads to dehydration and a thickening of the blood. An increase in blood viscosity creates more of a workload on a heart that is already stressed due to physical exertion. O'Connor (1996) explained that severe water loss increases the load on the cardiovascular system by increasing blood viscosity and making it harder to pump. In this study

hemoconcentration, demonstrated by electrolyte shifts, indicated an increase in blood viscosity. Anecdotally, it became increasingly more difficult to draw blood on the test subjects after the physical exertion component of this project. That result could be compounded by the small catheter left in for the duration of testing, but it is likely that fluid loss, through sweating and insensible loss, caused an increase in blood viscosity making the blood draws more difficult.

The last areas addressed in this ARP involve the rehabilitation of firefighters. The first issue to be addressed was what are the most effective short term and long term rehabilitation regimens for Provo Fire & Rescue. Fluid replenishment is the first area that will be evaluated. Welch (1999) indicates that water has been and will always be an excellent source of hydration for events less than one hour. To prevent dehydration Piepenburg (2006) recommends a higher volume of water intake for runners-four to eight quarts per day. Firefighters should also be maintaining a similar level of water intake. Verfuss (2005) cautions against consuming large amounts of coffee and soda as a general rule. That is because they are actually diuretics that cause a fluid shift at the cellular level. For longer operations Dickinson (2000) recommends sports drinks with their simple carbohydrates because they metabolize quickly.

For long-term sustained fire ground operations, additional nutritional support in the form of food is indicated. Finding an appropriate food for rehab during late night operations can be challenging. The USFA (1992) recommends broth-based soups or stews for rehabilitation on the fire ground, because they are digested more quickly than most commercially prepared foods or sandwiches. D. L.Schofield (Personal Communication February 12, 2006) also recommends broth based soups and indicates that by adding crackers there is a increase in the more complex carbohydrates resulting in short, medium, and long term nutritional support.

Just about any food can be used for rehabilitation. Bonanno (1996) cautions against the use of fruit juices because their nutrients are offset by the high concentration of simple sugars. Taking in that much simple sugar can cause a rebound effect, where the body secretes additional insulin under the mistaken impression that it has been fed.

The results of this project support a balanced rehabilitation regimen. As was shown in the results section, of this paper the soup regimen provided a much more stable nutritional base, in both the short term and long term. The sugar regimen provided an initial boost, but it quickly metabolized resulting in lower blood glucose levels in the long term. This study was able to replicate the rebound insulin effect using the sugar routine. In terms of Provo Fire & Rescue, this study provides a great deal of information, supported by data, to intelligently select more appropriate items to rehabilitate firefighters during late night operations. It also provides a foundation to establish a standard, or guideline, for all fire or physically taxing incidents.

The final problem faced in this study relates to whether or not effective rehabilitation improves firefighter safety. The answer is yes. Welch (1999) indicates that dehydration of as little as two percent can lead to diminished performance and capacity. Regarding low glucose levels, Smith (2001) described the symptoms as weakness, nervousness, anxiety, and those symptoms can progress to confusion and an altered or unconscious state. This is not exactly what is wanted on a long term fire ground operation. "Excessive sweating and evaporation rob a rescuer's body of vital fluids. Dehydration then saps the body of its strength and misaligns vital signs like an unbalanced scale" (Heightman, 2000, pg. 8). If rehabilitation is not effective in replacing fluids and nutrients, the firefighter's bodies will begin to breakdown. Bonanno (1996) speaks of a window of opportunity that happens immediately after exertion when the body can take nutrients and replenish glycogen stores. If that window of opportunity is missed and those

carbohydrates are not available, the firefighter's body will break down its own muscle and convert it to blood sugar to satisfy energy and glycogen replenishment needs. This study presents a compelling argument for the prioritization of rehabilitation. It will require a cultural shift at Provo Fire & Rescue and in the fire service as a whole. Rehabilitation of fatigued and dehydrated firefighters must become a priority, under in the fire incident priorities, in life safety.

Recommendations

From the information gathered in this ARP, several recommendations should be made. First, this ARP provides a brief glimpse of some of the physiological issues that face this department during firefighting operations. Much more research can, and should, follow to improve the understanding of how a firefighter's body responds to physical exertion.

Second, the study has identified some physiological indicators that should be included in firefighter and fire officer training. This project was successful because of collaborative partnerships with Provo Fire & Rescue, Gold's Gym, and Intermountain WorkMed. Expanding those collaborative partners to develop further studies and legitimate training materials will benefit firefighters for years to come.

Third, begin the process of a cultural shift within Provo Fire & Rescue. When new fire apparatus were obtained in 2001, each new engine or truck had a refrigerator inside. These have been stocked with water and a sports drink since then. This represented a cultural shift in this department. The department now needs to take the next step, evaluate the data, and create a reasonable plan that can provide effective nourishment at all hours of the day or night.

Fourth, renew the emphasis on physical fitness and conditioning. A portion of the data that was obtained, but not discussed in the body of this paper, is the apparent blood glucose levels being carried by Provo firefighters. A number of the test subjects came into the study with

their blood glucose in the high end of the normal range. This trend, if allowed to continue, increases the risk for Type II diabetes and cardiovascular disease. Certainly more study is needed in this area. An evaluation of data from the test subjects' annual physical will shed further light on this issue for those test subjects.

Fifth, and last, this study was an evaluation of hydration and glucose levels during late night operations for Provo Fire & Rescue. This was an evaluation of one department, with a convenience sample. It is important that future readers of this ARP realize that their department is probably different in many respects from Provo Fire & Rescue. The information obtained from this project should be used to help identify and meet the needs of their own department. Further research using the scientific method, control groups, and a more detailed analysis is indicated. This is indicative of the interest in firefighters' health and safety. To those who may desire to undertake that type of testing, it is recommended that the focus be on one specific portion of data at a time: complete that area, and then move on. There is a lot of information to be gleaned from this project. It is, to the best of this author's ability, accurate, relevant, and valid. There is much more to be done in the field of emergency incident hydration and rehabilitation.

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Appendix A

Letter of Inquiry to Kandi Negete, Manager of Gold's Gym

Letter of Inquiry to Laura Salazar, Marketing Director for Intermountain WorkMed

Letter of Appreciation to Kandi Negete

Letter of Appreciation to Laura Salazar

24 November 2005

Kandi Negrete
Gold's Gym
1259 South 800 East
Orem, UT 84097

Dear Ms. Negrete,

As per a previous discussion, I am writing to confirm the willingness of Gold's Gym to participate in a fire fighter safety research project. I anticipate the project beginning near the second week of November and continue until the middle of December. As I explained we would need to use five elliptical cycles with the arm bars for approximately two hours on nine separate occasions. The start times for these exercises would be 0200 a.m. and 0400 a.m. I would also appreciate it if we could use your scale to maintain consistency and use some space to draw blood during the research. I will provide all supplies and be responsible for the biohazard waste produced. A schedule will be forwarded to you as soon as it is available.

I appreciate your willingness to allow us to use your equipment. Using the same equipment for each session helps ensure the accuracy and validity of the research I am performing. If you have any questions please call me at 362-5875. Thank you much for your assistance and consideration.

Sincerely,

A. Lynn Schofield
Captain
Provo Fire & Rescue

17 January 2006

Laura Salazar
Marketing Director
Intermountain WorkMed
505 West 400 North
Orem, Utah 84057

Dear Laura,

As per our discussion in September, I am writing to inquire if Intermountain WorkMed would be interested in participating, as a partner, in a collaborative study on firefighter hydration and glucose levels during late night operations. I have made arrangements with Gold's Gym to use their facility on 900 East in Provo for the testing.

Would it be possible for Intermountain WorkMed to provide the laboratory testing services for this project? Provo Fire & Rescue will provide all of the testing supplies, and on-duty paramedics will collect, label and deliver the blood samples. If necessary the department may be able to fund a portion of the costs of the lab testing,

I appreciate your consideration. Thank you for all that you and your staff do for the health and wellbeing of the members of Provo Fire & Rescue.

Sincerely,

A. Lynn Schofield
Captain, Provo Fire & Rescue

March 6, 2006

Ms. Kandi Negete
Gold's Gym
1259 South 800 East
Orem, UT 84097

Dear Ms. Negete

On behalf of myself and Provo Fire & Rescue, I would like to thank you and your staff for your assistance in our study on the hydration and glucose levels of firefighters during late night alarms. Your staff was tremendous to work with and the facility is first rate. Please extend our gratitude to your night staff.

I have included a copy of the Daily Herald article, as well as a token of our appreciation. When the study is completed and written up I will forward a copy to you for your records. Again, thank you very much for your assistance.

Sincerely,

A. Lynn Schofield
Captain, Provo Fire & Rescue

Enclosures

March 6, 2006

Laura Salazar
Marketing Manager
Intermountain WorkMed
505 West 400 North
Orem, UT 84057

Dear Laura,

Thank you very much for your support the research project conducted as a part of my Executive Fire Officer Applied Research Project. I have now completed the testing portion of the research. I am currently analyzing the data to see where it will take us. Your support and generous contribution of the laboratory testing has made this project a great success.

I have enclosed the article from The Daily Herald. I have also enclosed a token of my appreciation. As soon as the study is completed, and the report written, I will forward you a copy for your records. Thank you for your continued support of Provo Fire & Rescue.

Sincerely,

A. Lynn Schofield
Captain, Provo Fire & Rescue

Appendix B

Test Subject Instructions

Testing Schedule

Blank Test Subject Questionnaire

Blank Consent to Release Medical Records

Blank Test Subject Record

Blank Rehabilitation Log

Blank Post-Test Survey

Test Subject Instructions

Thank you for your willingness to participate in this study to evaluate hydration and glucose levels during late night operations. It is hoped that this will provide valuable insight into how our bodies react and how we can improve our abilities as a department. The following instructions will provide you with the procedures we will be using. If you have any questions please don't hesitate to contact me, Captain Schofield, at 362-5875.

1. Please complete the attached questionnaire. This will provide a baseline of information to evaluate your fitness level and Body Mass Index.
2. Attached is a schedule for the testing. I have spoken to Chief Porter and during this testing period you will be out-of-service unless a disaster occurs.

The testing procedure is as follows.

1. Please do not eat or drink anything after 2200 hours'. This provides a common baseline to evaluate the changes to your blood chemistry.
2. You will be toned out by dispatch 15 minutes before the test is to begin. Please come to the Gold's Gym on 900 East. Wear your physical fitness clothes as you will be in turn-outs. Bring sweats for the trip back to the station.
3. When you arrive you will be weighed, and have your vital signs, pulse, blood pressure, respirations, oxygen saturation, and temperature taken.
4. After your vital signs are taken an IV will be started and the first of three tubes of blood will be drawn.
5. You will then don your full PPE, you may omit a glove if you have your IV in that hand. Put on your SCBA and go re-weigh yourself. Record your weight and proceed to one of the elliptical cycles.
6. The elliptical cycle will be set for the appropriate workout and resistance level. The timer starts when you are on air and on the machine.
7. Keep your rotations per minute between 50 and sixty steps per minute. Keep your hands on the arm bars.
8. If at any time you need assistance pat the top of your helmet and we will come and help you.
9. When your low air alarm sounds we will change out your cylinder. The timer will be stopped for the bottle change.
10. At 20 minutes into the exercise we will come to you and take your pulse, respirations, and oxygen saturation level.
11. When the timer sounds return to your assigned chair. We will immediately take your temperature, pulse, respirations, blood pressure, and oxygen saturation.
12. You will doff your turn-outs and re-weigh yourself. Make sure your weight gets recorded.
13. The second tube of blood will be drawn and you will be given water. 30 minutes after you get off the machine a timer will sound and you will need to get a blood sugar with the One Touch. Make sure it is recorded.
14. We will then return to the station and you will be given one of two rehabilitation regimens. You may have as much, or as little as you want. All of it needs to be recorded on your rehab log.
15. Thirty minutes after you finish your rehab, the third and final tube of blood will be drawn.

16. You can return to bed and, per Chief Porter, sleep in until 0930 as calls allow. When you get up. Take another blood sugar and record it.
17. Smile - you are now half way there.
18. You will repeat this routine at 0400 hours on your next go around,

If you have any questions or concerns, please contact Captain Schofield.

Testing Schedule

Testing for the study on fire fighter hydration and glucose levels is set for the following dates:

0200 Test

C Platoon February 21

A Platoon February 18

B Platoon February 22

0400 Test

B Platoon February 28

A Platoon March 2

C Platoon March 4

Make up testing will be arranged as needed.

All testing will take place at Gold's Gym at 455 North 900 East.

Please bring warm clothes to go back to your station.

If you have questions contact Captain Schofield.

Test Subject Questionnaire

Name:_____ Age: _____

1. How would you rate your overall fitness? *Circle One*

Excellent Good Fair Poor Very Poor

2. How often do you participate in the following activities?

Aerobic Exercise: *Circle One*

Never 1-3 days per week 3-5 days per week over 5 days per week

How long per session do you exercise? *Circle One*

0-30 Minutes 30 to 45 minutes over 45 minutes

Strength Training: *Circle One*

Never 1-3 days per week 3-5 days per week over 5 days per week

Flexibility Training: *Circle One*

Never 1-3 days per week 3-5 days per week over 5 days per week

3. Have you had a department physical in the last 12 months? *Circle One* YES NO

.....

To Be Completed By Test Administrator

Height:_____ Weight: _____ BMI: _____

CONSENT TO RELEASE INFORMATION

I, (Print Name)_____ hereby

DOB_____ SS#_____

authorize IHC WorkMed to release my medical records to:

NAME: _____

ADDRESS: _____

Phone: _____ Fax: _____

Specific Records to be Released:

___ Complete Medical Records
___ Clinical Notes
___ Laboratory Results
___ Admission and Discharge Results
___ X-Ray Films ___ X-Ray Results
___ Pulmonary Function Test Results
___ Pathology Results
___ Pre-Employment or Periodic Screening Exam
___ Other: _____

_____

Signature: _____ Date:_____
(Patient or Legal Representative)

A copy of this from is as valid as the original and remains valid for 90 days following dated signature

Test Subject Record

Test Subject Number:

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight		End Weight		Change/%	

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning					
20 minute					
End					

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st											
2nd											
BS											
3rd											
BS											

Test Date: Test Time: Rehab:

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight		End Weight		Change/%	

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning					
20 minute					
End					

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st											
2nd											
BS											
3rd											
BS											

Test Date: Test Time: Rehab:

Rehabilitation Log

Nutritional Information

Test Subject Number:

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings		# of Servings		# of Servings		# of Servings	
Total Calories		Total Calories		Total Calories		Total Calories	
Total Calories				Total Calories			

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200		Total Fluid 0400			

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75222

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories
All nutritional values included in the chart are based on a single serving

Post Testing Survey

Thank you for your participation in the firefighter testing for the Hydration and Glucose Level research. To complete the research please answer the following questions.

Testing

During the testing process did you have any of the following symptoms?
Circle all that apply

Nausea Lightheadedness Chest Pain Weakness Dizziness

If yes, please describe:

After the completion of the testing did you have any of the following symptoms?

Nausea Lightheadedness Chest Pain Weakness Dizziness

If yes, please describe:

Did you have any other complications as a result of this testing?

Which rehabilitation regimen provided you the best immediate relief?

Sugar Soup No Difference

Which rehabilitation regimen provided you the best long term relief?

Sugar Soup No Difference

Which rehabilitation regimen do you prefer for fire ground operations?

Sugar Soup No Preference

Thank You!

Appendix C

Test Subject by Age and Gender

Range of Normal Laboratory Limits

Testing Records

Test Subject 1
Test Subject 2
Test Subject 3
Test Subject 4
Test Subject 5
Test Subject 6
Test Subject 7
Test Subject 8
Test Subject 9
Test Subject 10
Test Subject 11
Test Subject 12
Test Subject 13

Rehab Logs

Test Subject 1

Test Subject 2
Test Subject 3
Test Subject 4
Test Subject 5
Test Subject 6
Test Subject 7
Test Subject 8
Test Subject 9
Test Subject 10
Test Subject 11
Test Subject 12
Test Subject 13

Test Subject Breakdown by Age and Gender
In Random Order

Male	Female
33	32
36	40
41	
44	
29	
35	
38	
31	
34	
29	
26	

Normal Range of Laboratory Values

Tested Item	Lower Limit	Upper Limit
Sodium	137	146
Potassium	3.5	5.0
Chloride	98	109
Carbon Dioxide	19	30
Anion Gap	3	16
Glucose	65	99
Blood Urea Nitrogen	6	21
Creatinine	0.8	1.3
Glomerular Filtration Rate	> 60	
Calcium	8.4	10.2

Source: Utah Valley Regional Medical Center Laboratory

Test Subject Record

Test Subject Number: 1

Height	69 inches	Weight	194.6	BMI	29
Start Weight	194.6	Dressed Wt	241.8	Change/%	47.2 lbs/ 24%
Start Weight	194.6	End Weight		Change/%	-2.2 / 1.1%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	86	16		95	94
20 Min	134	24		94	
End	124	20		95	96.7 / +1.1

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0228	139	4.1	107	24	8	99	19	1.1	>60	9.0
2nd	0325	141	4.3	107	22	12	124 h	19	1.2	>60	9.3
BS	0355						106 h				
3rd	0450	139	3.7	106	24	9	112 h	19	1.1	>60	8.9
BS	0930						94				

Test Date: 22 Feb Test Time: 0200 Rehab: Sugar

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	193.8	End Weight	192.2	Change/%	-1.6 / 0.8%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	80	16	134/88	95	95.4
20 minute	149	28		94	
End	96	20	131/96	95	96.7 / +1.1

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0425	138	3.8	105	25	8	109 h	21	1.3	>60	9.2
2nd	0518	139	3.8	106	23	10	145 h	21	1.3	>60	9.5
BS	0548						102 h				
3rd	0642	138	4.0	105	26	7	142 h	21	1.3	>60	9.0
BS	0930						101 h				

Test Date: Feb. 28 Test Time: 0400 Rehab: Soup

Test Subject Record

Test Subject Number: 2

Height	68 inches	Weight	143.4	BMI	22
Start Weight	143.4	Dressed Wt	191.4	Change/%	48/34%
Start Weight	143.4	End Weight	142.2	Change/%	-1.2 / 0.8%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	74	12	136/96	97	96.3
20 minute	152	24		90	
End	123	16	124/82	92	99.2 / +2.9

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0213	140	4.1	106	28	6	74	20	0.9	>60	9.3
2nd	0306	141	4.4	107	23	11	104 h	10	1.0	>60	9.9
BS	0336						92				
3rd	0401	139	4.1	107	25	7	141 h	20	0.9	>60	9.1
BS	0930						89				

Test Date: March 10, 2006 Test Time: 0200 Rehab: Soup

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	144.8	End Weight	143.4	Change/%	-1.4 / 0.9%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	66	16	129/76	96	97
20 minute	150	20		90	
End	135	20	124/76	95	96.4 / -0.6

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0418	141	3.9	104	28	9	97	17	1.1	>60	9.1
2nd	0531	141	4.1	106	25	10	102 h	17	1.1	>60	9.4
BS	0553						90				
3rd	0644	139	4.1	102	27	10	115 h	17	1.1	>60	9.2
BS	0930						123 h				

Test Date: March 4, 2006 Test Time: 0400 Rehab: Sugar

Test Subject Record

Test Subject Number: 3

Height	69 inches	Weight	181.8	BMI	27
Start Weight	181.8	Dressed Wt	226.8	Change/%	45 / 25%
Start Weight	181.8	End Weight	180.8	Change/%	-1.0 / 0.5%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	111	16		97	94.5
20 minute	156	24		95	
End	128	28		95	96.2 / +1.7

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0224	134 l	3.7	102	25	7	81	17	0.8	>60	8.7
2nd	0336	135 l	4.4	104	22	9	111 h	18	0.9	>60	9.1
BS	0406						122 h				
3rd	0440	(a)					108 h				
BS	0930						80				

Test Date: February 22 Test Time: 0200 Rehab: Sugar

(a) unable to draw 3rd sample. Used the glucometer to obtain a blood sugar level.

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	182	End Weight	180.2	Change/%	-1.8 / 1%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	83	16	128/78	96	96.1
20 minute	139	24		93	
End	112	22	114/76	92	98.1 / +1.2

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0431	136 l	3.9	105	24	7	88	16	0.9	>60	8.5
2nd	0524	138	4.3	107	23	8	90	18	0.9	>60	8.8
BS	0554						121 h				
3rd	0634	137	4.0	105	25	7	111 h	18	0.9	>60	8.5
BS	0930						86				

Test Date: February 28 Test Time: 0400 Rehab: Soup

Test Subject Record

Test Subject Number: 4

Height	70 inches	Weight	158.6	BMI	23
Start Weight	158.6	Dressed Wt	208.2	Change/%	50 / 31%
Start Weight	158.6	End Weight	156.8	Change/%	1.8 / 1%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	54	16	124/75	97	95.8
20 minute	123	24		93	
End	112	20	138/88	94	98.5 /+2.7

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0235	140	3.5	101	29	10	90	14	1.0	>60	9.5
2nd	0327	140	3.7	104	24	12	87	13	1.0	>60	9.9
BS	0357						107 h				
3rd	0428	135 l	3.5	100	27	8	133 h	13	1.0	>60	8.8
BS	0940						94				

Test Date: March 8 Test Time: 0200 Rehab: Sugar

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	155.6	End Weight	154	Change/%	-1.6 / 1%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	69	16	128/78	97	96.7
20 minute	166	28		93	
End	95	16	111/74	91	97.1 / +0.4

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0427	143	3.7	106	24	13	102 h	11	1.0	>60	9.2
2nd	0526	140	4.0	107	21	12	97	10	1.0	>60	9.4
BS	0600						95				
3rd	0658	140	3.6	105	26	9	141	h	0.9	>60	8.5
BS	0930						101				

Test Date: March 2 Test Time: 0400 Rehab: Soup

Test Subject Record

Test Subject Number: 5

Height	65 inches	Weight	155.6	BMI	24
Start Weight	155.6	Dressed Wt	204.6	Change/%	49 / 31%
Start Weight	155.6	End Weight	154.3	Change/%	-1.3 / 0.8%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	69	16	134/80	99	97.6
20 minute	132	28		92	
End	132	24	127/77	95	100.3 /2.7

Blood Work

Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	(a)										
2nd	0346	138	4.1	105	22	11	116 h	21	1.1	>60	9.6
BS	0420						68				
3rd	(b)						115 h				
BS	0648						68				

Test Date: Feb. 21 Test Time: 0400 Rehab: Soup

The first draw (a) hemolyzed, we were unable to draw the third (b) sample, used a glucometer for 3rd blood sugar.

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	154.8	End Weight	153.8	Change/%	-1.0 / 0.6%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	71	16	139/93	99	98.2
20 minute	155	24		92	
End	158	20	130/88	96	98.8 / +0.6

Blood Work

Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0416	139	3.7	107	24	8	95	15	1.1	>60	9.3
2nd	0525	145	4.2	113 h	18 h	14	103 h	15	1.2 h	55 l	9.8
BS	0556						97				
3rd	0634	137	3.9	106	25	6	120 h	15	1.1	>60	9.1
BS	0900						92				

Test Date: March 4 Test Time: 0400 Rehab: Sugar

Test Subject Record

Test Subject Number: 6

Height	74 inches	Weight	258	BMI	33
Start Weight	258	Dressed Wt	310	Change/%	52 / 20%
Start Weight	258	End Weight	257	Change/%	-1 / 0.3%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	78	16	127/78	99	96.6
20 minute	121	24		93	
End	112	24	127/80	96	97.5 / +0.9

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0215	136 l	4.1	105	24	7	105 h	16	0.8	>60	9.3
2nd	0339	137	3.7	106	22	9	121 h	16	0.8	>60	9.1
BS	0410						106 h				
3rd	0430	135 l	3.9	104	23	8	145 h	16	0.8	>60	9.0
BS	0745						114 h				

Test Date: Feb. 21 Test Time: 0200 Rehab: Soup

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	259.5	End Weight	257.8	Change/%	1.7 / 0.7%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	63	16	133/88	97	95.7
20 minute	121	20		93	
End	95	20	128/74	96	96.1 / +0.4

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0412	140	4.3	110 h	23	7	95	17	0.9	>60	9.1
2nd	0537	140	4.4	109	22	9	103 h	18	0.9	>60	9.2
BS	0607						103 h				
3rd	0635	139	4.2	108	21	10	147 h	17	0.9	>60	8.8
BS	0930						92				

Test Date: March 4 Test Time: 0400 Rehab: Sugar

Test Subject Record

Test Subject Number: 7

Height	71	Weight	239.5	BMI	34
Start Weight	239.5	Dressed Wt	288	Change/%	49 / 20%
Start Weight	239.5	End Weight	238	Change/%	1.5 / 0.6%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	77	14	129/85	96	97.3
20 minute	138	28		92	
End	141	24	117/76	92	101.4 / +4.1

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0232	138	4.2	103	27	8	103 h	17	1.0	>60	9.4
2nd	0326	139	4.3	104	19	16	116 h	18	1.2	>60	9.5
BS	0400						109 h				
3rd	0446	137	4.0	102	25	10	128 h	18	1.1	>60	9.3
BS		1020					91				

Test Date: Feb. 18 Test Time: 0200 Rehab: Sugar

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	239	End Weight	238	Change/%	-1 / 0.4%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	63	16	122/84	94	94.4
20 minute	148	18		87	
End	125	28	117/77	91	99.8 / +5.4

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0427	139	4.1	106	25	8	100 h	24 h	1.0	>60	8.8
2nd	0523	140	4.1	106	21	13	102 h	23 h	1.2	>60	9.1
BS	0600						91				
3rd	0658	138	3.8	107	25	6	151 h	23 h	1.1	>60	8.4
BS	1120						93				

Test Date: March 2 Test Time: 0400 Rehab: Soup

Test Subject Record

Test Subject Number: 8

Height	69 inches	Weight	179.2	BMI	26
Start Weight	179.2	Dressed Wt	228.8	Change/%	50 / 28%
Start Weight	1792	End Weight	177.8	Change/%	-2 / 1%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	58	16	136/85	97	97
20 minute	155	24		94	
End	119	20	127/79	95	101 / +4

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0223	139	4.1	103	27	9	83	14	1.0	>60	9.2
2nd	0315	138	4.3	105	23	10	94	14	1.1	>60	9.2
BS	0345						87				
3rd	0440	134 l	3.6	102	22	10	115 h	13	1.0	>60	8.38
BS	1030						79				

Test Date: Feb, 18 Test Time: 0200 Rehab: Sugar

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	181.4	End Weight	180.2	Change/%	-1.2 / 0.7%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	58	16	123/82	96	96.3
20 minute	159	20		90	
End	112	32	116/70	94	99.2 / +2.9

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0413	140	4.0	104	28	8	71	15	1.0	>60	9.2
2nd	0509	139	4.4	107	24	8	93	15	1.1	>60	9.0
BS	0540						82				
3rd	0655	137	3.7	105	24	8	148 h	14	1.0	>60	8.7
BS	0930						100				

Test Date: March 2 Test Time: 0400 Rehab: Soup

Test Subject Record

Test Subject Number: 9

Height	70 inches	Weight	174	BMI	25
Start Weight	174	Dressed Wt	224	Change/%	50 / 29%
Start Weight	174	End Weight	173	Change/%	-1 / 0.5%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	60	16	98/65	100	95.7
20 minute	155	24		92	
End	124	20	121/76	96	97.4 / +1.7

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0258	137	4.3	103	29	5	115 h	26 h	1.2	>60	8.4
2nd	0424	138	4.1	106	27	5	123 h	26 h	1.3	>60	8.3 l
BS	0455						101 h				
3rd	0559	138	4.3	105	29	4	131 h	25 h	1.3	>60	8.5
BS	0930						109 h				

Test Date: Feb. 21 Test Time: 0200 Rehab: Soup

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	171.8	End Weight	168.4	Change/%	-3.4 / 1.9%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	88	16	104/72	99	97.4
20 minute	135	20		86	
End	168	22	109/81	97	97.4

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0410	141	4.3	105	29	7	96	23	1.2 h	>60	8.5
2nd	0519	142	4.3	109	24	9	116 h	23	1.3	>60	8.7
BS	0550						80				
3rd	0637	139	4.4	105	29	5	120 h	23	1.2	>60	8.3 l
BS	0930						127 h				

Test Date: March 4 Test Time: 0400 Rehab: Sugar

Test Subject Record

Test Subject Number: 10

Height	71 inches	Weight	182.2	BMI	25
Start Weight	182.2	Dressed Wt	226.6	Change/%	44 / 24%
Start Weight	182.2	End Weight	179.2	Change/%	3 / 1.6%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	66	16	121/74	98	96.8
20 minute	138	24		95	
End	102	20	114/75	96	993.6 / +2.8

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0217	140	4.2	107	24	9	88	16	1.0	>60	9.7
2nd	0323	139	4.4	109	19	11	109 h	16	1.1	>60	10
BS	0355						119 h				
3rd	0442	136 l	4.1	105	24	7	117 h	16	1.1	>60	9.3
BS	1015						96				

Test Date: 18 Feb Test Time: 0200 Rehab: Sugar

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	180.4	End Weight	177.4	Change/%	-3 / 1.6%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	64	18	130/71	98	95.5
20 minute	146	22		90	
End	116	32	124/80	95	98.5 / +3

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0440	143	3.8	108	24	11	99	18	1.0	>60	9.3
2nd	0538	141	4.3	109	19	13	107 h	19	1.0	>60	
BS	0610						101 h				
3rd	0655	139	3.8	107	24	8	137	18	1.0	>60	8.8
BS	1130						102 h				

Test Date: March 2 Test Time: 0400 Rehab: Soup

Test Subject Record

Test Subject Number: 11

Height	73	Weight	209	BMI	29
Start Weight	209	Dressed Wt	263.2	Change/%	54.2 / 26%
Start Weight	209	End Weight	207.7	Change/%	1.6 / 0.8%

Vital Signs				
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	70	16		97	95.4
20 minute	132	24		95	
End	104	20		96	96.8 / +1.4

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0217	140	4.3	108	25	7	90	15	1.0	>60	8.8
2nd	0328	140	4.8	109	23	8	105 h	15	1.0	>60	8.8
BS	0351						85				
3rd	0436	139	4.1	108	24	7	114 h	14	1.0	>60	8.6
BS	0930						112				

Test Date: Feb. 22 Test Time: 0200 Rehab: Sugar

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	208	End Weight	206.8	Change/%	-1.2 / 0.6%

Vital Signs				
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	70	16	122/86	97	95.9
20 minute	130	28		95	
End	85	20	114/90	96	97.1 / -1.2

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0417	138	4.4	103	26	9	89	22	1.0	>60	9.3
2nd	0514	137	4.7	106	22	9	109 h	22	1.0	>60	9.2
BS	0539						83				
3rd	0631	136 l	4.2	105	25	6	132 h	20	1.0	>60	8.7
BS	1030						102 h				

Test Date: Feb. 28 Test Time: 0400 Rehab: Soup

Test Subject Record

Test Subject Number: 12

Height	69 inches	Weight	164.6	BMI	24
Start Weight	164.6	Dressed Wt	214.4	Change/%	50 / 30%
Start Weight	164.6	End Weight	163.6	Change/%	-1 / 0.6%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	81	20	131/82	96	94.1
20 minute	132	28		90	
End	128	24	126/89	94	95.9 / +1.8

Blood Work

Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0246	141	4.2	104	27	10	102 h	11	1.0	>60	9.5
2nd	0325	139	4.1	106	25	8	113 h	11	1.0	>60	9.1
BS	0355						86				
3rd	0500	139	4.6	106	25	8	133 h	11	1.0	>60	9.0
BS	0930						99				

Test Date: Feb. 21 Test Time: 0200 Rehab: Soup

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	167.4	End Weight	166.6	Change/%	0.8 / 0.5%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	92	16	133/88	96	96.4
20 minute	147	24		93	
End	106	20	113/99	90	95.1 /-1.3

Blood Work

Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0428	143	4.4	106	28	7	104 h	12	1.2	>60	9.2
2nd	0537	141	4.7	112 h	23	6	111 h	13	1.2	>60	9.5
BS	0607						98				
3rd	0651	140	4.4	1085	25	7	126 h	13	1.2	>60	9.4
BS	930						120 h				

Test Date: March 4 Test Time: 0400 Rehab: Sugar

Test Subject Testing Record

Test Subject Number: 13

Height	70	Weight	195.2	BMI	28
Start Weight	195.2	Dressed Wt	240.8	Change/%	46 / 23%
Start Weight	195.2	End Weight	193.8	Change/%	-1.4 / 0.7%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	70	12	121/85	97	96.4
20 minute	134	24		93	
End	100	20	125/83	96	97.2 / +1.2

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	(a)										
2nd	0338	139	4.7	107	23	9	111 h	21	1.0	>60	9.0
BS	0408						119 h				
3rd	(b)						166 h				
BS	0930						94				

Test Date: Feb. 24 Test Time: 0200 Rehab: Soup

(a) Blood sample was hemolyzed. (b) unable to draw sample, used the glucometer to obtain blood sugar.

Height		Weight		BMI	
Start Weight		Dressed Wt		Change/%	
Start Weight	193.8	End Weight	192.6	Change/%	-1.2 / 0.6%

Vital Signs					
Time	Pulse	Respirations	Blood Press	Sa O2	Temp
Beginning	65	16	121/83	98	96.6
20 minute	109	20		94	
End	96	20	125/76	96	94.6 / -2

Blood Work											
Draw	Time	Na+	K+	Cl	CO2	Anion	Gluc	BUN	Creat	GFR	Ca+
1st	0418	140	4.0	105	26	9	98	23	1.3	>60	9.0
2nd	0539	142	4.5	108	26	8	105 h	24	1.3	>60	9.3
BS	0610						89				
3rd	0648	140	4.9	105	26	9	106 h	23	1.3	>60	9.2
BS	0930						114				

Test Date: March 4 Test Time: 0400 Rehab: Sugar

Rehabilitation Log

Nutritional Information

Test Subject Number: 1

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	1	# of Servings	1	# of Servings	6	# of Servings	2
Total Calories	190	Total Calories	250	Total Calories	480	Total Calories	140
Total Calories		640		Total Calories		620	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings	2.5	# of Servings		# of servings	1
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	840 ml		Total Fluid 0400		600 ml

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 2

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	1	# of Servings	1	# of Servings	6	# of Servings	4
Total Calories	190	Total Calories	250	Total Calories	480	Total Calories	280
Total Calories		440		Total Calories		760	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings	2.5	# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	600 ml		Total Fluid 0400		1080 ml

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 3

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	1	# of Servings	0	# of Servings	4	# of Servings	1
Total Calories	190	Total Calories	0	Total Calories	320	Total Calories	70
Total Calories		190		Total Calories		390	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	840 ml		Total Fluid 0400		1080 ml

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 4

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	2	# of Servings	0	# of Servings	2	# of Servings	2
Total Calories	380	Total Calories	0	Total Calories	160	Total Calories	140
Total Calories		380		Total Calories		300	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) (c)Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings	5	# of Servings	0	# of servings	0
Total Calories	0	Total Calories	0	Total Calories	0
Total Fluid 0200	1200 ml		Total Fluid 0400	600 ml	

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 5

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	0	# of Servings	1	# of Servings	2	# of Servings	4
Total Calories	0	Total Calories	250	Total Calories	160	Total Calories	280
Total Calories		250		Total Calories		440	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	1200 ml		Total Fluid 0400	900 ml	

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 6

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	1	# of Servings	1	# of Servings	2	# of Servings	4
Total Calories	190	Total Calories	250	Total Calories	160	Total Calories	280
Total Calories		440		Total Calories		440	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	1200 ml		Total Fluid 0400		1200 ml

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b)Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 7

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	2	# of Servings	1	# of Servings	4	# of Servings	4
Total Calories	380	Total Calories	250	Total Calories	320	Total Calories	280
Total Calories		630		Total Calories		600	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	1200 ml		Total Fluid 0400	600 ml	

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 8

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	2.5	# of Servings	2	# of Servings	4	# of Servings	6
Total Calories	475	Total Calories	250	Total Calories	320	Total Calories	420
Total Calories		725		Total Calories		740	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	1800 ml		Total Fluid 0400	1200 ml	

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 9

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	0	# of Servings	1	# of Servings	2	# of Servings	2
Total Calories	0	Total Calories	250	Total Calories	160	Total Calories	140
Total Calories		250		Total Calories		300	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	600 ml		Total Fluid 0400		600 ml

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 10

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	3	# of Servings	0	# of Servings	4	# of Servings	2
Total Calories	570	Total Calories	0	Total Calories	320	Total Calories	140
Total Calories		570		Total Calories		460	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	1800 ml		Total Fluid 0400		900 ml

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 11

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	1	# of Servings	1	# of Servings	7	# of Servings	2
Total Calories	190	Total Calories	250	Total Calories	560	Total Calories	140
Total Calories		440		Total Calories		700	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	600 ml		Total Fluid 0400		600 ml

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 12

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	2	# of Servings	1	# of Servings	2	# of Servings	2
Total Calories	380	Total Calories	250	Total Calories	160	Total Calories	140
Total Calories		630		Total Calories		300	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings		# of servings	
Total Calories	0	Total Calories		Total Calories	
Total Fluid 0200	600 ml		Total Fluid 0400		600 ml

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.

Rehabilitation Log

Nutritional Information

Test Subject Number: 13

Sugar				Soup			
Cookie (a)	Cal	Doughnut (b)	Cal	Soup (c)	Cal	Crackers (d)	Cal
Fat 7gr	63	Fat 11gm	99	Fat 1gm	9	Fat 2gm	18
Chol 10 mg		Chol 10mg		Chol 5mg		Chol 0mg	
Na+ 120mg		Na+ 180mg		Na+ 890 mg		Na+ 220mg	
CHO 30gr	120	CHO 35gr	140	CHO 15gm	60	CHO 11gm	44
Sugar		Sugar		Sugar 2gm		Sugar 0gm	
Protein 2gr	8	Protein 1gm	4	Protein 5 gm	20	Protein 1gm	4
Cal/Serving*	190	Cal/Serving*	250	Cal/Serving*	80	Cal/Serving*	70
# of Servings	2	# of Servings	1	# of Servings	2	# of Servings	2
Total Calories	380	Total Calories	250	Total Calories	160	Total Calories	140
Total Calories		630		Total Calories		480	

(a) Lofthouse Frosted Chocolate Cookie: Serving size is 1 cookie. Lofthouse Foods Inc. Ogden, UT 84404

(b) Hostess Raspberry Filled Doughnuts: Serving size is 1 doughnut. Interstate Brands Corp., Kansas City, MO 64111

(c) Campbell's Vegetable Beef Soup: Serving size is ½ cup. Campbell's Soup Co. Camden, NJ 08103

(d) Nabisco Original Premium Saltine Crackers: Serving size is 5 crackers. Kraft Foods, East Hanover, NJ 07936

Fluid Replenishment

Water (a)		Powerade (b)		Milk (c)	
Fat 0g	0	Fat 0g	0	Fat 2.5g	22.5
Na+ 0mg	0	Na+ 55mg	0	Na+ 125mg	
K+ 0mg	0	K+ 30mg	0	K+ 0mg	
CHO 0g	0	CHO 17g	68	CHO 12g	48
Protein 0g	0	Protein 0g	0	Protein 8g	32
Cal/Serving	0	Cal/Serving *	60	Cal/Serving *	100
# of Servings		# of Servings	2.5	# of servings	
Total Calories	0	Total Calories	180 (0200)	Total Calories	
Total Fluid 0200	1200 ml		Total Fluid 0400	1200 ml	

(a) Arrowhead Mountain Spring Water: Serving size is 8 fluid ounces. Arrowhead Mountain Spring Water Company, Greenwich, CT 06830

(b) Powerade: Serving size is 8 fluid ounces. The Coca Cola Company, Atlanta GA, 30313

(c) Maid of Clover 1% milk: Serving size is 8 fluid ounces. Meadow Gold Dairies, Dallas TX 75223

Where indicated by an asterisk the calories per serving were taken from the manufacturer's nutritional information. A variation of up to 10 calories may occur from the calculated calories. Calorie calculation is based on: fat 1g = 9 calories, protein and carbohydrates 1g = 4 calories. All nutritional values included in the chart are based on a single serving.