Wildland Firefighter
Health & Safety Report

Spring 2000 Missoula Technology and Development Center No. 1

The National Wildfire Coordinating Group (NWCG) coordinates firefighting efforts among Federal and State agencies. As part of its mandate to ensure current, shared information, a report on Wildland Firefighter Health and Safety issues will be published twice a year by the Missoula Technology and Development Center (MTDC). The report will include activities related to the MTDC project on firefighter health and safety, including summaries of research, abstracts of related reports, articles, and field notes. Also included will be announcements of upcoming events and practical approaches to manage fatigue, environmental stress, and other factors that compromise the health and safety of wildland firefighters.

Background

Each fire season, 20,000 to 30,000 firefighters fight wildfires on Federal lands. Many more battle fires on State and private lands. The NWCG's Safety and Health Working Team (SHWT) oversees issues dealing with the safety and health of wildland firefighters.

Federal resource-management agencies participated in the 1998 Wildland Firefighter Safety Awareness Study to identify and change aspects of the organization that might compromise firefighter safety. Other studies have suggested new ways to improve and maintain the health and safety of firefighters. To explore these issues, MTDC and the SHWT hosted a conference in Missoula during April 1999. Researchers, fire managers, and on-the-ground firefighters met to share information, consider new approaches to health and safety, and make recommendations for research, development, and implementation. The recommendations and papers presented at the conference are included in an MTDC publication, *Wildland Firefighter Health and Safety: Recommendations of the April 1999 Conference* (ordering information is on the last page of this report).

MTDC Wildland Firefighter Health and Safety Project

The NWCG assigned MTDC the task of coordinating the Wildland Firefighter Health and Safety Project and of serving as the focal point for ongoing and future studies. MTDC has conducted numerous research and development projects related to the health, safety, and productivity of wildland firefighters, including work on nutrition, hydration, uniforms, heat stress, protective equipment, tools, fitness, work capacity, employee health, and the health hazards of smoke. The Wildland Firefighter Health and Safety project will focus on three main areas:

- Work and Rest Issues: **Assignment length, shift length, sleep, fatigue, and crew type. The goal of this phase is to develop an objective approach to determine work/rest standards and recommended assignment lengths for crews and overhead.**
- Energy and Nutrition: **The effect of energy and nutrition on immune function and oxidative stress. The goal of this phase is to improve the energy intake, nutrition, and immune function of wildland firefighters.**
- Fitness and Work Capacity: **Implementation of work capacity standards**

and tests, training for test administration, and medical standards for firefighters. The goal of this phase is safe implementation of work-capacity standards and improvements in the safety and productivity of firefighters.

MTDC has convened a technical panel to review existing research, and to identify research and funding priorities for the project. Panel members include: Wayne Askew, Ph.D., University of Utah; Brent Ruby, Ph.D., University of Montana; Steve Wood, Ph.D., R.D., Ross Laboratories; Becki Livingston, USDA Forest Service; and Dave Aldrich, USDA Forest Service. The panel, chaired by Brian Sharkey, Ph.D., of MTDC, will get direction from the SHWT and seek additional expertise as needed.

Recommendations of the April 1999 Conference

In April 1999, researchers and fire managers met to consider ways to improve the health and safety of wildland firefighters, and to make recommendations for research, development, or implementation in the areas of:

- **Illness, injury, and fatality prevention.**
- **Job requirements/issues.**
- **The working environment.**
- **Energy, nutrition, and health.**
- **Individual (human) factors.**

The recommendations are included in the MTDC publication *Wildland Firefighter Health and Safety: Recommendations of the April 1999 Conference* (9951-2841-MTDC).

Research

Oxidative Stress and Antioxidants: Fighting the Fire Within *Wayne Askew, Ph.D., University of Utah*

A fire is smoldering within the cells of your body that could burst into flame at any moment. Scientists who study aging, chronic disease, and preventive medicine call the "smoldering fire" free radical production and the "flame" oxidative stress. Oxidative stress is the term used to describe the damaging oxidation of biological tissues by free radicals. Free radicals are unstable and short-lived molecules that are especially reactive because they have an unpaired electron in their outer orbit. These molecules seek to stabilize their structure (pair the electrons in their outer orbit) by stealing an electron from an unsuspecting neighbor (Figure 1). When this happens, the free radical is stable once again. The molecule that lost an electron may quit functioning or become a free radical itself.

Oxygen molecules within the body are essential for life. However, a small percentage of these oxygen molecules can become damaging reactive oxygen species or free radicals. Since humans must exist in an atmosphere of oxygen and consume large quantities to survive, they have developed very effective antioxidant defense systems to neutralize these free radicals. A certain amount of free radical formation is a normal part of metabolism. Our antioxidant defense systems usually prevent free radicals from causing excessive damage. Factors that increase oxidative stress include high levels of energy expenditure, exposure to sunlight and oxidative

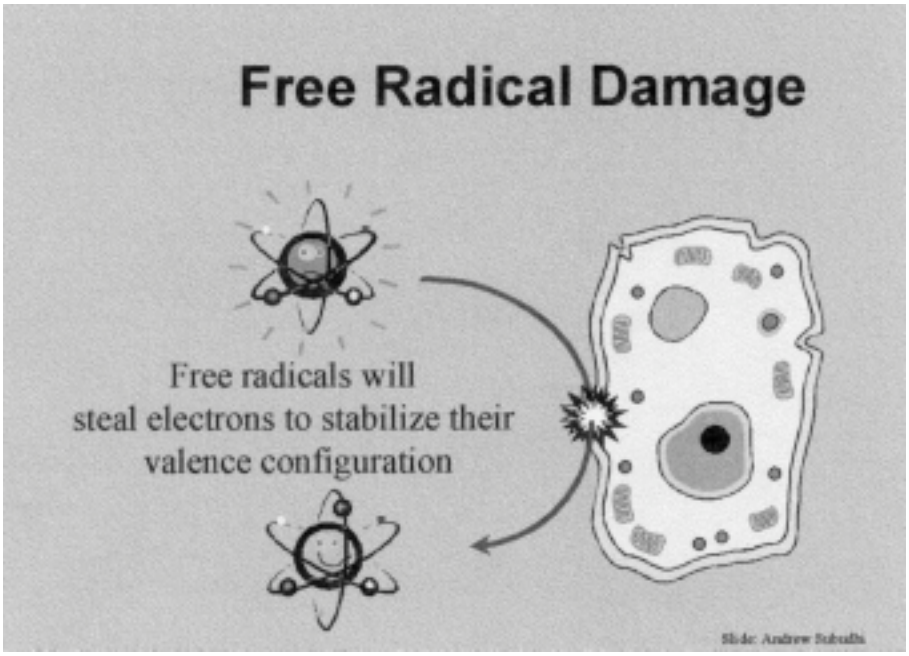

Figure 1—Free radical damage, (reprinted with permission of Andrew Subudhi).

pollutants, and inadequate dietary intake of antioxidants.

The good news is that the human body is remarkably well equipped to minimize oxidative stress caused by free radical damage. We must provide the body with the "biological flame retardants" or antioxidant nutrients it needs to neutralize free radicals. Antioxidant nutrients can be minerals, vitamins, or plant phytochemicals. The minerals zinc, selenium, magnesium, and manganese function as important nutrient cofactors or "helpers" for antioxidant enzymes. These minerals and enzymes work together to neutralize free radicals. Left unchecked, free radicals can strip electrons from unsuspecting neighbors, leading to leaky cell membranes, nonfunctional enzyme proteins, and even coding errors in DNA molecules. Antioxidant enzymes are fast acting and very effective as long as the level of invading free radicals is not excessive. When severe oxidative stress is present and the antioxidant enzymes are overwhelmed by the invading free radicals, the antioxidant vitamins and antioxidant phytochemicals become the last line of defense between our cells and free radical damage.

Some antioxidant vitamins such as vitamin E (a-tocopherol) and vitamin C (ascorbate) act as "tag team" partners to intercept and neutralize free radicals. Vitamin E is lipid (fat) soluble and can position itself in the membrane of cells and lipoproteins where it intercepts free radicals that attack cell membranes. Once vitamin E has intercepted a free radical, it can pass the task on to water-soluble vitamin C. In this manner, vitamin C regenerates the immobile vitamin E in the membrane and can, in turn, be regenerated by other antioxidant phytochemicals in the cell or pass out of the cell to be excreted in the urine.

Wildland firefighters expend large quantities of energy, are exposed to sunlight, work in an environment that contains pollutants from burning vegetative material, and often alter their dietary patterns while fighting fires.

Phytochemicals are molecules of plant origin consumed in the diet that are not true vitamins, but that can be very potent antioxidant nutrients. We gain the protective effect of these powerful antioxidant phytochemicals when we consume fruits and vegetables. Five servings of fruits and vegetables per day supply us with enough of these antioxidants to prevent or combat many chronic diseases such as cancer and macular degeneration.

Active people working in remote outdoor environments usually do not have access to ample quantities of fresh fruits and vegetables. In fact, Askew has found these individuals do not even consume the recommended five servings of fruits and vegetables per day when they are eating at home.

How can we tell if someone is experiencing excessive oxidative stress? Free radicals leave a trail of cellular damage—fragments of damaged lipids, proteins, and DNA. We can look for these "damage indicator fragments" in breath, blood, and urine. Bioindicators of oxidative stress can be used to establish the need for additional dietary antioxidants as well as the optimal intake of these antioxidants. Elevated levels of oxidative stress usually mean that the body needs reinforcements in its battle against free radicals. These "reinforcements" are usually dietary antioxidants that can come from food or antioxidant supplements.

Wildland firefighters expend large quantities of energy, are exposed to sunlight, work in an environment that contains pollutants from burning vegetative material, and often alter their dietary patterns while fighting fires. Research involving occupational groups that share these oxidative-stress risk factors leads us to predict that firefighters may also experience increased free radical formation. Therefore, firefighters might benefit from antioxidant supplementation. Certain types of military training are similar to the rigors of wildland firefighting. Preliminary studies of U.S. Army Ranger training and U.S. Marine Mountain Warfare training indicate that trainees may be under increased levels of oxidative stress and might benefit from supplemental antioxidants.

Research is needed to establish firefighter exposure to oxidative stress and to investigate firefighters' response to

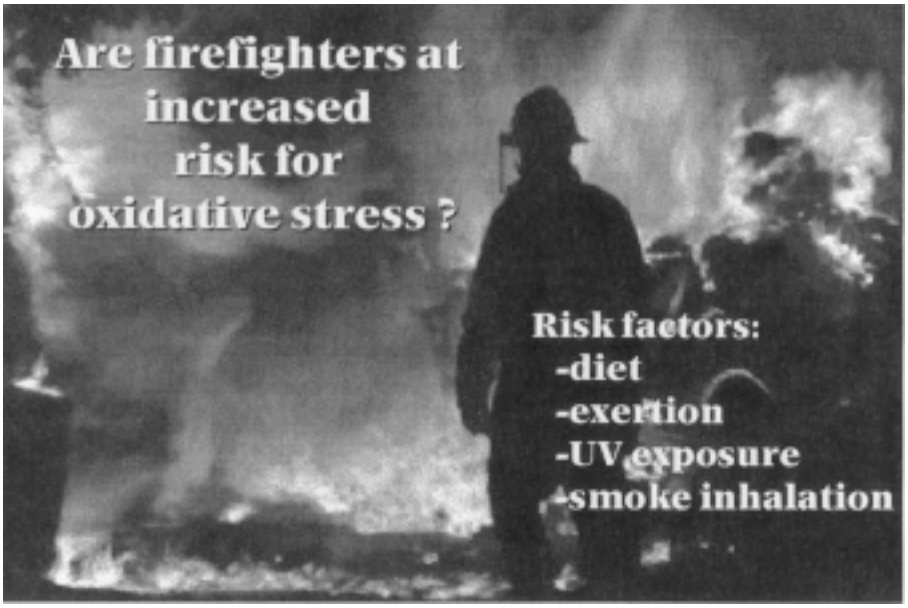

Figure 2—Risk factors for oxidative stress.

supplemental antioxidants. Until then, it is advisable to take a cautious and conservative approach that includes both diet and exercise as preventive measures. The Forest Service has recognized that physical fitness and diet are important components of maintaining firefighter health and safety. As recommended in the Forest Service manual *Fitness and Work Capacity* (NFES 1596), firefighters should be in excellent physical condition, participate in regular aerobic and strength training, and pay close attention to their diet to ensure that they have high levels of antioxidant defense enzymes and nutrients in their tissues.

The diet should include at least five servings of fruits and vegetables each day. During extended periods of training or actual firefighting, the catering service should be encouraged to supply foods that contain high levels of antioxidant nutrients. Fruits, fruit juices, and vegetable juices are appealing to most people even under adverse field conditions, and they are good sources of antioxidant nutrients.

Oxidative stress causes tissue damage, slows recovery from fatigue, and contributes to long-term health problems (heart disease, cancer, cataracts).

Consideration should be given to providing supplemental antioxidants during field training and firefighting. These supplements could be provided in beverage, solid (energy bar), or tablet form.

Dr. Askew is Professor and Director of the Department of Food and Nutrition at the University of Utah. He served many years as a researcher at the U.S. Army Research Institute for Environmental Medicine. He continues to conduct field research on military populations such as Army Rangers and Marines. The complete text of this paper can be found in *Wildland Firefighter Health and Safety: Recommendations of the April 1999 Conference* (9951-2841-MTDC).

Energy Balance and Oxidative Stress in Wildland Firefighters: A Preliminary Study

Brent Ruby, Ph.D., University of Montana

Our laboratory has been conducting field studies to determine the unique energy and nutritional concerns of the wildland firefighter during wildfire suppression. We have demonstrated that wildland firefighters may expend between 3,500 and 6,500 kcal per day for up to 7 days. Because of the physical demands of the job, energy intake must be adequate to maintain performance during each incident and over the course of the fire season. The data presented in this summary are a portion of those from a study funded by the Women's Health Research Initiative (Department of Defense). From previously collected data, a subset of subject data was analyzed for urinary markers of oxidative stress. Subjects were tested during a 5- to 7-day period of wildfire suppression. Urine samples were collected on day 1 before fire suppression, and on subsequent days up to the final day of firefighting activity. In addition, measures of body weight and skinfolds were obtained to estimate changes in body composition during the work period.

Data for 10 male subjects indicated an average weight loss of 1.2 kg (2.64 lb) and a 1.7 kg (3.74 lb) loss of fat-free (lean body) mass. Six female subjects lost an average of 0.6 kg (1.32 lb), but did not lose fat-free mass. Measures of oxidative stress are shown in Table 1. Although the group data did not demonstrate significant differences from early to late

Table 1—Markers of oxidative stress during 5 to 7 days of wildfire suppression.

	Pre	Mid	Late	Mean
Males				
Total alkenals (um)/ creatinine (mM)	0.51	0.73	0.61	0.61
8-OHDG (ng/ml)/ creatinine (mM)	1.22	1.36	1.29	1.28
Females				
Total alkenals (um)/ creatinine (mM)	0.86	0.99	0.82	0.89*
8-OHDG (ng/ml)/ creatinine (mM)	2.20	1.61	1.22	1.68

* p = 0.023, significant difference for gender (females demonstrated higher oxidative stress than males).

fire exposure, there was a significant effect for gender, with females demonstrating significantly higher values for oxidative stress. Furthermore, when individual subjects were evaluated, 4 of 10 males and 4 of 6 females exhibited elevated levels of oxidative stress.

These results indicate that wildland fire suppression is associated with nutritional stresses that may lead to a loss of body weight and lean body mass. However, the relationship between the maintenance of energy balance and oxidative stress remains unclear. The results do indicate considerable variability in response to occupational environments that cause oxidative stress. Males and females may respond differently. Although the results are preliminary, females may be more sensitive to oxidative stress, even when energy balance is maintained. Further research should be conducted with wildland firefighters to document the potential for oxidative stress and compromised immune function that may be associated with this work. Additional emphasis should be placed on the possibility of a gender-specific or individual response to the working environment and physical stress. Finally, if studies document the need, field studies could determine effective ways to supplement the antioxidant defenses of wildland firefighters.

Total Energy Expenditure and Hydration Demands in the Wildland Firefighter

Brent Ruby, Ph.D., and Brian Sharkey, Ph.D., University of Montana

This investigation used doubly-labeled water methodology to calculate the total energy expenditure (TEE) of wildland fire suppression in a group of male and female firefighters (Hotshots). In addition, rates of evaporative water loss (rH_2O) were calculated from D_2O elimination. Measurements of total body water (TBW) and body weight were used to evaluate changes in energy balance. Before wildland fire suppression duties, each subject was given an oral dose of doubly labeled water (^2H_2O and $H_2{}^{18}O$) adjusted for body weight. Morning urine samples were collected during the 5 to 7 days of fire suppression. Samples were analyzed using isotope-ratio mass spectrometry for ^{18}O and ^2H enrichment, and fitted using a linear elimination curve (Table 2). From prior research, TEE can range from 3000 to 6300 kcal/day, depending on assignment, conditions, and job detail. However, the environmental conditions associated with the work detail appear to affect evaporative water loss more than the rate of energy expenditure.

Table 2—Energy expenditure and water loss.

Location	Total Energy Expenditure (kcal/day)	Evaporative Water Loss (liters)
Florida	2960-4175	8.0 +/- 1.0
California, Idaho, Washington	3076-6260	6.8 +/- 1.6

The total energy expenditure (TEE) data indicate an arduous occupational environment. The hydration demands of the job cannot be predicted from TEE, but depend on the environmental conditions (temperature and humidity). These results demonstrate extreme occupational demands that represent a unique physiological challenge for the maintenance of energy balance and hydration.

This paper was presented at the International Association of Wildland Fire's third annual Safety Summit, Sydney, Australia, Nov. 5, 1999. Dr. Ruby is Director of the University of Montana Human Performance Laboratory. (Supported by DAMD17-96-1-63290; B. Ruby, principal investigator).

Death from Hyponatremia as a Result of Acute Water Intoxication in an Army Basic Trainee *T. Garigan and D. Ristedt*

Several reports during the past 15 years have described hyponatremia (abnormally low concentration of sodium in the blood) as a result of excessive water intake by athletes during endurance races. The high rates of fluid consumption have been attributed to the desire of athletes to prevent heat injury. The military has adopted guidelines for programmed drinking to maintain performance and minimize the risks of heat casualties. As military personnel increase their fluid intake, their risk of hyponatremia as a result of water overload increases. A potentially life-threatening complication is acute water intoxication. This paper reports the first known death of an Army basic trainee as a result of acute water intoxication. The misrepresentation of his symptoms as those of dehydration and heat injury led to continued efforts at oral hydration until catastrophic cerebral and pulmonary edema developed (Military Medicine 164: 234-238, 1999).

Note: **Wildland firefighters require about 1 liter of fluid per hour, which is consistent with the revised military hydration guidelines. See the Field Notes section for more on hydration.**

Risk Management

Health Habits

The daily habits of people have a great deal more to do with what makes them sick and when they die than all the influences of medicine. **L. Breslow, M.D.**

Seven habits associated with health and longevity include: regular exercise, adequate sleep, a good breakfast, regular meals, weight control, abstinence from smoking and drugs, and moderate use of alcohol.

According to Breslow, men could add 11 years of life and women 7 years by following six of the seven habits.

Smoking, Injury, and Long-Term Disability

Everyone knows about the health hazards of smoking, including lung cancer, coronary artery disease, stroke, and chronic obstructive lung diseases such as emphysema and chronic bronchitis. Recent research has added to that list. Some of the additions are surprising, such as depression and male impotence (erectile dysfunction). Wildland fire smoke has the potential to produce similar health problems, but the exposures are seasonal and intermittent, allowing the lungs time to recover. Combining cigarette smoke with wildland firefighting eliminates the opportunity for recovery, and may exacerbate the health risks, as is the case for the combination of smoking and asbestos exposure. According to the 1985 Surgeon General's report, *The Health Consequences of Smoking: Cancer and Chronic Lung Disease in the Workplace*, asbestos workers are five times more likely to die of lung cancer than the nonsmoking public. Smoking increases the risk of lung cancer 10 times, but the combination of asbestos exposure and smoking a pack of cigarettes or more a day increases the risk of death from lung cancer 87 times.

Recently researchers have demonstrated relationships among tobacco use, illness, injury, and long-term disability. Smokers and snuff-takers suffered more injuries in a 1997 study of Norwegian infantry conscripts undergoing physical training. Significant correlations were observed with smoking and injury, higher total lost workday injuries, and illnesses in a 1999 study of manual material handlers in the United States. In 1999 Eriksen found that a job with heavy lifting and much standing was associated with lower back pain in smokers, but not in nonsmokers. Musculoskeletal disorders were associated with cigarette smoking in a 1996 study of U.S. automotive workers, and the problems increased with exposure. Among smokers who were taking physical exercise less than once a week, Eriksen found that smoking predicted long-term work disability 4 years later. Ueno and coworkers

found that musculoskeletal pain in the hand, arm, and lower back was more likely among construction workers who smoked 20 or more cigarettes a day.

Researchers hypothesize that smoking constricts blood vessels and limits blood flow to muscles. These changes could lead to overuse injuries, lower-back pain and long-term disability. Army studies published in 1996 have documented higher musculoskeletal injury rates among smokers. Smokers are believed to be greater risk takers, heavier users of alcohol, and more frequently diagnosed with depression. They have been shown to have impaired healing of wounds and fractures, as well as chronic demineralization of bone, potentially increasing their susceptibility to fractures. Smoking has also been linked to an increased risk of overuse injuries, motor vehicle accidents, industrial accidents, lower back and shoulder pain, burns, fire deaths, and suicide.

The implications for wildland firefighting are obvious: firefighting is prolonged arduous work, with repetitive motions and heavy lifting. Any attempt to address problems of illness and injury among firefighters must consider those at higher risk, such as smokers and smokeless-tobacco users. In a 1998 study, Eriksen and coworkers found no association between smoking and long-term work disability for smokers who exercised regularly. One approach would be to require regular physical training. A more controversial approach would be to prohibit wildland firefighters from smoking, on and off the job.

No Smoking?

In 1990 the Tenth Circuit Court of Appeals upheld a fire department's right to prohibit personnel from smoking cigarettes both on and off the job. The suit was filed by a firefighter who was fired by the Oklahoma City Fire Department for smoking on an unpaid lunch break away from department property. The court ruled that an employee's freedom may be infringed if there is a rational relationship between a rule and a legitimate concern of the department. Fire organizations are concerned about the health

and safety of their employees. They spend millions of dollars for medical exams, lung function tests, and respiratory protection. It is difficult to determine the contribution of an occupational smoke exposure to a respiratory problem when the employee is a smoker.

Since smoking is associated with illness, injuries, lower-back problems, and long-term disability, the wildland fire community should consider ways to reduce the problem and its associated costs.

PROBATIONARY FIREFIGHTER
$29,849.41 + 10% paramedic

Applicants must:

- Be at least 18 years of age.
- Be a high school graduate or possess a High School Equivalency Diploma (GED)
- Possess a valid Florida Driver's License and have a good driving record.
- Possess a valid Emergency Medical Technician Certification.
- Obtain a certificate from the Broward Fire Academy indicating the candidate has passed the Firefighter Physical Ability test within the past six (6) months from date of application.
- Have not used tobacco products at least 12 months prior to application and agree not to use tobacco products in any form on or off duty during the tenure of their employment.

PLEASE NOTE: Individuals who are certified Paramedics and/or certified Firefighters are preferred. Once hired, an individual must obtain a valid Firefighter certification issued from the State of Florida during the probationary period in order to maintain employment with the City of Tamarac. **Copies of required documents must be submitted at the time of application or processing of your application may be delayed.**
Request Application from:
City of Tamarac: Personnel Department
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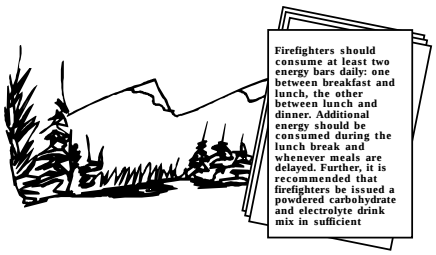
- **Have not used tobacco products at least 12 months prior to application and agree not to use tobacco products in any form on or off duty during the tenure of their employment.**

Job announcement in Fire-Rescue Magazine, February 2000

Field Notes



Energy and the Immune System

Studies by Ruby and Sharkey in the United States, Sleivert in Canada, and Budd and Brotherhood in Australia confirm the high energy demands of wildland firefighting (7.5 kcal per minute, over 400 kcal per hour, up to 6000 kcal per day). Studies on military populations by Askew and Wood indicate the contribution of energy supplementation to immune function during periods of arduous work. Studies by Nieman support the value of liquid carbohydrate supplementation to immune function during prolonged work. Solid and liquid energy supplements provide energy and help to maintain the function of the immune system during periods of prolonged arduous work. A University of Montana study (Puchkoff and others 1998) indicates that carbohydrates also help maintain mental performance during prolonged periods of physical stress.

The use of between-meal energy supplements is recommended, including:

- **Energy (or candy) bars.**
- **Carbohydrate and electrolyte (C/E) sports drinks.**

Specific Recommendation

Firefighters should consume at least two energy bars daily: one between breakfast and lunch, the other between lunch and dinner. Additional energy should be consumed during the lunch break and whenever meals are delayed. Further, it is recommended that firefighters be issued a powdered carbohydrate and electrolyte drink mix in sufficient quantity to provide for 25 to 50 percent of fluid needs. After work, the firefighter should be encouraged to rehydrate to replace fluid loss, and to immediately begin consuming carbohydrates to replace muscle carbohydrate stores.

Research has not indicated the superiority of a specific brand of energy bar. An energy or candy bar containing 200 to 250 kcal of energy, with at least 40 percent of the calories in the form of carbohydrate, will help sustain energy and immune function. Some energy bars include antioxidant supplements. Research on military populations suggests energy bars may help reduce muscle damage and subsequent fatigue. MTDC is studying the need for antioxidant supplementation in wildland firefighting.

No specific C/E sport drink has been proven more effective for firefighters. Regular use of C/E drinks will encourage fluid intake, provide energy, and diminish urinary water loss. The carbohydrate also helps to maintain immune function and mental performance during prolonged arduous work. Available products include between 200 and 400 kcal of energy per quart of liquid. Firefighters should be encouraged to provide 25 to 50 percent of fluid needs (2 to 4 quarts) with C/E drinks, mixed to suit their taste.

After work it is important to continue energy and fluid replacement. Ensure adequate carbohydrate intake in the first 2 hours after work to restore muscle glycogen levels. Rehydrate with a beverage containing some salt or eat foods containing salt to minimize urinary fluid loss. Continue energy and fluid replacement for several hours after the end of the work shift.

Information on dietary energy sources (carbohydrate, protein, and fat), vitamins, and minerals can be found in *Fitness and Work Capacity* (9751-2814-MTDC), along with information on nutrition and the immune function, oxidative stress, and dietary recommendations. USDA dietary recommendations suggest three to five servings of vegetables and three to four servings of fruit daily. Most

firefighters get fewer servings than recommended even though they need more servings to maintain health and sustain performance.

MTDC is planning field studies to document the dietary intake and nutritional needs of firefighters, and to determine the effects of energy and nutrition on immune function and antioxidant status in wildland firefighting. The results of these studies and related work will be disseminated in future editions of *Wildland Firefighter Health and Safety Report.*

Recommendations

To meet energy and fluid needs and to maintain immune system and cognitive function, firefighters should:

- **Eat two to three energy (or candy) bars daily (between meals).**
- **Drink carbohydrate and electrolyte (sport) drinks to provide up to 50 percent of fluid replacement needs.**
- **Continue carbohydrate and fluid replacement after work to ensure energy and fluid needs are met.**

Medical Standards for Wildland Firefighters

The Federal Fire and Aviation Leadership Council (FFALC) accepted draft medical standards at its January meeting in San Diego. After followup work to fine-tune the standards, the forms, and the process, the medical standards will undergo pilot testing in Fiscal Year 2001.

The medical standards are intended to help the examining physician, the agency personnel officer, and the medical review officer determine whether medical conditions may hinder an individual's ability to safely and efficiently perform the arduous work requirements of wildland firefighting without undue risk. They are also intended to ensure consistency and uniformity in the medical evaluation of applicants and incumbents. Each of the standards is subject to clinical interpretation by a medical review officer (MRO) who will incorporate knowledge of the job requirements and environmental conditions in which employees must work.

The medical standards were developed to address health and safety issues, to improve medical surveillance, and to reduce job-related injuries. The initial medical exam includes a medical history, physical examination, and tests of vision, hearing, and blood. Subsequent examinations will be administered every 5 years until the age of 45, then every 3 years thereafter. A medical history and medical screen will be employed in the years between medical examinations.

Future issues of this report will provide details of the program as they become available.

Firefighter Fatalities

According to the National Institute for Occupational Safety and Health's (NIOSH) Fire Fatality Investigation and Prevention Program, 49 percent of deaths among municipal (structural) firefighters are from heart disease. The largest firefighter mortality study ever conducted confirms that municipal firefighters died from heart disease at a rate similar to the population at large. Data for wildland firefighting indicates 42 percent of volunteer firefighter deaths were due to heart disease, compared to 15 percent for firefighters associated with Federal agencies, and 11 percent for those employed by States (Mangan 1999). The National Fire Protection Association (NFPA) has a standard on medical requirements for firefighters, (NFPA 1582).

Emergency Evacuation

Late summer wildfires on the Shasta Trinity National Forest, combined with stagnant meteorological conditions, culminated in the first declared state of emergency in a California county due to air pollution, and the first-known evacuation based on hazardous air pollution levels. Hourly

average particulate values (PM10) at the Hoopa monitoring station ranged up to 1000 ug/m^3, and area stations recorded several days of 24-hour average PM10 levels in excess of 400 ug/m^3. On October 22, 1999, the County Emergency Services Office prepared the following notice:

> **The Humboldt County Sheriff's Department Office of Emergency Services is strongly recommending evacuation of the Hoopa, Willow Creek and all smoke affected areas due to serious health risks caused by hazardous air quality.**

The conditions were reminiscent of those recorded in 1987, the year that led to the National Wildfire Coordinating Group's study of the effects of smoke exposure on wildland firefighters. For information on that project, contact MTDC for *Health Hazards of Smoke: Recommendations of the April 1997 Consensus Conference* (9751-2836-MTDC).

Aldrich Retires

Long-time chair of the Safety and Health Working Team, Dave "Shag" Aldrich retired June 2, 2000, after more than 40 fire seasons. MTDC and the entire fire community will miss this strong advocate for wildland firefighter health and safety.

Publications

Mangan, D. **1999. Wildland Fire Fatalities in the United States. Gen. Tech. Rep. 9951-2808-MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 14 p.**

Sharkey, B. **1997. Health Hazards of Smoke: Recommendations of the April 1997 Consensus Conference. Gen. Tech. Rep. 9751-2836-MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 84 p.**

Sharkey, B. **1997. Fitness and Work Capacity: Second Edition. Tech. Rep. 9751-2814-MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 78 p. (available from NFES, USDA Forest Service, Interagency Fire Center, 3833 S. Development, Boise, ID 83705 Phone: 208–387–5104 #1596).**

Sharkey, B. **1999. Wildland Firefighter Health and Safety: Recommendations of the April 1999 Conference. Tech. Rep. 9951-2841-MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 74 p.**

Coming up. . .

In the next Wildland Firefighter Health & Safety Report:

- **Wildland firefighting and the immune response.**
- **Human factors.**
- **Fitness and injury.**
- **Obesity and asthma.**

Additional single copies of this document may be ordered from:

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