



This is the local high school track where the Work Capacity Test was held on Sept. 21, 2011.

The Injured Employee's left leg after the fifth surgery. Muscle has been removed and skin grafts performed on damaged area due to both Compartment Syndrome and Rhabdomyolysis which were diagnosed and treated several days after the Work Capacity Test.



Work Capacity Test

Compartment Syndrome/ Rhabdomyolysis Incident

Facilitated Learning Analysis

Chequamegon-Nicolet National Forest



“The Facilitated Learning Analysis process helps us to maximize learning opportunities presented by unintended outcomes or near miss events. The intent is to improve performance by generating individual, unit, and organizational learning that capitalizes on shared experience—blaming is replaced by learning.”

**Facilitated Learning Analysis
Implementation Guide
August 2010**

“You are the only one who knows your body. You therefore need to listen when it may be trying to tell you something. Take action and take the necessary steps to ensure the well-being of your own health.”

Injured Employee Input
Chapter IV – Lessons Learned and Recommendations
From Participants

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I Background

Background

The Work Capacity Test “Compartment Syndrome/Rhabdomyolysis” Incident occurred on the Chequamegon-Nicolet National Forest on Sept. 21, 2011.

On Oct. 20, 2011, the Forest Supervisor elected to conduct a Facilitated Learning Analysis after consulting with:

- The Regional Forester,
- Regional Assistant Director of Fire and Aviation,
- National Fire Operations Risk Management Officer,
- Regional Safety Manager,
- Forest Safety Manager, and the
- Forest Fire Management Officer.

The Region’s Assistant Director of Fire and Aviation contacted Bequi Livingston, the Southwestern Region’s Fire Operations Health and Safety Specialist, to recommend Bea Day, Forest Fire Management Officer, Cibola National Forest and Grasslands, as the Facilitated Learning Analysis Team Leader.

The following Facilitated Learning Analysis Team members were also selected:

- Beth Rankin, Regional Safety Manager;
- Joe Domitrovich, Ph.D., Physiologist, Missoula Technology and Development Center (MTDC);
- Karen Vanzo, Forest Safety Manager; and
- Paul Keller, Technical Writer-Editor, Wildland Fire Lessons Learned Center.

The first week in November 2011, the Facilitated Learning Analysis Team participated in on-site discussions with:

- Two Work Capacity Test Administrators,
- Two Line Officers,
- One Work Capacity Test participant,
- Injured Employee’s supervisor, and
- Injured Employee.

II Incident Summary

Summary

On September 21, 2011, a Work Capacity Test (WCT) was planned at a local high school track for the Chequamegon-Nicolet National Forest.

One Work Capacity Test Administrator and one Co-Administrator coordinated the event for seven participants. A hospital's ambulance and crew with three personnel on board was also on scene.

On lap 10³/₄ (out of 12 total laps), one individual collapsed and complained of leg pain.

The Injured Employee was transported to a local "critical access" hospital and released that afternoon. The next day, the employee still had considerable left leg pain and sought further medical attention. At this time, the employee was diagnosed with "Compartment Syndrome." The condition required surgery to remove dead tissue in the patient's lower left leg.

The Injured Employee's prognosis is uncertain. In early November 2011, at the time of this Facilitated Learning Analysis report—45 days after the accident—the employee was on bed rest, as ordered by a physician.

Work Capacity Test Definition

"Work capacity tests (WCT) are used to ensure that persons assigned to fire activities are physically capable of performing the duties of wildland firefighting and to meet National Wildfire Coordinating Group (NWCG) standards for wildland firefighters (Wildland Fire Qualification Subsystem Guide 310-1, NWCG, 1993)."

"Pack Test: The pack test is a job-related test of the capacity for arduous work. It consists of a 3-mile hike with a 45-pound pack over level terrain. A time of 45 minutes, the passing score for the test, approximates an aerobic fitness score of 45, the established standard for wildland firefighters."

"Arduous: Duties involve field work requiring physical performance calling for above-average endurance and superior conditioning. These duties may include an occasional demand for extraordinarily strenuous activities in emergencies under adverse environmental conditions and over extended periods. Requirements include running, walking, climbing, jumping, twisting, bending, and lifting more than 50 pounds; the pace of work typically is set by the emergency condition."

National Wildfire Coordinating Group Glossary of Wildland Fire Terminology



Image from Wikipedia Commons

A "Compartment Syndrome" patient with skin graft.

What is 'Compartment Syndrome'?

"A condition that occurs when the amount of swelling and/or bleeding in a muscle compartment causes pressure that is greater than the capillary pressure and results in tissue ischemia (lack of oxygen) and potential tissue death."

From *Athletic Training and Sports Medicine*, 1999;
Editor: Robert C. Schenck Jr., MD

What is 'Rhabdomyolysis'?

"'Compartment Syndrome' can lead to 'Rhabdomyolysis,' the breakdown of muscle fibers resulting in the release of muscle contents (myoglobin) into the bloodstream. These releases can cause multiple symptoms and, if left undiagnosed, can lead to kidney and muscle damage, and in rare cases, results can be fatal."

May 12, 2011, Safety Alert on Rhabdomyolysis ("Rhabdo") sent out by the NWCG's Risk Management Committee

III Incident Chronology

Incident Chronology

Winter/Spring 2010-2011

- According to the Injured Employee, with the onset of the spring fire season, off-Forest fire-details, and work assignments, it was difficult to find the necessary time to stay consistent with a personal physical fitness program.

Summer 2011 Fire Season

- At the time of incident, the Injured Employee had five off-Forest fire assignments. These were single-resource positions (Division Supervisor, Dozer Boss, and Engine Boss). All were at least 14 day dispatches.

September 20, 2011

Day Prior to Incident

- The Injured Employee returned from fire assignment in Texas—arriving home at approximately 1600 hours.
- The employee stated that the “most” strenuous Initial Attack (IA) activity occurred on days eight and nine of the detail, including hot temperatures, (ranging up to 104 degrees Fahrenheit) and long shifts. IA activity then slowed down and temperatures were not as extreme on the following days. The last three days of the fire assignment—prior to demob home—the employee was staged in a hotel for IA.

September 21, 2011

Day of Incident

- The weather is 49 degrees Fahrenheit with 96 percent relative humidity and cloudy skies. The Work Capacity “Pack Test” location is a local high school track with an all-weather rubber track.
- Administration of the Pack Test is in accordance with Work Capacity Test Administrator’s Guide (PMS 307), including review of Job Hazard Analysis and appropriate time for warming up prior to beginning the test.
- The employee who will suffer the injury, arrives in “normal attire for a WCT”—including: elastic sleeve wraps over the knees, lace-up ankle supports, and lower leg wraps over the shins. Employee has always worn these items to help prevent shin splints (precautionary measures).

- The employee stated that the employee consumed water with “MiO® Flavoring”¹—but did not consume any breakfast, which is not out of the ordinary for this employee on mornings prior to taking the Work Capacity Test.

0925 Hours

- The Pack Test begins.
- The employee starts out at a quicker pace than normal—asking the Pack Test Administrator if the employee is on pace.
- During the Pack Test, the employee wants a couple sips of something cold—only has warm water. Decides to open a cold “Amp Energy Drink.”² Takes a couple a sips (less than ¼ can) and places the can down alongside the track. Employee feels fine at this time, doesn’t feel the need to drink the entire drink. Just wanted a few sips of something cold.

1000 Hours

Lap 10 of Pack Test

- The employee progressively dials back on the employee’s pace during the Pack Test’s tenth lap. (There are a total of 12 laps in this Pack Test.)
- Turning the corner, with ¼ left in lap 10, the employee is observed swaying—and then collapsing.
- The Pack Test Administrator runs over to Injured Employee and evaluates the employee’s condition.
- Initially, the Injured Employee is worried about not finishing the Pack Test. In discussion with the Pack Test Administrator, the employee decides that the Pack Test cannot be continued.
- The on-scene ambulance crew is summoned. The Injured Employee is given oxygen, has blood pressure taken, and is stabilized for transportation.
- The employee keeps telling the ambulance crew that the employee’s legs hurt.
- The ambulance is located on the other side of a fence/gate. Without opening the gate, transporting the Injured Employee will require carrying the employee up two flights of narrow steps on the ambulance gurney. The track’s groundskeeper is located to open the gate—and does so.

1015 Hours

- The Injured Employee is transported alone (ambulance company rules prohibit non-patients from riding in the vehicle) and admitted to a local critical care hospital (with 24-hour inpatient and outpatient services, licensed for 25 beds, including intensive care unit and medical/surgery). This hospital is located one mile away from the Pack Test site.

¹ This zero-calorie, concentrated line of liquid fruit flavorings with artificial colors, sweeteners, and preservatives, was introduced to consumers by Kraft Foods in March 2011.

² Amp Energy drinks, produced by PepsiCo., contain guarana (a Brazilian plant known to be an effective energy stimulant), taurine (a naturally occurring sulfonic amino acid), ginseng, B-vitamins, and caffeine.

- The Line Officer is notified in person by the Pack Test Administrator (the District Office is located one and one-half miles from the Pack Test site). The Line Officer, Pack Test Administrator, and others go to the hospital to meet with Injured Employee.
- At the hospital, the Injured Employee is treated with IVs and is given a resting EKG.
- During this time, the hospital staff continues to address “possible” heart issues and schedules the Injured Employee to come in the following week to take an “active” EKG. Despite continued complaining about serious leg pain, the hospital staff assures the Injured Employee that everything will be “OK” in 24 to 48 hours, and readies the employee for release.

1430 Hours

- The Injured Employee is released from the hospital.

Later That Evening

- That evening, the Injured Employee still has considerable leg pain and is not able to sleep.

September 22, 2011

Day After Incident

- The Injured Employee is still experiencing serious left leg pain and is not able to put any weight on this leg. In addition, the employee has dark-colored urine.

1345 Hours

- With serious pain and swelling in the left leg, the Injured Employee is transported back to the same hospital by the employee’s spouse.
- This time, the Injured Employee is seen by a different physician who states: “This is an emergency situation.” Arrangements are immediately made to have the Injured Employee transported by ambulance to a larger major medical hospital (a 500-plus bed, tertiary care teaching institution).
- The Injured Employee is diagnosed with Compartment Syndrome and Rhabdomyolysis and undergoes an operation to relieve the pressure in the lower left leg (calf region).

September 24, 2011

Three Days After Incident

- The Injured Employee has another surgery to clean-up the infected area and save the muscle area. However, during the surgery, the surgeons realize that muscle has been damaged and needs to be removed.
- The organ doctor informs the Injured Employee that, three days before, the employee’s kidneys had only been functioning at one-third their normal capacity. The doctor informs that they are doing much better now—but it had been very serious.

Sept. 26-29, 2011

- The Injured Employee undergoes a third and fourth surgery to continue to “clean up” the leg’s damaged areas.

October 1, 2011
Ten Days After Incident

- The Injured Employee is released from the hospital and placed on bed rest by physician.

October 20, 2011
20 Days After Incident

- The Injured Employee undergoes a fifth surgery to graft skin from the upper leg to cover the wound area.

November 1, 2011

- At the time of this Facilitated Learning Analysis, on physician’s orders, the Injured Employee is still on bed rest.
- The physician gives permission for the FLA Team to meet and discuss the incident with the Injured Employee.

November 14, 2011

- The Injured Employee’s condition continues to improve. Next week, the Injured Employee will learn when the surgery will occur to remove the metal “halo” from the employee’s leg.
- The prognosis is uncertain whether or not the employee will be released back to full duty.



The Injured Employee’s left leg after the fifth surgery on Oct. 20, 2011. Muscle has been removed and skin grafts have been performed after damage occurred due to both Compartment Syndrome and Rhabdomyolysis. The metal “halo” is mounted onto leg to help prevent muscle atrophy during the healing process.

IV Lessons Learned and Recommendations from Participants

The Facilitated Learning Analysis Team asked the individuals associated with this incident to share their stories and consider “Lessons Learned” from their varied perspectives.

Their following “Lessons Learned” and “Recommendations” are not listed in any order of priority sequence.

A. Contributing Factors

1. Prioritize Staying Physically Fit

When a firefighter’s job requires meeting an arduous physical capacity level/standard, it is critical to make time for physical fitness. Employees should prioritize “other work” to prevent eliminating the necessary time to participate in firefighter physical fitness training (PT) on the clock (during work hours). We also encourage the incorporation of healthy lifestyle choices and better nutrition. Implementing small changes and a more balanced nutrition plan can help keep/improve overall fitness levels and maintenance of physical fitness status.

2. Specific Recommendations from the Injured Employee

- After being released from the hospital, the Injured Employee wanted to share the following insight and advice with everyone: *“Continue to listen to your body. After the Pack Test when my legs hurt, I shouldn’t have ‘cowboyed-up’—I should have been more of a realist about my pain.”*
- You are the only one who knows your body. You therefore need to listen when it may be trying to tell you something. Take action and take the necessary steps to ensure the well-being of your own health.
- When it comes to your health, know your body and know what/when you should seek medical help.
- Ask questions and express your concerns directly to medical professionals. If you are not satisfied, request follow up and/or other opinions.

B. Important Reminders for Future Operations

(These are Not Contributing Factors to this Incident)

1. Prevent Obstructions that Could Limit an Ambulance’s Availability

Ambulance placement was not a contributing factor to this incident. However, it should be noted that the ambulance and its personnel should always be located as close as possible to the Work Capacity Test site. There should be no gates or other obstructions that limit the ambulance’s ability to get to participants, or the ability to quickly get necessary equipment to the individual and transport individuals away from the scene.

2. Ensure Adequate Physical ‘Warm-Up’ Time

Participants should be encouraged to stretch and warm-up prior to starting the Work Capacity Test.

3. Avoid ‘Out and Back’ Type Work Capacity Tests

The Injured Employee was attended to immediately upon collapsing. All employees—at all times—were in full view of ambulance personnel. However, concern was expressed that—previously—each year this Forest administers one Work Capacity Test using the “out and back” method (rather than using an “enclosed” track as was done on Sept. 21, 2011). Due to the “lessons learned” of this incident—the importance of having the ambulance and Work Capacity Test Administrators in full view of all participants at all times—using this “out and back” method in the future is now being reconsidered.

4. Develop Protocols for Assisting Injured Employees at Medical Facilities

The Forest needs to develop protocols for ensuring that when an injured employee goes to a medical facility an advocate is available from the Forest Service to help assist the employee or family members. (See also: “3. Create Checklist for Medical Community” on next page.)

V Lessons Learned and Recommendations from the Facilitated Learning Analysis Team

The following “Lessons Learned” and “Recommendations” identified by the Facilitated Learning Analysis (FLA) Team are not listed in any order of priority sequence.

- 1. The Facilitated Learning Analysis Process Should Be Encouraged**
Encourage and endorse the continued education and use of the Facilitated Learning Analysis process and its intent.
- 2. Ensure That Safety Alerts Receive the Appropriate Attention**
On May 12, 2011, a Safety Alert on Rhabdomyolysis (“Rhabdo”) was sent out by the NWCG’s Risk Management Committee [<http://www.wildlandfire.com/docs/2011/safe/rhabdo.pdf>]. After this Work Capacity Test medical incident, individuals remembered seeing an email about this topic. Due to the volume of emails that individuals receive, safety alerts are often lost in the mix and do not receive the attention that they deserve. Employees suggested to the FLA team that it might be beneficial to explore other—more effective—methods for posting and communicating such vital safety information.
- 3. Create Checklist for Medical Community**
Create a checklist of other “watch outs” to be aware of regarding firefighter injuries—besides heart problems or dehydration—that can be provided to the medical community.
- 4. R&R Days Serve a Valid Purpose**
The Injured Employee should have been on a post-fire incident R&R day on the Work Capacity Test day. Such R&R days serve a purpose to ensure that employees rest and recuperate, and—when called upon—are able to function at the level expected.
- 5. Disseminate More Information on Compartment Syndrome and Rhabdomyolysis**
More information needs to be collected on occurrences of these injuries. Are Compartment Syndrome as well as the similar Rhabdomyolysis incidences on the rise because of an increased awareness/diagnosis? Or, is this due to decreases in overall health/fitness? Need to update specific questions for firefighter injuries in SHIPS (Safety and Health Information Portal System).
- 6. Be Aware of When Compartment Syndrome and Rhabdomyolysis Can Occur**
In this incident, Compartment Syndrome and Rhabdomyolysis occurred when an individual was taking the Pack Test. However, these medical conditions can occur under *any* type of physical activity that is over and above what one is used to performing.

VI Facilitated Learning Analysis Team

Bea Day, Team Leader

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