Rhabdomyolysis

Facilitated Learning Analysis

NezPerce - Clearwater National Forests

June 2016

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A. Summary

Sunday, June 5th, 2016

Mike, a first year crewmember on a 20-person Type II Initial Attack Crew, was admitted to the hospital having been diagnosed with Exertional Rhabdomyolysis (Rhabdo). Mike had just completed the first three weeks of initial training with his crew prior to fire season. These three weeks were as much about physical fitness and skills training as it was about a group of unacquainted individuals coming together as a team. After these initial three weeks of getting to know the crew, Mike would be headed to Guard School (Basic Wildland Firefighter Training) with the other first year crewmembers on his crew.

Saturday morning, June 4th, having completed his third week of work he woke up with minor soreness and swelling in his biceps. By noon he noticed significant swelling in his arms and his urine became very dark (cola colored). Mike's crew had previously discussed the symptoms and dangers associated with Rhabdomyolysis during their training, so Mike was aware that he might be experiencing Rhabdo. Mike decided that if his symptoms did not improve by Sunday morning he would call his supervisor John (who is also the crew EMT) and let him know what was going on.

By Sunday morning Mike's condition had not improved so he phoned his supervisor. Upon hearing Mike describe his symptoms of swelling and dark urine, John told Mike to go to the Emergency Room and that he would meet him there. After an initial evaluation in the ER, Mike was admitted to the hospital and began treatment for Rhabdomyolysis. He remained in the hospital for six days. No permanent physical damage is suspected.

B. Narrative

It is important to note that Mike's symptoms, while considered classic signs, are not always recognized by wildland firefighters as Rhabdo if there is not a severe dehydration component. During the incident and prior Mike stated that he never felt like he was dehydrated. He said he drank 3 to 4 quarts of water daily at work and 3 quarts of water after work in the evening. His supervisors observed the same. He experienced some pain, but not as severe as described in other cases. Mike did state that while the pain was not severe, it didn't get better with rest.

> *"I was surprised about how little actual pain there was, considering the amount of damage that was occurring to my body." – Mike*

Rhabdomyolysis is the breakdown of skeletal muscles resulting in the release of intracellular contents into the circulatory system. It can result in clotting disorders, acidosis, hypovolemia, electrolyte abnormalities, acute muscle wasting, and acute renal failure. Over 100 conditions can cause the initial cell destruction. Diagnosis is confirmed by testing the creatinine (CPK). levels in the blood, which is the most specific indicator of myocyte injury. Normal CPK enzyme levels are 45 to 260 U/L. Levels may be several hundred in individuals who have recently had excessive physical exertion or surgery. CPK levels in individuals with rhabdomyolysis have CPK levels over 10,000 U/L. No other conditions cause CPK values to be this elevated.

Criddle, L.M. "Rhabdomyolysis. Pathophysiology, Recognition, and Management." *Crit Care Nurse 2003; 23:14-30.*

1. Patient Background

This was Mike's first season in fire. He previously served in the U.S. Military for seven years. He had no previous cases of Rhabdomyolysis or Heat Injury of any kind, nor had he ever been admitted to a hospital. He does not use tobacco. He consumes only a minimal amount of alcohol (two beers per week) and drinks one cup of coffee per day. He takes a daily vitamin and fish oil, but no other supplements or over-the-counter medications. He drinks approximately 7 quarts of water per day. He reports having a normal sleep schedule.

2. Timeline of Events

The timeline of events is broken out into five different phases consisting of; pre-season prior to reporting to duty, weeks one through three consisting of initial training activities, and week four during which Mike was hospitalized and being treated for Rhabdomyolysis.

Pre-Season

Mike began physical training (PT) March 1st, prior to reporting to work on May 16th. His PT routine consisted mainly of running two to four miles or hiking, pushups, and sit-ups six times a week. There was no major focus on weight training. Prior to being hired Mike had visited with the Crew Supervisors and was given expectations on fitness standards and the importance of showing up to work physically fit. Included also was a letter from the Crew Supervisor at the time of hiring that covered the same information.

Week One: May 16th- 20th (Critical Training)

Mike began work on the crew, on May 16th. The first week "Critical Training", consists of wildland firefighter refresher training, skills building and drills, crew standard operating procedures and a focus on initial development of crew cohesion.

The crew did daily PT during critical training week. The Crew EMT, John, designed the PT program around ideas consistent with prevention of injury and Rhabdomyolysis, of which he was aware of due to knowledge and experience in the past. Workouts included a variety of running, hiking, circuits, pushups, pullups, sit-ups, and calisthenics. The crew intentionally limited amount of high intensity "cross- fit style" training due to Rhabdo and overuse injury concerns. PT focused on long range cardio training and mixing up calisthenics. During this week the crew covered Heat Illnesses and Rhabdomyolysis in a Power Point discussion as an awareness topic for the crew. The crew EMT conducted this discussion using materials he had developed on his own. The crew thought it was very useful information.

1st Week

Sun	Mon	Tue	Wed	Thurs	Fri	Sat
	Administrative Paperwork	Circuits	PT Hike (Long)	Line Digging 12 – 14 hour Day	Day off from PT	
	Work Capacity Test (Pack Test)	Pull-ups, Push-ups, sit-ups, calisthenics.		Hiking with packs		

Week Two: May 23rd-27th
(Saw Week)

The crew continued with daily PT and miscellaneous training during "Saw Week". Saw week is the week between Critical Training and District Orientation. The crew typically focuses on providing S-212 (Wildland Fire Chainsaws) training this week and providing initial and refresher chainsaw training to district personnel.

2nd Week

Sun	Mon	Tue	Wed	Thurs	Fri	Sat
	3 Mile Run with Calisthenics	6 Mile Run (11 min mile Pace)	3-5 mile run	Circuit PT	Hike 4-5 mile	
	S-212 Class	S-212 Class	Hill sprints			
		3 Mile Run	Calisthenics			
		Circuit PT				

Week Three: May 30th-June 3rd
(District Orientation)

The crew continued with daily morning PT during District Orientation week. During this week the entirety of district personnel participate in required safety trainings like (First Aid)/CPR, Defensive Driving, and ATV training. There is also a lot of administrative process training during this week.

Thursday's maximum temperature was 66˚F. PT included sprints, pushups and sit-ups. It was estimated Mike did over 100 pushups that day.

Friday's maximum temperature was 78˚F. PT consisted of a three mile crew run with "on your own" hill sprints, followed by a pullup pyramid. He estimated doing over 50 pullups. During this time, Mike completed PT without issues. Throughout the rest of the day he noticed soreness, but nothing out of the ordinary. Mike himself said he felt pretty good.

"Mike was not on our radar, he was never struggling with PT"- John

3rd Week

Sun	Mon	Tue	Wed	Thurs	Fri	Sat
	4 mile run	4 mile run	Circuit PT	Wind-sprints	3 mile run (crew pace run with self-pace hill sprints)	
	Calisthenics	Calisthenics	Interval Sprints	Pushups	Pull-up Pyramids	
				Sit-ups		

Saturday, June 4
(Home for the Weekend)

Mike woke up Saturday morning at 0700 with some soreness and mild swelling in his biceps, but nothing inconsistent with what he would have expected from PT. His urine was normal in color and volume. His arms and other muscles were sore from PT but not abnormally painful.

At approximately 1200 hours, Mike noticed the swelling had increased in his biceps enough that it was difficult to straighten his arms. His urine color had become dark (cola colored). He took some Ibuprofen at this time. He considered the possibility of Rhabdomyolysis, so he increased his water intake and further researched symptoms of Rhabdomyolysis on-line. Later in the day he found he could not straighten his arms, having to hold them at 90-degree angle. He took Aleve® (Naproxen) an over-the-counter (OTC), nonsteroidal anti-inflammatory (NSAID) pain reliever in addition to using an ice pack and elevating both biceps. Nothing changed or improved in his condition. Mike decided he wanted to wait it out and sleep on it to see if the pain and swelling got better by morning. Mike's arms being locked in a 90 degree angle, made sleep very difficult.

Sunday, June 5
(Admitted to Hospital)

4th Week

Sun	Mon	Tue	Wed	Thurs	Fri

Mike's symptoms had not improved when he awoke Sunday morning. His suspicion of Rhabdomyolysis was now high. At 0800 hours he called his supervisor John (EMT) and described his symptoms. John told Mike to go to straight to the ER and that he would meet him there. John then called the Crew Boss, Gary, whom later met them at the ER to serve as hospital liaison.

John (EMT) spoke with the ER doctor about the concern of Rhabdomyolysis, which was also a concern of the doctor's, and provided the ER nurse with the pamphlet that provided information about Rhabdomyolysis and Wildland Firefighters. He carries a copy of this pamphlet in his crew boss kit. The nurse said this was one of the better information sheets she had seen. Staff at the hospital were familiar with Rhabdomyolysis and had recently seen a few cases, so they were not hesitant to test for Rhabdo.

Mike's vitals were good: his body temperature was 98.4°, his heart rate was low due to good physical condition but his blood pressure was good. Other than swollen arms and dark urine, Mike did not present with other typical indicators of Rhabdomyolysis.

Mike and John agreed that it took 2 hours after checking into the ER to get results from the blood tests that indicated his CPK

Creatine phosphokinase (CPK) is an enzyme in the body. It is found mainly in the heart, brain, and skeletal muscle.

When the total CPK level is very high, it most often means there has been injury or stress to muscle tissue, the heart, or the brain.

Muscle tissue injury is most likely. When a muscle is damaged, CPK leaks into the bloodstream.

"Day One Rhabdo Facilitated Learning Analysis – Rogue River-Siskiyou National Forest" 2016, pg. 7

numbers were greatly elevated (40,000; normal values are 80-200). Initially they were unable to obtain a reading because his CPK levels were so high that the sample had to be diluted for their equipment to be able to generate a value. By approximately 1030 hours he was started on saline IV. His blood was drawn every six hours to check his CPK level. He was moved into a hospital room on the main floor to stay overnight.

"In hindsight, I should have gone to the hospital sooner" – Mike

Monday, June 6
(Moved to ICU)

The doctors Mike saw at the hospital did have past experience with Rhabdo, but to various degrees. The primary doctor said that given a proven Rhabdo case (as of 1000 hrs Sunday in the ER), that he suspected there could be compartment syndrome, but was not completely sure so said he would call in an Orthopedic Surgeon that did have compartment syndrome experience to have a look. This occurred and the Orthopedic Surgeon said that it was definitely Rhabdo, but no compartment syndrome yet; and to continue Rhabdo treatment while monitoring closely for compartment syndrome. If swelling continued and compartment syndrome became an issue, surgery would occur immediately.

"My arms were so tight I couldn't grab a pinch of skin, after a couple days my elbows were not visible they (my arms) were so swollen" –Mike

The swelling remained in his biceps and also moved into his forearms. By Monday afternoon the swelling compromised the IV site and he was moved to ICU to have a central line put in.

Tuesday, June 7 - Thursday, June 9

Mike's CPK values remained too high for the doctors to feel comfortable releasing him on Tuesday. Mike was becoming frustrated that the numbers of his CPK count had stopped coming down (plateaued). He began to wonder if he was receiving the proper treatment for Rhabdo. The Crew Boss (Gary) told Mike he would contact someone with more information about treatment of Rhabdo. Gary remembered the Rhabdo Report by Missoula Technology and Development Center (MTDC) and that the Forest Service has a Management Medical Officer D.O., so he thought to call the Region 1 Safety Director to ask if someone could contact the doctor and ask the question about treatment and recommendations. The Forest Service Medical Officer said that the treatment was appropriate and that it can take some time for recovery. This was helpful information in that it made Mike feel a lot better about the treatment he was receiving. However, it was still frustrating to not really know how long until he could be released from the hospital.

Gary also talked to the doctors at the hospital about renal issues and concerns with kidney damage associated with Rhabdo. The doctors assured him that all was good, stating that it was caught quickly enough so kidney damage was unlikely. Had Mike been left untreated there would likely have been significant renal damage.

Friday, June 10
(Released from hospital)

Sun	Mon	Tue	Wed	Thurs	Fri

Friday morning Mike's CPK values were 13,000. Six hours later his values were 10,066 and he was able to be discharged. His follow up care was scheduled with his regular doctor with another set of blood tests done for CPK values.

Mike's discharge instructions were as follows: regular diet, 2000cc fluid restriction with 50% electrolytes daily minimum. Okay to do running and other activities with the arms and be careful with backpack due to arm swelling (from medical records).

Mike also received instructions from 3 different doctors who he asked each one about recovery instructions. Instructions consisting of; take it easy, you may feel muscle weakness, drink plenty of fluids.

Saturday and Sunday after being released Mike indicated that his arms still felt weak and that muscles felt kind of like gel. He said that after about 20 minutes of activity he would start feeling weak.

The following week Mike returned to work on light duty and had a follow up visit scheduled with his primary care doctor. That Friday Mike was told by his doctor that he could return to full duty without restrictions; his CPK value was approximately 500.

C. What went well:

- The crew fosters an open environment and provided a contact list to all crewmembers. Mike felt comfortable calling his supervisor on the weekend to inform him of his condition.
- John (EMT) said he met Mike at the ER to inform the ER of the possibility of Rhabdomyolysis and to serve as an advocate for the patient.
- The Crew Boss, Gary, also went to the ER and served as hospital liaison. The crew boss visited Mike on a daily basis and coordinated with medical staff and additional resources to ensure Mike received proper care.

> *"Would you want your family to go to the hospital by themselves?" – John (EMT)*

- The crew EMT provided additional training and information to the crew concerning Rhabdomyolysis during "Critical Training" week. Mike felt that the training covering Rhabdomyolysis was key to his recognizing the symptoms early.
- The OWCP (Workers Compensation) process went smoothly and a case number was given within the week.

D. Lessons Learned by those Involved:

- If you have the symptoms or suspect Rhabdo go to the hospital and get it checked out. Don't wait and don't try and tough it out.
- It's not always about extreme exercise or a high amount of risk factors, it [Rhabdo] can come about during regular PT.
- It is extremely helpful to have a Patient Advocate talk to doctors about the possibility of Rhabdomyolysis and to ask that they test for it.
- Rhabdo can occur in well fit individuals following their regular exercise routine.
- Symptoms will always vary in how many present and the severity of each symptom.
- It was surprising how long the recovery time was. We [supervisors and the patient] didn't expect it to be as long as it was and the doctors never really gave a good indication. After talking with the FS Medical Officer we had a better feel for the length of recovery time, and that it was normal for it to take several days.
- The patient should talk to doctors and set up some "goals" or "benchmarks" of recovery towards being released from hospital (or ICU) to have a better idea of what to expect. "Not knowing was very frustrating".

A couple things Mike thinks every firefighter should know:

1. HOW SERIOUS of a problem this condition can be to kidneys.
2. HOW IMPORTANT it is to seek IMMEDIATE medical attention

E. Lessons Learned by FLA Team

- Not all Rhabdomyolysis cases in wildland fire involve excessive environmental heat or dehydration, nor "extreme" physical training activities. We must recognize the symptoms and seek medical attention even if our mental models of what causes Rhabdomyolysis doesn't match the situation.
- There is a need for Rhabdomyolysis information to be disseminated in a manner that all employees receive it. (Included should be education on risk factors, prevention strategies, symptom identification, and medical response).
- Importance of Rhabdomyolysis Information Sheet for Medical Providers cannot be overstated. This information sheet should be part of every Crew Boss's kit. Many may not be so lucky as to have medical personnel at their community hospital that are familiar with Exertional Rhabdomyolysis.
- Rhabdomyolysis could occur in anyone involved in exertional type of work. Don't think that this is just a wildland firefighter issue.

F. Facilitated Learning Analysis Team

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