

the **CrossFit**  
JOURNAL ARTICLES

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## Killer Workouts

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Rhabdomyolysis was first described in the victims of crush injury during the 1940- 1941 London, England, bombing raids of World War II - and more recently in Eugene's garage.

A rugby player performs intense sets of squat jumps on a hot day, collapses, and is rushed to the hospital, where he spends two days in intensive care. Doctors notice that his heart is beating abnormally and that he has unusually high levels of potassium in his blood. A soccer player runs a series of 100- meter sprints at near maximum intensity. After his eighth sprint he collapses to the ground; when he gets to the hospital he is found to have high levels of potassium and myoglobin in his bloodstream. He spends several days in the hospital and is unable to train for several weeks. A highly fit marathoner holds a 6:30 pace for 26 miles but collapses only a few feet short of the finish line. Blood tests reveal a potassium concentration three or four times the normal level and he dies.

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## Killer Workouts (continued...)

What does all this mean to you? A condition called rhabdomyolysis, brought on by intense athletic activity is what brought these athletes down. Intense athletic activity... Does that sound familiar? Apparently, one of the three CrossFit pillars (functionality, intensity, and variance) done, in extremis, can introduce a character to the scene whom we have dubbed "Uncle Rhabdo". Uncle Rhabdo is a close relative of "Pukie" the vomiting clown. While Pukie represents a light hearted approach to the discomforts of training with intensity, his uncle depicts the dark, potentially deadly results of the inappropriate use of intensity. The purpose of this article is to make you aware of the potential pitfalls of intense physical training so that you can reap the benefits while remaining cognizant of a small, but not inconsequential possibility of catastrophic physical trauma. Exercise intensity is like nuclear energy--deployed without certain controls the result can literally be meltdown.

So what do we do that opens the door to rhabdo? Rhabdomyolysis is a breakdown of muscle cell contents that results in the release of muscle fiber contents into the bloodstream. Eccentric muscle contractions, in which muscles attempt to shorten while they are being stretched, seem to significantly increase tension on muscle cell membranes, and it is this tension that appears to break them down. When the membranes are compromised, stuff that is normally enclosed inside the wrapper seeps out into the circulation, where it gums up the works. Potassium is normally in high concentrations inside muscles; when it is found in high concentrations in the blood, it is a good indicator of rhabdo. Sodium and calcium also move from outside the muscles inward and start building up inside the muscle cells, causing very painful swelling that can lead to compartment syndrome, which requires urgent surgery to slice open the membranes to relieve the pressure.

But wait, there's more. When everything is working properly, the extra potassium would probably be filtered out of the blood by the kidneys. But with the onset of rhabdo the amount of potassium is overwhelming and that extra volume is complicated by yet another player called myoglobin. Myoglobin is another resident inside the muscle cells that acts as a warehouse for oxygen. When myoglobin leaks out with the potassium and makes its way to the kidneys, it breaks down into a toxic chemical called ferrihemate, which damages kidney cells. This damage prevents the kidneys from working properly and can be permanent. The extra potassium can peak

at such high levels in the blood that heart function is altered; arrhythmia is a common consequence, and eventually the heart may fail completely if the potassium levels are not controlled.

It is likely that you don't know anyone who has had rhabdo, but the truth is that many athletes suffer from a mild case of it from time to time. Dr. Marc Rogers, Ph.D., an exercise physiologist at the University of Maryland, goes so far as to say, "If you've ever had stiff and tender muscles after exercising, you've probably had a slight case of rhabdomyolysis." Novice exercisers can develop the problem, but so can the most highly trained, accomplished athletes. Moderate cases of rhabdo can sometimes be found in competitors after triathlons. In a test of 25 triathletes who had just completed a half-Ironman triathlon (1.2-mile swim, 56-mile bike ride, and a 13.1-mile run), it was found that most of the 25 participants in the study had unusually high levels of myoglobin in their blood. This suggests that some amount of muscle membrane leakage had occurred.

My interest in this topic peaked when a very close friend of mine spent a week in the hospital after I put him through his very first CrossFit workout. Brian was no couch potato who suddenly jumped into exercise, but he did have a long layoff from intense exercise for nearly two years before that fateful afternoon with me. He was a state champion wrestler from Iowa, an Army Ranger, and a pretty serious weightlifter and member of our department's SWAT team. Although he was not working out hard he had not degenerated to full-blown spudhood. He was running and "staying in shape," as he said, but he did nothing that could be described as intense. Until he came to my house.

Our workout was nothing crazy hard, but the thing that did him in was the swings. His second set of 50 swings (an eccentric contraction to be sure) was difficult for him and proved to be his undoing. Afterward, he was unable to kneel in my driveway to change from shoes to boots and had to sit. He could barely do that and had to use all the force of his will to get on his Harley and ride home. No pain to speak of during this time, just complete muscle weakness. Brian thought his muscles were tightening up (in fact they were dying) so he put on a heat pad to loosen things up. Instead of relaxing the muscles, the heat released even more fluid and within two minutes the pain started. Excruciating pain. Pain is frequently quantified in the medical community on a scale from 1 to 10. Brian said the pain was way past 10. Once he was at the hospital,

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our SWAT team doc, who works at the emergency room Brian went to, worked his morphine dose up to 16 mg every two hours, and Brian said that only dulled the pain enough that he didn't scream.

The primary diagnostic indicator of rhabdomyolysis is elevated serum creatine phosphokinase or CPK. The normal value runs below 200; rhabdo brings the CPK level to at least five times this level. When Brian was admitted to the hospital his CPK level was at 22,000. Within two days it peaked at 98,000. He was pumped full of fluids to help flush the kidneys and he puffed up like the Michelin man. His head looked like a big fat white pumpkin from all the fluid and the medical staff was very concerned about mineral imbalances, which could cause heart problems. Any movement brought suppressed screams of pain through gritted teeth. He was out of the hospital after six days but was off from work for two months. The muscles in his lower back had been destroyed and no longer functioned. He was unable to sit or stand without leaning backwards or he would fall over. He brought an empty cereal bowl to the sink one morning and when he reached slightly forward with his arms to put the bowl in the sink he started to fall and would have gone straight to the ground had he not had the edge of the sink to stop his fall.

Brian is now back to normal and works out in true CrossFit fashion, tempting a Pukie visit nearly every time we train. Our resumption of training was a gradual build rather than a jump into the deep end. We ramped up the intensity of the training week by week and made sure he never did anything with great intensity unless he had done it moderately at least one time before. Now he can hammer whatever workout I throw at him.

There is a silver lining to the rhabdo story. A small dose of rhabdo might actually have a positive effect on your development as an athlete. Some scientists have speculated that the build-up of calcium inside muscle cells during rhabdo can stimulate increased protein synthesis inside the cells, which might produce some of the beneficial adaptations we associate with training such as more aerobic enzymes, more contractile proteins, and more mitochondria. But the line between these positive adaptations and the onset of full-blown rhabdo is a fairly thin one. Tread softly; here there be dragons.

There are things you can do to minimize the risk of rhabdomyolysis. The studies in this area a somewhat thin (imagine the protocol...take some people who

never exercise, break them down into groups, and have some of them exercise until they die), but they suggest that as fitness improves and an athlete's training program becomes more challenging and of longer duration, the likelihood of rhabdo declines. While high-volume, highly fit athletes are not immune to rhabdo, fitness is an excellent prophylactic measure.

The warning label for CrossFit, then, counsels gradual introduction to CrossFit at its highest intensity levels. Other rhabdo invitations are heavy alcohol consumption, cocaine usage, and the use of a cholesterol-lowering drug called Mevacor (lovastatin is the generic name). Intense exercise after a recent infection raises the risk as well because certain viral infections can inflame muscle membranes and make their deterioration more likely during exertion. Exercise when it is very hot—especially if it is also humid—can exacerbate the onset of rhabdomyolysis so you must acclimate to increases in temperature before you train hard. The lack of fluid in the body under these conditions increases the risk of heat stress and dehydration, which places strain on the muscles and the kidneys. The Camelbak tag line “Hydrate or die” is more meaningful in light of some understanding of rhabdo.

Interestingly, only two species of animals—humans and horses—are known to develop rhabdomyolysis, and only male humans appear to be susceptible. The exact reasons for this are not completely understood, but some experts speculate that decreased total muscle mass and more efficient heat regulation in females may protect against full-blown rhabdo. Key female sex hormones such as estrogen may also have a soothing and stabilizing effect on muscle membranes, making it hard to mortally wound them during strenuous exercise.

Unfortunately rhabdomyolysis is pretty sneaky and does not make an announcement prior to showing up on your doorstep. But if your urine looks just like Coca-Cola, that's a sign that you have myoglobin in your kidneys and you need to get to the hospital immediately. Brian's initial complaint was not of pain but rather of complete muscle weakness in his back, so be mindful of that. Also, no heat pads after workouts; use ice. Train hard, but pay attention to what you are doing. Practice mindful exercise, thoughtful intensity.

