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THE PATIENT'S PERSPECTIVE
Observations from an Outlier

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COMMENTARY

"The Devil is in the details." These were the parting words from my spinal cord specialist at Vancouver General Hospital (VGH). I was frustrated, confused and still very much in shock from the drastic changes with my body as I left for rehabilitation. However, I will never forget Dr. Marcel Dvorak's parting words that seemed to be spoken as a warning.

Quadriplegia (Tetraplegia) is an intricate but manageable condition. All aspects of life need to be learned anew. Big and small things that were within reach were now out of reach. It was suggested I try new pastimes completely foreign to me such as wheelchair rugby or finger painting. I decided I would stick with rock climbing, possibly out of stubbornness or possibly to see the reaction from the doctors. I had dealt with never being able to walk again, but I needed to get back on the rock somehow.

To make a long story short, we did it. As a team, we designed custom gear and spent many hours going through "trial and error, mostly error". A simple iterative process, over a long time. We climbed "The Chief" in Squamish BC in the summer of 2005, over ten years after my days staring at the VGH ceilings. There were many problematic details that had to be solved. We laboured away at the engineering without paying too much attention to physiology. At this point in my life, I thought, "Well, just try harder!"

To climb higher, I needed more expertise on what my heart and lungs were doing at the moment and would be capable of on the mountain. Maybe it was the excitement and exercise mixed together, but I felt that I was having a heart attack during the climb up the Grand Wall in 2005. This experience brought me to the research labs at UBC to see Dr. Darren Warburton. I have volunteered for every medical experiment available to get more information on how a quadriplegic's body functions or fails while under stress. Some of these tests are available for viewing on YouTube (http://www.youtube.com/watch?v=hqbtcjXDxto). Maximal aerobic power (VO_2max) tests, orthostatic challenges, and max bicep curl tests became my new benchmarks. As a quadriplegic, the usual resting heart rate and body weight measurements were simply not adequate anymore to tell if I was improving.

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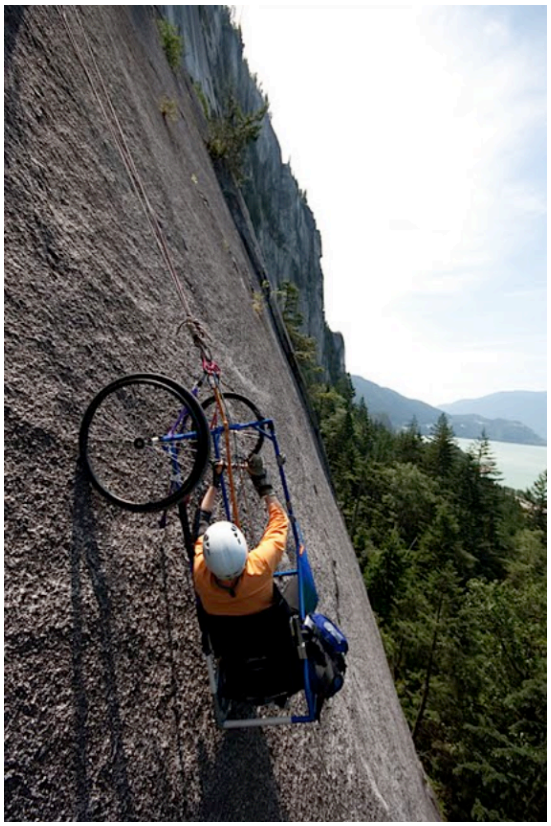


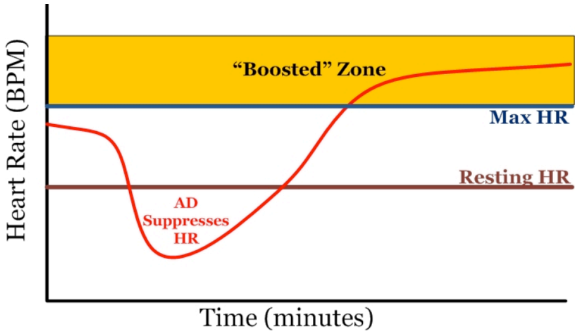
Most quadriplegic individuals have limited sympathetic nervous system control with only the main Vagus nerves left to constantly reduce heart rate. Consequently, the standard heart rate zones that fitness trainers would want to use no longer apply. As a quadriplegic there is only one gear. However, when I push harder I experience "EH" – exertional hypotension. Most of the literature uses the term "post-exercise hypotension" as it gets worse after stopping the activity. Without some other sympathetic stimulus to counterbalance, "'trying harder" will only lead to dyspnea (laboured breathing) and light-headedness. Unfortunately, this is a consequence that many quadriplegics must learn to manage. It is not uncommon for me to have a maximal heart rate of 120 beats per minute (bpm), with low blood pressure, and laboured breathing. How can I keep climbing? Imagine having to pull on a rope as hard as you can because darkness and weather are threatening? Combine this with a cardiovascular system that does not respond "normally" and you have a very dubious and potentially life threatening situation.

As a quadriplegic who is passionate about climbing, I have found ways to get around my neurological limits. In a controlled environment (such as at the local gym) there are ways to address these limits. This is where some of the controversy begins. It is well established by patients and clinicians alike, that when a noxious stimulus is applied to someone with a lesion (injury) level above T6, that the condition known as Autonomic Dysreflexia (AD) can set in quickly. This is a well known reaction in Spinal Cord Injury (SCI), but when used deliberately to increase blood pressure it is called "boosting".

Boosting is commonly used by SCI athletes to enhance their performance (see Figure 1). The performance benefits of this procedure are so well known, that inducing AD is a banned practice for most high performance SCI events (such as the Paralympic Games). There are also serious potentially life threatening consequences of inducing AD. The problem is that AD can cause a marked increase in blood pressure, with a dramatic drop in heart rate. In my case, my blood pressure can rise (within seconds) from 100/60 to 220/160 mmHg, while my heart rate (normally 55-60 bpm at rest) can go into the low 30s for several minutes. These are very large swings to the extremes in a short time, and can be very unpleasant and potentially very dangerous.

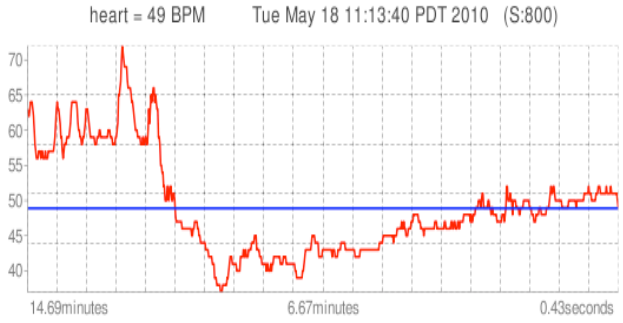
From my experience as a quadriplegic and climber, the art is in balancing the timing of the heart rate depression to only last a few moments while blood pressure

Figure 1: Example of the potential physiological effects of boosting in spinal cord injury (SCI).



rises. After this I will feel a surge of power as I "drop the hammer". If the AD is mild, my heart rate will recover and stabilize above the normal maximums. This is the ideal outcome, but not easy to achieve on demand. It is fundamental to highlight that physiologists or clinicians dealing with SCI would never recommend the practice of boosting (although commonly done by quadriplegics in high performance sport). In fact, it is their mandate to reduce the incidence of AD in SCI. However, when you are a quadriplegic hanging hundreds of feet in the air on a climbing apparatus you find yourself trying everything to be able to finish the climb safely. We choose the hazards carefully. For this reason, vital signs are monitored closely while climbing. It is even possible to stream data to the web in real time to get expert advice if needed (Figure 2).

Figure 2: Example of real-time monitoring of heart rate during induced autonomic dysreflexia with no boosting effect.



What I have learned from being around highly motivated athletes, clinicians, and qualified exercise professionals (such as CSEP-certified individuals) is simply this: "Trying Harder" will simply not work, and boosting is too dangerous for the environment (e.g., remoteness and wildness) where my sport takes place.

I am fully aware that trying to induce and modulate AD is akin to playing with fire. There is no way to know how much stimulus (pain) to apply to get a desired increase in blood pressure. Overshooting the target blood pressure increases the risk for stroke, hemorrhages or heart attack. Those living with SCI are well aware of the risks associated with AD, and they also realize that no physician or qualified exercise professional would ever recommend this practice. However, clinicians and exercise professionals should also be aware that boosting is standard operating procedure in most high-level SCI games.

Therein lies the challenge, and the debate. Little is known about how to manage AD during exercise conditions, and consequently most experts will shy away completely from this area of research. However, it is clear that persons living with quadriplegia often experience AD on a daily basis, and some even choose to induce AD to enhance their physical performance. A better understanding of the management of AD during exercise is certainly needed. Therefore, I challenge exercise physiologists and clinicians to work more closely with those living with AD to gain more insight into the effective management of AD, particularly during exercise conditions. It is considered cheating, but often happens by accident anyway. Yes, it can dangerous, but it does work for me.

A word of caution for those athletes that choose to induce AD, you should pay attention to those details…they can kill you!

Qualifications

Brad Zdanivsky's qualifications include:

- Applied Computer Science and Technology (Langara College 2005)
- Real Time, Embedded Systems and Software Design (for an example on sensors and data acquisition please see http://www.circuitcellar.com/library/print/1205/Zdavinsky-185/2.htm).
- Disability Advocate (http://verticalchallenge.org).

Editor's Notes

This article was peer-reviewed. Dr. Darren Warburton also provides a commentary related to this article in a subsequent paper.