

## **FEELING FAINT? HYPOTENSION AND SYNCOPE; MECHANISMS AND PREVENTION**

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A 25-year-old woman who was an Olympic rower competing in the single sculls event had experienced two episodes of syncope (transient loss of consciousness) immediately after a 2K time trial on a rowing ergometer. Alarming, especially for a single rower, she had warning signs while rowing on water that did not result in syncope. At the British Olympic Medical Centre<sup>1</sup>, she also admitted to the same symptoms during medical and dental procedures.

During the cardiopulmonary exercise stress testing, her maximum oxygen consumption was 60.6 ml/kg/min (185% of age and sex predicted), blood pressure (BP) and heart rate were normal during exercise. However, upon completion of the exercise stress test, her BP dropped precipitously accompanied by symptoms of pre-syncope similar to those she had experienced at the end of a workout or when rowing on water.

Dr. Greg Whyte and his colleagues at the British Olympic Medical Centre had ruled out cardiac disease and had also taken into consideration this athlete's history of the same warning (pre-syncopal) symptoms after the less demanding exercise stress test. The diagnosis of exercise-induced syncope was made.

Because of the danger of drowning should this Olympic athlete lose consciousness on the water, Dr. Whyte and his colleagues needed to come up with a program designed to maintain BP and venous return to the heart.

These were the instructions for this athlete:

- Do not abruptly stop exercise. Gradually decelerate intensity, especially after competition or high intensity workouts. She had already taken care of this herself when she was on the water because of the necessity for a single scull rower to continue rowing after the competition. However, she also needed to gradually back off intensity after her 2K row on the ergometer and her weightlifting workout.
- If unable to continue the exercise for a cooling-off period, she was instructed to cross her legs or tense the lower body muscles.

## SYNCOPE

Syncope is a short-lived loss of consciousness with inability to maintain postural tone (a faint.) It has many causes, but all have the same result, which is transient decrease in the blood supply to the brain to such an extent that the victim loses consciousness and falls to the ground. Its onset is rapid, duration short, and recovery complete and spontaneous.<sup>2</sup> Other terms for syncope are 'passed out', 'blackout', and the rather colorful British 'drop attack'. Its Greek root (synkiptein) means 'to cut short', so it is well named, since the blood supply to the brain is temporarily short-changed resulting in loss of consciousness and postural tone.

The most common type of syncope occurs when the blood vessels in the legs dilate, causing a large volume of blood to pool, leaving the heart with less blood to pump and the brain with less than an adequate amount of oxygen to maintain consciousness. This type of syncope is self-correcting in that once the person collapses to the ground, gravity is no longer an issue and blood returns to the heart and brain – unless some helpful soul props the victim up. The problem is of course, injury in the fall. Collapsing like a rag, helplessly to the ground is not something we want to do. Luckily, most of the time there are warning signs and body positions we can assume to prevent the faint. These will be demonstrated in Dr. Wieling's video.

**Vasovagal syncope.** This is a common type of syncope seen in young adults who have no structural heart disease. It has no specific trigger,<sup>3</sup> and is caused by prolonged standing or emotional distress such as fear, pain, blood draws, etc. and is usually preceded by warning signs (prodromal symptoms).

**Situational syncope.** This type of syncope may be triggered by exercise, playing a wind instrument, or something as ordinary as a meal, a cough or sneeze, urination or defecation. It knows no age constrictions.

**Syncope caused by carotid sinus hypersensitivity.** Within the carotid artery just below the angle of the jaw in a place called the carotid sinus there are special cells that are sensitive to pressure and in some cases can be hypersensitive to pressure. Pressure on the neck over the carotid sinus can mimic that of arterial hypertension, setting up a concatenation of reflexes and responses from the nerves in the carotid sinus to the brain and then the heart and systemic arteries. The heart slows down its rate and conduction velocity, and the systemic arteries dilate in order to relieve the perceived arterial pressure.

In those who are hypersensitive, even mild pressure on the carotid sinus can elicit profound bradycardia (slow heart rate) and a drop in systolic BP for 3 seconds or more or even asystole. The definitive diagnosis is made in the clinical setting with carotid sinus massage, BP and ECG documentation. Of interest, one study,<sup>4</sup> documented with sinus node electrograms (direct recordings) during carotid sinus stimulation has shown profound changes in conduction between the sinus node pacemaker and the atrial myocardium, including complete block. Clinically, carotid sinus massage is avoided when the patient is >65 years of age; in such cases, sinus pauses of up to 7 seconds have been reported.

Carotid sinus hypersensitivity is more common in the elderly than in the young or middle aged. However, it is known to occur in isolated cases of young athletes. The physicians in the syncope unit at the Academic Medical Center, University of

Amsterdam<sup>5</sup> relate the case of a man who lost consciousness during a cycling race while looking back to check out the competition. When the cyclist was seen in their syncope unit, carotid sinus massage triggered cardiac arrest for 8 seconds and a diagnosis of carotid sinus syndrome was made.

**Syncope due to orthostatic hypotension.** Orthostatic hypotension is an abnormal fall in BP upon standing. As you will see in the continuous BP graph in Dr. Wieling's video, normally when one stands from a sitting or lying down position, the BP dips slightly, the blood vessels in the legs respond quickly by constricting, leaving the individual with no awareness of what has transpired.

## POST-EXERCISE HYPOTENSION

In young healthy individuals with normal BP, moderate-intensity dynamic exercise for 30–60 minutes produces a post-exercise BP reduction of only 5–10 mm Hg in the supine position that lasts several hours, but is insufficient to cause symptoms and passes unnoticed.<sup>5,6</sup> However, a few individuals develop pre-syncopal symptoms if they remain standing or even seated after a workout; if standing motionless after a workout, syncope may occur during the first 5 to 10 minutes. Once lying down, recovery is rapid.<sup>7</sup>

## A CROSSFIT SANTA CRUZ STUDY

All studies that I have found on post-exercise hypotension are based on “medium intensity” workouts. At CrossFit Santa Cruz we thought it would be of interest to look at the BP after an intense workout. A group of very fit men and women volunteered to have BP measurements before and after a typically intense anaerobic/aerobic workout.

In this study we were comparing BPs in our athletes to published data of 5-10 mm Hg reduction in BP after moderate intensity exercise. Over the two days of CrossFit workouts, we found 6-29 mm Hg reduction in post-workout BP in  $\frac{3}{4}$  of the group.

### Workout Day-1

5 rounds for time of:  
5 Power Cleans  
5 Handstand Push ups  
(Men's weight 185 lbs;  
Women 102 lbs)

### Workout Day-2

Run 800 meters  
Then complete 21-15-9:  
Kettlebell swing  
Burpee

## MECHANISM OF POST-EXERCISE HYPOTENSION

- **Decreased vascular resistance.** This dilatation of the blood vessels increases the volume of venous pooling.
- **Muscle pump.** During exercise, the rhythmically contracting skeletal muscles in the leg reduce the degree of venous pooling in the lower body by squeezing veins to pump blood back to the heart. This phenomenon is known as the “muscle pump”.<sup>8</sup> During passive recovery from exercise, the muscle pump is absent and there is less blood entering the heart (decreased preload).

- **Fluid loss during exercise.** The loss of the muscle pump, blunted vasoconstriction, and the increase in venous pooling is compounded by fluid loss during exercise, especially during hot weather. All of this translates into a loss of plasma volume, less blood into the heart, and hypotension.
- **An increase in heart rate and contractility.** The fall in BP is sensed by the baroreceptors with compensation in the form of a faster heart rate, improved cardiac contractility, and a steal of blood flow from the skeletal muscles and the gut in favor of the central veins. The heart is still unable to pump enough blood to offset the effect of venous pooling in the lower extremities and the effect of loss of fluid on plasma volume. It is therefore not surprising that when the affected individual remains standing or in the seated position after an intense workout, their BP dips even lower causing symptoms of post-exercise hypotension.<sup>9 10</sup>

### SYNCOPE DURING EXERCISE

Syncope during exercise is diagnosed when the exercise is continuous, the loss of consciousness sudden and within the exercise time frame, and the person must have collapsed to the ground (loss of postural tone.) Such an event has serious implications and the individual should see a Cardiologist, who will want to rule out underlying structural cardiovascular conditions and arrhythmias with an ECG, exercise testing and echocardiography.<sup>5</sup>

That is not to say that syncope cannot occur during exercise in a person without a cardiovascular condition. In 2002, a study was completed involving 33 highly trained athletes with exercise related syncope. All were competing at national or international levels; none had evidence of cardiac disease. But, a little over half of them had in the past at least one syncopal episode *during* exercise almost exclusively associated with running. Because tests for cardiovascular disease were negative, training and participation in competition continued during up to 68 months of follow-up. The danger of course, was traumatic injury should syncope occur. All were instructed in ways to counteract hypotension, extremely valuable to 23 of the athletes in the study who had warning symptoms (nausea, profuse sweating, lightheadedness, rapid heart rate, epigastric discomfort). Although the prevalence of syncope during exercise is reportedly low, the consequences of misdiagnosis are serious. An individualized and thorough diagnostic evaluation is needed.<sup>11</sup>

### CATHERINE'S STORY

"Fainting, passing out, whatever you want to call it, has happened to me on numerous occasions. It is actually extremely humiliating, but you have little control over it. My first experience with fainting was as a child. I was standing for too long with my knees locked. I guarantee you I never locked my knees again. I fainted once while having my skinned knee cleaned, fell and hit my head on a concrete floor and got a concussion. In my adult life, I have fainted while ill with Giardia and while working out when I had an undiagnosed case of pneumonia. Recently I have fainted after donating blood.

Movies and books always portray fainting as something that happens unexpectedly and suddenly. For me, it is a slow process and everything is moving in slow motion. The first sensation is feeling lightheaded, then my eyes lose the ability to focus. Colors become muted. I've heard some people say they lose the ability to see colors, particularly red. Then I get really hot. So hot that an ice pack on my stomach, chest and back of the neck feels perfect. Then comes the dark.

It is important to get yourself to a safe place, before the dark. Nobody wants to faint. It is embarrassing to have to sit down or even lie down in a public place, but it beats falling down. The only times I have gotten hurt fainting is when I failed to pay attention to the signals my body was sending."

### WHEN YOU FEEL A FAINT COMING ON

This video has been sent to us by W. Wieling M.D., Ph.D., Director of the Syncope Unit at the Academic Medical Centre, University of Amsterdam, The Netherlands. The video was accompanied with a message for you from this kind, humble, and famous physician and researcher.

*"It will be a pleasure to inform the Crossfit world about physical counterpressure maneuvers. You can use the DVD the way you feel it will be effective." W.Wieling*

#### [When you feel a faint coming on](#)

**Lying flat with the legs elevated** remains the classic maneuver to avoid fainting. However, when one is in a public place or faced with the problem of recurrent syncope, alternative maneuvers need to be offered. In a CrossFit gym, a flop on the floor is common and perfectly acceptable (even if you haven't been working out); but think for a minute of doing that downtown. There are a number of things you can do to abort the chain of events that ends in syncope. Recognition of prodromal signs, described in "Catherine's Story", and early use of counter pressure maneuvers are pivotal to the prevention of syncope.

Each of the maneuvers listed below prevents syncope and can be chosen according to the particular social scenario—whichever is comfortable.<sup>5 12 13</sup>

- **Keep moving or sit.** This may be all that is needed.
- **Standing leg crossing (without muscle tensing)** can be used preventatively in scenarios that are known to result in pre-syncope and syncope. As Dr. Wieling explained in the video, this maneuver increases leg muscle tension, decreasing the volume of blood in the legs. The blood available for the heart to pump is increased and the brain receives more oxygen.
- **Standing leg tensing plus total body tensing.** The video is your best reference to actually see on the BP graph that this maneuver is very effective and, as with leg crossing, is unobtrusive.
- **Head between the knees,** if sitting. If cycling, bend over the bicycle.
- **Squatting.** Sink into a deep squat for 1 min. If the BP is falling rapidly this is a most effective maneuver. As you noted in the video this action raises the BP

dramatically. Upon rising, tense the muscles as described for 40 seconds to avoid another fall in BP.<sup>15 16</sup>

- **Lie down.** If syncope is imminent and you are in a public place or social situation, at this point you really won't care what people think! Sinking to the ground under control is far better than a helpless collapse that may result in serious trauma.
- **When donating blood.** If you are in a semi-recumbent position, ask to be lying flat during the procedure. When you sit up or stand after the procedure, tense your legs and abdominal muscles and clench your buttocks for 40 seconds.

### **SYNCOPE IN PILOTS—THE G-SUIT AS A WEAPON**

In the early days of World War II, a strong whole-body clenching maneuver was tested and prescribed by Earl Wood M.D, Ph.D (1912-2009) and his group at Mayo Clinic for U.S. fighter pilots, who were blacking out during high centrifugal force in fast, tight turns and dives. Although very effective, it precluded concentration on the enemy.

Soon the same group at Mayo Clinic, one of them a pilot, invented the G-suit (Gravity suit) so that our pilots could concentrate on fighting the enemy and not become a helpless casualty.<sup>17 18</sup> The G-suit is still used today by high performance pilots, astronauts, and by the 2005 researchers in Amsterdam<sup>12</sup> who explain in detail in their article, the physiology, not only of the counter-pressure maneuvers listed herein, but also of the G-suit.

### **IN THE EYES OF OTHERS**

For the observer or the non-fainting friend, recognition of the signs and symptoms of a faint prior to the loss of consciousness may give you time to physically support the victim and avoid an unsupported fall to the ground for them. The person may not be thinking clearly, which you may not consider unusual. However, fixation of the eyes in the midline and a 'frozen' appearance should get your attention, especially if you're tuned in and know that this person has the tendency to faint. The victim might report that colors have gone strange. This is followed by complete loss of vision (blacking out) and the eyes rolling up; there is no incontinence.

**If blood supply to the brain tapers off slowly**, as it did in Catherine's case, there are warning signs (prodromal or pre-syncope symptoms). She has accurately described her own symptoms. They seem to differ a little from person to person. Those symptoms not experienced by her are nausea or abdominal discomfort, weakness, profuse perspiration, and tinnitus (ringing in the ears.) Tinnitus can actually be an early enough warning to prevent fainting. The inner ear is less protected against a reduction in blood supply than the brain so that ringing in the ears may be an excellent early warning sign for some individuals.<sup>19</sup>

**If blood flow to the brain ceases more abruptly**, as when the heart stops pumping completely, there are only a few seconds before loss of consciousness and more dramatic symptoms may appear, such as spasms and jerks, which have nothing to do with epileptic seizures.<sup>20</sup>

**During or after the workout?** Apart from physically attending to the person who has fainted, there is an important question that needs to be addressed if the faint occurred in a workout setting. Did the person lose consciousness after the workout or without warning when the exercise was on-going and a sudden drop to the ground? Should the latter be the case it is important for the person to seek medical attention. The Physician will want to know the circumstances surrounding the sudden loss of consciousness and of any spasm-like movements while unconscious. The possibility of structural heart disease is less likely if the event occurred after the person finished the workout.

### **ADVANTAGE OF EXERCISE FOR HYPERTENSIVES**

**The young.** The effect of exercise on a young individual with hypertension is more pronounced than in the elderly. The BP dip may be as much as 20 mm Hg and lasts up to 12 hours following a workout of moderate intensity.<sup>5</sup>

**The old.** This effect is not as pronounced in the elderly, but lasts longer. One study involving 69 year olds with high BP, found that exercise significantly reduced BP for a 22-hour period.<sup>21</sup> For those elders with hypertension who wish to exercise, this is very good news. Even if there were no desire to exercise, this fact alone would surely get a person moving!

**The medicated.** If your trainee is an older person who is taking anti-hypertensive medications, be aware that the chance of developing prodromal symptoms and loss of consciousness is increased because of the vasodilatation already in place.<sup>22</sup> The trainee should be made aware of warning symptoms and the necessity to use specific maneuvers described herein to raise the BP.

**The victories.** There have been isolated albeit undocumented cases of young men in the prime of their careers starting CrossFit with hypertension, having been advised by their Physicians to “find another line of work”, and within 3 months of consistent CrossFit training and workouts have been able to discontinue their medications, enjoy a normal BP, and continue their chosen profession.

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