Sport for athletes with spinal cord injury has grown rapidly since its humble beginnings during the Second World War, when injured war veterans were encouraged to participate in sport as a form of therapeutic exercise to enhance rehabilitation. In the 50 years since then we have seen a tremendous increase in participation, visibility, sophistication of training techniques and equipment, level of athletic excellence, and funding for wheelchair sport.

No longer do athletes with spinal cord injuries consider sport simply as a form of rehabilitation. For many it is an important part of their recreational lifestyle. Increasing numbers are becoming professional athletes, training and competing full time and living off race earnings and advertising endorsements.

Not surprisingly, these athletes are keenly interested in techniques to improve their sport performance. One such technique has been termed “boosting.” Boosting is the practice of intentionally inducing autonomic dysreflexia to enhance athletic performance.

**Effects of Boosting**

Autonomic dysreflexia is a condition in which blood pressure rises dramatically as a result of a range of painful stimuli occurring below the level of the spinal cord lesion, for example, a full bladder or a broken limb. The condition tends to occur in individuals with spinal injury levels above the sixth thoracic vertebrae and results from impaired autonomic nervous system communication. The proposed pathophysiology of the syndrome is as follows:

The cell bodies of the sympathetic nervous system are contained in the spinal cord between the first thoracic (T1) and first lumbar (L1) levels. Most of the parasympathetic nervous system is controlled from the brain stem. Under normal circumstances, the autonomic nervous system controls homeostasis, thanks in part to feedback between the spinal cord sympathetic centers and the brain stem parasympathetic centers via the spinal cord.

As a result of spinal cord injury above the T6 level, however, these two centers are disconnected from each other and normal autonomic homeostasis is disrupted. This becomes particularly evident when a noxious stimulus is inflicted on part of the body distal to the spinal cord injury level.

Even though not consciously perceived, the peripheral nerves carry the pain message to the spinal cord where it is relayed as far up as the spinal cord lesion. Reflex connections between the pain-carrying tracts and the sympathetic cell bodies of the spinal cord are activated, resulting in unchecked sympathetic outflow to various organs.

The magnitude of the autonomic nervous system response to painful stimuli is exaggerated in persons with high spinal cord injury (SCI). This is due to a number of factors including loss of ability to regulate blood pressure and the increased sensitivity of nerves to stimuli as a consequence of injury.

The end result of the mass sympathetic discharge is peripheral piloerection and vasoconstriction. This is clinically manifested as goose flesh, shivering, pallor, and sweating distal to the level of the spinal cord lesion in conjunction with elevated blood pressure.

The elevation of blood pressure stimulates aortic and carotid baroreceptors (which lie peripheral to the spinal cord), activating the parasympathetic nervous system above the level of the injury. This is manifested by facial flushing, vascular headache, nasal stuffiness, and bradycardia (Erickson, 1980) (Figure 1).

Autonomic dysreflexia has traditionally been considered a
impaired autonomic regulation & communication

mass sympathetic outflow
- vasoconstriction
- increased BP
- piloerection

Baroreceptors
Carotid sinus
Aortic Arch

parasympathetic

vasodilatation
vascular headache

sympathetic

bradycardia

spinal cord lesion level

noxious stimulus
eg:
distended bladder
full colon
pressure sore
seat position

Figure 1 Proposed mechanism of autonomic dysreflexia.

Major emergency in spinal cord medicine, as associated extreme elevations in blood pressure can lead to cerebral hemorrhage, blindness, aphasia, seizure, cardiac dysrhythmia, or death.

Despite this, some SCI athletes intentionally induce autonomic dysreflexia (boosting) prior to or during competition in order to take advantage of the mass sympathetic nervous system discharge and resultant catecholamine (adrenaline, noradrenaline) release.

Although some athletes with spinal cord injury have reported that boosting is a common and effective practice, no scientific study of the practice was undertaken until 1994.

Athletes’ Experiences With Boosting

The investigation conducted by Burnham et al. in 1994 involved detailed assessment of 8 world-class quadriplegic wheelchair road-racers who responded to questionnaires about their experience and perception of boosting. They also were subject to multiple scientific measurements while participating in simulated wheelchair road races and VO₂ max tests under boosted and unboosted conditions.

The purpose of the investigation was to determine whether boosting is an effective performance enhancing technique and, if so, how it works and whether it is safe. In summary, the investigation revealed the following:

1. The athletes indicated that the practice of boosting was widespread and they felt it was effective.

2. Most of the athletes induced boosting by bladder over-distention; they achieved this by drinking large quantities of fluid prior to the race and sometimes clamping an indwelling catheter. Other methods included using tight leg straps to cause pressure to the skin or sitting on a sharp object in the wheelchair.

3. Boosting proved effective, as evidenced by a mean race time improvement of 9.7%.

4. Blood pressure was significantly higher in the boosted state; moderately hypertensive levels were detected in 13 of 192 recordings, and severely hypertensive levels were detected twice. The highest recorded BP was 220/120 mmHg.

5. Boosting was associated with significantly increased blood levels of noradrenaline, increased oxygen uptake, and greater arteriovenous oxygen difference, suggesting that peripheral oxygen utilization was enhanced with boosting. This may be due to improved redistribution of blood flow.

The Ethics Challenge

Boosting presents a challenging ethical dilemma. It is a remarkably effective performance enhancing technique. However, not all athletes are capable of boosting as effectively as others, and this makes it unfair. It can be danger-