Autonomic dys

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Staff Physician, GF St
Chair of Internati

Objectives

- To introduce anatomy and physiology of autonomic nervous system
- What do we know about autonomic dysfunctions in Paralympics athletes? Are the autonomic dysfunctions the same for Paralympic athletes with Spinal Cord Injury, Polio, or Multiple Sclerosis?
- To outline major known autonomic dysfunctions:
  - cardiovascular dysfunctions
  - control of sweating and temperature
  - bladder/bowel dysfunctions
- To discuss issues related to autonomic dysreflexia and boosting.
- What is the future?

Autonomic nervous system 101.

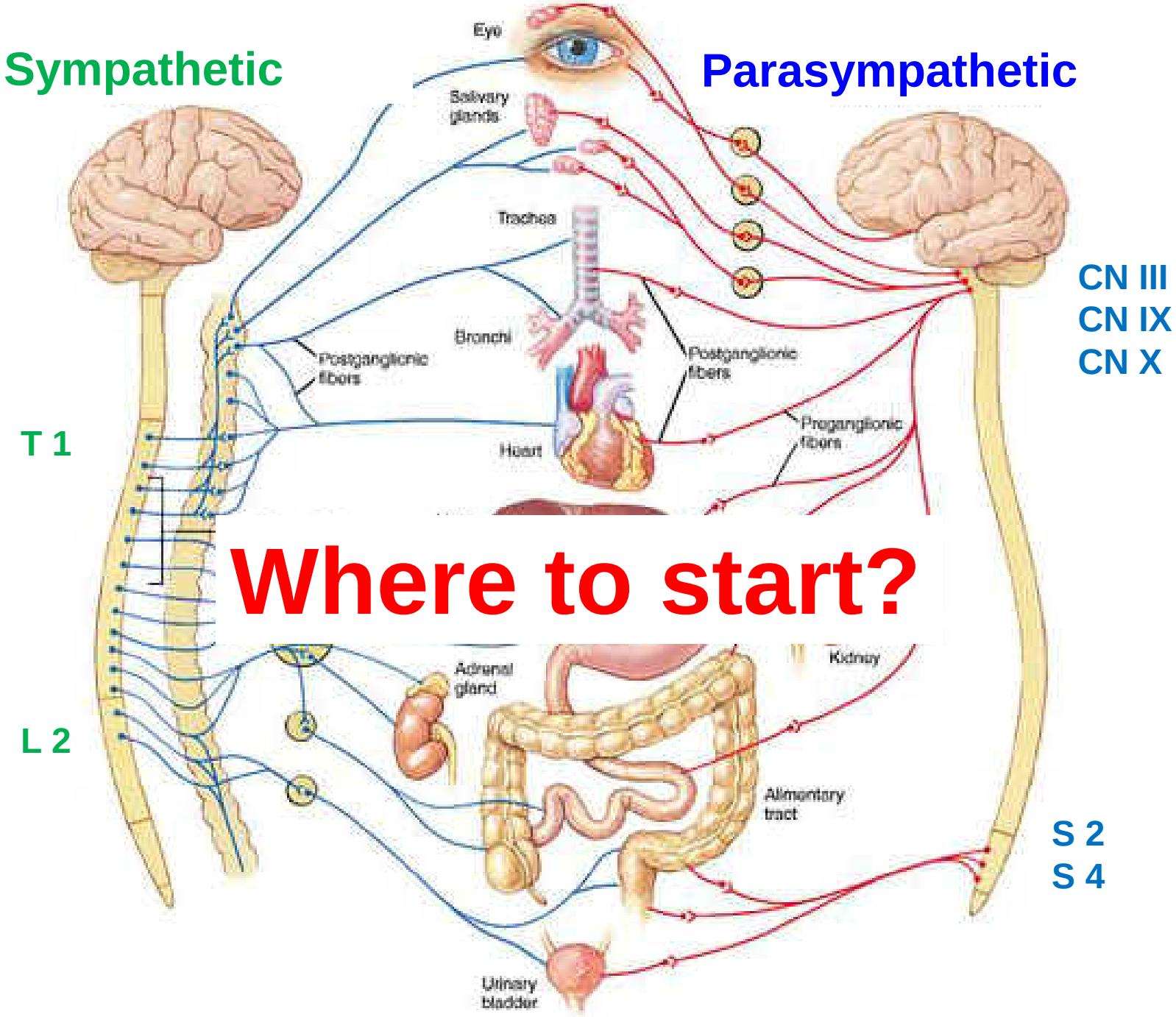
Q 1. Autonomic nervous system is …

A. … part of the vertebrate nervous system that regulates involuntary actions

B. … also known as vegetative

C. I have no clue what you are talking about

D. A+B


Sympathetic
Parasympathetic
Eye
Salivary glands
Trachea
Bronchi
Postganglionic fibers
Postganglionic fibers
Preganglionic fibers
Heart
T 1
CN III
CN IX
CN X
Where to start?
Adrenal gland
Kidney
Alimentary tract
L 2
S 2
S 4
Urinary bladder

Fight and flight response

Introduction

- Since 1980 we stopped using medical classification for Paralympic games and implemented Functional classification.

- In order to appreciate the impact of autonomic nervous system on Paralympic athletes we have to appreciate medical conditions of these athletes.

- The knowledge of the medical conditions could give us insight to some specifics of the autonomic deficits in some of these conditions. Autonomic dysfunction in some medical conditions are studied in more details than in others.

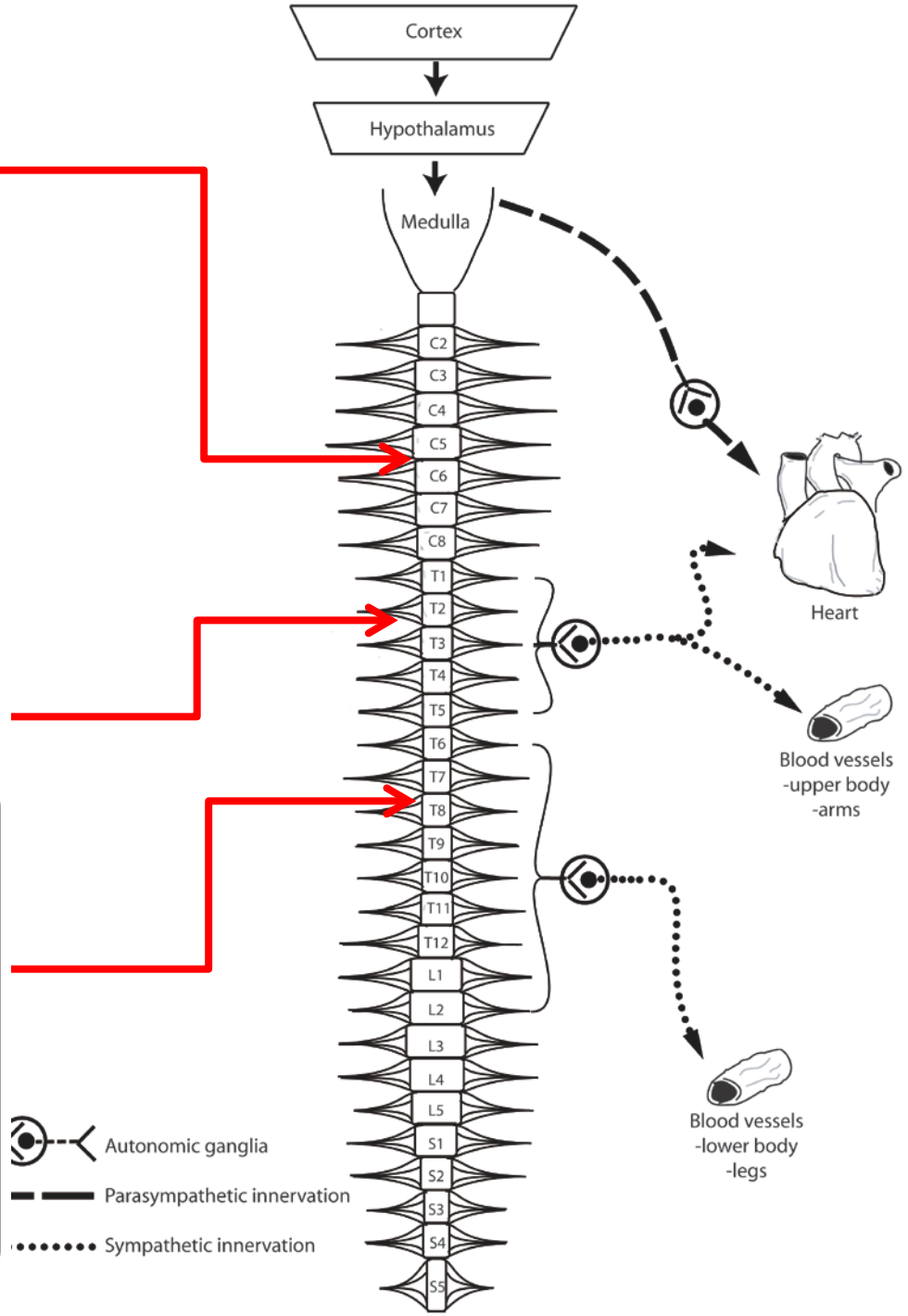
  - Spinal cord injury
  - Spina bifida
  - Multiple sclerosis
  - Cerebral palsy
  - Friedreich's ataxia
  - Polio
  - and others

Cardiovascular control in Paralympic athletes with SCI

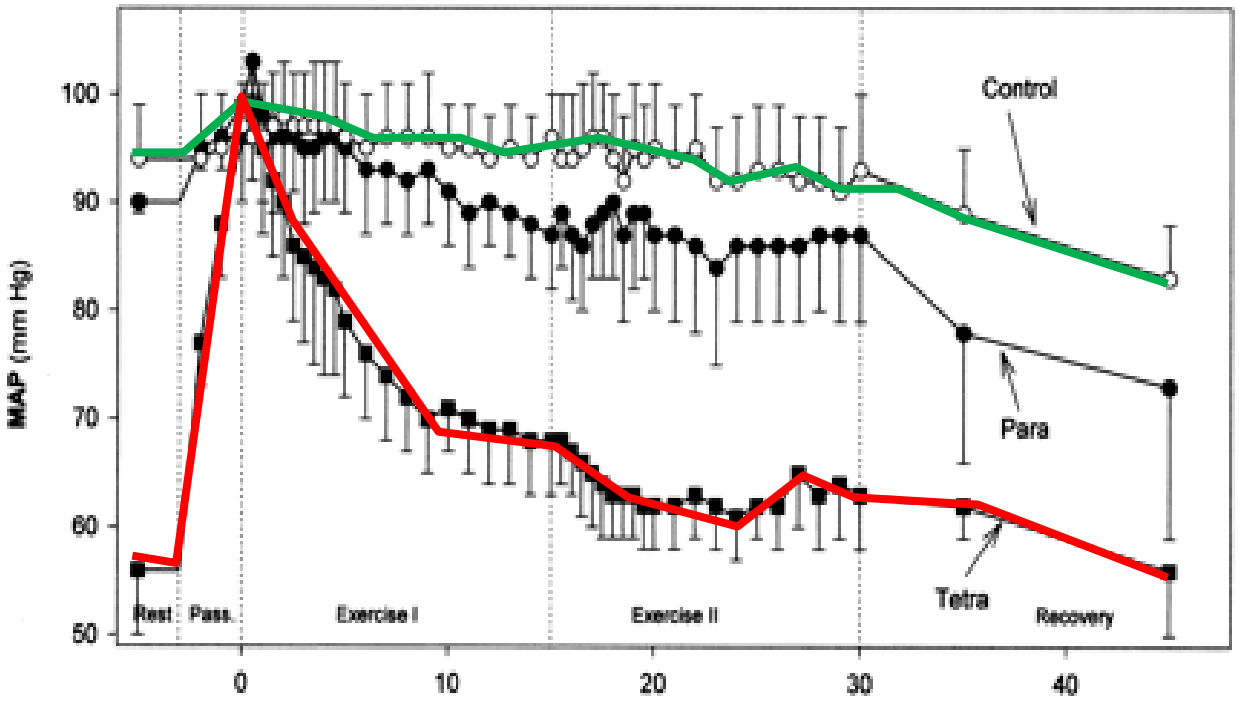
Cervical SCI:
Autonomic control: Loss of supraspinal control of the spinal sympathetic neurons controlling heart and blood vessels below the level of injury; the parasympathetic (vagal) control of the heart is intact.
Possible cardiovascular outcomes that could affect athletic performance:
- Low arterial blood pressure,
- Orthostatic hypotension
- Frequent episodes of autonomic dysreflexia
- Impaired blood redistribution
- Low stroke volume, heart rate and cardiac

High-thoracic SCI (Injuries between T1-T5):
Autonomic control: Loss of supraspinal control to the spinal sympathetic neurons controlling splanchnic and lower-body vasculature. Depending on the level of injury supraspinal control of the spinal sympathetic neurons controlling heart will be partially or fully intact; parasympathetic (vagal) control of the heart is intact.

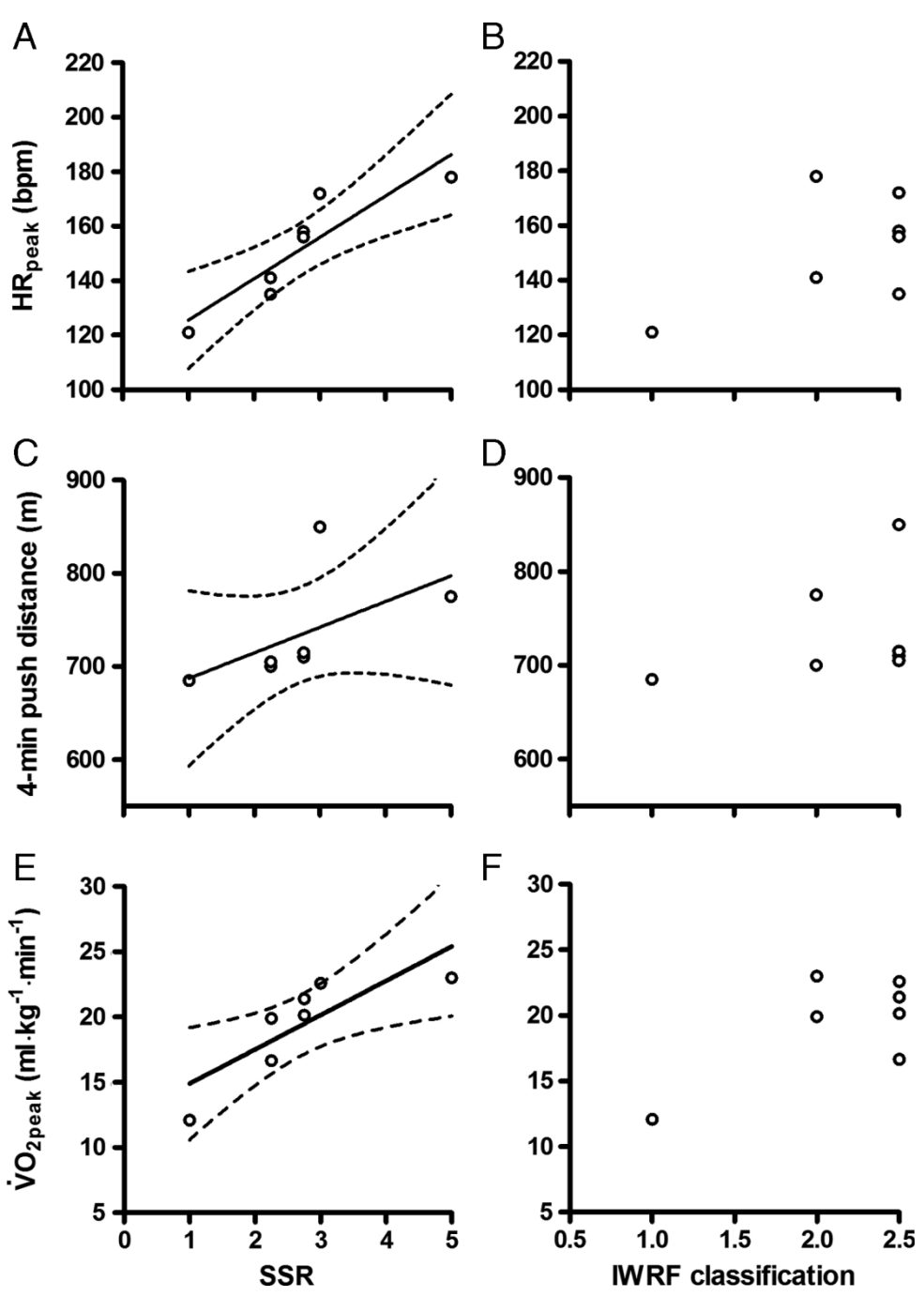
Mid-thoracic and lower SCI:
Autonomic control: Loss of supraspinal control to only portion of the spinal sympathetic neurons controlling blood vessels below the level of injury; however, the heart has intact sympathetic (T1-T5) and parasympathetic (vagal) control.
Possible cardiovascular outcomes that could affect athletic performance:
- Resting blood pressure could be within normal range
- Episodes of autonomic dysreflexia are less common or absent
- Heart and blood pressure responses to exercise are typically intact



Responses in blood pressure to excesses (Control non SCI, and individuals with Paraplegia and Tetraplegia)



Dela et al Circulation. 2003



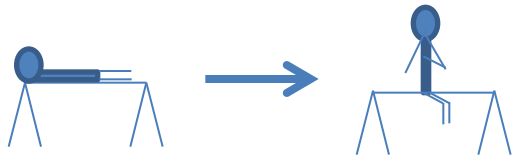
Autonomic Function and Exercise Performance in Elite Athletes with Cervical Spinal Cord Injury

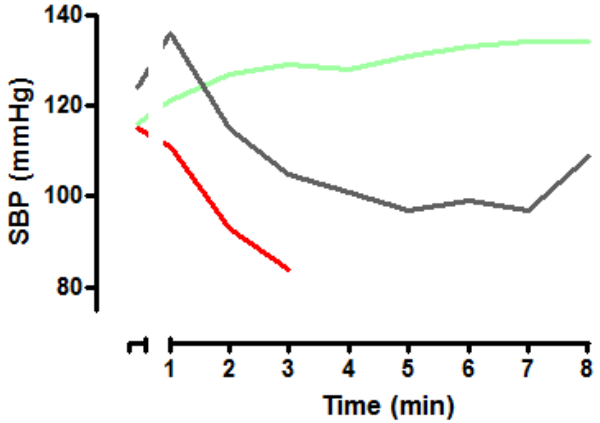
CHRISTOPHER R. WEST[1], LEE M. ROMER[2], and ANDREI KRASSIOUKOV[1,3,4]

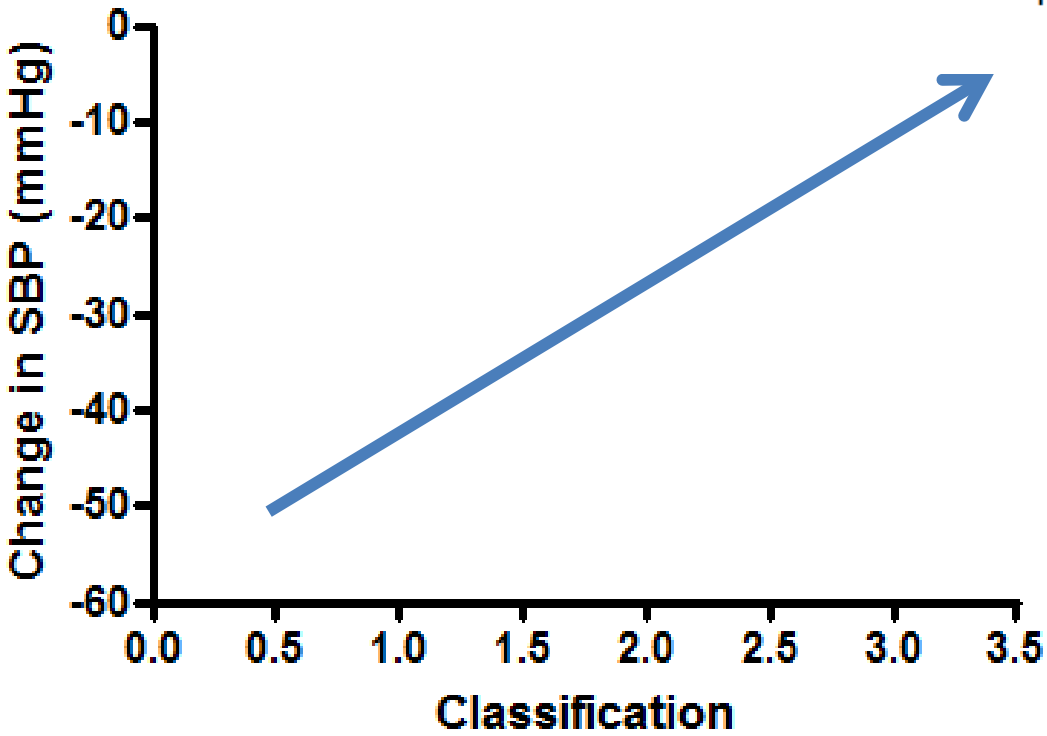
[1]International Collaboration on Repair Discoveries (ICORD), University of British Columbia, Vancouver, CANADA; [2]Centre for Sports Medicine and Human Performance, Brunel University, Uxbridge, UNITED KINGDOM; [3]Division of Physical Medicine and Rehabilitation, Department of Medicine, University of British Columbia, CANADA; and [4]G. F. Strong Rehab Centre, Vancouver, CANADA

MEDICINE & SCIENCE IN SPORTS & EXERCISE 2012

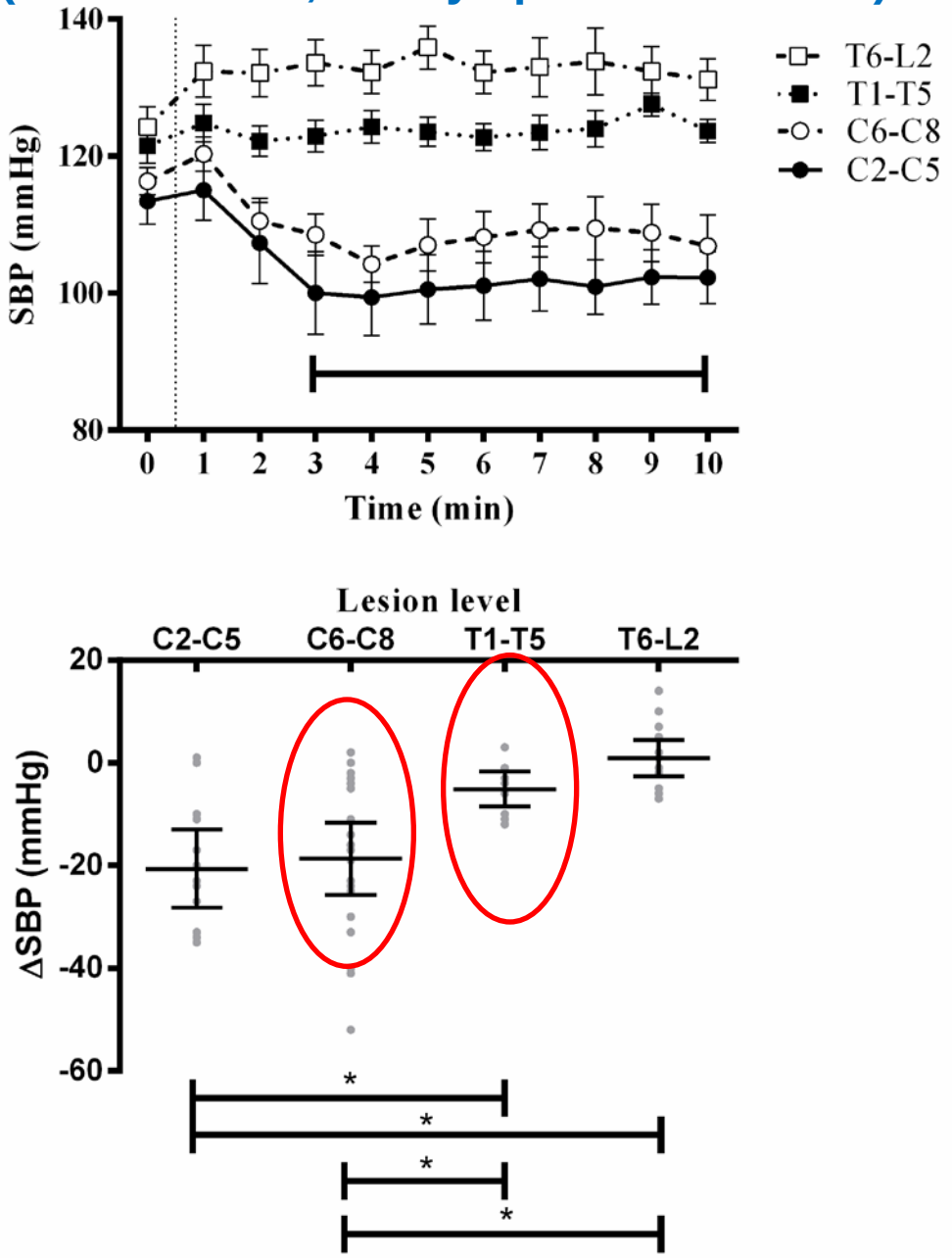
- 7 Paralympic Wheelchair Rugby athletes
- Autonomic battery: SSRs, Orthostatic challenge test
- Performance assessment: HR peak, 4 min push, VO2 peak
- The degree of preserved SSRs (autonomic spinal integrity) but not motor function established by International Wheelchair Rugby Federation classification correlated with HR peak, 4min push distance, and VO2 peak.




SBP (mmHg)
140
120
100
80
1
2
3
4
5
6
7
8
Time (min)

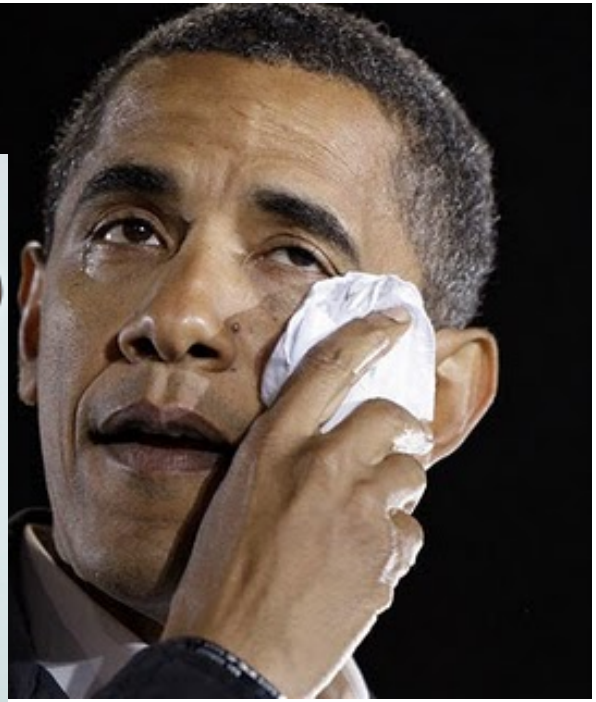

Change in SBP (mmHg)
0
-10
-20
-30
-40
-50
-60
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
Classification

Responses to orthostatic challenge test (sit up test) in SCI Paralympic athletes (London 2012, Paralympic Games n=57).



Sweating and Thermoregulation in Paralympic athletes with SCI

Sweating: blessing or curse?



J. Physiol. (1958) 142, 406–419

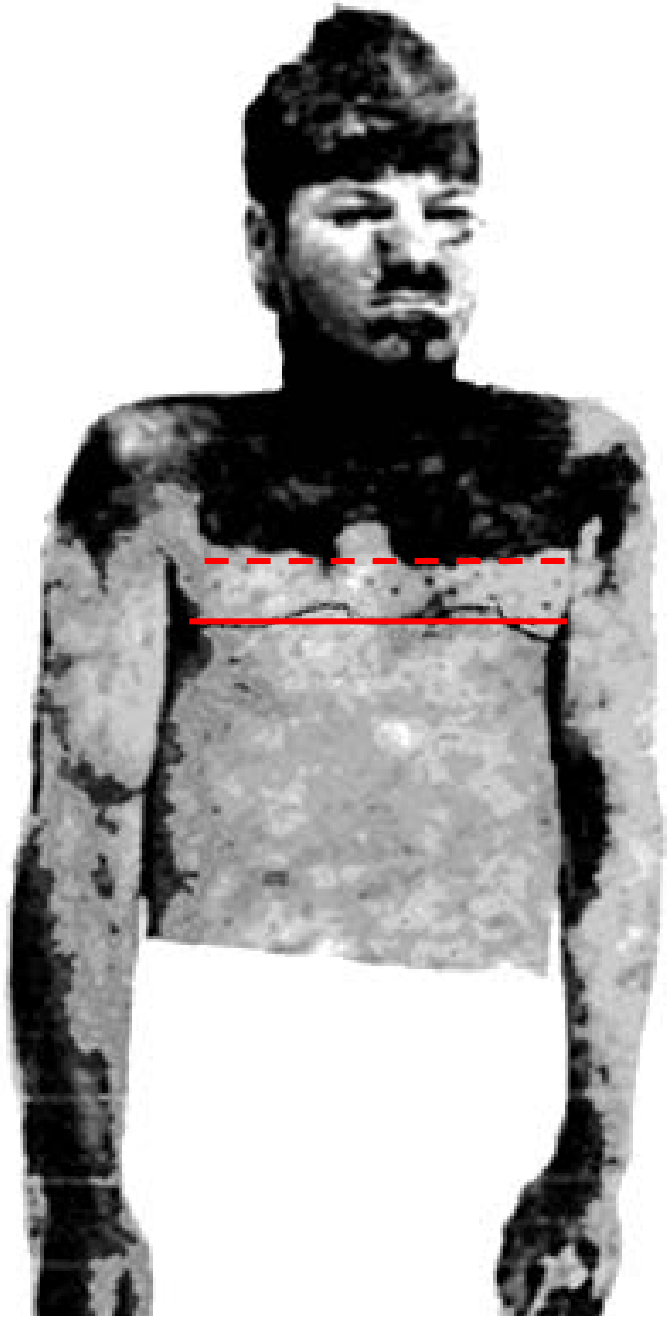
THERMOREGULATION IN SPINAL MAN

By L. GUTTMANN, J. SILVER and C. H. WYNDHAM

From the National Spinal Injuries Centre, Stoke Mandeville, Aylesbury, Bucks, and the Applied Physiology Laboratory, Transvaal and Orange Free State Chamber of Mines, Johannesburg

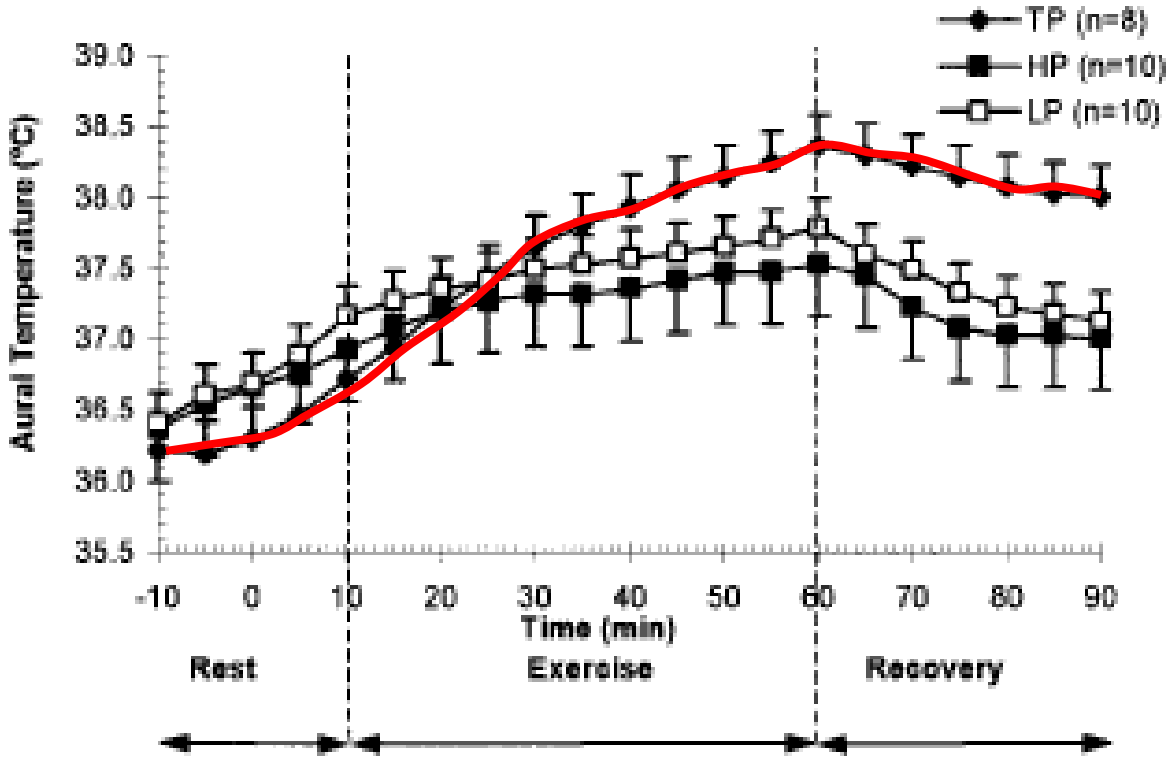
(*Received* 3 *March* 1958)

- Individual with a complete lesion at **T4** during early stages of thermoregulatory sweat test.
- Dotted line illustrates border of analgesia and uninterrupted line that of anaesthesia.
- Sweating is confined to the face, neck, upper limbs, and upper chest, and there was complete anhidrosis below that level in the first stages of the test.
- In later stages, sweating gradually extended to **T10**.



A starch iodine test results in purple to black discoloration which delineates the affected area of excessive sweating.

Price et al Med Sci Sport Exerc 2003.



- Aural temperature in athletes with tetraplegia (TP) high and low paraplegia (HP; LP) at rest, during exercise, and recovery in warm conditions.

- Pronounced increased in auricular temperature was observed for TP athletes, who demonstrated a much greater imbalance in temperature regulation.

- Increasing the exercise or environmental strain may result in the thermoregulatory responses of athletes with SCI being compromised.

Circulatory dysfunctions in other conditions

- **Spinal Bifida:** High arterial wall shear stress and endothelial dysfunction were reported in SB compared with SCI that could predispose these individuals to cardiovascular disease. Boot et all. Spinal Cord. 2003
- **Polio**: Orthostatic instability, due to peripheral nervous system deterioration and muscle atrophy is documented. Borg et al. Acta Neurol Scand. 1988.
- **MS:** Orthostatic hypotension and Postural orthostatic tachycardia syndrome (POTS) reported among individuals with MS. Adamec et al. J Neurol Sci. 2013
- **Cerebral palsy:**
  - HR variability demonstrates that individuals with cerebral palsy present cardiovascular changes consistent with disturbed sympathovagal balance. Ferreira et al. J Oral Pathol Med. 2011
  - The decrease of heart rate variability in children with cerebral palsy is related to the motor impairment level. Zamunér et al. Res Dev Disabil. 2011

Other Conditions and Temperature dysfunctions:

- **MS:** heat sensitivity and central regulation of body temperature are among major issue for individuals with MS. Davis et a J Appl Physiol (1985). 2010
- **Polio:** known temperature dysfunctions (low amplitude of SSRs were reported) Emad et al Iran Red Crescent Med J. 2011
- **Spina Bifida:** skin temperature and peripheral circulation could be compromised depending on the severity of neurological deficits.

Autonomic dysreflexia and Boosting

Spinal Cord (2005) 43, 738–740

www.nature.com/sc

Case Report

Cerebral hemorrhage due to autonomic dysreflexia in a spinal cord injury patient

M Vallès[1], J Be
[1]*Spinal Cord In*

Review

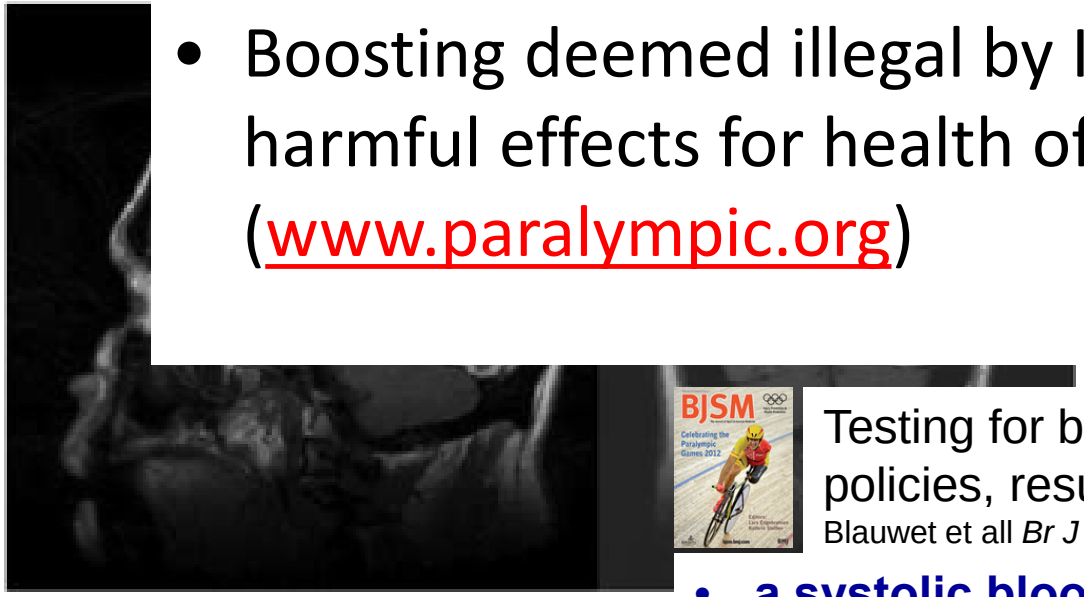
Life-threatening outcomes associated with autonomic dysreflexia: A clinical review

Darryl Wan[1], Andrei V. Krassioukov[1,2]

[1]Department of Medicine, International Collaboration on Repair Discoveries (ICORD), University of British Columbia, Vancouver, BC, Canada, [2]Vancouver Coastal Health, Vancouver, BC, Canada

Context: Autonomic dysreflexia (AD) is a life-threatening complication of chronic traumatic spinal cord injury (SCI).

- **Mean BP during life-threatening**



- Boosting deemed illegal by IPC due to possible harmful effects for health of athletes' (www.paralympic.org)

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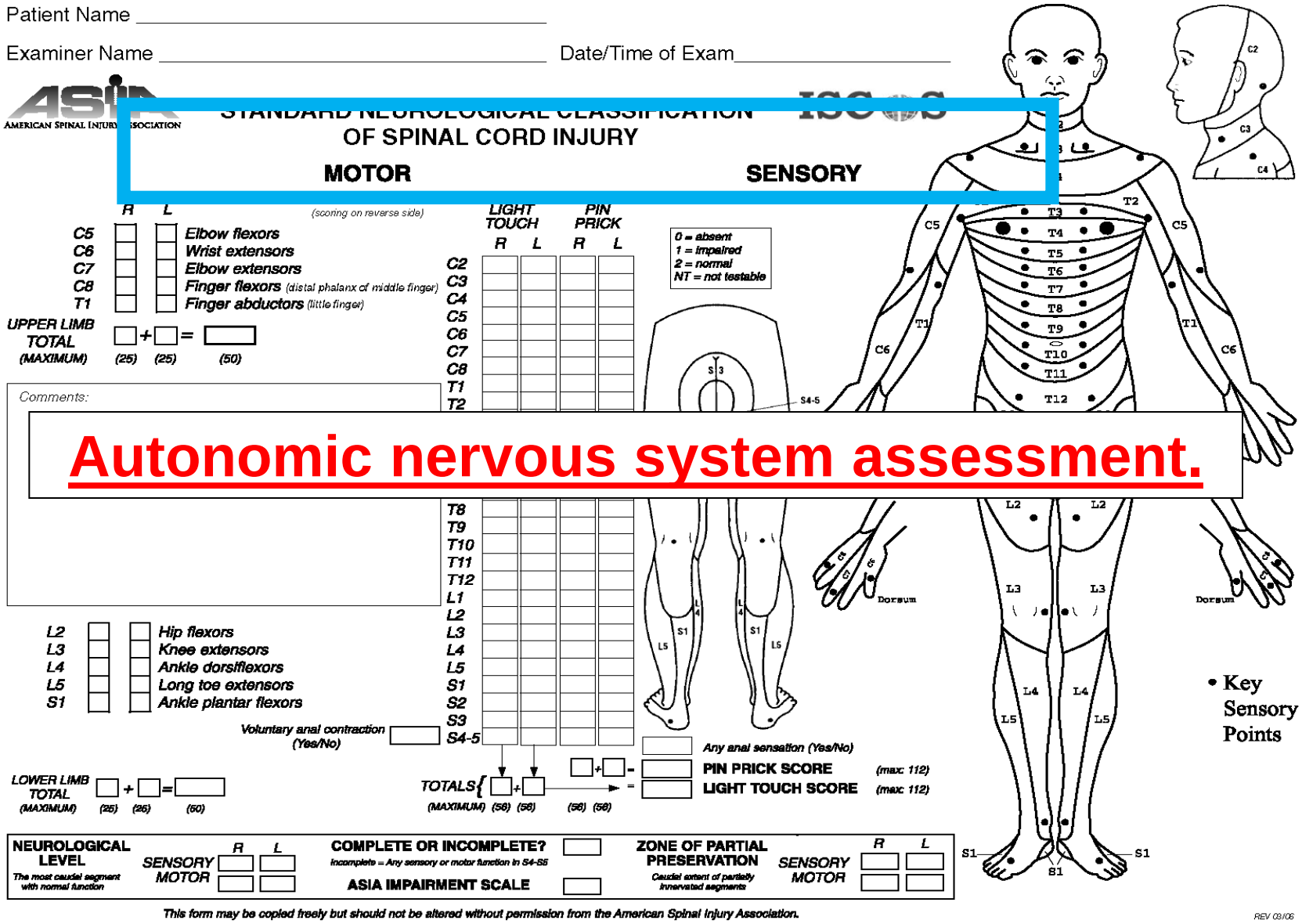
Testing for boosting at the Paralympic games: policies, results and future directions.
Blauwet et all *Br J Sports Med* .2013.

- **a systolic blood pressure of ≥180 mmHg was considered a positive test.**
- **the average systolic and diastolic blood pressures were 135 mm Hg (range 98-178) detected**
- **no positive test for boosting were detected**

What is next?

ASIA Impairment Scale. What is missing?



Evaluation of individuals with SCI 2008

Page 1

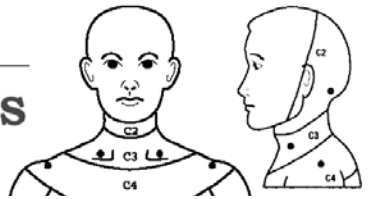
_____

_____ Date/Time of Exam_____

ASIA AMERICAN SPINAL INJURY ASSOCIATION

STANDARD NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

ISCOS



MOTOR **SENSORY**

KEY (scoring)

	R	L	
C5	☐	☐	Elbow flexors
C6	☐	☐	Wrist extensors
C7	☐	☐	Elbow extensors
C8	☐	☐	Finger flexors (distal phala
T1	☐	☐	Finger abductors (little fin

UPPER LIMB TOTAL (MAXIMUM) ☐ + ☐ = ☐ (25) (25) (50)

Comments:

L2	☐	☐	Hip flexors
L3	☐	☐	Knee extensors
L4	☐	☐	Ankle dorsiflexors
L5	☐	☐	Long toe extensors
S1	☐	☐	Ankle plantar flexors

Voluntary anal con (Yes/No)

LOWER LIMB TOTAL (MAXIMUM) ☐ + ☐ = ☐ (25) (25) (50)

NEUROLOGICAL LEVE		R	L	C
The most caudal segment with normal function	SENSORY	☐	☐	
	MOTOR	☐	☐	

This form may be copied freely bu

Autonomic Standards Assessment Form

Patient Name: _____

Anatomic Diagnosis: (Supraconal ☐, Conal ☐, Cauda Equina ☐)

Page 2

General Autonomic Function

System/Organ	Findings	Abnormal conditions	Check mark
Autonomic control of the heart	Normal		
	Abnormal	Bradycardia	
		Tachycardia	
		Other dysrhythmias	
	Unknown		
	Unable to assess		
Autonomic control of blood pressure	Normal		
	Abnormal	Resting systolic blood pressure below 90 mmHg	
		Orthostatic hypotension	
		Autonomic dysreflexia	
	Unknown		
	Unable to assess		
Autonomic control of sweating	Normal		
	Abnormal	Hyperhydrosis above lesion	
		Hyperhydrosis below lesion	
		Hypohydrosis below lesion	
	Unknown		
	Unable to assess		
Temperature regulation	Normal		
	Abnormal	Hyperthermia	
		Hypothermia	
	Unknown		
	Unable to assess		
Autonomic and Somatic Control of Broncho-pulmonary System	Normal		
	Abnormal	Unable to voluntarily breathe requiring full ventilatory support	
		Impaired voluntary breathing requiring partial vent support	
		Voluntary respiration impaired does not require vent support	
	Unknown		

Lower Urinary Tract, Bowel and Sexual Function

System/Organ	Score
Lower Urinary Tract	
Awareness of the need to empty the bladder	
Ability to prevent leakage (continence)	
Bladder emptying method _____ (specify)	
Bowel	
Sensation of need for a bowel movement	
Ability to Prevent Stool Leakage (Continence)	
Voluntary sphincter contraction	
Sexual Function	
Genital arousal (erection or lubrication) Psychogenic	
Reflex	
Orgasm	
Ejaculation (male only)	
Sensation of Menses (female only)	

2=Normal function, 1=Reduced or Altered Neurological Function
0=Complete loss of control NT=Unable to assess due to preexisting or concomitant problems

Urodynamic Evaluation

System/Organ	Findings	Check mark
Sensation during filling	Normal	
	Increased	
	Reduced	
	Absent	
	Non-specific	
Detrusor Activity	Normal	
	Overactive	
	Underactive	
	Acontractile	
Sphincter	Normal urethral closure mechanism	
	Normal urethral function during voiding	
	Incompetent	
	Detrusor sphincter dyssynergia	
	Non-relaxing sphincter	

Date of Injury_____ Date of Assessment:_____ Examiner:_____

This assessment should use the terminology found in the International SCI Data Set (ASIA and ISCoS (http://www.asia-spinalinjury.org/bulletinBoard/dataset.php)

Questions to take home:

Should we do autonomic assessments in Paralympians?

What autonomic test to select in the future?

Should we develop and implement for athletes passport with autonomic parameters?