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# ORIGINAL ARTICLE

# International spinal cord injury cardiovascular function basic data set

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**Objective:** To create an International Spinal Cord Injury (SCI) Cardiovascular Function Basic Data Set within the framework of the International SCI Data Sets.
**Setting:** An international working group.
**Methods:** The draft of the data set was developed by a working group comprising members appointed by the American Spinal Injury Association (ASIA), the International Spinal Cord Society (ISCoS) and a representative of the executive committee of the International SCI Standards and Data Sets. The final version of the data set was developed after review by members of the executive committee of the International SCI Standards and Data Sets, the ISCoS scientific committee, ASIA board, relevant and interested international organizations and societies, individual persons with specific interest and the ISCoS Council. To make the data set uniform, each variable and each response category within each variable have been specifically defined in a way that is designed to promote the collection and reporting of comparable minimal data.
**Results:** The variables included in the International SCI Cardiovascular Function Basic Data Set include the following items: date of data collection, cardiovascular history before the spinal cord lesion, events related to cardiovascular function after the spinal cord lesion, cardiovascular function after the spinal cord lesion, medications affecting cardiovascular function on the day of examination; and objective measures of cardiovascular functions, including time of examination, position of examination, pulse and blood pressure. The complete instructions for data collection and the data sheet itself are freely available on the websites of both ISCoS (http://www.iscos.org.uk) and ASIA (http://www.asia-spinalinjury.org).
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**Keywords:** spinal cord injury; international data set; cardiovascular function

## Introduction

Cardiovascular abnormalities have been well documented in humans after spinal cord lesions.[1,2] The recognition and management of these cardiovascular dysfunctions after spinal cord injury (SCI) represent challenging clinical issues. Moreover, cardiovascular disorders in the acute and chronic stages of SCI are among the most common causes of death in individuals with SCI.[3–5] Unfortunately, little attention has been paid to the documentation of these dysfunctions in individuals with spinal cord lesions.[6]

In accordance with the aims of the International SCI Data Sets,[7] the aim of the Cardiovascular Function Basic Data Set for SCI is to standardize the collection and reporting of a minimal amount of information on cardiovascular function in daily practice. Furthermore, the International SCI Cardiovascular Function Basic Data Set makes it possible to evaluate and compare results from various published studies on cardiovascular function after SCI.

The International SCI Cardiovascular Function Basic Data Set is applicable to adults with traumatic or non-traumatic supraconal, conal or cauda equina lesions. To ensure that data are standardized, each variable and each response category within variables have been specifically defined. The Cardiovascular Function Basic SCI Data Set will be used in connection with the background information within the International SCI Core Data Set.[8] The SCI Core Data Set documents the level, completeness and time post-spinal cord lesion, which have an important role in cardiovascular outcomes after injury.

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## Materials and methods

The first draft of the International SCI Cardiovascular Function Basic Data Set was made by a working group consisting of members appointed by the American Spinal Injury Association (ASIA) and the International Spinal Cord Society (ISCoS), together with a representative of the Executive Committee of the International SCI Standards and Data Sets. The developmental process for the International Cardiovascular Function Basic SCI Data Set followed the steps given below:

(1) The working group of the International SCI Cardiovascular Function Basic Data Set finalized the first draft during a 2 day meeting in Copenhagen in March 2007. This was further elaborated by frequent e-mail contacts between the group members.
(2) The data set has been reviewed by members of the executive committee of the International SCI Standards and Data Sets.
(3) The comments from the committee members were discussed in the working group and appropriate responses were made to the data set.
(4) Members of the ISCoS scientific committee and ASIA board were also asked to review the data set.
(5) The comments from the committee and board members were discussed in the working group and a response was made, and further adjustments of the data set were performed.
(6) Relevant and interested scientific and professional international organizations and societies (International Society of Physical Medicine and Rehabilitation, American Paraplegia Society; and others) and individuals who were interested were also invited to review the data set. In addition, the data set was posted on the ISCoS and ASIA websites for over 2 months to allow comments and suggestions.
(7) The comments were discussed and responded to by the working group and wherein appropriate, adjustments to the data set were made.

## Results

The International SCI Cardiovascular Function Basic Data Set is structured according to established protocol for the International SCI Data Sets. [7] The complete data set form is included in the Appendix. The complete data syllabus, data sheet and training cases will be available at the respective websites of ISCoS (www.iscos.org.uk) and ASIA (www.asia-spinalinjury.org).

*Date of data collection*
As the collection of data on cardiovascular functions may be conducted at any time after SCI, the date of data collection is imperative to compute the length of time since the spinal cord lesion occurred and to identify data collected in relation to other data collected on the same individual at various time points.

*Cardiovascular history before spinal cord lesion*
This variable will document the history of cardiovascular function present before the spinal cord lesion and should be collected only once. Cardiovascular abnormalities present in an individual before SCI is a major concern as additional deterioration of cardiovascular function could occur as a result of SCI.

Abnormal heart rates (HRs) and rhythms are commonly present after a spinal cord lesion.[9,10] Presence of a cardiac pacemaker, previous surgeries (for example, ablation of ectopic foci) or other conditions (for example, pre-existing atrial fibrillation, myocardial infarction or congestive heart failure) could influence these parameters.[11]

Pre-injury the level of arterial blood pressure (BP) could be either low because of hypotension or elevated because of hypertension. Altered autonomic control after spinal cord lesion could further exacerbate preexisting instability of BP. Hypotension (systolic arterial BP $<90$ mm Hg) is common in acute and chronic spinal cord lesions.[12–14] Addition, intermittent hypertension can be associated with noxious or non-noxious stimuli and resultant autonomic dysreflexia.[2] Preexisting abnormalities of BP can influence the cardiovascular functions after spinal cord lesion.[15]

*Hypertension*. (arterial BP $>140/90$ mm Hg),[15] preexisting elevation in arterial BP, not associated with episodes of autonomic dysreflexia.

*Orthostatic hypotension* is symptomatic or asymptomatic decrease in BP usually exceeding 20 mm Hg systolic or 10 mm Hg diastolic on moving from the supine to an upright position.[16]

Deep vein thrombosis of the legs, pelvis or arms, because of coagulopathy, stasis or endothelial injury are common in individuals with spinal cord lesion.[17]

Preexisting *neuropathies* (for example, diabetic or alcoholic neuropathy) and *other conditions* associated with autonomic dysfunctions (for example, Parkinson's disease, multiple sclerosis and traumatic brain injury) can affect altered cardiovascular functions post-spinal cord lesion, and should therefore be included.[16,18–20]

*Events related to cardiovascular function after spinal cord lesion*
Any events related to cardiovascular functions after spinal cord lesion should be documented. These time-limited cardiovascular events with long-term sequelae should be dated to enable computation of time since injury and to identify the relationship between data points.

Cardiovascular function history after spinal cord lesion within the last 3 months *Cardiac conditions* with subjective symptoms related to the heart that occur post-spinal cord lesion should be documented (for example, abnormal HRs/rhythm, angina, palpitation, and so on).

*Orthostatic hypotension* similarly as above.[16]

*Dependent oedema* is a clinically detectable increase in extracellular fluid volume localized in a dependent area, such as a limb, characterized by swelling or pitting.[15]

*Hypertension*. The diagnosis of *hypertension* (arterial BP $>140/90$ mm Hg) in individuals with SCI should be considered after careful monitoring and documentation of arterial BP and exclusion of elevation of BP because of episodes of autonomic dysreflexia.

*Autonomic dysreflexia* is a constellation of signs and/or symptoms in persons with SCI above T5-6 in response to noxious or non-noxious stimuli below the level of injury. Autonomic dysreflexia is characterized by an increase in systolic BP (>20 mm Hg above baseline), and may include one of the following symptoms: headache, flushing and sweating above the level of the lesion, vasoconstriction below the level of the lesion, and dysrhythmia.[1,2,21–23] This syndrome may or may not be symptomatic and may occur at any time after SCI.[24,25]

*Medication affecting cardiovascular function on the day of examination*. All medications affecting cardiovascular functions (for example, HR, BP), which are presently taken by the individual should be documented.

The final part of the International SCI Cardiovascular Function Basic Data Set contains true cardiovascular data that should be collected on the day of examination.

*Time performed*. Cardiovascular parameters are affected by circadian rhythms, therefore, the exact time of evaluation should be reported to appreciate this variability.[26,27]

*Position during testing*. Cardiovascular parameters similarly are affected by the position of the individual during the testing. For example, BP could decrease because of sitting or standing position.[14,28]

*Devices in use during the testing*. The wearing of compression devices (abdominal binder or pressure stockings) could affect cardiovascular parameters during the examination,[29,30] therefore, their use during the examination should be documented.

*Pulse*. HR is a standard cardiovascular parameter documented during evaluations. The time after injury, as well as level and completeness of spinal cord lesion are crucial factors that affect HR. Individuals with injuries at T6 and below have preserved sympathetic and parasympathetic control to the heart and do not show HR abnormalities related to spinal cord lesion.[31] Both abnormal HR and rhythm are commonly observed in individuals with cervical and high thoracic spinal cord lesions.[10,32,33]

*Blood pressure*. Low resting arterial BP is common in individuals with spinal cord lesions at T6 and above.[34,35] Furthermore, these individuals are also prone to abnormal arterial BP fluctuation because of orthostatic instability or episodes of autonomic dysreflexia. Individuals with lesions at the lower thoracic spinal cord or conus medullaris usually show normal arterial BP because of preserved sympathetic control to the heart and splanchnic circulation.[1,2,36] Resting arterial BP and HR should be obtained after voiding and 5 min of rest. Both physical activity and full urinary bladder could affect cardiovascular parameters.[37]

## Discussion

The International SCI Cardiovascular Function Basic Data Set incorporates the data that shall be observed in conjunction with data in the International SCI Core Data Set[8] and other relevant autonomic functions data sets (Pulmonary, Skin/Thermoregulation/Sudomotor and Endocrine/Metabolic Data Set) that are presently in development. The International SCI Core Data Set includes, among other things, information on the date of birth and injury, gender, the cause of spinal cord lesion and neurological status, whereas the International SCI Cardiovascular Function Basic Data set includes variables on date of data collection, cardiovascular history before the spinal cord lesion, events related to cardiovascular functions after the spinal cord lesion, cardiovascular functions after the spinal cord lesion, medications affecting cardiovascular functions on the day of examination; and objective measures of cardiovascular functions (time of examination, position of examination, BP and HR).

It is understood that the arterial BP and HR are very sensitive to various intrinsic and extrinsic factors including preexisting cardiovascular diseases, medications, time of day and position in which the measures were taken.[29,38,39] Accordingly, the International SCI Cardiovascular Function Basic Data Set includes data on numerous variables that could influence interpretation of the cardiovascular parameters collected in individual with SCI on the day of examination.

Abnormal cardiovascular control should be expected in individuals with spinal cord lesion of both traumatic[1] or non-traumatic etiology.[40,41] Although, the most prominent cardiovascular dysfunctions are observed in individuals with cervical and upper thoracic lesions all lesions to the spinal cord including conus medullaris and cauda equina are included in this context. Even individuals with lower levels of spinal cord trauma could experience cardiovascular dysfunctions in the early stages after the SCI.[12]

It is extremely important that data be collected in a uniform manner. Furthermore, the use of a standard format is essential for combining and comparing the data from multiple sites. For these reasons, each variable and each response category within each variable have been specifically defined in a way that is designed to promote the collection and reporting of comparable minimal data. It is expected that more detailed information on cardiovascular parameters will be provided when using the International SCI Cardiovascular Function Extended Data Set. This information will be probably too extensive in the typical clinical setting and is mainly intended for clinical studies.

Although, the International SCI Cardiovascular Function Basic Data Set has been revised by the international community it is expected that this data set will require periodic revisions and updates. Ideas for improvement of the data set are welcome and should be forwarded to the corresponding author.

## Conflict of interest

The authors declare no conflict of interest.

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International SCI Cardiovascular Function Data Set will be announced at the websites of ISCoS (http://www.iscos.org.uk) and ASIA (http://www.asia-spinalinjury.org).

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## Appendix

### INTERNATIONAL SPINAL CORD INJURY DATA SETS

### CARDIOVASCULAR FUNCTION BASIC DATA SET (VERSION 1.0)—DATA FORM

**Date performed:** YYYYMMDD

**Cardiovascular history before spinal cord lesion (collected once):**
Cardiac pacemaker, date last inserted YYYYMMDD
Cardiac surgery, specify _____, date last performed YYYYMMDD
Other cardiac disorders, specify _____
Hypertension
Hypotension
Orthostatic hypotension
Deep vein thrombosis
Neuropathy (alcoholic, diabetic, and others)
Diabetes
Hyperlipidemia
Myocardial infarction
Stroke
Family history of cardiovascular disease _____
Other, specify_____
None of the above
Unknown

**Events related to cardiovascular function after spinal cord lesion:**
Cardiac pacemaker, date YYYYMMDD
Pulmonary embolism, date YYYYMMDD
Myocardial infarction, date YYYYMMDD
Stroke, date YYYYMMDD
Deep vein thrombosis, date YYYYMMDD
Other, specify_____, date YYYYMMDD
None of the above
Unknown

**Cardiovascular function after spinal cord lesion within the last three months:**
Cardiac conditions, specify _____
Orthostatic hypotension
Dependent oedema
Hypertension
Autonomic dysreflexia
Deep vein thrombosis, date YYYYMMDD
Other, specify_____
None of the above
Unknown

**Any medication affecting cardiovascular function on the day of examination:**
No
Yes, anticholinergics
Yes, antihypertensives (beta-blocker, antiarhythmics, ACE etc)
Yes, antihypotensives
Yes, cardiac (digitalis etc)
Yes, other, specify_____
Unknown

**Objective measures:**

**Time performed:** HHMM Unknown

**Position during testing:** Sitting Supine Unknown

**Devices in use during testing:** Abdominal binder Pressure stockings
None Unknown

**Pulse:** _____beats per minute (bpm)
Regular Irregular

**Blood pressure:** ____/____mmHg