TRAINING CASES FOR THE INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET

The 5 cases included were prepared by Drs.Fin Biering-Sørensen, William Donovan, Ann-Katrin Karlsson and Andrei Krassioukov. The cases were reviewed and adjusted for inconsistencies by the others in the working group for the International Spinal Cord Injury Cardiovascular Function Basic Data Set, and by the external reviewer Dr. Clive Inman, to whom we are indebted for his careful review and expert comments. If the readers find specific issues requiring clarification, or any other issues related to the International Spinal Cord Injury Cardiovascular Function Basic Data Set that may be improved, please inform the working group for this Data Set.
Contact: Andrei Krassioukov, e-mail: Krassioukov@icord.org

CASES FOR TRAINING OF THE INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET – VERSION 1.0.

Case 1

This 47 years old woman sustained a C5 tetraplegia in a road traffic accident 1st of December 2009. She also got intrathoracic injuries and was admitted to intensive care unit. She received a tracheostomy and was treated with invasive ventilation. Both parents had died from myocardial infarction. She was healthy except a history of hypertension and was treated with betablockers before injury. On admission to the hospital, her blood pressure was 90/60 mmHg, heart rate 55 and her betablockers were not given. She suffered from dependent oedema in the legs and was treated with pressure stockings. Three days post injury when still being in bed her oxygenation suddenly dropped to 80 %. There were signs of mucus in her trachea and suction of the tracehostomy was performed. During the suctioning she developed significant bradycardia with heart rate of 35 bpm. After tracheal suction her heart rate increased to 45 but decreased again when suction was initiated again. Pulse and blood pressure was monitored every 6th hour and her pulse was found to be between 40-45 bpm and systolic blood pressure was 90-100, diastolic blood pressure 55-70 mmHg. A 24 h Holter ECG recording showed sinus bradycardia and a pacemaker was implanted on the 15th of December.

On the day of examination (January 5, 2010) at 10:00 am she was in bed in the supine position and her blood pressure was measured as 90/60 mmHg with regular pulse of 55 bpm. She used laxatives for bowel emptying, 5.000 IE low molecular weight heparin for DVT prophylaxis and paracetamol for pain management.

INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET – Version 1.0 – DATA FORM

CASE 1

Date performed: 20100105

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 _____
X Hypertension
□ Hypotension
□ Orthostatic hypotension
□ Deep vein thrombosis
□ Neuropathy (alcoholic, diabetic, and others)
□ Myocardial infarction
□ Stroke
X Family history of cardiovascular disease ___myocardial infarction_____
□ Other, specify_____
□ None of the above
□ Unknown

Events related to cardiovascular function after spinal cord lesion:
X Cardiac pacemaker, date 20091215
□ Myocardial infarction, date YYYYMMDD
□ Stroke, date YYYYMMDD
□ Pulmonary embolism, 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:
X Cardiac conditions, specify sinus bradycardia _____
□ Orthostatic hypotension
X 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:
XNo □ Yes, anticholinergics
□ Yes, antihypertensives (beta-blocker, antiarhythmics, ACE etc)
□ Yes, antihypotensives

□ Yes, cardiac (digitalis etc)
□ Yes, other, specify_____
□ None of the above
□Unknown

Objective measures:

Time performed: 10:00 □ Unknown

Position during testing: □ Sitting **X** Supine □ Unknown

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

Pulse: _55_beats per minute (bpm) **X** Regular □ Irregular

Blood pressure: _90_/_60_mmHg

CASES FOR TRAINING OF THE INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET – VERSION 1.0.

Case 2

Mr Smith is a 20 years old man (Date of birth March 15, 1989) that was involved in a ski accident on February 15, 2010. He was admitted to the local hospital and diagnosed with a C6/7 fracture dislocation injury resulting in C6 AIS B tetraplegia.

He was a healthy young man prior the accident and denied use of any medications or recreational drugs.

On admission to the emergency department, he was alert and oriented and did not require ventilator support; his arterial blood pressure was measured at 80/60 mmHg with HR of 58 bpm. He was started on intravenous fluid and Dopamine drip.

Following evaluation by the trauma team and MRI evaluation, he underwent decompression and bone graft fixation at C5-C7 using posterior approach.

His postoperative recovery was uneventful. However, the first attempt with mobilization in the bed and transfer to the wheelchair resulted in significant episodes of dizziness and light-headedness. He required an abdominal binder and midodrine in the morning hours for management of orthostatic hypotension.

Despite the initiation of the DVT prophylaxis protocol with enoxoparine, one month following injury (March 19, 2010) he developed a sudden onset of shortness of breath. On examination, swelling of the right calf was established and the patient also had tachycardia of 135 bpm. Following Spiral CT a right pulmonary embolism with plural effusion was diagnosed and consequently right popletal vein DVT was also established by ultrasound.

Following one month's admission to the Spine Surgical Unit, the patient was transferred to the inpatient rehabilitation at the local rehabilitation centre.

Presently, it is three months post his injury (May 20, 2010), he has continued with his rehabilitation at the rehabilitation centre. He is using a manual wheelchair for mobility. He continued to use an abdominal binder and pressure stockings to manage his lower arterial blood pressure; however, midodrin was discontinued approximately three weeks ago. He recently was switched from a Foley catheter to the intermittent catheterisation for the management of his bladder. Since admission to the rehabilitation centre he had one urinary tract infection that required oral antibiotics and was associated with episodes of autonomic dysreflexia. His bowel routine is occurring every other day on the commode and he requires digital stimulation. His present medications include baclofen 10 mg three times per day; warfarin 5 mg once per day (with INR ranging between 2-3 international units).

Today during the morning examination (9:30 am) his supine arterial blood pressure was measured at 100/80 mmHg with regular HR of 68 bpm. Following transfer to the sitting position in the wheelchair his arterial blood pressure was measured at 80/65 mmHg with regular HR of 85 bpm and the subject complained on light-headedness. Neither abdominal binder or stockings were used during the testing today.

INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET - Version 1.0 – DATA FORM

CASE 2

Date performed: 2010/05/20

Cardiovascular history <u>before</u> 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_____
X None of the above
☐ Unknown

Events related to cardiovascular function <u>after</u> spinal cord lesion:

☐ Cardiac pacemaker
X Pulmonary embolism **2010/03/19**
☐ Myocardial infarction,
☐ Stroke, date
X Deep vein thrombosis **2010/03/19**
☐ Other, specify_____, date YYYYMMDD
☐ None of the above
☐ Unknown

Cardiovascular function <u>after</u> spinal cord lesion within the last three months:

☐ Cardiac conditions, specify _____
X Orthostatic hypotension
☐ Dependent oedema
☐ Hypertension
X Autonomic dysreflexia
☐ Other, specify_____
☐ None of the above
☐ Unknown

Any medication affecting cardiovascular function on <u>the day of examination</u>:

□ No □ Yes, anticholinergics
□ Yes, antihypertensives (beta-blocker, antiarhythmics, ACE etc)
□ Yes, antihypotensives
□ Yes, cardiac (digitalis etc)
□ Yes, other, specify_____
X None of the above
□ Unknown

<u>Objective measures:</u>

Time performed: 09:30 am □ Unknown

Position during testing: **X** Sitting □ Supine □ Unknown

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

Pulse: _85_beats per minute (bpm) **X** Regular □ Irregular

Blood pressure: 80/65 mmHg

CASES FOR TRAINING OF THE INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET – VERSION 1.0.

Case 3

Mr. Elm is a 54 years old man (date of birth July 27, 1955) who was involved in a motor vehicle accident on January 20, 2010.
He was extracted from the vehicle by the fire department crew and required resuscitation on the scene of the accident. He was admitted to the local hospital unconscious with ventilator support. His arterial blood pressure on admission was 90/60 mmHg. He regained consciousness a few hours following admission.
Evaluation by the trauma team and following MRI evaluation established that the subject had a C2 odontoid fracture with complete C2 spinal cord injury.
Five years ago he was diagnosed with diabetes mellitus type 2 and hyperlipidemia. He also had a history of hypertension and obesity. In addition to Insulin he was also taking ramipril, hydrochlorothiazide and atorvastatin on a regular basis.
His postoperative recovery was complicated with atelectasis and pneumonia that required antibiotic therapy. Furthermore, the first attempt with mobilization in the bed resulted in significant episodes of dizziness and light-headedness. His supine blood pressure was usually within 135/85 mmHg but with transfer to the sit up position he demonstrated a significant drop to 70/50 mmHg despite the use of an abdominal binder. The initiation of midodrine 10 mg per mouth 60 min before the transfer to the wheelchair in the morning and an additional dose in the afternoon resulted in stabilization of blood pressure and resolution of light-headedness and dizziness.
Despite the initiation of the DVT prophylaxis protocol with enoxoparine, one month following injury (February 15, 2010) he developed a right leg swelling and redness. Ultrasound confirmed the right popliteal vein DVT.
Presently, it is five months post his injury (June 20, 2010), he has continued with his rehabilitation at the inpatient Rehabilitation Unit. He requires a power wheel chair for mobility that also has a ventilator for respiratory support. He continued to use an abdominal binder and midodrine for management of his lower arterial blood pressure and orthostatic hypotension. He has a Foley catheter and since admission to the rehabilitation centre he had numerous urinary tract infections complicated with significant episodes of autonomic dysreflexia (AD). His bowel routine is occurring every other day in the bed and also accompanied with mild episodes of AD during the digital stimulation. There is also persistent oedema present in his legs (right>left) from the knee down, and patient required pressure stockings during the day time. His present medications include baclofen 10 mg three times per day; warfarin 5 mg once per day (with INR ranging between 2-3 international units); atorvastatin, insulin sliding scale.
Today during the morning examination (8:30 am) while seated in his wheelchair his arterial blood pressure was measured at 95/70 mmHg with regular HR of 68 bpm. Neither abdominal binder or stockings were used during the testing today.

INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET – Version 1.0 – DATA FORM

CASE 3

Date performed: 2010/06/20

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

Events related to cardiovascular function <u>after</u> spinal cord lesion:
□ Cardiac pacemaker
□ Pulmonary embolism
□ Myocardial infarction,
□ Stroke, date
X Deep vein thrombosis 2010/02/15
□ Other, specify_____, date YYYYMMDD
□ None of the above
□ Unknown

Cardiovascular function <u>after</u> spinal cord lesion within the last three months:
□ Cardiac conditions, specify _____
X Orthostatic hypotension
X Dependent oedema
□ Hypertension
X Autonomic dysreflexia
□ Other, specify_____
□ None of the above
□ Unknown

Any medication affecting cardiovascular function on <u>the day of examination</u>:
□ No □ Yes, anticholinergics
□ Yes, antihypertensives (beta-blocker, antiarhythmics, ACE etc)

X Yes, antihypotensives
□ Yes, cardiac (digitalis etc)
□ Yes, other, specify_____
□ None of the above
□ Unknown

Objective measures:

Time performed: 08:30 am □ Unknown

Position during testing: **X** Sitting □ Supine □ Unknown

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

Pulse: _68_beats per minute (bpm) **X** Regular □ Irregular

Blood pressure: 95/70 mmHg

CASES FOR TRAINING OF THE INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET – VERSION 1.0.

Case 4

Mr. Oak is a 49-year-old man with a history of alcoholism and peripheral neuropathy who fell off a bar stool, striking his chin against the floor when preparing to leave the pub on March 5, 2010. He was unable to get up. Ambulance was called and he was taken to a trauma center where he was noted to be oriented to person and place but not to time, and in no respiratory distress. Vital signs at admission were following: blood pressure (BP) - 100/75 mmHg, pulse (P) - 48 bpm, irregular, respiration (R) – 14 per minute. Abdominal exam revealed hepatomegally 3 finger breaths below the right costal margin. International Standards exam revealed a C6 AIS D central cord syndrome. C-spine plain films were unremarkable except for the degenerative joint disease and cervical stenosis at C 4/5 and 5/6. MRI showed cord swelling and edema from C4 to C7 with a small central hemorrhage at C5, 6 levels. He was noted to have a past history of atrial fibrillation. Medications included warfarin and digoxin. The latter was held due to bradycardia.

No surgery was deemed warranted. He was placed in a cervical orthosis. During the rehabilitation he remained hypotensive and required midodrine 10 mg, 1 hour before rising in the morning. At discharge, he was able to walk with a spastic gait, using a rolling walker, he had hand intrinsic atrophy and could void voluntarily to completion but with urgency. He required oxybutinin 5 mg twice daily. He also had sensation of bowel fullness but required a suppository each evening to completely evacuate. Following inpatient rehabilitation he was discharge home.

Today, during his first clinic visit (June 12 2010, 9:30 AM), his vital signs taken in the morning, while seated, without abdominal binder were as following BP - 108/76 mmHg, P - 69 bpm (irregular); R -12 per minute. He admitted that he had numerous falls during the last few weeks but did not seek medical attention. He stated that falls commonly associated with episodes of lightheadedness and dizziness. Exam shows a bruise over the right trochanter but no evidence of bone injury. Exam was noted for 2 finger breath hepatomegally, safe but still spastic gait with 1 forearm crutch. X-rays of the right hip were negative for fracture. His present medication includes following: warfarin with weekly INR (his INR today was 2.1), oxybutinin; and digoxin.

INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET – Version 1.0 – DATA FORM

CASE 4

Date performed: 2010/06/12

Cardiovascular history <u>before</u> spinal cord lesion (collected once):
□ Cardiac pacemaker, date last inserted
□ Cardiac surgery, specify _____, date last performed
X Other cardiac disorders, specify ___ **atrial fibrillation**
□ Hypertension
□ Hypotension
□ Orthostatic hypotension
□ Deep vein thrombosis
X Neuropathy **alcoholic**
□ Myocardial infarction
□ Stroke
□ Family history of cardiovascular disease _____
□ Other, specify: _____
□ None of the above
□ Unknown

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

Cardiovascular function <u>after</u> spinal cord lesion within the last three months:
□ Cardiac conditions, specify _____
X Orthostatic hypotension
□ Dependent oedema
□ Hypertension
□ Autonomic dysreflexia
□ Deep vein thrombosis, date YYYYMMDD
X Other, specify: atrial fibrillation
□ None of the above
□ Unknown

Any medication affecting cardiovascular function on <u>the day of examination</u>:
□ No □Yes, anticholinergics

□Yes, antihypertensives (beta-blocker, antiarhythmics, ACE etc)
□ Yes, antihypotensives
X Yes, cardiac (digitalis etc) digoxin
X Yes, other, specify **oxybutinin, warfarin**
□ None of the above
□ Unknown

Objective measures:

Time performed: 09:30 AM □ Unknown

Position during testing: **X** Sitting □Supine □ Unknown

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

Pulse: 69 beats per minute (bpm) □ Regular **X** Irregular

Blood pressure: 108/76 mmHg

CASES FOR TRAINING OF THE INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET – VERSION 1.0.

Case 5

This 48 years old previously healthy man without any medicine intake crashed with his mountain bike on June 17, 2010. He was unconscious and initially without pulse or respiration. Witnesses started resuscitation. He was not seen to move any of the extremities. When the ambulance arrived he had pulse and difficult respiration and Glasgow Coma Scale (GCS) of 3. He was intubated at the site of accident and during this procedure he woke up to GCS 8-9. Afterwards he was transferred to the Trauma centre, still without any movement or reflexes and with flaccid anal sphincter. His head CT scan showed no fractures other intracranial pathologies. The cervical spine CT showed a type II C2 fracture with a little posterior subluxation and fracture of C4 right lamina and facet joint. His chest and abdominal CT was without trauma signs. Initially the blood pressure (BP) was labile and infusion with noradrenalin was started. His BP stabilized to 105/53 mmHg with a regular heart rate (HR). On June 19, 2010 he was surgically stabilised with a screw in C2 and on the same time he had a tracheostomy performed. Following recovery from anaesthesia, he was found to have an AIS A, C1 lesion. Within the first week after injury there was tendency to bradycardia, including four incidences of asystole, usually caused by tracheal suction or turning in the bed. The latest incidence was a 30 second sinus arrest followed by ventricular escapade rhythm. With initiation of isoprenalin his cardiovascular parameters were measured at 159/92 mmHg with regular HR of 90 bpm. On June 24, 2010 he was instrumented with a permanent pacemaker. During the hospitalisation to the ICU he also developed orthostatic hypotension that required midodrine for management and episodes of autonomic dysreflexia that required administration of captopril. On August 2, 2010 he was transferred from the ICU to the Centre for Respiratory Disabled to have instituted home ventilation with 24 hours team support. On November 1, 2010 he was transferred to the Spinal Injures Centre for final adaptation of his aids including the electric wheelchair, which he learned to drive with the chin. When he was discharged to his adapted home on November 29, 2010 his neurological lesion was unchanged AIS A C1, he used various pharmacological agents for the bowel management and midodrine 10+10+5 mg for his orthostatic hypotension. During the last few months he has been experiencing episodes of orthostatic hypotension and autonomic dysreflexia that required pharmacological management. On examination at 1:00 PM on the day of discharge his BP was 110/65 mmHg, with regular HR of 60 bpm, measured sitting in the wheelchair without use of pressure stockings or abdominal binder.

INTERNATIONAL SPINAL CORD INJURY CARDIOVASCULAR FUNCTION BASIC DATA SET – Version 1.0 – DATA FORM

CASE 5

Date performed: 2010.11.29

Cardiovascular history <u>before</u> 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)
□ Myocardial infarction
□ Stroke
□ Family history of cardiovascular disease _____
□ Other, specify_____
X None of the above
□ Unknown

Events related to cardiovascular function <u>after</u> spinal cord lesion:
X Cardiac pacemaker, date 2010.06.24
□ Myocardial infarction, date YYYYMMDD
□ Stroke, date YYYYMMDD
□ Pulmonary embolism, date YYYYMMDD
□ Deep vein thrombosis, date YYYYMMDD
□ Other, specify_____, date YYYYMMDD
□ None of the above
□ Unknown

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

Any medication affecting cardiovascular function on <u>the day of examination</u>:
□ No
□ Yes, anticholinergics
□ Yes, antihypertensives (beta-blocker, antiarhythmics, ACE etc)
X Yes, antihypotensives (Midodrine)

□ Yes, cardiac (digitalis etc)
□ Yes, other, specify_____
□ None of the above
□ Unknown

Objective measures:

Time performed: 13:00 □ Unknown

Position during testing: **X** Sitting □ Supine □ Unknown

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

Pulse: ___60_____beats per minute (bpm) **X** Regular □ Irregular

Blood pressure: _110/65_mmHg