

Trauma Services BC
Specialist Trauma Advisory Network

Spine Specialist Advisory Group

Clinical Practice Guideline

for the management of

SUSPECTED OR CONFIRMED SPINAL INJURY in adults (16 years and older)

Version 2.3
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Purpose

The purpose of this clinical practice guideline (CPG) is to review best evidence and generate expert consensus on recommendations for the management of suspected spinal injury in adult patients (age ≥ 16) in B.C.

Key management questions

I. INITIAL MANAGEMENT

1. What are the key considerations in the initial assessment and management of patients with suspected injury to the spine (without suspected neurological deficit)?
2. What are the key considerations in the initial assessment and management of patients with suspected injury to the spine and with suspected neurological deficit?
3. What is the appropriate management of the cervical spine in awake, evaluable and symptomatic patients?
4. What is the appropriate management of the cervical spine in obtunded or otherwise unevaluable patients?

II. DIAGNOSTIC IMAGING – WITHOUT NEUROLOGIC DEFICIT

5. What are the indications for imaging of the cervical spine in alert and evaluable patients? What is the imaging modality of choice in these patients?
6. What are the indications for imaging of the cervical spine in obtunded or unevaluable patients? What is the imaging modality of choice in these patients?
7. What are the indications for imaging of the thoraco-lumbar spine in patients with suspected spinal injury? What is the imaging modality of choice in these patients?
8. Under what circumstances would it be appropriate to transfer the patient to another site without definitive care for a CT or MRI?

III. DIAGNOSTIC IMAGING – WITH SUSPECTED OR CONFIRMED NEUROLOGIC DEFICIT

9. What are the indications for imaging of the cervical spine in alert and evaluable patients with suspected or confirmed neurological deficit? What is the imaging modality of choice in these patients?
10. What are the indications for imaging of the cervical spine in obtunded or unevaluable patients? What is the imaging modality of choice in these patients?
11. What are the indications for imaging of the thoraco-lumbar spine in patients with suspected or confirmed neurological deficit? What is the imaging modality of choice in these patients?
12. Under what circumstances would it be appropriate to transfer the patient to another site without definitive care for a CT or MRI?

IV. TRANSFER TO HIGHER LEVEL OF CARE

13. What are the indications for and timing of transfer of patients with confirmed or suspected spinal injury without neurological deficit to a higher-level trauma centre?
14. What are the indications for and timing of transfer of patients with confirmed or suspected spinal injury with suspected or confirmed neurological deficit to a higher-level trauma centre?
15. What are the indications for local (remote) management of spinal fractures (fractures not requiring transfer)?

V. PRE-TRANSFER CARE

16. What is the optimal pre-transfer management and preparation of patients with suspected or confirmed spinal injury without neurological deficit?
17. What is the optimal pre-transfer management and preparation of patients with suspected or confirmed spinal injury with neurological deficit?

VI. LOCAL MANAGEMENT OF STABLE SPINAL FRACTURES

18. What is the appropriate local (remote) management of stable spinal fractures (fractures not requiring transfer)?

Guidelines referenced

ORGANIZATION	TITLE, YEAR	CITATION	GRADING SYSTEM
National Institute for Health and Care Excellence	Spinal injury: assessment and initial management, 2016	NICE	NICE uses 'offer' (or words such as 'measure', 'advise', or 'refer') to reflect a strong recommendation, usually where there is clear evidence of benefit. NICE uses 'consider' to indicate a recommendation for which the evidence of benefit is less certain.
British Orthopedic Association (with British Association of Spine Surgeons and Society of British Neurological Surgeons)	Spinal Clearance in the Trauma Patient (version 2), 2015	BOA 2015	None
British Orthopedic Association (with British Association of Spine Surgeons, Society of British Neurological Surgeons, and British Association of Spinal Cord Injury Specialists)	The Management of Traumatic Spinal Cord Injury, 2012	BOA 2012	None
Eastern Association for the Surgery of Trauma	Cervical spine collar clearance in the obtunded adult blunt trauma patient, 2015	EAST 2015	None
	Screening for thoracolumbar spinal injuries in blunt trauma, 2012	EAST 2012	Level 1: Convincingly justifiable based on available scientific information alone. Supported by prospective randomized studies or prospective, noncomparative studies or retrospective series with controls.
	Practice Management Guidelines for Identification of Cervical Spine Injuries Following Trauma, 2009	EAST 2009	Level 2: Reasonably justifiable by available scientific evidence and strongly supported by expert opinion. Supported by prospective, noncomparative studies or retrospective series with controls or a preponderance of retrospective analyses. Level 3: Supported by available data but lacking adequate evidence. Supported by retrospective analyses.
Joint Section of the American Association of Neurological Association and Congress of Neurological Surgeons	Guidelines for the Management of Acute Cervical Spine and Spinal Cord Injuries, 2013	AANS/CNS	Level I: (High degree of clinical certainty based on evidence) Level II: (Moderate degree clinical certainty) Level III: (Unclear clinical certainty)

Clinical Practice Guideline

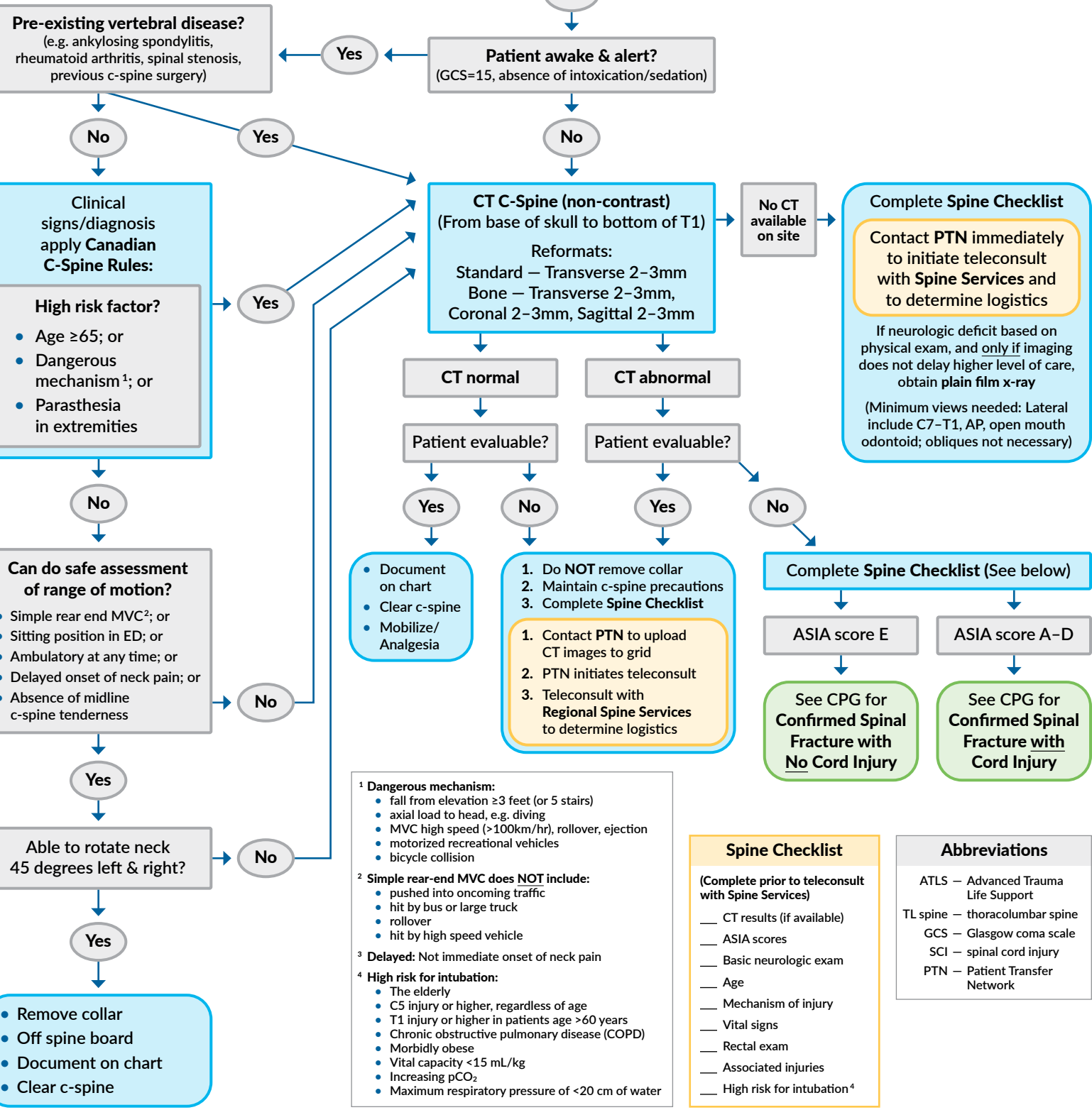
Management of suspected or confirmed spinal injury in adults (16 years and older)

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Legend

- Investigation
- Action
- Diagnosis
- Teleconsult



- Remove collar
- Off spine board
- Document on chart
- Clear c-spine

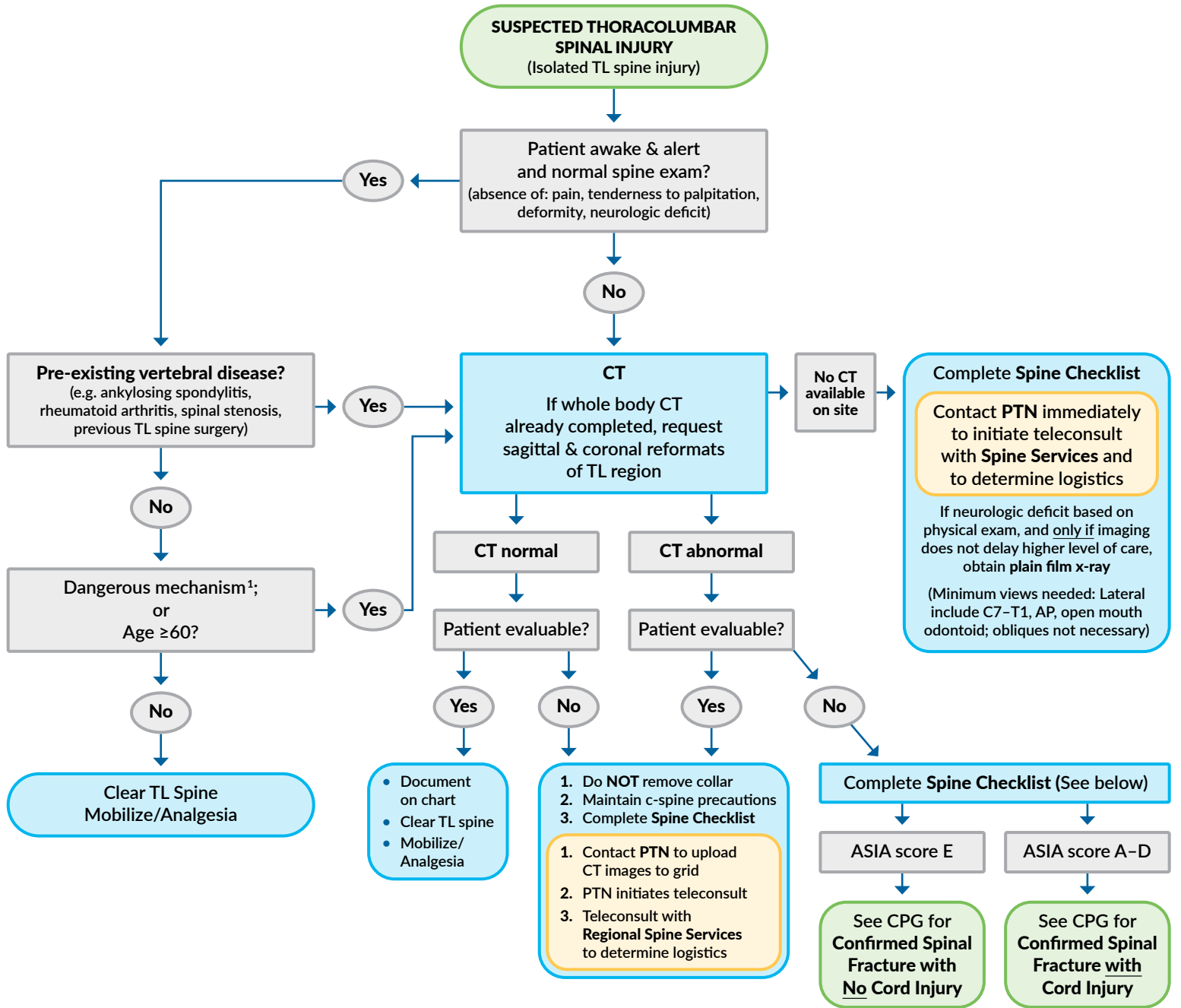
- 1 Dangerous mechanism:**
- fall from elevation ≥ 3 feet (or 5 stairs)
 - axial load to head, e.g. diving
 - MVC high speed (>100 km/hr), rollover, ejection
 - motorized recreational vehicles
 - bicycle collision
- 2 Simple rear-end MVC does NOT include:**
- pushed into oncoming traffic
 - hit by bus or large truck
 - rollover
 - hit by high speed vehicle
- 3 Delayed:** Not immediate onset of neck pain
- 4 High risk for intubation:**
- The elderly
 - C5 injury or higher, regardless of age
 - T1 injury or higher in patients age >60 years
 - Chronic obstructive pulmonary disease (COPD)
 - Morbidly obese
 - Vital capacity <15 mL/kg
 - Increasing pCO_2
 - Maximum respiratory pressure of <20 cm of water

- Spine Checklist**
- (Complete prior to teleconsult with Spine Services)
- ___ CT results (if available)
 - ___ ASIA scores
 - ___ Basic neurologic exam
 - ___ Age
 - ___ Mechanism of injury
 - ___ Vital signs
 - ___ Rectal exam
 - ___ Associated injuries
 - ___ High risk for intubation⁴

- Abbreviations**
- ATLS — Advanced Trauma Life Support
 - TL spine — thoracolumbar spine
 - GCS — Glasgow coma scale
 - SCI — spinal cord injury
 - PTN — Patient Transfer Network

Clinical Practice Guideline

Management of suspected or confirmed spinal injury in adults (16 years and older)



¹ Dangerous mechanism:

- fall from elevation ≥3 feet (or 5 stairs)
- axial load to head, e.g. diving
- MVC high speed (>100km/hr), rollover, ejection
- motorized recreational vehicles
- bicycle collision

² High risk for intubation:

- The elderly
- C5 injury or higher, regardless of age
- T1 injury or higher in patients age >60 years
- Chronic obstructive pulmonary disease (COPD)
- Morbidly obese
- Vital capacity <15 mL/kg
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- Maximum respiratory pressure of <20 cm of water

Spine Checklist
(Complete prior to teleconsult with Spine Services)

- ___ CT results (if available)
- ___ ASIA scores
- ___ Basic neurologic exam
- ___ Age
- ___ Mechanism of injury
- ___ Vital signs
- ___ Rectal exam
- ___ Associated injuries
- ___ High risk for intubation²

Abbreviations

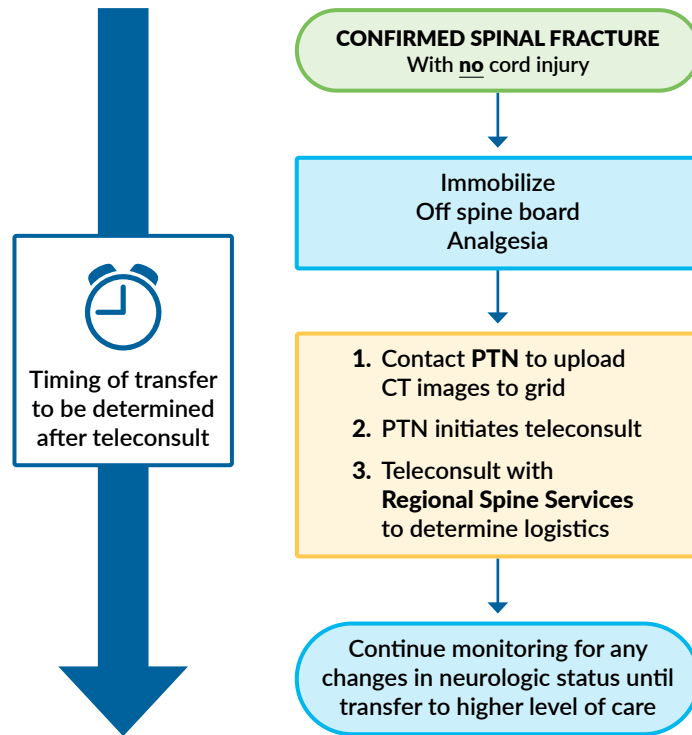
TL spine – thoracolumbar spine
SCI – spinal cord injury
PTN – Patient Transfer Network

Legend

- Investigation
- Action
- Diagnosis
- Teleconsult

Clinical Practice Guideline

Management of suspected or confirmed spinal injury in adults (16 years and older)



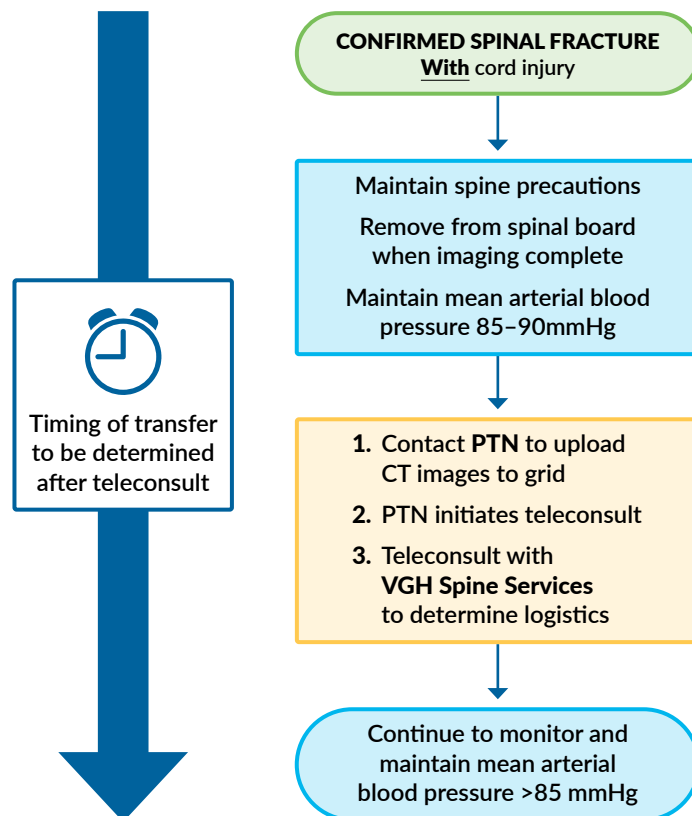
Note

¹High risk for intubation:

- The elderly
- C5 injury or higher, regardless of age
- T1 injury or higher in patients age >60 years
- Chronic obstructive pulmonary disease (COPD)
- Morbidly obese
- Vital capacity <15 mL/kg
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- Maximum respiratory pressure of <20 cm of water

Legend

- Investigation
- Action
- Diagnosis
- Teleconsult



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Summary of recommendations

Recommendations are newly drafted by the Spine SAG, unless indicated otherwise.

I. INITIAL MANAGEMENT

KMQ-1. What are the key considerations in the initial assessment and management of patients with suspected injury to the spine (without suspected neurological deficit)?

- A.** On arrival at the scene of the incident, use a prioritizing sequence to assess people with suspected trauma, for example <C>ABCDE:
- Catastrophic hemorrhage
 - Airway with in-line spinal immobilization
 - Breathing
 - Circulation
 - Disability (neurological)
 - Exposure and environment. [Adopted from NICE]
- B.** On arrival in the emergency department:
- Maintain airway, high flow O₂
 - Maintain c-spine protection (Aspen collar)
 - Prioritize concomitant injuries based on ATLS protocols
 - Call Trauma Services for triage of polytrauma patients
- C.** Spinal immobilization of all trauma patients with a cervical spine or spinal cord injury or with a mechanism of injury having the potential to cause cervical spinal injury is recommended. [Adopted from AANS/CNS]
- D.** At all stages of the assessment protect the person's cervical spine with a collar or manual in-line spinal immobilization during any movement or interventions. Avoid moving the remainder of the spine. [Adopted from NICE with modifications]
- E.** A protocol for protection of the entire spine must be in place in all hospitals managing trauma patients at risk of spinal injury. This protection must be maintained from arrival until appropriate examination or investigations are completed and either the spine is cleared of injury, or the patient is transferred for definitive care. [Adopted from BOA 2015 with modification]

F. Assess the person for spinal injury, initially taking into account the factors listed below. Check if the person:

- Has any significant distracting injuries (see [Rationale-i.](#))
- Is under the influence of drugs or alcohol
- Is confused or uncooperative
- Has a reduced level of consciousness
- Has any spinal pain
- Has any hand or foot weakness (motor assessment)
- Has altered or absent sensation in the hands or feet (sensory assessment)
- Has priapism (unconscious or exposed male)
- Has a history of past spinal problems, including previous spinal surgery or conditions that predispose to instability of the spine.

Carry out full in-line immobilization if any of the above factors are present or if this assessment cannot be done. [Adopted from NICE]

G. Assess whether the person is at high, low or no risk for cervical spine injury using the Canadian C-spine rule as follows:

- the person is at high risk if they have at least one of the following high-risk factors:
 - age 65 years or older
 - dangerous mechanism of injury (fall from a height of greater than 1 metre or 5 steps, axial load to the head – for example diving, high-speed motor vehicle collision, rollover motor accident, ejection from a motor vehicle, accident involving motorized recreational vehicles, bicycle collision, horse riding accidents)
 - paresthesia in the upper or lower limbs
- the person is at low risk if they have at least one of the following low-risk factors:
 - involved in a minor rear-end motor vehicle collision
 - comfortable in a sitting position
 - ambulatory at any time since the injury
 - no midline cervical spine tenderness
 - delayed onset of neck pain
- the person remains at low risk if they are unable to actively rotate their neck 45 degrees to the left and right (the range of the neck can only be assessed safely if the person is at low risk and there are no high-risk factors).
- the person has no risk if they have one of the above low-risk factors and are able to actively rotate their neck 45 degrees to the left and right. [Adopted from NICE] (See [Rationale ii.](#) for the benefits of applying the Canadian C-Spine Rule to clear the cervical spine)

- H.** Assess the person with suspected thoracic or lumbosacral spine injury using these factors:
- age 65 years or older and reported pain in the thoracic or lumbosacral spine
 - dangerous mechanism of injury (fall from a height of greater than 3 metres, axial load to the head or base of the spine – for example falls landing on feet or buttocks, high-speed motor vehicle collision, rollover motor accident, lap belt restraint only, ejection from a motor vehicle, accident involving motorized recreational vehicles, bicycle collision, horse riding accidents)
 - pre-existing spinal pathology, or known or at risk of osteoporosis – for example steroid use
 - suspected spinal fracture in another region of the spine
 - abnormal neurological symptoms (paresthesia or weakness or numbness)
 - on examination:
 - abnormal neurological signs (motor or sensory deficit)
 - new deformity or bony midline tenderness (on palpation)
 - bony midline tenderness (on percussion)
 - midline or spinal pain (on coughing) [Adopted from NICE with modification]
- I.** Carry out or maintain full in-line spinal immobilization if:
- a high-risk factor for cervical spine injury is identified and indicated by the Canadian C-spine rule (see [Appendix A](#) for the full criteria)
 - a low-risk factor for cervical spine injury is identified and indicated by the Canadian C-spine rule (see [Appendix A](#)) and the person is unable to actively rotate their neck 45 degrees left and right
 - indicated by one or more of the factors listed in Recommendation H above (or see [Appendix B](#)). (See [Rationale ii](#), for the benefits of applying the Canadian C-Spine Rule to clear the cervical spine.) [Adopted from NICE]
- J.** When carrying out full in-line spinal immobilization in adults, manually stabilize the head with the spine in-line using the following stepwise approach:
- Fit an appropriately sized semi-rigid collar unless contraindicated by:
 - a compromised airway
 - known spinal deformities, such as ankylosing spondylitis (in these cases keep the spine in the person's current position).
 - Reassess the airway after applying the collar.
 - Place and secure the person on a scoop stretcher.
 - Secure the person with head blocks and tape, ideally in a vacuum mattress. [Adopted from NICE]
- K.** Discontinue use of spinal boards as soon as possible after trauma assessment. Spine boards are only to be used for extrication of injured patients. Prolonged use of spinal boards should be avoided, particularly in those with suspected or confirmed neurologic deficit.

- L. Assess pain regularly in people with spinal injury using a pain assessment scale suitable for the patient's age, developmental stage and cognitive function. Continue to assess pain in hospital using the same pain assessment scale that was used in the pre-hospital setting. [Adopted from NICE]
- M. The American Spinal Injury Association (ASIA) international standards for neurological and functional classification of spinal cord injury are recommended as the preferred neurological examination tool for clinicians involved in the assessment and care of acute spinal cord injury patients. (See [Appendix C](#)) [Adopted from AANS/CNS]
- N. Clinical evaluation of injured patients must include appropriate and repeated examination of the nervous system which should be recorded in the medical notes on an ASIA chart in keeping with the International Standards for Neurological Classification in Spinal Cord Injury (SNCSCI). [Adopted from BOA 2012 with modification]
- O. Documentation of the neurological status must be made in all at-risk patients; any sign of spinal cord injury mandates a teleconference with on-call Spine Service at VGH. A clinical examination of the whole spine should be documented. [Adopted from BOA 2015 with modification]

KMQ-2. What are the key considerations in the initial assessment and management of patients with suspected injury to the spine and with suspected neurological deficit?

- A. On arrival in the ED:
 - Maintain airway, high flow O₂
 - Maintain c-spine protection (Aspen collar)
 - Prioritize concomitant injuries based on ATLS protocols
 - Call Trauma Services for triage of polytrauma patients
- B. Spine boards are only to be used for extrication of injured patients. Prolonged use of spinal boards should be avoided, particularly in those with suspected or confirmed neurologic deficit.
- C. In cases of a suspected or confirmed spinal cord injury with neurological deficit, insertion of an arterial line and management of the mean arterial pressure (MAP) is recommended. MAP goal should be 85 to 90 mmHg. Preferred IV vasopressor is norepinephrine. Euvolemic status prior to initiation and titration of vasopressors must be measured. (See [Rationale iii.](#) for the optimal MAP in acute spinal injury, and [Rationale ix.](#) for complications in hemodynamic management of acute spinal cord injury.)
- D. If there is considerable difficulty in maintaining MAP and there is a potential of serious adverse effects from vasopressors, drop MAP goal to 80 mmHg after consultation with Spine Service at VGH.

- E. Intravenous steroids are not recommended in the acute management of traumatic spinal cord injury.
- F. The American Spinal Injury Association (ASIA) international standards for neurological and functional classification of spinal cord injury are recommended as the preferred neurological examination tool for clinicians involved in the assessment and care of acute spinal cord injury patients. (See [Appendix C](#)) [Adopted from AANS/CNS]
- G. Clinical evaluation of injured patients must include appropriate and repeated examination of the nervous system which should be recorded in the medical notes on an ASIA chart in keeping with the International Standards for Neurological Classification in Spinal Cord Injury (SNCSCI). [Adopted from BOA 2012 with modification]
- H. Documentation of the neurological status must be made in all at-risk patients; any sign of spinal cord injury mandates a teleconference with on-call Spine Service at VGH. A clinical examination of the whole spine should be documented. [Adopted from BOA 2015 with modification]

KMQ-3. What is the appropriate management of the cervical spine in awake, evaluable and symptomatic patients?

- A. When there is no immediate CT access on site and:
 - If the patient has definite neurologic deficit with cord injury, call Spine Service at VGH immediately.
 - If the patient has definite neurologic deficit without cord injury, call regional Spine Service immediately to consult a spine surgeon and call PTN to initiate transfer to higher level of care.
 - If the patient has no neurologic deficit but there is a high suspicion of spinal fracture based on the Canadian C-Spine Rule (see [Appendix A](#)), conduct plain film X-rays and then call regional Spine Service for a consult and PTN for transfer to higher level of care. (See [Rationale ii](#). for the benefits of applying the Canadian C-Spine Rule to clear the cervical spine.)
- B. In awake and alert patients with normal CT results with unreliable clinical exam, maintain cervical spine precautions and consult a spine surgeon at regional Spine Services immediately.
- C. In awake and alert patients with abnormal CT results and high index of suspicion for spinal cord injury (i.e., due to mechanism of injury or midline tenderness), maintain cervical spine precautions and consult a spine surgeon at Spine Services at VGH immediately.

KMQ-4. What is the appropriate management of the cervical spine in obtunded or otherwise unevaluable patients?

- A.** In the obtunded or unevaluable patient with a normal high-quality CT, the following recommendations should be considered:
- Call PTN to discuss case with regional Spine Service on call,
 - Continue cervical immobilization until evaluable and asymptomatic, or until transfer, or
 - Discontinue cervical immobilization following a normal MRI study obtained within 48 hours of injury. [Adopted from AANS/CNS with modification]
- B.** When there is no immediate CT access on site and:
- If the patient has definite neurologic deficit with cord injury, call Spine Service at VGH immediately.
 - If the patient has definite neurologic deficit without cord injury, call regional Spine Service immediately to consult a spine surgeon and call PTN to initiate transfer to higher level of care.
 - If the patient has no neurologic deficit but there is a high suspicion of spinal fracture based on the Canadian C-Spine Rule (see [Appendix A](#)), conduct plain film x-rays and then call regional Spine Service for a consult and PTN for transfer to higher level of care. (See [Rationale ii.](#) for the benefits of applying the Canadian C-Spine Rule to clear the cervical spine.)

II. DIAGNOSTIC IMAGING – WITHOUT NEUROLOGIC DEFICIT

KMQ-5. What are the indications for imaging of the cervical spine in alert and evaluable patients? What is the imaging modality of choice in these patients?

- A.** Perform CT if imaging for cervical spine injury is indicated by the Canadian C-spine rule (see [Appendix A](#) for full criteria, and see [Rationale ii.](#) for the benefits of the Canadian C-spine Rule). [Adopted from NICE]
- B.** All patients in whom C-spine injury is suspected (see [Appendix A](#)) must have radiographic evaluation. This applies to patients with pain or tenderness, patients with neurologic deficit, patients with altered mental status, and patients with distracting injury. [Adopted from EAST 2009] (See [Rationale-i.](#) for what constitutes distracting injuries, and [Rationale ii.](#) for the benefits of applying the Canadian C-Spine Rule to clear the cervical spine.)
- C.** Radiographic evaluation of the cervical spine is not recommended in the patient who:
- is awake and asymptomatic,
 - is without neck pain or tenderness
 - has a normal neurological examination
 - is without an injury detracting from an accurate evaluation, and
 - is able to complete a functional range of motion examination.

Discontinuance of cervical immobilization for these patients is recommended without cervical spinal imaging. [Adopted from AANS/CNS]

- D.** For the cervical spine, the appropriate imaging standard is a thin slice (1–3 mm) helical CT scan from the base of the skull to at least T2 with both sagittal and coronal reconstructions. [New SAG recommendation adapted from EAST 2009]
- E.** Where a CT scan is available, plain radiographs contribute no additional information and should not be obtained. (See [Rationale iv.](#) for a comparison of CT and plain radiography in detecting cervical spine injuries.) [Adopted from EAST 2009 with modification]
- F.** If high-quality CT imaging is not available, a 3-view cervical spine series (anteroposterior, lateral, and odontoid views) is recommended. This should be supplemented with CT (when it becomes available), if necessary, to further define areas that are suspicious or not well visualized on the plain cervical X-rays. [Adopted from AANS/CNS]

KMQ-6. What are the indications for imaging of the cervical spine in obtunded or unevaluable patients? What is the imaging modality of choice in these patients?

- A.** If it is anticipated a patient will remain unconscious, unassessable or unreliable for clinical examination for more than 48 hours, radiological spinal clearance imaging should be undertaken. It is recommended that this cervical spine CT scan be undertaken as a routine with the first CT brain scan in all head-injured patients who have an altered level of consciousness. [Adopted from BOA 2015]
- B.** For the cervical spine, the appropriate standard is a thin slice (1–3 mm) helical CT scan from the base of the skull to at least T2 with both sagittal and coronal reconstructions. It is recommended that this cervical spine CT scan be undertaken as a routine with the first CT brain scan in all head-injured patients who have an altered level of consciousness. [Adopted from BOA 2015]
- C.** Where a CT scan is available, plain radiographs contribute no additional information and should not be obtained. (See [Rationale iv.](#) for a comparison of CT and plain radiography in detecting cervical spine injuries.) [Adopted from EAST 2009 with modification]
- D.** If high-quality CT imaging is not available, a 3-view cervical spine series (anteroposterior, lateral, and odontoid views) is recommended. This should be supplemented with CT (when it becomes available) if necessary to further define areas that are suspicious or not well visualized on the plain cervical X-rays. [Adopted from AANS/CNS]
- E.** In patients in whom there is a high clinical suspicion of spinal injury yet have a normal high-quality CT imaging study, it is recommended that further patient management be discussed via PTN with the VGH Spine Service on call. It is recommended that, where possible, all spinal imaging performed be officially reported on by the radiologist on call. [Adopted from AANS/CNS with modification]
- F.** In the obtunded or unevaluable patient with or without a normal high-quality CT, the routine use of dynamic imaging (i.e., Flexion extension views) is not recommended. [Adopted from AANS/CNS with modification]

KMQ-7. What are the indications for imaging of the thoraco-lumbar spine in patients with suspected spinal injury? What is the imaging modality of choice in these patients?

- A.** Patients with back pain, TL-spine tenderness on examination, neurologic deficits referable to the TL-spine, altered mental status, intoxication, distracting injuries, or known or suspected high-energy mechanisms should be screened for TL-spine injury with a CT scan. (See [Appendix B](#) for full assessment criteria, [Rationale i.](#) for what constitutes distracting injuries, and [Rationale vi.](#) for the effectiveness of clinical examination in ruling out thoraco-lumbar spine injuries.) [Adopted from EAST 2012 with modification]
- B.** When imaging is deemed necessary, we recommend performing a CT scan (1–3 mm slices) as the first line investigation. Perform X-rays only if CT is not available. (See [Rationale v.](#) for a comparison of CT and plain radiography in detecting thoraco-lumbar spine injuries.) [Adapted from EAST 2012]
- C.** In blunt trauma patients with a known or suspected injury is confirmed anywhere in the spinal column, conduct thorough evaluation of the entire spine using CT owing to a high incidence of spinal injury at multiple levels within this population. [Adopted from EAST 2012 with modification]
- D.** If a person with suspected spinal column injury has Whole Body CT, carry out multiplanar reformatting to show all the thoracic and lumbosacral regions with sagittal and coronal reformats. [Adopted from NICE]
- E.** Patients without complaints of TL-spine pain that have normal mental status, as well as normal neurological and physical examinations may be excluded from TL-spine injury by clinical examination alone, without radiographic imaging, provided that there is no suspicion of high-energy mechanism or intoxication with alcohol or drugs. [Adopted from EAST 2012]

KMQ-8. Under what circumstances would it be appropriate to transfer the patient to another site without definitive care for a CT or MRI?

- A.** When there is no immediate CT access on site and if the patient has no neurologic deficit but there is a high suspicion of spinal fracture based on the Canadian C-Spine Rule (see [Appendix A](#)), conduct plain film X-rays and then call regional Spine Service for consult and PTN for transfer to higher level of care. (See [Rationale ii.](#) for the benefits of applying the Canadian C-Spine Rule to clear the cervical spine.)

III. DIAGNOSTIC IMAGING – WITH SUSPECTED OR CONFIRMED NEUROLOGIC DEFICIT

KMQ-9. What are the indications for imaging of the cervical spine in alert and evaluable patients with suspected or confirmed neurological deficit? What is the imaging modality of choice in these patients?

- A.** Perform CT if imaging for cervical spine injury is indicated by the Canadian C-spine rule (see [Appendix A](#)), including patients with pain or tenderness, patients with neurologic deficit, patients with altered mental status, and patients with distracting injury. (See [Rationale i.](#) for what constitutes distracting injuries, and [Rationale ii.](#) for the benefits of applying the Canadian C-Spine Rule to clear the cervical spine.) [Adopted from NICE and EAST 2009]
- B.** Radiographic evaluation of the cervical spine is not recommended in the awake, asymptomatic patient who is without neck pain or tenderness, who has a normal neurological examination, is without an injury detracting from an accurate evaluation, and who is able to complete a functional range of motion examination. Discontinuance of cervical immobilization for these patients is recommended without cervical spinal imaging. [Adopted from EAST 2009 and AANS/CNS]
- C.** For the cervical spine, the appropriate standard is a thin slice (1–3 mm) helical CT scan from the base of the skull to at least T1 with both sagittal and coronal reconstructions. Extending that scan to T4/5 overcomes the difficulties of imaging the upper thoracic spine. It is recommended that this cervical spine CT scan be undertaken as a routine with the first CT brain scan in all head-injured patients who have an altered level of consciousness. [Adopted from EAST 2009 and BOA 2015 with modification]
- D.** Where a CT scan is available, plain radiographs contribute no additional information and should not be obtained. (See [Rationale iv.](#) for a comparison of CT and plain radiography in detecting cervical spine injuries.) [Adopted from EAST 2009 and AANS/CNS with modification]
- E.** If high-quality CT imaging is not available, a 3-view cervical spine series (anteroposterior, lateral, and odontoid views) is recommended. This should be supplemented with CT (when it becomes available) if necessary to further define areas that are suspicious or not well visualized on the plain cervical X-rays. [Adopted from AANS/CNS]

KMQ-10. What are the indications for imaging of the cervical spine in obtunded or unevaluable patients? What is the imaging modality of choice in these patients?

- A.** If it is anticipated a patient will remain unconscious, unassessable or unreliable for clinical examination for more than 48 hours, radiological spinal clearance imaging should be undertaken. It is recommended that this cervical spine CT scan be undertaken as a routine with the first CT brain scan in all head-injured patients who have an altered level of consciousness. [Adopted from BOA 2015]
- B.** For the cervical spine, the appropriate standard is a thin slice (1–3 mm) helical CT scan from the base of the skull to at least T1 with both sagittal and coronal reconstructions; extending that scan to T4/5 overcomes the difficulties of imaging the upper thoracic spine. It is recommended that this cervical spine CT scan be undertaken as a routine with the first CT brain scan in all head-injured patients who have an altered level of consciousness. [Adopted from EAST 2009 and BOA 2015 with modification]
- C.** Where a CT scan is available, plain radiographs contribute no additional information and should not be obtained. (See [Rationale iv.](#) for a comparison of CT and plain radiography in detecting cervical spine injuries.) [Adopted from EAST 2009 with modification]
- D.** If high-quality CT imaging is not available, a 3-view cervical spine series (anteroposterior, lateral, and odontoid views) is recommended. This should be supplemented with CT (when it becomes available) if necessary to further define areas that are suspicious or not well visualized on the plain cervical x-rays. [Adopted from AANS/CNS]
- E.** In patients with a normal high-quality CT imaging result in whom there is a high clinical suspicion of spinal cord injury, a discussion with the VGH Spine Services via PTN is recommended for further patient management. It is recommended that, where possible, all spinal imaging performed be officially reported by the radiologist on call. [Adopted from AANS/CNS with modification]
- F.** In the obtunded or unevaluable patient with a normal high-quality CT, the routine use of dynamic imaging is not recommended. [Adopted from AANS/CNS with modification]

KMQ-11. What are the indications for imaging of the thoraco-lumbar spine in patients with suspected spinal injury and with neurologic deficit? What is the imaging modality of choice in these patients?

- A.** Perform CT as the first-line investigation for people with suspected spinal column injury without abnormal neurological signs or symptoms in the thoracic or lumbosacral regions. This includes patients with back pain, TL-spine tenderness on examination, neurologic deficits referable to the TL-spine, altered mental status, intoxication, distracting injuries, or known or suspected high-energy mechanisms. [Adapted from EAST 2012] (See [Appendix A](#) and [Appendix B](#) for assessment criteria) (See [Rationale i.](#) for what constitutes distracting injuries, and [Rationale vi.](#) for the effectiveness of clinical examination in ruling out thoraco-lumbar spine injuries.)
- B.** In blunt trauma patients with a known or suspected injury is confirmed anywhere in the spinal column, conduct thorough evaluation of the entire spine using CT owing to a high incidence of spinal injury at multiple levels within this population. [Adopted from EAST 2012 with modification]
- C.** Patients without complaints of TL-spine pain that have normal mental status, as well as normal neurological and physical examinations may be excluded from TL-spine injury by clinical examination alone, without radiographic imaging, provided that there is no suspicion of high-energy mechanism or intoxication with alcohol or drugs. [Adopted from EAST 2012]
- D.** When imaging is deemed necessary, CT scans with sagittal and coronal reformats should be used to screen for and diagnose, as CT scans are superior to plain films in identifying TL-spine fractures. (See [Rationale v.](#) for a comparison of CT and plain radiography in detecting thoraco-lumbar spine injuries.) [Adopted from EAST 2012 and NICE]

KMQ-12. Under what circumstances would it be appropriate to transfer the patient to another site without definitive care for a CT or MRI?

- A.** When there is no immediate CT access on site and
- If the patient has definite neurologic deficit with cord injury, call VGH Spine Service immediately to consult a spine surgeon and call PTN to initiate transfer to higher level of care.
 - If the patient has definite neurologic deficit without cord injury, call regional Spine Service immediately to consult a spine surgeon and call PTN to initiate transfer to higher level of care.

IV. TRANSFER TO HIGHER LEVEL OF CARE

KMQ-13. What are the indications for and timing of transfer of patients with confirmed or suspected spinal injury without neurological deficit to a higher-level trauma centre?

- A.** For patients who have a suspected or confirmed spinal injury with neurological deficit or spinal cord injury, immediately contact the spinal surgeon on call at VGH through PTN. [Adopted from NICE with modification]
- B.** When there is no immediate CT access on site and:
- If the patient has definite neurologic deficit with cord injury, call Spine Service at VGH immediately to consult a spine surgeon and call PTN to initiate transfer to higher level of care.
 - If the patient has definite neurologic deficit without cord injury, call regional Spine Service immediately to consult a spine surgeon and call PTN to initiate transfer to higher level of care.
 - If the patient has no neurologic deficit but there is a high suspicion of spinal fracture based on the Canadian C-Spine Rule (see [Appendix A](#)), conduct plain film x-rays and then call regional Spine Service for a consult and PTN for transfer to higher level of care. (See [Rationale ii.](#) for the benefits of applying the Canadian C-Spine Rule to clear the cervical spine.)
- C.** In acute spinal cord injury, patients should undergo surgical decompression within 24 hours of arrival at ED. (See [Rationale vii.](#) for optimal timing of surgical decompression)
- D.** Complete the Spine Checklist prior to initiating transfer and have available the following information for the call:
- CT results (if available)
 - ASIA scores (see [Appendix C](#))
 - Basic neurologic exam
 - Age
 - Mechanism of injury
 - Vital signs
 - Rectal exam
 - Associated injuries
 - High risk for intubation:
 - The elderly
 - C5 injury or higher, regardless of age
 - T1 injury or higher in patients age >60 years
 - Chronic obstructive pulmonary disease (COPD)
 - Morbidly obese
 - Vital capacity <15 mL/kg
 - Increasing pCO₂
 - Maximum respiratory pressure of <20 cm of water

KMQ-14. What are the indications for and timing of transfer of patients with confirmed or suspected spinal injury with suspected or confirmed neurological deficit to a higher-level trauma centre?

- A.** In acute spinal cord injury, patients should undergo surgical decompression within 24 hours of arrival at ED. (See [Rationale vii.](#) for optimal timing of surgical decompression)
- B.** Complete the Spine Checklist prior to initiating transfer and have available the following information for the call:
- CT results (if available)
 - ASIA scores (see [Appendix C](#))
 - Basic neurologic exam
 - Age
 - Mechanism of injury
 - Vital signs
 - Rectal exam
 - Associated injuries
 - High risk for intubation:
 - The elderly
 - C5 injury or higher, regardless of age
 - T1 injury or higher in patients age >60 years
 - Chronic obstructive pulmonary disease (COPD)
 - Morbidly obese
 - Vital capacity <15 mL/kg
 - Increasing pCO₂
 - Maximum respiratory pressure of <20 cm of water

KMQ-15. What are the indications for local (remote) management of stable spinal fractures (fractures not requiring transfer)?

- A.** Stable fractures, without neurological deficit, may be treated remotely, and not be transferred. This should be done on a case-by-case basis, after discussion with the regional spine surgeon on call via PTN. Adequate resources for local treatment and supervision must be available and confirmed. Complete the Spine Checklist below prior to initiating transfer and have available the following information for the PTN call:
- CT results (if available)
 - ASIA scores (see [Appendix C](#))
 - Basic neurologic exam
 - Age
 - Mechanism of injury
 - Vital signs
 - Rectal exam
 - Associated injuries
 - High risk for intubation:
 - The elderly
 - C5 injury or higher, regardless of age
 - T1 injury or higher in patients age >60 years
 - Chronic obstructive pulmonary disease (COPD)
 - Morbidly obese
 - Vital capacity <15 mL/kg
 - Increasing pCO₂
 - Maximum respiratory pressure of <20 cm of water

V. PRE-TRANSFER CARE

KMQ-16. What is the optimal pre-transfer management of patients with suspected or confirmed spinal cord injury without neurological deficit?

- A. Adequate pain management is recommended to control pain in the acute phase after spinal injury. [Adopted from NICE with modification]
- B. For people with spinal injury use intravenous morphine as the first-line analgesic and adjust the dose as needed to achieve adequate pain relief. [Adopted from NICE]

KMQ-17. What is the optimal pre-transfer management and preparation of patients with suspected or confirmed spinal injury with neurological deficit?

- A.** All receiving facilities should have province-wide written guidelines for the immediate management of a person with spinal cord injury and these should have been agreed upon with the linked spinal cord injury centre. [Adopted from NICE with modification]
- B.** Do not use the following medications, aimed at providing neuroprotection and prevention of secondary deterioration, in the acute stage after acute traumatic spinal cord injury:
- Methylprednisolone
 - Nimodipine
 - Naloxone. [Adopted from NICE and AANS/CNS]
- C.** Adequate pain management is recommended to control pain in the acute phase after spinal injury. [Adopted from NICE with modification]
- D.** For people with spinal injury use intravenous morphine as the first-line analgesic and adjust the dose as needed to achieve adequate pain relief. [Adopted from NICE]
- E.** Management of patients with an acute cervical spinal cord injury in an intensive care unit or similar monitored setting is recommended. [Adopted from AANS/CCNS]
- F.** Use of cardiac, hemodynamic, and respiratory monitoring devices to detect cardiovascular dysfunction and respiratory insufficiency in patients following acute spinal cord injury is recommended. [Adopted from AANS/CCNS]
- G.** Correction of hypotension in spinal cord injury (systolic blood pressure, 90 mmHg) when possible and as soon as possible is recommended. [Adopted from AANS/CCNS]
- H.** Maintenance of mean arterial blood pressure (MAP) between 85 and 90 mmHg for the first 7 days following an acute spinal cord injury is recommended. If there is considerable difficulty in maintaining MAP and there is a potential of serious adverse effects from vasopressors, drop MAP goal to 80 mmHg after consultation with the VGH Spine Service. [Adopted from AANS/CCNS with modification]
- I.** Consider the need for intubation for transfer in patients with high risk for respiratory failure, such as:
- The elderly
 - C5 injury or higher, regardless of age
 - T1 injury or higher in patients age >60 years
 - Chronic obstructive pulmonary disease (COPD)
 - Morbidly obese
 - Vital capacity <15 mL/kg
 - Increasing pCO₂
 - Maximum respiratory pressure of <20 cm of water

VI. LOCAL MANAGEMENT OF STABLE SPINAL FRACTURES

KMQ-18. What is the appropriate local (remote) management of stable spinal fractures (not requiring transfer)?

- A.** Stable fractures, without neurological deficit, may be treated remotely, and not be transferred. This should be done on a case by case basis, after discussion with the regional spine surgeon on call via PTN. Adequate resources for local treatment and supervision must be available and confirmed. Complete the Spine Checklist below prior to initiating transfer and have available the following information for the PTN call:
- CT results (if available)
 - ASIA scores (see [Appendix C](#))
 - Basic neurologic exam
 - Age
 - Mechanism of injury
 - Vital signs
 - Rectal exam
 - Associated injuries
 - High risk for intubation:
 - The elderly
 - C5 injury or higher, regardless of age
 - T1 injury or higher in patients age >60 years
 - Chronic obstructive pulmonary disease (COPD)
 - Morbidly obese
 - Vital capacity <15 mL/kg
 - Increasing pCO₂
 - Maximum respiratory pressure of <20 cm of water

Rationale

This CPG emphasizes initial assessment and early care phase of suspected spinal injury. External recommendations regarding long-term management were omitted as out of scope of this CPG. Emphasis was placed on blunt injury, as gunshot or other penetrating injuries are rarer in Canada than in the United States.

Modifications to external recommendations and the development of new recommendations were based on the following considerations:

- Relevance and applicability to the BC trauma system, including the Patient Transfer Network (PTN) and the importance of consult with VGH Spine Services prior to transfer
- Alignment with recommendations in the [BC Diagnostic Imaging Guidelines for Polytrauma](#)

Additional literature support is provided below.

i. What constitutes distracting injuries?

There is conflicting evidence (small retrospective studies) with regard to lower extremity injuries distracting patients from a cervical spine injury.

Several studies conclude that lower-body injuries (i.e., bony fractures in the pelvis, lower extremity) should not be distracting to clear the cervical spine.^{1,2,3}

One study concluded femur fractures should not be considered distracting amongst lower extremity injuries.⁴

¹ Heffernan DS, Schermer CR, Lu SW. What defines a distracting injury in cervical spine assessment? J Trauma. 2005 Dec;59(6):1396-9.

² Ong AW, Rodriguez A, Kelly R, Cortes I, Protetch J, Daffner RH. Detection of Cervical Spine Injuries in Alert, Asymptomatic Geriatric Blunt Trauma Patients: Who Benefits From Radiologic Imaging? The American Surgeon. 2006 Sep 1;72(9):773-7.

³ Kulvatunyou N, Lees JS, Bender JB, Bright B, Albrecht R. Decreased use of cervical spine clearance in blunt trauma: The implication of the injury mechanism and distracting injury. Accident Analysis & Prevention. 2010 Jul 1;42(4):1151-5.

⁴ Dahlquist RT, Fischer PE, Desai H, Rogers A, Christmas AB, Gibbs MA, et al. Femur fractures should not be considered distracting injuries for cervical spine assessment. The American Journal of Emergency Medicine. 2015 Dec 1;33(12):1750-4.

ii. What are the effectiveness and benefits of the Canadian C-Spine Rule in clearing cervical spine injuries?

The sensitivity rate of the Canadian C-Spine Rule ranges from 98–100 %.^{5, 6, 7, 8, 9}

Implementing the Canadian C-Spine Rule resulted in a 12.5–56 % reduction in imaging without missing clinically important cervical spine injury.^{5, 9, 10}

Implementing the Canadian C-Spine Rule resulted in cost savings of US \$226,500 and prevention of 105.7 mSv in radiation exposure, with no missed injuries, over a 3-month period at a level 1 trauma centre.¹¹

iii. What is the optimal Mean Arterial Blood Pressure (MAP) after acute spinal cord injury?

Threshold for optimal MAP is >85 mmHg, based a systematic review.¹²

Duration and time below the threshold 85 mmHg may have greater influence on neurological outcomes than average MAP.¹³

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- ⁵ Stiell IG, Clement CM, McKnight RD, Brison R, Schull MJ, Rowe BH, et al. The Canadian C-Spine Rule versus the NEXUS Low-Risk Criteria in Patients with Trauma. *New England Journal of Medicine*. 2003 Dec 25;349(26):2510–8.
- ⁶ Hoffman JR, Mower WR, Wolfson AB, Todd KH, Zucker MI. Validity of a Set of Clinical Criteria to Rule Out Injury to the Cervical Spine in Patients with Blunt Trauma. *New England Journal of Medicine*. 2000 Jul 13;343(2):94–9.
- ⁷ Bandiera G, Stiell IG, Wells GA, Clement C, De Maio V, Vandemheen KL, et al. The Canadian C-Spine rule performs better than unstructured physician judgment. *Annals of Emergency Medicine*. 2003 Sep 1;42(3):395–402.
- ⁸ Anderson PA, Muchow RD, Munoz A, Tontz WL, Resnick DK. Clearance of the Asymptomatic Cervical Spine: A Meta-analysis. *Journal of Orthopaedic Trauma*. 2010 Feb;24(2):100–106.
- ⁹ Michaleff ZA, Maher CG, Verhagen AP, Rebeck T, Lin C-WC. Accuracy of the Canadian C-spine rule and NEXUS to screen for clinically important cervical spine injury in patients following blunt trauma: a systematic review. *CMAJ*. 2012 Oct 9;cmaj.120675.
- ¹⁰ Stiell IG, Clement CM, Grimshaw J, Brison RJ, Rowe BH, Schull MJ, et al. Implementation of the Canadian C-Spine Rule: prospective 12 centre cluster randomised trial. *BMJ*. 2009 Oct 29;339:b4146.
- ¹¹ Paydar S, Ahmadi A, Dalfardi B, Shakibafard A, Abbasi H, Bolandparvaz S. Clinical and economic effects of selective radiological evaluation of high-energy trauma patients: a prospective experience of a level 1 busy trauma centre. *Emerg Med J*. 2015 Jul 1;32(7):535–8.
- ¹² Casha S, Christie S. A Systematic Review of Intensive Cardiopulmonary Management after Spinal Cord Injury. *Journal of Neurotrauma*. 2009 Dec 23;28(8):1479–95.
- ¹³ Hawryluk G, Whetstone W, Saigal R, Ferguson A, Talbott J, Bresnahan J, et al. Mean Arterial Blood Pressure Correlates with Neurological Recovery after Human Spinal Cord Injury: Analysis of High Frequency Physiologic Data. *Journal of Neurotrauma*. 2015 Feb 10;32(24):1958–67.

iv. What is the effectiveness of CT vs. plain radiography in detecting cervical spine injuries?

According to a meta-analysis, plain radiography has a sensitivity rate of 52 % while CT has a sensitivity rate of 98 % in detecting cervical spine injuries.¹⁴

v. What is the effectiveness of CT vs. plain radiography in detecting thoraco-lumbar spinal injuries?

According to a systematic review, plain radiography has a sensitivity rate of 22–75 % while CT has a sensitivity rate of 95–100 % in detecting thoraco-lumbar spinal injuries.¹⁵

vi. What is the effectiveness of clinical examination and using age and mechanism of injury in ruling out thoraco-lumbar spinal injuries?

A prospective observational study found clinical examination has a sensitivity of 78.4 % and specificity of 72.9 %.¹⁶

The same study found the addition of age ≥60 years and high-risk mechanism (fall, crush, motor vehicle crash with ejection/rollover, unenclosed vehicle crash, auto vs. pedestrian) as factors resulted in:

- Sensitivity of 98.9 % and specificity of 29.0 % for clinically significant injuries, and
- Sensitivity of 100 % and specificity of 27.3 % for injuries requiring surgery.

¹⁴ Holmes JF, Akkinapalli R. Computed tomography versus plain radiography to screen for cervical spine injury: a meta-analysis. *J Trauma*. 2005 May;58(5):902–5.

¹⁵ Sixta S, Moore FO, Ditillo MF, Fox AD, Garcia AJ, Holena D, et al. Screening for thoracolumbar spinal injuries in blunt trauma: An Eastern Association for the Surgery of Trauma practice management guideline. *Journal of Trauma and Acute Care Surgery*. 2012 Nov;73(5):S326.

¹⁶ Inaba K, Nosanov L, Menaker J, Bosarge P, Williams L, Turay D, et al. Prospective derivation of a clinical decision rule for thoracolumbar spine evaluation after blunt trauma: An American Association for the Surgery of Trauma Multi-Institutional Trials Group Study. *Journal of Trauma and Acute Care Surgery*. 2015 Mar;78(3):459–467.

vii. What is the optimal timing of surgical decompression in acute spinal cord injury?

The STASCIS study is the largest prospective non-randomized study on the timing of decompression for acute c-spine cord injury to date (313 patients enrolled between 2002–2009 from 6 centres across Canada). The study investigators reported at least 2 grade AIS improvement at 6-month follow-up with decompression conducted within 24 hours of SCI, with no significant complications.¹⁷

Two small prospective (quasi-)randomized studies on the topic showed mixed results of early decompression:

- One study found no significant differences in neurologic outcome, LOS in hospital, LOS in ICU or rehabilitation facility between early (≤ 72 hours) and late (> 72 hours) groups ($n=34$).¹⁸
- Another study observed better neurologic outcomes, shorter hospital stays, shorter ICU stays and lower complication rates in early surgery group (≤ 8 hours) than late group (3–15 days) ($n=27$).¹⁹

Overall, systematic reviews and meta-analyses report benefits of early surgery, which can range from 4–72 hours.^{20, 21}

Significantly higher hospitalization cost and increase in length of stay in hospital is associated with surgery after 24 hours in spinal cord injuries.²² Savings to the Canadian health-care system has been estimated at over US\$58 million for one quality adjusted life years (QALY) gained for patients with complete SCI, and over US\$536K for one QALY gained in patients with incomplete SCI.²³

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- ¹⁷ Fehlings MG, Vaccaro A, Wilson JR, Singh A, Cadotte DW, Harrop JS, et al. Early versus Delayed Decompression for Traumatic Cervical Spinal Cord Injury: Results of the Surgical Timing in Acute Spinal Cord Injury Study (STASCIS). *PLOS ONE*. 2012 Feb 23;7(2):e32037.
- ¹⁸ Vaccaro AR, Daugherty RJ, Sheehan TP, Dante SJ, Cotler JM, Balderston RA, et al. Neurologic Outcome of Early Versus Late Surgery for Cervical Spinal Cord Injury. *Spine*. 1997 Nov 15;22(22):2609–2613.
- ¹⁹ Cengiz ŞL, Kalkan E, Bayir A, Ilik K, Basefer A. Timing of thoracolumbar spine stabilization in trauma patients; impact on neurological outcome and clinical course. A real prospective (rct) randomized controlled study. *Arch Orthop Trauma Surg*. 2008 Sep 1;128(9):959–66.
- ²⁰ van Middendorp JJ, Hosman AJF, Doi SAR. The Effects of the Timing of Spinal Surgery after Traumatic Spinal Cord Injury: A Systematic Review and Meta-Analysis. *Journal of Neurotrauma*. 2013 Jul 1;30(21):1781–94.
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- ²² Mac-Thiong J-M, Feldman DE, Thompson C, Bourassa-Moreau É, Parent S. Does Timing of Surgery Affect Hospitalization Costs and Length of Stay for Acute Care following a Traumatic Spinal Cord Injury? *Journal of Neurotrauma*. 2012 Aug 24;29(18):2816–22.
- ²³ Furlan JC, Craven BC, Massicotte EM, Fehlings MG. Early Versus Delayed Surgical Decompression of Spinal Cord after Traumatic Cervical Spinal Cord Injury: A Cost-Utility Analysis. *World Neurosurgery*. 2016 Apr 1;88(Supplement C):166–74.

viii. What is the rate of pressure ulcers development associated with cervical spine immobilization?

The incidence rate for the development of pressure ulcers ranges from 6.8–38 %, according to a systematic review.²⁴

The risk of pressure ulcer development increases by 66 % for every day on the collar.²⁵

ix. What are the potential complications in hemodynamic management of acute spinal cord injury?

A retrospective study found significant complications associated with vasopressor use, especially tachycardia and bradycardia. Dopamine had the highest rates of complication among the vasopressors studied (69.2%), particularly when used in injuries below T6.²⁶

A multi-centre randomized trial showed that dopamine is associated with significantly more arrhythmic events than norepinephrine in patients with septic shock but no significant difference in mortality rate at 28 days between the two drug groups.²⁷

According to a meta-analysis, dopamine was associated with greater mortality and a higher incidence of arrhythmic events compared to norepinephrine in patients with septic shock.²⁸

²⁴ Ham W, Schoonhoven L, Schuurmans MJ, Leenen LPH. Pressure ulcers from spinal immobilization in trauma patients: A systematic review. *Journal of Trauma and Acute Care Surgery*. 2014 Apr;76(4):1131–1141.

²⁵ Ackland HM, Cooper JD, Malham GM, Kossmann T. Factors Predicting Cervical Collar-Related Decubitus Ulceration in Major Trauma Patients. *Spine*. 2007 Feb 15;32(4):423–428.

²⁶ Inoue T, Manley GT, Patel N, Whetstone WD. Medical and Surgical Management after Spinal Cord Injury: Vasopressor Usage, Early Surgeries, and Complications. *Journal of Neurotrauma*. 2013 Sep 10;31(3):284–91.

²⁷ De Backer D, Biston P, Devriendt J, Madl C, Chochrad D, Aldecoa C, et al. Comparison of Dopamine and Norepinephrine in the Treatment of Shock. *New England Journal of Medicine*. 2010 Mar 4;362(9):779–89.

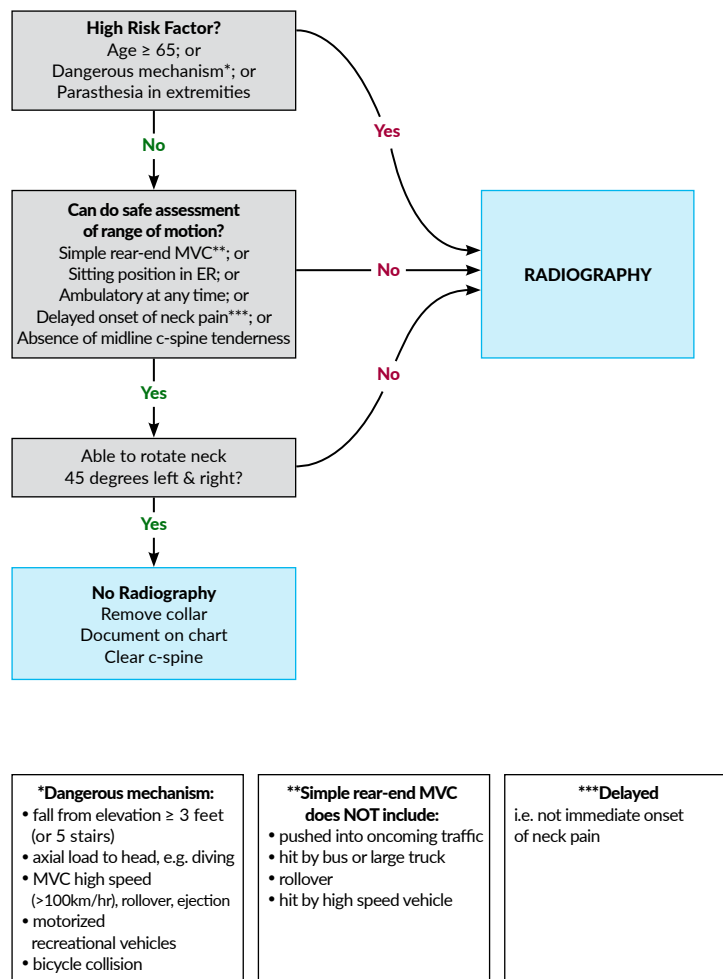
²⁸ De Backer D, Aldecoa C, Njimi H, Vincent J-L. Dopamine versus norepinephrine in the treatment of septic shock: A meta-analysis*. *Critical Care Medicine*. 2012 Mar;40(3):725.

Appendix

Appendix A: Canadian C-Spine Rule

For alert (GCS=15, absence of intoxication/sedation) and stable patient where cervical spine injury is a concern (adapted from Stiell et al. 2003²⁹).

Computed tomography (CT) is imaging modality of choice in obtunded patients (GCS<15) and in awake and alert patients who do not clear the Canadian C-Spine Rule. Cervical spine radiographs should have an extremely limited role in trauma imaging due to their relative lack of sensitivity for subtle fractures and injuries compared to CT imaging. Plain film x-rays are indicated only in settings where CT is unavailable and neurologic deficit is suspected based on physical exam, and only if imaging does not delay definitive care.



²⁹ Stiell IG, Clement CM, McKnight RD, Brison R, Schull MJ, Rowe BH, et al. The Canadian C-Spine Rule versus the NEXUS Low-Risk Criteria in Patients with Trauma. *New England Journal of Medicine*. 2003 Dec 25;349(26):2510-8.

Appendix B: Assessment for Thoraco-Lumbar Spine Injury

Assess the person with suspected thoracic or lumbosacral spine injury using these factors:

- age 65 years or older and reported pain in the thoracic or lumbosacral spine
- dangerous mechanism of injury (fall from a height of greater than 3 metres, axial load to the head or base of the spine – for example falls landing on feet or buttocks, high-speed motor vehicle collision, rollover motor accident, lap belt restraint only, ejection from a motor vehicle, accident involving motorized recreational vehicles, bicycle collision, horse riding accidents)
- pre-existing spinal pathology, or known or at risk of osteoporosis – for example steroid use
- suspected spinal fracture in another region of the spine
- abnormal neurological symptoms (paresthesia or weakness or numbness)
- on examination:
 - abnormal neurological signs (motor or sensory deficit)
 - new deformity or bony midline tenderness (on palpation)
 - bony midline tenderness (on percussion)
 - midline or spinal pain (on coughing) [Adopted from NICE with modification]

Key Performance Indicators

Purpose: To measure improvements in the system, including CPG compliance

INDICATOR	RATIONALE
1. Number of patients with neurologic deficit who arrived at VGH with mean arterial blood pressure (MAP) <85 mmHg	CPG Compliance
2. Number of patients with spinal injuries whose spine was not immobilized (verify with BCEHS if this is a useful indicator)	CPG Compliance
3. Number of patients with spinal fractures without neurologic deficit who were managed locally (outside VGH), with PTN call	CPG Compliance
4. Number of patients with suspected spine injury transferred to hospital other than VGH for CT or MRI without/before PTN call	CPG Compliance
5. Number/percentage of patients with neurologic deficit transferred directly to hospital other than VGH	Destination Compliance
6. Time from acceptance of patient to arrival at VGH	CPG Compliance
7. Time from arrive in ED to PTN call	CPG Compliance

Destination Criteria

Purpose: To identify key criteria for the transfer of patients, including timing and requirements for resource capabilities in receiving centres

INDICATOR
1. If there are no other life-threatening injuries and logistically feasible, transport people with suspected acute traumatic spinal cord injury (with or without column injury), with full in-line spinal immobilization, directly to the spinal cord injury centre at VGH from the scene of the incident.
2. Divert to the nearest hospital if a patient with suspected acute traumatic spinal cord injury (with or without column injury) needs an immediate life-saving intervention, such as rapid sequence induction of anaesthesia and intubation that cannot be delivered by the pre-hospital teams. This patient should have full in-line spinal immobilization before transfer.
3. Transport adults with suspected spinal column injury without suspected acute traumatic spinal cord injury, with full in-line spinal immobilization, to the nearest hospital with trauma service, unless there are pre-hospital triage indications to transport them directly to VGH Spine Services.

Key Stakeholders

Purpose: To identify key stakeholder groups to either a) consult for direct input on the CPG content during its development, or b) to inform for review and final approval when the CPG content is complete

- EMS
- ED physicians (and physicians who make transfers)
- PTN: Physicians that oversee PTN transfer (EPOS)

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3. Kulvatunyou N, Lees JS, Bender JB, Bright B, Albrecht R. Decreased use of cervical spine clearance in blunt trauma: The implication of the injury mechanism and distracting injury. *Accident Analysis & Prevention*. 2010 Jul 1;42(4):1151–5.
4. Dahlquist RT, Fischer PE, Desai H, Rogers A, Christmas AB, Gibbs MA, et al. Femur fractures should not be considered distracting injuries for cervical spine assessment. *The American Journal of Emergency Medicine*. 2015 Dec 1;33(12):1750–4.
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