Prevention of Chest Infections and Weaning in SCI

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Introduction

• Worldwide SCI mortality is from resp system failure
  – Especially in tetraplegia (1,2,3,4,5)
  – More complete injuries (6)
• Ascending level correlates with ↑ RTI (6,7,8,9) probably due to more RMW.
• Exp muscles usually more compromised than insp muscles – innervation levels (10, 11)
• Studies group other neuro conditions together, but often insp and exp muscles equally affected.
• ExpMW impairs cough → mucous retention, atelectasis, pneumonia, RF; so ↑s morbidity, mortality & health related costs (12, 13, 14, 15, 16, 17).
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Acute Respiratory Problems

- Unstable cervical spine & risk of worsening neurology
- Haemodynamic instability e.g. hypothermia, bradycardia, hypotension. Spinal shock.
- Acute neurogenic pulmonary oedema
- Impaired inspiration – loss of respiratory musculature (respiratory pump), ?flail segments?
- VC monitoring important - self vent or vented pts.
Acute Respiratory Problems

• Direct trauma to airways
• 2° trauma to airway – ETT/trachy/fixation complications
• Aspiration risk
• Loss of effective cough – muscle loss/ decreased exp pressures (ETT/Trachy)
• Pain, pain meds, sedation.
• ?brain injury – ability to follow commands
• Parasympathetic tone (discussed later)
Muscles of Respiration

Muscles of Inspiration with corresponding Spinal Innervation Level | Muscles of Expiration with corresponding Spinal Innervation Level
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Sternomastoid – Accessory XI, C1, C2. | Pectoralis Major – C5 – T1
Trapezius – Accessory XI, C1, C2. | Lateral Intercostals – C8-T11
Diaphragm – C3-5 | Abdominals – T6-L3 (note variation)
Scalenes – C4-8
Lateral Intercostals – C8-T11

Adapted from Estenne and De Troyer, 1990; and Schiler et al, 2009. (18, 11).
Effect of Position on VC & Treatment

Diagram:

- **Gravity** affects the abdominal contents.
- In **a**, the dome diaphragm is shown with gravity pulling the abdominal contents downward.
- In **b**, the diaphragm is flat, and the abdomen protrudes due to lack of muscle tone.
Wright’s Respirometer (Ferraris)

Tend to use Mark 14 or Haloscale. (Others acceptable).
http://www.nspirehealth.co.uk/default.asp?LINKNAME=RESPIROMETER&aftercare)  
http://gracemed.net/Wright_Respirometer.html (refurbished)
This two person method is preferred if spinal stability is a consideration as both people are pushing bilaterally which will minimise rotation. Stand on either side of the bed. Each person places one forearm across the upper abdomen of the patient with their other hand on the upper or lower ribs of both sides of the chest. As the patient attempts to cough, push inwards simultaneously.

Single person technique: spread your hands anteriorly around the lower rib cage and upper abdomen. With your elbows extended push inwards and upwards with both arms as the patient attempts to cough. Arms must be kept extended for this technique to work effectively, it may therefore not be appropriate to use if the patient’s bed does not lower to a suitable height.
Manual Assisted Cough in Tetraplegia (MAC)

- Prospective controlled trial of 40 motor complete tetras \(^{19}\)
- Mean VC 47.8% predicted in sitting, rose to 61.3% in supine
- Differed from DMD as MAC significantly increased PCF (peak cough flow) compared to BS (breath stacking)
- Probably due to no abdo innervation to aid unassisted cough!
- BS with MAC produced significantly better PCFs (\(p<0.001\))
- Again optimisation of insp with BS improves MAC & PCF
Mechanical Insufflation/Exsufflation

• Testing of MI:E on artificial lungs showed that to achieve PCF >160L/min, P°’s need to be at least 30 to -30 cmH2O \(^{(21)}\).
• At 40 to -40 cmH2O, only 248 L/min may be achieved.
• This is far less than a normal healthy cough, but larger than normal exp vols may be achieved.
• Lung compliance & airway resistance would affect results.
• Suggest P°s & time adjusted for max insufflation & quick exsufflation
• MAC during exsufflation may improve results
• They note no volutrauma has been reported with P°s of 60 to −60 cmH2O, so these warrant further study.
• Many studies use poor P°s
• Paucity of any good studies on SCI!!!
Manual Hyperinflation & Suction

- MHI & suction on turns is recommended in acute stage – check safety (e.g. high PEEP dependency)
- Check that chest movement is more than that on vent!
- Ensure sufficient exhalation time...don’t rush
- Suction – deep recommended and routine (4hrly or more)...insufficient clearance/patient may not feel secretions (22)
Management of Respiration

Ventilate to normal blood gases unless there is chronic underlying lung morbidity. Provide humidified supplemental oxygen, particularly in the acute phase, to ensure that the cord is kept oxygenated and reduce the risk of further damage.
Impaired inspiratory capacity
   1. Decreased respiratory muscle strength and fatigue
   2. Paradoxical chest wall movement causing an increase in effort of breathing
   3. Decreased inspiratory capacity
   4. Atelectasis
   5. Chest wall rigidity
Retained secretions and development of mucus plugs
   1. Increased secretion production
   2. Decreased cough effectiveness
Autonomic nervous system dysfunction
   1. Increased secretions
   2. Bronchospasm
   3. Pulmonary oedema
• For high injuries ~40 – 60%* of patients will develop atelectasis particularly in the left lower lung.
• Pneumonia is common in acute spinal injuries in the first 3 – 5 days
• Early tracheostomy if appropriate
• Cuff leaks, assisted devices to allow speech
• Consider NIV early
Parasympathetic tone

- “Increased” tone with injuries above the T1 level
- Bronchoconstriction, narrowing of the airways/Sub-clinical bronchospasm
- Increased mucus production via bronchial mucus glands
- Increased viscosity of the mucus
- Nebulised bronchodilators
- Mucolytics carbocysteine/Nebulised hypertonic saline
Prevention of Atelectasis

• Management of atelectasis is the cornerstone of early SCI respiratory care.
• Decreased inflation of the alveoli also leads to a significant reduction in the release of surfactant, which further contributes to atelectasis.
• Atelectasis may worsen over the first few days as respiratory muscles fatigue, secretions accumulate and lung compliance decreases.
Ventilatory strategies

• High volume ventilation to prevent atelectasis 10-20ml/kg
• ARDS net 6-8mls/kg insufficient, none of these studies involved SCI and weaning.
• High levels of Positive-end expiratory pressure (PEEP) is not recommended because of the lack of studies showing the effectiveness of PEEP in treating atelectasis in acute SCI.
• Pressure Assist Control Ventilation
• Use large Vts rather than PEEP due to position of diaphragm & surfactant production.
Weaning

• Ventilator Free Breathing
• The VFB weaning method is applicable when the patient is stable, infection free, with minimal positive end-expiratory pressure (PEEP) or oxygen dependency.
• It consists of gradually increasing periods of breathing humidified, oxygen enriched air independently of the ventilator.
• The permitted length of time is matched to the vital capacity (VC) as measured with a Wright’s respirometer.
• Position – don’t sit up/out as increase work of breathing.
• The session is curtailed if the VC drops below two thirds of the starting value, or the patient appears distressed.
• In between, the diaphragm is rested using a controlled ventilation mode ensuring a tidal volume delivery of 10–20 ml/kg.
• The other components of the weaning schedule are tracheostomy tube cuff deflation during VFB.
• The use of a speaking valve or an occlusive bung on the tracheostomy tube.
• Guidelines can be found on SDGH website via ‘about us & our services’ ‘spinal injuries centre’ ‘spinal cord injury care’ ‘ventilator dependence & weaning’ ‘outline of weaning protocol’
We welcome you contacting us for guidance. Thank you.
To Conclude...

- Atelectasis is not our friend!
- Optimise positioning
- Pharmacology
- Ventilation
- Aggressive secretion management
- All via a team approach – Drs, nurses, physiotherapists, SALT, dieticians.
References.


