Appendix 9

Screening and management options for ventilatory failure in spinal cord injury (SCI) patients. [Can be used for all acute neurological diagnoses that involve respiratory muscles]

The risk of ventilatory failure after SCI is significant. The risk increases as the level of injury ascends. There is a high risk of deterioration in ventilatory function over the first 3-7 days post injury, as oedema (swelling) tends to spread vertically.

As a rough guide, the following levels of cord injury can be expected to produce the following limitations:

Injury level	FVC as % of normal	Cough
C1 - C2	5-10%	absent
C3 – C7	20%	ineffective
T1 -T4	30-50%	weak
T4 – T11	Improves caudally	variable
below T11	essentially normal	strong

Screening for deteriorating function should be part of routine care and should consist of:

1. Eliciting symptoms of worsening dyspnoea, fatigue, somnolence and poor sleep quality.

2. Eliciting signs of a high / increasing respiratory rate, use of accessory muscles, reduced volitional thoracic cage expansion, focal signs of abnormal mechanics and assessment of cough strength. Thoracic cage injuries, lung contusions, atelectasis secondary to supine posture +/- reduced respiratory muscle strength, lobar pneumonia, lobar collapse, pleural collections and intercostal drains all need to be considered.

3. Forced Vital Capacity (FVC) is the maximal volume expelled after maximal inspiration and should be used as a global measure of overall ventilatory status in SCI patients. It should be routinely monitored at 4 - 6 hourly intervals. If measured FVC falls below 50% predicted consider therapy. If measured FVC falls below 30% predicted and / or consistently declines by >10% in a 24 hour period then refer to ICU.

    a. If safe and practical measure FVC in both supine and upright postures. This is a more sensitive test of diaphragm strength. A >10% reduction in FVC (from upright to supine) is associated with a higher risk of respiratory failure. If present, consider more regular surveillance and initiating therapy. Simultaneous postural oxygen saturation monitoring may be of additional benefit by increasing the sensitivity of postural testing. Any decline in SpO_2 >2% in 5 minutes is significant. Ensure FiO_2 is constant throughout test.

4. Arterial blood gases should be performed to assess arterial carbon dioxide levels in high risk patients.

Calculating Normal Predicted FVC

Normal predicted values for FVC are ~70ml/kg (ideal body weight) for males and ~55ml/kg (ideal body weight) for females.

Ideal body weight (IBW):
IBW (kg) for men = [(height (cm) -154) x 0.9] + 50
IBW (kg) for women = [(height (cm) -154) x 0.9] + 45.5
(Online calculator http://www.ukmicentral.nhs.uk/resource/calcs/ibw.asp?group=m)

Normal Predicted FVC (ml) for men = IBW x 70
Normal Predicted FVC (ml) for women = IBW x 55

Treatment options

1. Breathing exercises, incentive spirometry and volitional cough manoeuvres.

2. Intermittent positive pressure breathing (IPPB) Consider routine use of IPPB if FVC is < 30% predicted. Initially use IPPB to give 3-4 big breaths, rest, and repeat for 4 cycles.

3. Intermittent non-invasive pressure support ventilation (BiPAP, nasal / full face / helmet *OR* Cuirass) – usually nocturnal +/- intermittent daytime.

4. Elective intubation, ventilation and early tracheostomy.

Review articles

Berlly M, Shem K: **Respiratory management during the first five days after spinal cord injury**. *J Spinal Cord Med* 2007, **30**(4):309-318.
Full text:
http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed&pubmedid=17853652

Zimmer MB, Nantwi K, Goshgarian HG: **Effect of spinal cord injury on the respiratory system: basic research and current clinical treatment options**. *J Spinal Cord Med* 2007, **30**(4):319-330.
Full text:
http://www.pubmedcentral.nih.gov/articlerender.fcgi?tool=pubmed&pubmedid=17853653

Patient Name		Hospital No.
Height in cm	Ideal Body Weight in kg	Predicted FVC in ml
Risk and treatment thresholds	50% predicted FVC in ml	30% predicted FVC in ml

Forced vital capacity chart

Date																												
Time																												
5000 ml																												
4000 ml																												
3000 ml																												
2000 ml																												
1000 ml																												
Value																												
Posture (S/P)																												
%Predicted																												
% Change																												

% predicted = measured FVC / predicted FVC x 100

% change = (Current FVC – Last FVC) / Last FVC x 100 *OR* (Upright FVC – Supine FVC) / Supine FVC