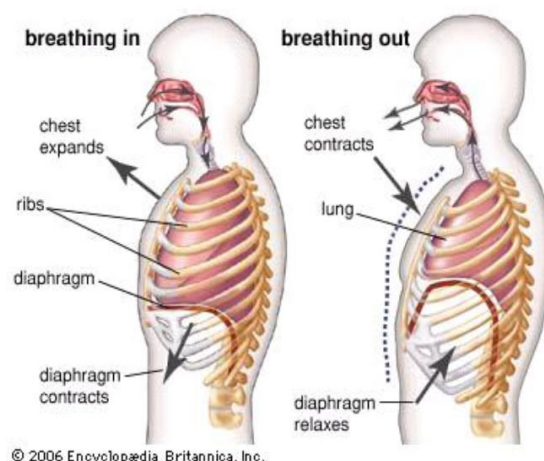


Inspiratory Muscle Training – Clinician information

After a spinal cord injury (SCI), respiratory function is affected by muscle weakness or paralysis, reducing the person's ability to take deep breaths in, reducing the amount of oxygen entering the body, and also restricting the ability to force air out or cough to clear secretions from the airways. Sometimes the accident or injury that causes the SCI can directly impact upon the chest as such as fractured ribs from falls or car accidents, aspiration from diving accidents, or direct trauma to the lung tissue itself. Down the track, secondary complications can occur such as respiratory fatigue, pneumonia and respiratory failure, and recent evidence shows that obstructive sleep apnoea (OSA) is very common in people with SCI. Maintaining respiratory health is very important for **everyone** with a spinal cord injury, and one very effective way to do this is with **inspiratory muscle training**.

Research suggests....

A Cochrane review identified that respiratory muscle training (RMT) is effective for increasing respiratory muscle strength ⁽¹⁾ and increasing lung volumes for people with cervical SCI, including vital capacity, maximal inspiratory pressure and inspiratory volume ^(1, 2, 3). RMT has been shown to improve lung function and reduce the severity of sleep apnoea ⁽²⁾ and higher inspiratory muscle power may reduce the risk of pneumonia and improve cough efficacy ⁽⁴⁾. A feasible and effective treatment is resistance-based inspiratory muscle training (IMT) ⁽²⁾. No adverse effects of respiratory muscle training have been reported ⁽¹⁾.



Inspiratory Muscle Training (IMT) - HOW DOES IT WORK?

It has been established that pneumonia is related to muscle strength, and it is suggested that increasing muscle strength may reduce the risk of pneumonia ⁽⁵⁾.

Respiratory muscle training has been found to be feasible and effective in increasing respiratory muscle strength, improving lung function and reducing the severity of sleep apnoea ⁽²⁾. There is also some current work being performed by the same research group into inspiratory muscle strength training and the potential effect on other factors such as quality of life, life expectancy, sleep disordered breathing and respiratory health. This work is still in progress, but there are trends towards widespread improvements from IMT.



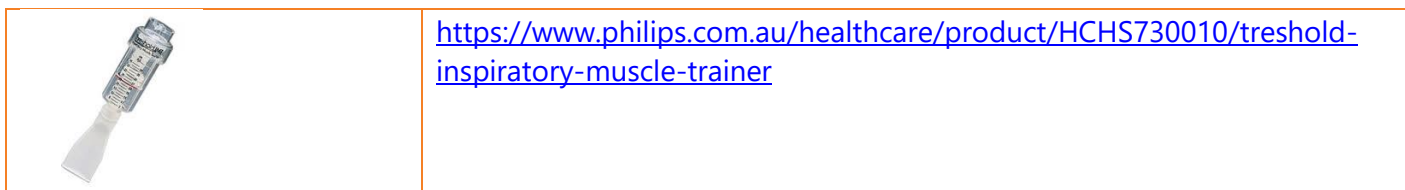
Recently published evidence has that found that lowered values of Maximum Inspiratory Pressure (PImax) was the strongest predictor of pneumonia in people with spinal-cord injury⁽⁵⁾. It is suggested that inspiratory muscle strength is important to provide a deep inspiration and increased pre-cough inspiratory capacity as well as improved resistance to airways collapse⁽⁵⁾. PImax is directly influenced by inspiratory muscle strength and this volume is significantly improved after a period of inspiratory muscle training^(2, 3).

As far as we aware, there are two key pieces of equipment that can provide this respiratory muscle training stimulus they are;

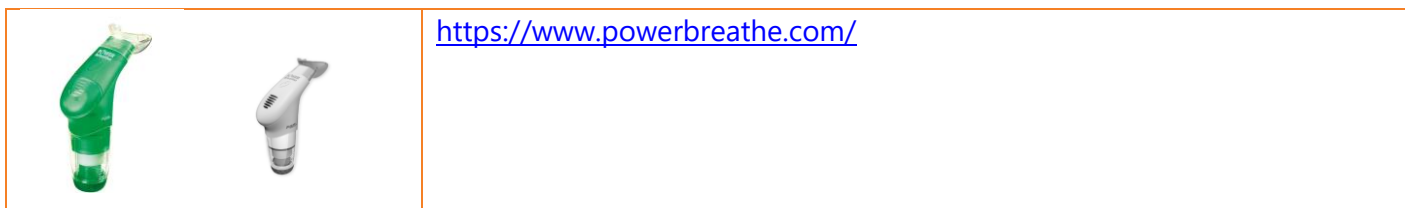
- ⇒ **Phillips Respironics Inspiratory Muscle Trainer (IMT)** (9 – 41cm H2O)
- ⇒ **POWERbreathe Plus**Light Resistance (green): 17cm H2O – 98cmH2O)
- ⇒ **POWERbreathe Medic** (Resistance 9cmH2O -78cmH2O) (practitioner purchase only)

Please note: As of 2018, there are some difficulties with distribution of *PowerBreathe* in Australia.

Phillips Respironics Threshold Inspiratory Muscle Trainer:



POWERbreathe Plus Inspiratory Muscle Trainer:



There are some different features of each type of inspiratory muscle trainer that are worth considering. The Philips IMT costs approximately \$33.00 and goes up to a pressure of 41cm/H2O. The POWERbreathe costs over \$100.00 and goes up to a pressure of up to 98cmH2O. After SCI, even pressures of 20 – 30cm H2O are quite intense and so lower pressures such as those from the IMT can still provide a good training stimulus. The Threshold IMT has been used in research studies in SCI, whereas the POWERbreathe has not as far as we are aware. However, anecdotally some clients have reported that they feel increased comfort using the POWERbreathe, with a deeper slower breath and less chance of developing the “Kazoo” sound that can occur if breathing in through the IMT with a technique that is too fast and too sharp.



Treatment / dose recommendations: Start with 3 x 10 repetitions of breathing in against the machines resistance at 10-15cmH₂O with a 5 second inspiration time, to see how your client tolerates the training stimulus ⁽⁴⁾.

Further research is needed...

Further research is needed to examine the impact of respiratory muscle training on functional outcomes such as symptoms of dyspnea/shortness of breath, cough strength and efficacy, incidence of respiratory complications, number of hospital admissions, and overall quality of life (1).

Also, longer-term and longitudinal studies are needed to determine any carryover effects of RMT on respiratory function, quality of life, respiratory morbidity, and mortality (1, 3). Short and long term studies are needed to ascertain optimal dosage and dose-response relationships. (1, 2)

RMT appears to be particularly effective at increasing vital capacity, inspiratory volumes and strength (3), and research is needed to further quantify these effects.

Training Protocol – Principles and Practice

Strength Training:

If possible, assess the the maximal inspiratory pressure (MIP) using a Micro RPM device to use as a baseline. Note: Micro RPM manufactured by Carefusion <http://www.carefusion.com/our-products/respiratory-care/pulmonary-function-testing/microrpm>

If you are unable to test the MIP, use an estimate predicted by the person's level of spinal cord injury. From the literature we know that a person with tetraplegia will have a baseline MIP around **30-40cmH₂O** (*an able bodied individual without lung disease, will have a baseline around 100-120cmH₂O*). Training should begin at **30% of this value**. For example, if the person had a MIP volume of 30cmH₂O, start training at **10cmH₂O**).

Start training at **3 sets of 10 repetitions, once/day**.

To progress the training stimulus, increase the pressure by **10% every 2nd or 3rd day**.

Endurance Training:

You can also increase the repetitions, to focus on endurance rather than strength for example, increasing to a twice daily session or increasing the number of repetitions in a row. However, as with a 10RM musculoskeletal strengthening program, keeping a strength training regime with the maximal pressure to do over 3 x 10 is most beneficial.

Please refer to the accompanying client training program for inspiratory muscle training diary.



Top Tips:

Get more out of the device! For individuals with an *incomplete SCI* and some abdominal and expiratory muscle function, it is possible to turn the IMT around and do expiratory muscle training through the wider end (with an adaptor) for abdominal muscle/expiratory muscle strengthening too! Alternatively consider an addition Positive Expiratory Pressure (PEP) training device.

SUMMARY:

- Pneumonia is a major cause of morbidity and mortality in chronic SCI.
- Inspiratory muscle weakness contributes to reduced respiratory volumes after SCI.
- New research shows that reduced inspiratory pressure is a risk for the development of pneumonia after SCI.
- Inspiratory muscles respond to training stimulus to increase their strength and function.
- Research suggests that the most feasible and effective currently known treatment is resistance based inspiratory muscle training.

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- (3) Tamplin, J and Berlowitz, D (2014). A systematic review and meta-analysis of the effects of respiratory muscle training on pulmonary function in tetraplegia. Spinal Cord, 52, 175–180.
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- (5) Raab, A., Krebs, J., Perret, C., Michel, F., Hopman, M., Mueller, G. (2016) Maximum Inspiratory Pressure is a Discriminator of Pneumonia in Individuals With Spinal-Cord Injury. Respiratory Care, 61, 12, pp. 1636 – 1643.