Welcome to the first edition of TechnoTalk for 2011. I hope you are all keeping to your New Year's resolutions so far. Our resolution is to continue to bring you lots of interesting and informative articles in the next year.

As of the 8 February 2011, The Spastic Centre changed its name to Cerebral Palsy Alliance. This new name reflects our focus on cerebral palsy and the alliance that we form with people with cerebral palsy, their families and communities. Our handprint logo has been changed to reflect the new name, and please also note our updated website and email addresses.

This month, TASC seating consultant/physiotherapist Debbie Davis has written a comprehensive guide on considerations for respiratory function when prescribing a seating system, an important area which may be overlooked in the seating prescription process.

Sadly, we also say goodbye to Debbie this month. Debbie has brought a wealth of knowledge and skill to the TASC team, from her background as a physiotherapist and her specific clinical experience in respiratory physiotherapy. We would like to thank Debbie for her hard work and the enthusiasm that she has shown in her time here and wish her the best for her new role as Level 3 physiotherapist in NSW Health.

We will introduce you to our new seating consultant in the next edition, and also a new speech pathologist as we have also recently said goodbye to Angela Vass who is pursuing a career dream of working in international aid and development.

Happy Reading
Liza MacLean,
TASC Team Leader

Registrations are now open for the 2011 AGOSCI Conference to be held in Adelaide, 11-14th May.

AGOSCI is a group representing people with complex communication needs, as well as those who live, know or work with people with complex communication needs.

The conference theme is ‘Taking it to the Streets’ which is designed to encourage innovation and action whilst increasing understanding and awareness of persons with complex communication needs and their use of augmentative and alternative communication.

There is a scholarship program for people with complex communication needs, or their parents/guardians who wish to attend to increase their knowledge, understanding and/or skills in the area of complex communication needs.

For more information go to:
Whilst wheelchair seating prescription appears to be a straightforward task, there are many aspects of the person’s life and their day-to-day activities that need to be considered. Wheelchair seating should be prescribed based upon musculoskeletal findings, swallowing requirements and functional goals.

Despite it being one of the most important body systems, the impact upon the respiratory system is often overlooked during the wheelchair seating assessment and prescription process. For people with cerebral palsy, this is of particular importance as it is a neuromuscular condition that may lead to chest wall deformity (Seddon, 2003) and can affect respiratory muscle performance (Shaffer, 1981).

This article has been prepared to assist therapists in improving their understanding of respiratory function and how to practically apply it to seating.

### Basic Mechanics of Respiration

Respiration is a 3-dimensional dynamic activity that involves the:

- **Diaphragm**: A thin muscle that separates the thoracic cavity from the abdominal cavity – it is the main ‘pump’ driving respiration (Abrahams, 2002).
- **Rib cage**: expands on inspiration causing an increased thoracic volume, which draws air into the lungs.
- **Abdominal muscles**: They relax and contract to provide forces through the abdominal cavity which impacts on the position of the diaphragm. They become increasingly involved in expiration as respiratory effort increases, e.g. during intense exercise or coughing, to actively assist in expelling air from the lungs.
- **Surrounding musculature**: Assists with respiration by becoming increasingly active as respiration becomes more intense.

There are three main patterns of respiration that you can observe, including:

#### Diaphragmatic Breathing

During inspiration the diaphragm contracts; causing the dome to move downwards to flatten out by moving into the abdominal cavity. This facilitates lung expansion and ‘pushes’ down onto the the abdominal organs.

When the diaphragm relaxes, it returns to its original domed position, gently expelling air from the lungs. This type of respiration is observed during quiet breathing.

The abdominal muscles become increasingly involved with exertion by increasing the pressure from the abdominal cavity to make expiration more forceful.
Bucket Handle
The lower ribs move up and out to the side increasing the width of rib cage causing air to move into the lungs on inspiration.
If you put your hands on the side of your own rib cage and take a deep breath in, you should be able to feel this movement.

Pump Handle
The lower end of the sternum (breastbone) and upper ribs move forward during inspiration increasing the depth of the rib cage (Abrahams, 2002), causing air to enter the lungs.
You can feel this by placing your hand on the top part of your rib cage and taking a deep breath in.

Different body systems impact on respiratory function
Different body systems impact on respiratory function independently as well as in combination with each other. Not all interactions are fully understood and ongoing research continues in this area, but here is some food for thought.

Gastro-intestinal system
- When a person is constipated, they tend to have a large and distended abdomen. When they sit in a slumped position (i.e. combination of posterior pelvic tilt and kyphosis), the abdominal contents will push up into the ribcage causing the lungs to have limited expansion capability. If you imitate the position in the picture you will be able to feel how it affects your ability to take a deep breath.
- Poor nutrition or increased energy requirements can lead to respiratory muscle weakness if energy requirements are not met adequately.

Reflux
Gastro Oesophageal Reflux Disease (GORD) has been linked to respiratory disease and is frequently diagnosed in people with cerebral palsy (estimated between 32%-75% (Seddon, 2003)).
The exact cause remains unknown, but it is thought to be linked to gastric contents entering the lungs by a combination of:
- Abdominal muscle spasticity increasing the pressure in the abdominal cavity (Seddon, 2003).
- Poor coordination of oesophageal sphincter and peristalsis (Seddon, 2003).

Fig 1: Abdomen
Skeletal system

Chest wall deformity and stiffness can reduce the amount of expansion that the lungs are able to achieve. This can affect the amount of air entering the lungs as well as the effort required to maintain normal respiration. This may become more noticeable when people attempt physical tasks (e.g. dressing or communication) as their breathing may become more laboured with physical effort.

Muscular system

Cerebral palsy can result in chest muscle weakness which may result in respiratory muscles dysfunction. This can then lead to abnormal chest wall development (Massery, 1991 and Park et al, 2006).

Aims of improving respiratory functions

1. All muscles have an optimal length at which they work best, including the diaphragm and other accessory muscles for respiration. Improving positioning by ensuring posture is as neutral as possible for the individual and using appropriate postural supports can assist in providing optimal positioning and length of these muscles.

2. Maximise chest wall freedom of movement to assist with the ability to take optimal sized breaths without compromising postural support, e.g. consider how firmly thoracic supports are fitted. If they are:
   - Too tight: they may limit the ability to expand the rib cage laterally.
   - Too loose: they may not provide adequate postural support causing increased muscular effort and the rib cage may not be in an optimal position.

3. Use of gravity to assist movement. This will vary between individuals, you may be attempting to:
   - Position the abdominal contents so that there is more room for the lungs to expand, e.g. in a slumped position, the abdominal organs limit the ability of the diaphragm to contract effectively.
   - Use the abdominal contents to provide support for the diaphragm in people who have very low tone and an extremely anteriorly tilted pelvis, e.g. in this position it is very difficult to expire forcefully as the abdominal muscles are stretched and the abdominal contents are not providing adequate support to the diaphragm.

4. Improve coordination between muscles of abdomen and trunk. This means that they will work together, making them most efficient (see section on athetosis).

Impact of seating

Common postures and their impact on respiratory function

It is recommended that you position yourself into these postures to feel how it affects your breathing.
Posterior pelvic tilt and kyphosis

- Ribs are limited with ability to expand forward (pump handle) so must move laterally (bucket handle) to compensate.
- Abdominal organs limit the diaphragm from moving downwards during inspiration.
- Due to the mechanics of this position full inspiration may be difficult (Sparacio, 2001) which may decrease lung volumes and increase risk of lung collapse and difficulty completing an effective cough.
- Where breath/swallow coordination is impaired, possible increased risk of aspiration.
- If neck extension is present, it may open the airway, which can impair airway protection and lead to aspiration.

Anterior pelvic tilt and lordosis

- Abdominal muscles are unable to assist effectively with expiration as they are stretched in this position, making contraction difficult.
- Due to the mechanics of this position, full expiration may be difficult (Sparacio, 2001) which may make activities such as effective coughing difficult.
- Lower ribs have limited ability to expand, so the ribs must expand laterally (bucket handle) and increase movement at the top of the rib cage to compensate.
- Flaring or winging anteriorly of the bottom of the ribs due to lack of ‘pull’ from abdominal muscles may be noted during the mat evaluation.

Severe spinal deformities

- Severe spinal deformities often lead to an increased chest wall stiffness, which will decrease chest wall movements (meaning that the lungs cannot inhale air as effectively).
- This may vary from side to side depending on deformity.
- This can lead to the anatomy of the airways becoming altered leading to increased difficulty in moving air in and out of the lungs.

Athetoid movements

- Athetoid movements lead to desynchrony between abdominal muscles/diaphragm and thorax muscles because the abdominal muscles are activated subconsciously, whereas thorax muscles tend to be used mainly as an accessory. This means that when one group of muscles are working on inhaling, others may be working on exhaling.
- This leads to smaller and more rapid and disjointed breaths and can impair breath/swallow coordination.
- Can result in a flatter upper rib cage, depressed sternum, flaring of lower ribs and an overall smaller rib cage.
Seating considerations

Correct postural asymmetries to the most neutral position as possible to improve respiratory mechanics. It has been shown that adaptive seating can improve respiratory function (Nwaobi, 1986), likely by:

- Reversing flexible spinal deformities.
- Positioning the head and neck in optimal alignment to reduce airway obstruction and improve swallowing mechanics
- Support the thorax to provide better control of the muscles of respiration.

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<thead>
<tr>
<th>Body Area &amp; Optimal Posture</th>
<th>Tips</th>
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<tbody>
<tr>
<td><strong>Pelvis</strong></td>
<td>A neutral pelvis provides a stable base of support for the trunk to assist in ease of respiration. Some things to consider if this is not achievable:</td>
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<tr>
<td>Slight anterior tilt of pelvis</td>
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<tr>
<td>Posterior pelvic tilt</td>
<td>If poor hip flexion is observed consider opening the seat-to-back angle to assist with spine alignment. If hamstrings are tight consider reviewing footplate hanger angle.</td>
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<tr>
<td>Anterior pelvic tilt</td>
<td>Correct excessive anterior pelvic tilt to a neutral position with:</td>
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<tr>
<td>Changing the line of pull of the pelvic belt.</td>
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<td>‘Dumping’ the seat cushion (i.e. when the cushion is higher under the distal thigh and ramps downwards towards the pelvis which reduces hip flexion and may reduce amount of anterior pelvic tilt. However you must consider if this will cause the wheelchair user hip pain).</td>
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<tr>
<td><strong>Shoulder Girdle</strong></td>
<td>Use of:</td>
</tr>
<tr>
<td>Retracted shoulder girdle and shoulder blades</td>
<td>Harness, backpack straps or shoulder keepers Tilt-in-space Soft or hard tray to provide upper limb support</td>
</tr>
<tr>
<td><strong>Upper Limb</strong></td>
<td>Poor respiratory function may be compensated for by small amounts of shoulder external rotation and abduction to change skeletal mechanics to assist inspiration (Sparacio, 2001).</td>
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<tr>
<td>Shoulders slightly abducted with externally rotated</td>
<td>If this movement is blocked by using shoulder blocks, this may increase the person’s respiratory effort. Supporting the upper limbs and the shoulder girdle can also assist if respiration is difficult, e.g. by prescribing armrest pads or a hard/soft tray.</td>
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| **Head and Neck**<br>Neutral chin position | • Involve a speech pathologist to advise on optimal positioning for mealtimes. This may involve some changeability in the seating system.  
• Muscles in the head and neck are used as stabilisers for positioning the head as well as during respiration.  
• A neutral head position and a supportive headrest will decrease the activity of these muscles required to support the head. This will improve the ability of the neck muscles (including the sternocleidomastoid) to assist with respiration by assisting with upper chest wall movements as required (Massery, 1994).  
• Compensatory positioning such as a chin tuck may be recommended by a speech pathologist in order to promote airway protection. |
| **Spine**<br>Corrected ‘C’ Curve scoliosis | • Correcting a flexible scoliosis will allow both sides of the rib cage and lungs to expand fully and equally.  
• However, take care that thoracics and harnesses are not fitted too tightly or they may restrict rib cage expansion. |
| **Kyphosis** | Provide anterior trunk supports to correct flexible component of kyphosis to allow efficient expansion of lungs, including:  
• Soft or hard tray  
• Harness or shoulder keepers  
• Tilt-in-space |
| **Lordosis** | Consider loading the diaphragm using:  
• Anterior abdominal support  
• Closing the seat-to-back angle of the seating (where appropriate)  
• Tilt-in-space |
| **Athetosis**<br>Stability | • Stabilise pelvis and trunk to decrease uncoordinated movements of the thorax with use of:  
➢ Thoracics  
➢ Anterior trunk supports  
➢ Armrest pads/arm cuffs  
➢ Soft or hard tray |
## Body Area & Optimal Posture

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<td>Stability</td>
<td>• Stabilise upper limbs in slight shoulder abduction and external rotation for maximal efficiency.</td>
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<td></td>
<td>• Consider the changes that occur to a person’s posture and respiratory effort required when completing functional tasks and reaching requirements such as access to joystick or a device. You may need to consider stabilising the upper limb or position the joystick or switch in a position so that a kyphotic posture is not encouraged.</td>
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### Articles and References


### Suggested Readings