NHS SCOTLAND

WoSCoR

West of Scotland Paediatric Complex Respiratory Managed Clinical Network

Guidelines for Paediatric Respiratory Physiotherapy Assessment

Introduction

Cerebral palsy is the most common cause of serious motor impairment in young children with European studies showing the incidence to be approximately 2 per 1000 live births (Surman et al, 2006; SCPE, 2002). Children with complex neurodisabilities are at risk of developing respiratory disease due to a host of inter related risk factors including poor cough, aspiration, movement difficulties and gastro oesophageal reflux (Seddon & Khan, 2003). Life expectancy in the most severely disabled children remains lower than age matched peers (Hutton, 2008; Hemming et al, 2006; Strauss et al, 1998) with studies reporting respiratory problems being an important cause of increased mortality and morbidity rates in these children (Fitzgerald et al, 2009). Studies suggest that 15- 45 % of deaths arise from respiratory causes (Strauss et al, 1999; Maudsley et al, 1999; Evans & Alberman, 1990).

Respiratory complications are commonly reported in practice however literature existing to guide the management of the respiratory system of these children is sparse (Fitzgerald et al, 2009). Historically there existed an expectation for these children that are more profoundly disabled to be "chesty" and little proactive management was delivered. These children were often seen regularly in hospital with recurrent chest infections.

Children who are at the highest risk of developing chest infections are those who are categorised as Grade 4 or 5 on the Gross Motor Classification Scale (Palisano et al, 1997). These children are wheelchair users and are limited in their ability to maintain anti-gravity head and trunk postures and control arm and leg movement.

An objective of the West of Scotland Paediatric Respiratory Physiotherapy Managed Clinical Network was to improve the physiotherapy respiratory assessment of children with neurodisabilities. Improved assessment would hopefully lead to better clinical reasoning and treatment.

Physiotherapists provide a specialist respiratory paediatric service to this client group. An assessment form was produced to ensure a comprehensive assessment that encompassed all the risk factors that could lead to respiratory ill health in the child with neurodisabilities. Information could then be passed on to relevant members of the multidisciplinary team (MDT) to promote a coordinated and logical approach to respiratory management. These guidelines were produced to help physiotherapists complete a respiratory assessment on a child with neurodisabilities. However these guidelines are not exhaustive and appropriateness of each aspect of the assessment for the individual child is determined by the physiotherapist undertaking the assessment.

Why do Children with Neurodisabilities Develop Respiratory Disease?

There are a host of related factors why a child with neurodisabilities may develop respiratory signs and symptoms. These include:

1. Prematurity of Birth

Children with neurodisabilities may have been born prematurely. Children born early have underdeveloped lungs and may develop scarring and inflammation due to neonatal care and ventilation. Those very preterm babies are at risk of developing bronchopulmonary dysplasia (chronic lung disease) thus predisposing the child to future respiratory disease and symptoms (Smith et al, 2010).

2. Poor Cough

Coughing is a complex activity which requires a strong contraction of the expiratory abdominal and intercostals muscles plus precise coordination and timing of the expiratory and glottis muscles to produce an effective expiratory force (Sly and Collins 2006). As a result of abnormalities of muscle tone, weakness and spasticity of the trunk and poor control of the laryngeal muscles the child may struggle to produce an effective cough. Musculoskeletal changes developed from muscle weakness and poor posture, i.e. kyphoscoliosis, causes stiffening of the rib cage. This further reduces the ability to produce an effective cough.

Coughing is a protective reflex that removes secretions or foreign bodies from the airways. Due to excess saliva, a poor swallow or reflux secretions may sit and pool in the upper respiratory tract and oral cavity. With persistent presence, cough receptors found in the larynx, pharynx, trachea and bronchi may become desensitised preventing spontaneous clearance of material. Even with the added secretions of a chest infection the child may not cough (Toder, 2000).

The effect of not clearing upper respiratory tract secretions is an increase in the number of pathogens in the respiratory system. These can result in inflammation and obstruction of the airways. Eventually this can result in the irreversible airway damage, bronchiectasis, which affects the normal mucociliary clearance mechanism. This can predispose the child to recurrant chest infections. Chronic sputum production may result and the destructive cycle continues (Seddon & Khan, 2003; Toder, 2000).

3. Aspiration

Swallowing is a complex choreography. Due to failure of proper bolus formation, oesophageal peristalsis, glottic closure and turn taking between swallowing and breathing aspiration is often noted in the child with neurodisabilities. Aspiration can occur from eating and drinking, excess saliva or from refluxing material and can be silent with no obvious signs such as choking or cough evident (Seddon & Khan 2003).

4. Excess saliva

Due to poor head control, maintaining an open mouth, poor lip control, a poor swallow, disorganised tongue motility and decreased tactile sensation a child with neurodisabilties may display excess saliva which leads to aspiration and presence in the airways (Toder, 2000).

5. Gastro –oesophageal Reflux

Children with severe neurodisabilities may present with persistent gastro-oesophageal reflux (GOR). This may be due to spasticity of the abdominal muscles and poor coordination of the oesophageal and sphincter muscles. Aspirated material may not be cleared due to poor peristalsis. Reflux can cause discomfort, wheezing, apnoea and laryngeal spasm (Seddon and Khan, 2003). Reflux material may be aspirated leading to aspiration pneumonia, inflammation, and bronchiectasis and lung parenchymal damage.

6. Movement/ Tone

Children with severe neurodisabilities struggle to be spontaneously physically active and miss out on the ventilatory advantages of exercise (Lagerkvist et al., 2005). Due to unequal muscle tone and pull, expansion of the chest is difficult which limits adequate ventilation to all parts of the lung. This predisposes to segmental collapse and atelectasis. Spasticity may cause the ribs and sternum to be pulled upwards and forwards placing the respiratory muscles at a disadvantage with spasticity of the abdomen preventing adequate functioning of the diaphragm. Hypotonus and poor abdominal tone can produce ineffective stability for the ribs and flaring of the ribs when the diaphragm is contracting. Spasms may prevent descending of the diaphragm. All results in poor inhalation and exhalation of the lungs. As the child grows secondary musculoskeletal changes result from reduced expansion and mobilisation of the chest. The ribs and spine stiffen and kyphoscoliosis can be seen.

7. Kyphoscoliosis

Kyphoscoliosis restricts lung compliance, may increase GOR and aspiration, impairs mucociliary clearance and places the skeletal and respiratory muscles at a disadvantage. Chest wall deformity results as a consequence with unequal expansion with basal atelectasis on the concave side and over expansion on the convex side (Koumberlis, 2006). This further compounds chest and lung compliance and ventilatory ability. With the continued ineffective clearance of the chest resulting in recurrent infections and bronchiectasis, respiratory failure will eventually develop (Seddon & Khan, 2003).

8. Poor nutrition

Due to feeding difficulties, GOR and increased energy expenditure it can be difficult to maintain a sufficient nutritional status in the child (Seddon & Khan, 2003). Malnutrition leads to catabolism of the respiratory muscles leading to atrophy, weakness and reduced lung function. It can also lower their immune system and increase the recovery time from chest infections.

9. **Sleep apnoea**
   The pharyngeal muscles play a complex and vital role in maintaining upper airways patency during the changes in pressures of the respiratory cycle. This is disturbed in the child with neurodisabilities and obstructive sleep apnoea may be seen. Sleep apnoea results in disturbed sleep, failure to thrive and hypertension.

10. **Poor oral health**
    Spasticity, inability to clear secretions, lack of oral fluid and oral sensitivity may result in poor oral hygiene. This can be compounded by poor oral hygiene. This may increase aspiration and place pathogens and bacteria in the normally sterile airways (Toder, 2000).

11. **Asthma** is seen in the paediatric population including children with neurodisabilites.

Respiratory Assessment of the Child with Neurodisabilities - Taking a Subjective History

Reason for Referral/ Assessment
What is the main reason for referral/need for a respiratory paediatric physiotherapy assessment? This could be recurrent chest infections or at a risk of developing chest problems.

Primary Diagnosis
Has the child got a diagnosis for their neurodisability/ developmental delay, e.g. cerebral palsy or a genetic condition?

GMFCS/ Functional Status/Comprehension/Communication
The GMFCS is a useful tool to place children with neurodisabilties. Children who are more profoundly disabled, e.g. in categories 4 or 5 are more likely to develop respiratory disease. Comprehension and communication enables a full picture of the child and appropriate levels of communication and treatment modalities to be used.

PMH
A child's past medical history can begin to tease out risk factors that may add to respiratory disease, e.g. GOR, fundoplication etc. Unstable cardiac histories may alter chest physiotherapy modalities. Unstable seizure activity may also increase the risk of aspiration pneumonia with inhaling of fluid/ saliva into the lungs.

Medication

A full medication report should be taken. Respiratory medication includes inhaled nebulisers for saline and bronchodilators. Children that have frequent chest infections may be on home antibiotics for parents to administer when the child begins to become unwell. A lower antibiotic threshold is often required to allow the parent to begin their treatment as early as possible to prevent a full blown chest infection. Longer courses of antibiotics may be required, e.g. two weeks, as children with neurodisabilities can take longer to recover from chest infections. Children may be on anti reflux medication or anticholinergics for excess saliva.

Social History

An understanding of the child's home and school life allows for a child centred approach and many people can be involved in their overall care and respiratory management.

Respiratory History

When asking about the respiratory history of the child it is useful to gain understanding what the carer is concerned about or troubles them the most, e.g. a troublesome cough etc. The five main symptoms of respiratory disease are breathlessness, cough, sputum and haemoptysis, wheeze and chest pain (Hough, 1993).

Questioning the number of chest infections/ antibiotics/ hospital admissions/ GP contacts can give a baseline that can trace any improvements seen. It is useful to ascertain the normal process when the child has a chest infection as this allows insight how the family manage the child's illnesses and who is involved in the management.

Respiratory Signs and Symptoms

It is useful to note the duration of any respiratory signs and symptoms (current and previous), severity of symptoms, aggravating or relieving factors and if the problems are worsening or improving (Pryor and Prasad, 2008). It is important to differentiate the respiratory symptoms when the child is well compared to when they have a chest infection. The signs and symptoms may differ when the child is unwell, for example a wheeze or secretions may increase. The carer is often the expert at the subtle changes that occur when the child begins to become unwell, e.g. becoming withdrawn. These changes may not be as obvious to the people who are not as familiar to the child, and therefore knowledge of this can be invaluable to all people involved with the child.

Breathlessness

Breathlessness is the subjective awareness of increased work of breathing and is the predominant symptom of cardiac and respiratory disease. Breathlessness is abnormal if inappropriate for the level of exercise and can be at rest or related to exercise, posture or emotion. Causes of breathlessness can be pulmonary, cardiovascular, metabolic, muscle weakness or a mixture. Orthopnoea (increased breathless when lying flat) can be caused by heart or lung problems. In lung disease pressure on the diaphragm from the abdomen can compromises breathing and in heart disease may be due to a poorly functioning left ventricle. Paroxysmal nocturnal dyspnoea (breathless that wakes the patient at night) may be due to cardiac issues or asthma/ broncho constriction (Pryor and Prasad, 2008).

Asthma, wheeze and bronchial hyperactivity

Asthma can be common in children with neurodisabilities. Wheeze is a tightness of the chest on breathing out. It may be aggravated with exertion or other factors such as cold or pets. Wheeze can indicate bronchospasm or retained secretions. Wheeze is a whistling sound produced by turbulent airflow passing through narrowed airways. A wheeze can also indicate reflux. A stridor can be mistaken for a wheeze which is produced by an upper airway obstruction.

Cough

A cough is abnormal if persistent, painful or productive of sputum.

Secretions

Secretions may always be present in the child with neurodisabilites and the child may cope with them during a time when they are well, though struggle with them when they increase during a chest infection.

Paradoxical breathing

Paradoxical breathing is an abnormal breathing pattern in a decreasing, or asymmetrical chest wall movement rather than a normal chest expansion and can be indicative of respiratory disease.

Poor Cough / Details of Cough

A poor cough can predispose the child to having chest infections. A cough is spontaneous and a child may not be able to cough to command due to learning disabilities. An abnormal cough is a persistent cough or present with secretions. A moist cough may be a result of secretions, excess saliva, reflux materials or due to poor swallow of food and/or drink. It should be ascertained if the child is effective at expectorating secretions or if they appear to clear by swallowing. The ability to expectorate requires a high level of coordination of the oral muscles and this can be problematic. A dry cough may be indicative of asthma, GOR, post viral infection, ACE inhibitors used in hypertension and congestive heart failure or environmental irritants (smoke). A loud barking "bovine" cough may indicate laryngeal or tracheal disease. A cough pattern includes if a child has a night time cough: this may be indicative of asthma or reflux. A child who has suffers from a chronic moist cough can often be worse in the morning, evening or during the night when relaxation of the airways causes secretions to mobilise (Pryor and Prasad, 2008).

Other Notes

- ### Chest Pain

  Chest pain can be pleural, musculoskeletal or tracheal inflammation in origin.
  Pleuritic type pain is caused by inflammation, increases with inspiration and is severe and stabbing in nature. Tracheitis is a constant burning central pain aggravated by breathing.
  Musculoskeletal chest pain is well localised, increases with chest or arm pain and with palpation. Angina is caused by the heart and pericarditis can be similar to angina. Chest pain should be discussed with a medical colleague.

- ### Other Pain

  Other types of pain may be an issue. Abdominal discomfort may affect breathing.
  Musculoskeletal pain may affect positioning and postural management and this may affect their respiratory system.

Sputum

Production of sputum is abnormal as daily secretions are swallowed. Sputum is excess secretions found in the tracheobronchial system that are normally removed through coughing. Details of sputum should be sought for children when they are well and when they have a chest infection. Sputum may contain mucus, cellular debris, microorganisms, blood and foreign particles.

Details of Sputum

- ### Colour

  Saliva is clear watery fluid. Sputum is normally clear/ white when well. During a chest infection the sputum is normal discoloured, e.g. yellow, green, brown and this normally improves with time and treatment. Infected sputum may have an offensive odour. If sputum is blood stained this can indicate trauma/irritation to the upper respiratory tract. Haemoptysis ranges from blood specks to frank blood. Old blood is dark brown. If this is persistent or if you are concerned medical attention should be sought. Note frank haemoptysis is a medical emergency and medical attention should be sought. Serous secretions are produced in pulmonary oedema, and are white or pink and frothy. This can be an indication of cardiac issues and therefore medical attention should be sought.

- ### Consistency

  Purulent sputum describes material which is thick, viscous yellow, dark green/brown, rusty, redcurrant jelly, infected and contains pus. Tenacious is sputum that is thick and keeps a firm hold. Pulmonary oedema is frothy and pink or white. Plugs are when firmer plugs of sputum are present and shape can represent the lung tree.

- ### Amount

  It can be difficult to quantify the amount of sputum. Minimal is the description of small amounts only with moderate describing an increased amount but able to cope with and clear. Some sources describe copious as "a mouthful" and represents frequent large amounts of secretions and less able to cope and clear (Prior and Prasad, 2008).

Suction

Questions relating to the frequency of suctioning can indicate how the child is affected with secretions. It should be noted if suction is completed orally by catheter or yankeur, or by nasal pharyngeal method. It should be noted who completes the suctioning.

Aspiration

Aspiration can result from excess saliva, poor swallow of food or drink or from reflux material. Signs of aspiration include coughing, choking, eye tearing, refusal of food, change in colour/facial expression, signs of distress (i.e. arching), gurgly/ wet voice, chest infections and excess saliva. Coughing at night may indicate saliva aspiration at night. A swallow assessment is completed by a speech and language therapist and a video fluoroscopy allows a detailed assessment of a child's swallow. Any concerns or changes a speech and language therapist should be contacted to complete a swallow assessment.

Feeding

Feeding difficulties may be problematic due to tongue thrusting, prolonged or exaggerated bite reflex, an abnormal increase or decrease in gag reflex, tactile sensitivity or excess saliva. Due to aspiration the child may be PEG (percutaneous enteral gastrostomy) fed. Other assisted feeding includes or nasogastric or nasojejunal feeding.

If the child does eat or drink orally the consistency of the liquid or food should be ascertained. The food may be mashed or smoothed and the liquid may be thickened. Note a child may also receive a mixture of feeding methods. If a child receives tasters the amount should be noted to ensure only small amounts are given. Again, any concerns regarding feeding/ swallow should be discussed with dietician/speech and language therapist.

Excess saliva

Excess saliva can be an issue for the child due to poor head control, open mouth, poor lip control, disorganised tongue motility and decreased tactile sensation (Toder, 2000). Aspiration of the saliva can add to respiratory compromise. Treatments may include anticholinergic medication (such as hyoscine patches), botoxulin toxic injections or surgery to the salivary glands. ENT may be involved in this process.

Gastro- oesophageal reflux (GOR)

Children with complex needs may have persistent and severe GOR. The refluxed material may not be effectively cleared and reflux aspiration may result. Treatment can include anti reflux medication or surgical options such as fundoplication. This should be suspected if there is persistent vomiting, especially after eating. A wheeze may also be indicative of reflux due to the inflammatory effects of aspirated stomach contents irritating the airways.

Poor oral health

Poor oral health can lead to bacteria in the system. Secretions which are thick can remain in the oral cavity leading to obstruction. Nasal restrictions should also be cleared. Dehydration by lack of fluid or secretion patches can be cause of thickened secretions. Oral defensiveness or spasticity can make tooth brushing difficult. Poor nutrition and medications can increase the problem (Toder, 2000). Bacteria seen in the mouth can then be aspirated into the sterile airways. Oral health is important in the child with neurodisabilties.

Nutrition

Children with complex needs may find it difficult to gain the appropriate levels of nutrients. Low weight may mean that they take longer to recover from illness, may lead to catabolism of the respiratory muscles leading to atrophy and weakness and ventilatory compromise. Alternatively, there may be issues with being overweight which can compromise movement to restrict lung capacity. If this appears to be so, discussion with the dietician and speech and language therapist should occur.

Sleep disordered breathing

Children with neurodisabilites have a greater prevalence of sleep problems (Fitzgerald, 2009). The pharyngeal muscles maintain patency in upper airways during the normal respiratory cycle. In children with cerebral palsy stimulation of the receptors that leads to this patency may be altered and upper airway obstruction may be apparent by noisy breathing during wakefulness, with increases during sleep. This can result in obstructive sleep apnoea. A history of snoring or pauses in breathing during sleep may suggest the need for physiological investigations of the child's breathing during sleep. This may be overnight saturation monitoring or a more detailed sleep study. Muscle weakness can result in under breathing (hypoventilation) during sleep resulting in an inability to maintain adequate gas exchange. This can result in retention of carbon dioxide. A child who wakes in the morning and doesn't appear well rested or has early morning headaches may be retaining carbon dioxide.

Concerns with sleep should be discussed with medical staff.

Scoliosis Concerns

Spinal curvature may occur because of the inequalities of muscle tone and gravity. Poor positioning and postural management can lead to scoliosis which can impact a child's respiratory health. This decreases chest wall compliance preventing adequate ventilation and leads to restrictive lung disease. Unequal lung expansion can result with basal atelectasis on the concave side and overexpansion on the convex side leading to increase in respiratory rate and makes the child more predisposed to respiratory failure. Note that lung growth may be impaired if scoliosis is developed early in life (Koumbourlis, 2006).

Tone medication

Medication such as baclofen is prescribed to decrease tone. Any suspected adverse effects on the respiratory status should be noted.

Any other relevant information

Other things to note: tendency to bleed, long term steroid therapy, bone density, recent CPR (fractured ribs), arthritis and peripheral oedema (caused by cardiac issues).

Oxygen therapy

Children with complex needs may have additional oxygen requirements in advanced respiratory disease and oxygen may be needed all the time or just during the night. Overnight sleep studies are performed with these children to assess their oxygen requirements.

Airways clearance techniques

Carers may have been shown airways clearance techniques in the past or developed their own ways of helping the child clear their chest. It is useful to understand this to help gain knowledge of how to help the child and to address any future training requirements.

Postural Management

Optimal 24 hour posture management allows optimal muscle length and tone, prevents secondary musculoskeletal effects and allows the child to ventilate their lungs appropriately.

Assessment of the Child with Neurodisabilities - Objective Assessment

Observations

- **General Appearance**
  Is the posture indicative of fatigue, pain, altered consciousness or respiratory distress.
- **Body weight**
  Are there any issues re: malnourishment or obesity. Both may compromise respiratory function. Malnourished children may have depression of their immune system and weakened respiratory muscles both leading to increased risk of developing chest infections. Obesity can cause an increase in residual volume and a decrease in functional residual capacity which affects the capacity of the respiratory system.
- **Pallor**
  Children with neurodisabilities may be pale normally due to decreased access to sunlight, anaemia or hypoxaemia. Alternatively poor temperature control can lead to redness of the cheeks. A red or plethoric appearance may also be caused by excess red blood cell production in polycythaemia.
- **Cyanosis**
  In respiratory distress infants can show pallor or cyanosis and can shut down peripherally. Cyanosis refers to the bluish discolouration of the skin and mucous membranes due to hypoxaemia with the colour reflecting unsaturated haemoglobin in the blood. Central cyanosis is discolouration of the tongue and mouth with peripheral cyanosis affecting the toes, fingers and earlobes. Peripheral cyanosis may be due to hypoxaemia or poor circulation. Note cyanosis can be unreliable in small infants. Any signs of cyanosis should be discussed with a medical professional.
- **Finger Clubbing/ Hands**
  Finger clubbing is indicative of advanced respiratory disease with a loss of angle between the nail and nail bed. Hands that are warm from peripheral vasodilation and show a flapping tremor may suggest carbon dioxide retention. A fine tremor may be a side effect of bronchodilator medication.
- **Chest Shape**
  Surface landmarks can be used to assess lobar segments of the lungs. The chest should be symmetrical and the transverse diameter greater than the anterioposterior dimension. Abnormalities include pectus excavatum (sternum depressed inwards, “funnel chest”) and pectus carinatum (“pigeon chest”). Also note hyperinflation where the shape of the chest is affected by trapped air causing the rib cage to remain partially expanded increasing the anteriorposterior diameter. Problems associated with hyperinflation include poor exhalation and inability to produce an effective cough and clearance of the chest.

- **Use of Accessory Muscles**
  Muscles used in respiration include the diaphragm, abdominal muscles, sternocleidomastoid, scalene and intercostals. In respiratory distress and increased work of breathing additional muscles may be utilised including the serratus anterior, pectoralis major & minor, upper trapezius, latissimus dorsi and erector spine.

Posture/scoliosis

Any abnormalities of the spine should be noted: thoracic kyphosis or kyphoscoliosis (lateral curvature of the spine with vertebral rotation plus thoracic kyphosis). Poor positioning in the wheelchair/ chair could result in detriments to the respiratory system.

Respiratory Pattern

An altered breathing pattern may reflect lung or chest wall pathology, dyspnoea or neurological defect. In normal breathing inspiration is active with expansion of the diaphragm followed by the rib cage. This is followed by a passive expiration. The approximate values of inspiration versus expiration are 1: 1.5 to 1:2. Tachypnoea describes an increased respiratory rate with bradypnoea being a decreased respiratory rate. A prolonged expiration may be seen in severe obstructive lung disease where expiratory airflow is severely limited by dynamic closure of the smaller airways. In severe obstruction the I:E ratio may increase to 1:3 or 1:4. Any abnormalities of respiratory pattern should be noted.

Respiratory Rate

To accurately assess the respiratory rate it should be counted for a full minute to allow for any discrepancies or periods of erratic breathing. Different conditions can alter values and children with respiratory compromise may have altered normal values as their norm. Identifying what the child's normal is required to allow comparison in future. Also consider the child's body size may not reflect their age. Lung disease can cause abnormal increases in respiratory rate (tachypnoea). Congenital cardiac problems causing inadequate or obstructed pulmonary blood flow may also cause alterations to normal respiratory rate values. Congenital diaphragmatic hernias which prevent normal development of the lung may alter normal values. An increased respiratory rate can also indicate metabolic acidosis, pain, anxiety, anaemia or fatigue. A sudden increase or decrease in respiratory rate should necessitate a medical review. Decreases in respiratory rate (bradypnoea) can be due to central nervous system depression, narcotics or trauma (Hough, 1993).

Signs of Upper airway obstruction

Children with neurodisabilities may show signs of upper airway obstruction as a result of increased secretions from poor swallow/ cough and poor tone in the laryngeal or postural muscles. Upper airway obstruction may be postural dependant improving with supported positioning and control of head and neck. A stridor noise may be noted due to the extra thoracic obstruction. It is mostly heard on inspiration but if severe can be heard on inspiration or expiration. Any concerns, medical attention should be sought.

Tone

A general awareness of the abnormalities of tone is necessary to understand how to improve the respiratory management of the child. For example the child may be low toned centrally causing issues with the respiratory capacity or have spasticity of the abdomen affecting the functioning of the diaphragm.

Auscultation

Auscultation in the younger child can be more difficult than in the adult. The trachea and bronchi are relatively larger compared with the lungs and secretions can transmit coarse sounds making it harder to differentiate subtle sounds. Heart sounds can also reverberate loudly. Underlying lobes should be visualised to improve accuracy of assessment.

- **Normal Breath sounds**
  Normal breath sounds should be heard throughout inspiration and a short period during expiration. Breath sounds should be equal on both sounds and quieter in the lower lobes. Normal breath sounds represent filtering of the bronchial breath sounds in the larger airways. They are faint, lower pitched and absent through last half of expiration.
- **Bronchial breath sounds**
  Bronchial breath sounds are heard when breath sounds are transmitted through consolidated lung tissue or over areas of collapse if the trachea is patent. They are a similar sound to listening with the stethoscope over the trachea. They are hollow sounding, loud, high pitched, harsher and can be heard equally through inspiration and expiration with or without a short pause in between.
- **Diminished sounds**
  Diminished sounds occur when reduced flow occurs in the lungs causing less sound to be filtered. This may be due to atelectasis or hyperinflation (air entry but reduced turbulence). It may also indicate an acoustic barrier such as pleural effusion or pneumothorax. Due to muscle weakness this may be noticed in the basal lobes of children with neurodisabilities due to poor basal expansion. Localized reduced sounds may indicate a sputum plug. The silent chest can be dangerous in children with asthma as it may indicate severe bronchospasm.
- **Wheeze**
  Wheeze is a musical tone produced by airflow oscillating a narrowed or compressed airway. Airways can be compressed due to a variety of reasons: e.g. bronchospasm, sputum, foreign body or pulmonary oedema. Wheeze is normally heard in expiration. The volume of wheeze does not necessarily indicate severity as no wheeze can indicate a severe obstruction and bronchospasm.
- **Crackles**
  Crackles are heard on mostly on inspiration and represent the abrupt opening of small airways which have been previously closed. Crackles can be described as late, early, fine or coarse, localised, scattered or widespread.
- **Pleural Rub**
  Pleural rub is a rubbing sound of the two pleura surfaces that have been roughened due to inflammation, infection or neoplasm.

- **Stridor**
  Compression of the soft trachea in a small child or poor laryngeal control may produce a stridor. This is a harsh noise similar to a wheeze.
- **Grunt**
  Expiratory grunt may be heard in attempt to produce PEEP (Pryor and Prasad, 2008).

Websites to hear added sounds for auscultation: www.med.ucla.edu/wilkes/intro.html

Chest Expansion

Chest expansion should be assessed through observation and palpation. It is performed posteriorly with the physiotherapist's hands spanning the posterolateral segments of both bases with the thumbs touching in the midline posteriorly. It can also be measured anteriorly in the child with neurodisabilities.

While the child inhales observe for similarity of movement of both hands. During a normal inspiration there is a symmetrical increase in anterior posterior, transverse and vertical diameters of the chest. The increase in vertical is produced by diaphragmatic contraction causing the abdomen to descend. Sternal and rib movements produce increases in the anterior and posterior diameters.

Palpation

Palpation can be of equal value to auscultation. Palpable vibration can produced during breathing caused by partial airway obstruction due to mucus or secretions. Place your hand over the upper zones and compare left and right. Secretions cause a palpable vibration during breathing caused by partial airways obstruction. The trachea can be palpated in relation to the sternal notch to note an underlying mediastinal shift. The trachea may be pulled towards a collapsed or fibrosed upper lobe or pushed away from a pneumothorax or pleural effusion. Surgical emphysema is a crackling under the skin caused by air in the subcutaneous tissues and requires immediate medical attention.

Cough

Is a cough present spontaneous and/ or to command. Note the strength of the cough: weak, moderate, strong. Is the cough dry or moist. Does the child expectorate or swallow. Mastication of secretions may be noted with a cough as the child attempts to clear the upper airways and oral cavity.

Sputum

Is there any sputum present and if so what is the colour/ consistency and amount. Does is necessitate obtaining a sample for bacteriology analysis.

Other:

Positional Considerations

Preferred positions should be investigated. Spinal scoliosis and perfusion matching all affect oxygen and comfort. Looking at respiratory rate or comfort can indicate preferred positions.

Oxygen

Desirable oxygen levels are 94% and above. Some children with respiratory disease may have slightly lower normal values. Medical staff may not prescribe oxygen due to concerns regarding increasing hypercarbia. Any decreases below optimum should be discussed with medical staff.

Heart Rate

Tachycardia is an increased heart rate can result from anxiety, fever, anaemia or hyopoaemia. It can increase with cardiac conditions and some medications such as bronchodilators or cardiac medication.

Bradycardia is a decreased heart rate can reduce with medications, such as beta blockers.

Additional Notes

Examination of the older child is similar to that of the adult. The following specific factors should be considered in the younger child and infant:

Recession	High negative intrathoracic pressure during inspiration pulls soft compliant chest wall inward. May be sternal (known as tracheal tug), subcostal or intercostal. May be normal in preterm infants but in older infants is a sign of respiratory distress.
Nasal flaring	Dilatation of the nostrils is a sign of respiratory distress. May be an attempt to decrease airway resistance.
Tachypneoa	(>60 breaths/min) may indicate respiratory distress.
Grunting	Expiration against a partially closed glottis. An automatic response which increases functional residual capacity in an attempt to improve ventilation.
Stridor	Heard in the presence of a narrowing of the upper trachea and/or larynx. May be due to collapse of the floppy tracheal wall, inflammation or an inhaled foreign body. Commonly heard in inspiration but if severe can be heard in both inspiration and expiration.
Cyanosis	See earlier notes.
Cardiac manifestations	Initially tachycardia and possible increases in systemic blood pressure. With worsening hypoxia this then results in bradycardia and hypotension.
Neck Extension	May be present in an attempt to reduce airway resistance.
Head Bobbing	May be present when child is using accessory respiratory muscles. Seen due to relatively weak extensor muscles in infant.
Reluctance to feed	Often associated with respiratory distress and infants may need to take pauses from feeding when tachypnoeic.
Pallor	Commonly seen in infants with respiratory distress. May be due to hypoxaemia or anaemia etc.
Alterations in levels of consciousness	May be associated neurological deficit, analgesia or with hypoxia.
Agitation or irritability	May be a sign of hypoxia.

Adapted Pryor AJ and Prasad SA (2002) Physiotherapy for Respiratory and Cardiac Problems Adults and Paediatrics.3rd Ed.

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