Bronchiolitis: A Physiotherapists Perspective

*Laura Lowndes (Cambridge University NHS Foundation Trust)
Kieren Lock (Cambridge University NHS Foundation Trust)
Naomi Winfield (UCL; Milton Keynes NHS Trust)

*Corresponding author: l.lowndes@nhs.net

Introduction

Bronchiolitis is an acute lower respiratory tract infection mainly affecting young children. It is caused by different viruses with cough, increased work of breathing and difficulty feeding being the predominant symptoms (Øymar et al, 2014). Bronchiolitis is the most common reason for children up to 2 years old to be hospitalised and admitted to paediatric intensive care (PICU).

This article presents current knowledge of bronchiolitis and the clinical considerations for a physiotherapist who might be asked to assess and treat these children.

Clinical definition

The NHS definition of bronchiolitis is 'a common lower respiratory tract infection that affects babies and young children under 2-year-old' (NICE, 2021). Internationally definitions vary with the American Academy of Pediatrics (AAP) definition being: 'a constellation of clinical symptoms and signs including a viral upper respiratory prodrome followed by increased respiratory effort and wheezing in children less than 2 year of age' (Øymar et al, 2014).

Epidemiology

Bronchiolitis occurs most frequently during the winter months (Øymar et al, 2014). Approximately 1 in 5 children develop bronchiolitis in the first year of life (Øymar et al, 2014). Most mechanically ventilated patients with bronchiolitis spend less than 7 days on paediatric intensive care (Tasker, 2014). For most it is a mild illness not requiring any medical intervention; only 24.2 per 1000 children with bronchiolitis will be admitted to hospital (Murray et al, 2014). During 2020, the first year of the Covid-19 pandemic, the bronchiolitis infection rates were significantly lower than average due to infection control measures in place such as lockdowns, mask wearing and encouragement for more hand washing (Hussain et al, 2021). In 2021 case rates of Respiratory syncytial virus (RSV) bronchiolitis increased up to 50% in Australia out of season once infection control measured eased (Hussain et al, 2021). This pattern was then mirrored in the UK once Covid restrictions eased (www.gov.co.uk).

Pathophysiology

Bronchiolitis can be caused by many different viruses with RSV accounting for 60-80% of bronchiolitis cases (Øymar et al, 2014). Other viruses that can cause bronchiolitis include adenovirus, influenza virus, human metapneumovirus, rhinovirus and parainfluenza virus. Virology is obtained via a nasal pharyngeal aspirate (NPA), often performed on admission to the emergency department. It has been shown that in approximately 20% of bronchiolitis cases children will have dual infections, however this does not seem to be linked with increased severity (Thorburn et al., 2006). Improvements in detection may be the reason that multiple virus are now found acutely.

The virus begins by replicating in the upper airways, causing typical coryzal symptoms of nasal discharge, sneezing, sore throat and fever before tracking further down into the lower airways and bronchioles 1-3 days later. This leads to an inflammatory response where immune cells infiltrate the area causing oedema and increased mucus production from the goblet cells. This leads to a cycle of cell necrosis and cell regeneration within the epithelial cells (Nagakumar et al, 2012). This oedema, mucus production and necrosis can lead to distal airflow obstruction, increased airway resistance, gas trapping, ventilation perfusion mismatch and atelectasis, producing the common symptoms seen in children with bronchiolitis such as increased work of breathing and hypoxemia (Nagakumar et al, 2012).

Clinical characteristics

Infants with bronchiolitis will generally present with a persistent cough (Bush and Thomson, 2007), increased work of breathing and poor feeding (NICE, 2021). Commonly a NPA is sent for virology, however treatment should commence based upon clinical signs.

Most infants can be treated at home; however, the NICE guidelines recommend that those with apnoeas, persistent low oxygen levels (below 90% for 6 weeks old and over and below 92% for under 6 weeks old), poor oral intake (under 50% of usual volume) or persistent severe respiratory distress should be admitted to hospital for observation, oxygen and nasogastric feeding if indicated (NICE, 2021).

The majority of infants hospitalised with bronchiolitis are previously healthy. Infants with a past medical history of premature birth, chronic lung disease, congenital heart disease, immunodeficiency or neuromuscular disease are particularly vulnerable to more severe bronchiolitis infection (NICE, 2021).

Table 1: Typical features of bronchiolitis infection

Assessment	Bronchiolitis presentation
Feeding	Reduced in moderate to severe cases
Temperature	Elevated, RSV infection associated with higher temperature than other viruses
X-Ray	Not routinely performed. Typical presentations include lobar consolidation, segmental or lobar atelectasis, cardiomegaly. Other potential findings: prominent bronchial opacities, peri bronchial infiltrates, hyperinflation.
Work of breathing	Increased, characterised by recession, nasal flaring, head bobbing
Auscultation	Coarse crackles and wheeze; decreased breath sounds if areas of atelectasis **(Image 1)**
Respiratory rate	Increased but in severe cases or neonates apnoeas can be seen
Oxygen Saturation	Decreased in severe cases
Heart Rate	Increased but can have bradycardia in severe respiratory failure
Urinary output	Decreased associated with reduced feeding
Nasal symptoms	Increased nasal secretions
Cough	Often develops within 1-3 days; wet sounding

Image 1: During auscultation course crackles and wheeze may be heard. Decreased breath sounds may be evident if areas of atelectasis exist

Applied anatomy and physiology

Infant airways have a higher proportion of mucus producing goblet cells, poorly developed cilia, and non-functional collateral ventilation channels, making the airways more susceptible to mucus obstruction (Gompelmann, Eberhardt and Herth, 2013). Infant airways are of course small; a thin layer of mucus leads to a very significant increase in airways resistance. Increased airways resistance will require increased effort to achieve airflow.

The cross-sectional shape of the infant thorax is cylindrical, and the ribs are horizontal in relation to the sternum; infants are therefore unable to access the 'bucket handle' motion by which older children and adults increase lung volumes. They are therefore reliant upon increased respiratory rate to increase minute volume. In adults, more than 50% of muscle fibres in the diaphragm and intercostal muscles are Type 1, slow twitch fatigue resistant fibres. In infants this is as little as 25%, leaving them highly vulnerable to fatigue and rapid onset of respiratory failure.

Infants under 6 months of age are preferential nose breathers. It is therefore important to ensure that the nasal passages of infants with bronchiolitis are kept clear. Usual treatment includes saline drops to reduce airways resistance and reduced work of breathing. Suction may cause oedema in the upper airways, with insufficient evidence of its overall efficacy (Florin, Plint and Zorc, 2017).

Babies have poor postural stability and very compliant chest walls which is why chest recession and head bobbing is observed with increased work of breathing. Positioning to reduce work of breathing is thus vitally important. The prone position stabilises the chest wall and optimises ventilation perfusion matching. Because of the increased risk of sudden unexpected death in infancy (SUDI) the prone position should only be used where the child is constantly monitored (Carpenter et al., 2004).

Treatment of Bronchiolitis

The mainstay of hospital treatment for infants with bronchiolitis is supportive therapy to reduce work of breathing and support adequate nutrition, as detailed in table 2.

Table 2: Treatment aims and interventions

Aim	Intervention
Supplemental oxygenation, often high flow nasal oxygen	Maintain oxygenation, reduce respiratory effort
Positioning	Stabilise chest wall to reduce work of breathing
Adequate nutrition and hydration	Nasogastric feeding, intravenous fluids
Reduce airways resistance	Saline drops and suction to nasal passages
Reduce fatigue	Minimal handling

Children with moderate bronchiolitis, not requiring intubation do not generally benefit from chest physiotherapy. A Cochrane review by Roqué i Figuls et al (2016) reported no significant benefit of chest physiotherapy techniques on disease severity, respiratory parameters, length of hospital stay or oxygen requirements in this population.

Non-invasive ventilatory support

Non-invasive ventilatory support is often provided to children with bronchiolitis, including Continuous Positive Airway Pressure (CPAP) and High Flow Nasal Oxygen (HFNO). CPAP should be considered in children with bronchiolitis who have impending respiratory failure (NICE, 2021), though evidence for this is of low quality according to a 2019 Cochrane review (Jat and Mathew, 2019). However, participants in the papers included in the latter review were all children without co-morbidities, thus more research is needed to establish the effectiveness of CPAP in children with co-morbidities (Roqué i Figuls et al., 2016; NICE 2021). There is limited evidence to demonstrate the effectiveness of CPAP in children with bronchiolitis, however early research suggests that there is a decreased respiratory rate in children with bronchiolitis who receive CPAP (Jat and Mathew, 2019). In some cases, CPAP can be used to avoid mechanical ventilation. The function of CPAP is to provide low levels of positive end-expiratory pressure to decrease airway resistance, thus improving gas exchange (Pryor and Prasad, 2008). HFNO provides humidified oxygen at high volumes and is used increasingly on paediatric wards; its use has been proved to be safe in a general paediatric ward setting (Oñoro et al., 2011) (Daffyd et al., 2021). HFNO reduces both the duration of oxygen therapy and ICU treatment in children with bronchiolitis (Ergul et al., 2018).

When not to treat

In severe bronchiolitis, where a child is self-ventilating on high levels of oxygen and showing signs of respiratory distress, conventional physiotherapy techniques have failed to show benefit in the primary outcome of change in severity status of bronchiolitis. Indeed, there is evidence that physiotherapy interventions can lead to severe adverse clinical effects for hospitalised patients with severe bronchiolitis including bradycardias, desaturations, transient respiratory destabilisation and vomiting during procedure. Physiotherapy is therefore not indicated in severe cases of bronchiolitis in the non-intubated population (NICE, 2021), (Roqué i Figuls et al., 2016).

When to treat

Ventilated children with an increased sputum load often benefit from chest physiotherapy intervention. Indications for treatment include high peak inspiratory pressures, high oxygen requirements, large volume of or thick secretions reported on suctioning and low partial pressure of oxygen or saturations.

Where a child has a sputum yielding co-morbidity (such as Cystic Fibrosis, Primary Ciliary Dyskinesia) or neurological co-morbidity chest physiotherapy should be considered in the non-ventilated population (NICE 2021).

Treatment options

Removal of secretions is the primary aim in the physiotherapy treatment of children with bronchiolitis, in order to optimise ventilation-perfusion ratios and reduce strain put on the cardiovascular system (Morrow, 2015). There are a number of treatment methods available to a physiotherapist treating children with bronchiolitis (NICE, 2021). If treatment is indicated, start with positioning and manual techniques and then increase and change these (if indicated) in a stepwise approach. Generally shorter treatment sessions are tolerated better with regular breaks for rest and to reassess the child.

Positioning

Positioning is vital in infants with bronchiolitis. It can improve chest wall stability and oxygenation and promote comfort and sleep. The prone position (Image 2) has been shown to be beneficial, increasing oxygen saturations and reducing episodes of hypoxaemia (Gillies et al, 2012) however it should only be used in those infants that are continuously monitored due to the risk of SUDI. It is also worth considering the ventilation/perfusion ratio (V/Q ratio), used to assess the efficiency and adequacy of the matching of two variables: V; ventilation which refers to the air that reaches the alveoli and Q; perfusion which refers to the blood that reaches the alveoli via the capillaries. Positioning is used to optimise V/Q ratios, also known as V/Q matching. V/Q matching is necessary for efficient gas exchange. In infants, ventilation is greater in the non-dependent lung (top lung) and perfusion is greater in the dependent lung (bottom lung). Therefore, if an infant is in respiratory distress then positioning them in the 'good lung up' position is more beneficial for gaseous exchange.

Image 2: The prone position has been shown to be beneficial, increasing oxygen saturations and reducing episodes of hypoxaemia

When treating a child for secretion clearance, postural drainage can be used alongside manual techniques in children with bronchiolitis. It functions by changing the patient's position to facilitate airway clearance using gravity to enhance mobilisation of bronchial secretion from the peripheral airways towards central airways (Balachandran et al., 2005; Paz et al., 2019). Whilst postural drainage can facilitate airway clearance, head-down positioning is not recommended in neonates and infants. Head-down tilt has many potential issues including gastro-oesophageal reflux, raising intracranial and systemic blood pressures, the potential for intraventricular haemorrhage in neonates, and placing the diaphragm at mechanical disadvantage (Morrow, 2015).

Percussions

Chest percussion is commonly used in ventilated infants to facilitate airway clearance. It functions by rhythmical cupping of the chest wall producing an energy wave, which is transmitted through the chest wall to the airways, loosening secretions from the bronchial walls (Hussey and Prasad, 1995). Percussion is often the first option when treating a ventilated patient with bronchiolitis. Chest percussion in the infant population generally uses a facemask or tented fingers. Where a facemask is used, tissue should be used to block the opening to prevent loss of energy waves. Percussions should be hard enough to produce a slight head bob in the infant. It is important to stabilise the head, especially in neonate, while doing percussions. Chest percussions are generally well tolerated in infants, though vigorous and rapid percussion may induce bronchospasm, particularly relevant in bronchiolitis, hence should not be used in the self-ventilating population with bronchiolitis (Pryor and Prasad, 2008).

Manual Hyperinflation

Manual hyperinflation (MHI) is commonly used in the critical care setting with both adults and children. The hypothesised effect of manual hyperinflation is that it may improve lung function, enhance secretion clearance and reopen areas of atelectasis (Rhodes, 1987), (Ntoumenopoulos, 2005), (van der Lee et al., 2017). Providing additional positive pressure can facilitate in recruitment of collapsed lung tissue and promotes air flow behind areas of secretion load. When used for airway clearance, MHI should have three or four tidal volume breaths followed by one large breath (at approximately 20% higher than ventilated tidal volume peak pressures); this allows for monitoring of cardiovascular status and prevents hyperventilation (Hussey and Prasad, 1995). This cycle should then be followed by suction and re-auscultation. Where secretions remain and there are no adverse events, i.e. desaturation or bradycardias, then this cycle should be repeated. Manometers can be attached to the water circuit to allow therapists to monitor the pressures being reached throughout this technique; these can also be useful in monitoring the PEEP provided throughout MHI. During MHI, clinicians will often use expiratory vibrations to facilitate airway clearance. There is limited research suggesting there are benefits to MHI in paediatric critical care settings. One study suggests that fast release techniques during MHI can promote secretion clearance, with others suggesting MHI can cause retrograde movement of secretions (Pryor and Prasad, 2008). The hypothesised mechanics of MHI are disputed and evidence of its use in ventilated children remains inconclusive (Mackenzie and Shin, 1985), (Shkurka et al., 2021), yet clinically this remains a consistently used treatment option (Godoy, Zanetti and Johnston, 2013).

Vibrations

Vibrations are a useful adjunct particularly in children due to the increased compliance of the chest wall (Pryor and Prasad, 2008). Vibrations are particularly useful during MHI and should be applied at the start of expiration when releasing the bag. Where vibrations are applied early, potentially dangerous peak inspiratory pressures are generated and, although not harmful, where late, vibrations are not effective at increasing peak expiratory flow (Shannon et al., 2010). The vibration creates a high expiratory flow which can assist in mobilising secretions towards central airways. Vibrations with a frequency of more than 60Hz, can also improve mucociliary transport and alters the thixotropic property of mucous (reducing its viscosity) (McIlwaine, 2006). Vibrations are effective at clearing peripheral airways due to the above physiology (Hussey and Prasad, 1995).

Saline lavage

Saline lavage is a regularly utilised adjunct on paediatric intensive care units and aims to loosen thick or sticky secretions to facilitate easy removal with suction (Pryor and Prasad, 2008), (Mercer et al., 2018). Saline should not be used routinely, but where secretions are thick use of 0.9% saline instils alongside endotracheal suctioning may be beneficial (McKinley et al., 2018). Saline is drawn up into a syringe at varying volumes between 0.5-10mls; in infants 0.5-1ml is the most appropriate volume (Hussey and Prasad, 1995). The syringe of saline is then inserted in to the endotracheal tube. Saline is generally provided alongside manual techniques or MHI by respiratory specialist physiotherapists (Shannon et al., 2015).

Suction

Suction should not be routinely performed in spontaneously ventilating infants with bronchiolitis, but nasal suction should be considered in those with respiratory distress or apnoea (NICE, 2021). In intubated and ventilated patients, however, airway suctioning is the most important secretion removal technique and should be used where there is a significant build-up of secretions (Branson, 2007). Infants with viral bronchiolitis appear to tolerate suctioning techniques without adverse short-term physiological effects (Ringer et al., 2020). The following link is a recorded simulation scenario for an infant with bronchiolitis and the physiotherapy airway clearance techniques that should or should not be considered:

https://portal.e-lfh.org.uk/Component/Details/737794

Conclusion

Bronchiolitis is a common condition in infants. It is important to consider the pathophysiology of the condition as well as the differences in physiology between children and adults when treating these patients. There is very little evidence to suggest routine physiotherapy has positive effects in this population and in some cases can hinder recovery. Therefore, for self-ventilating patients without co-morbidities causing secretion retention, chest physiotherapy is not indicated. Where these co-morbidities are present, airways clearance adjuncts and the use of nebulisers should be considered, ensuring monitoring for potential bronchospasm and desaturations.

Whilst patients with bronchiolitis can become extremely unwell, those who require critical care on average spend less than seven days on PICU before stepping down to the ward (Tasker, 2014). Ensuring adequate oxygenation during this week in PICU is the key role for a physiotherapist treating a patient with bronchiolitis. Percussions and positioning should be the first option for someone treating an intubated infant with bronchiolitis, ensuring the patient does not have a head down tilt. MHI and saline instillation can be particularly useful when a patient has thick secretions, though should not be routinely used for intubated infants with bronchiolitis due to a lack of supporting clinical evidence. Suction should not be routinely performed, but where ventilated or in respiratory distress, airway suctioning becomes one of the key parts of bronchiolitis management.

For more information go to: Respiratory Surge in Children - elearning for healthcare (e-lfh.org.uk)

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