Acute viral bronchiolitis in South Africa: Intensive care management for severe disease

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It is estimated that 2 - 3% of children will be hospitalised with viral bronchiolitis during their first year of life, and a small proportion of them will have a severe course of the disease, requiring intensive care and ventilatory support. In South Africa, 20% of children admitted to a paediatric intensive care unit (PICU) had positive respiratory viral isolates (especially respiratory syncytial virus), with symptomatic respiratory disease. Rapid laboratory-based diagnosis using multiplex polymerase chain reaction is recommended to reduce overall antibiotic use in the PICU and neonatal ICU (NICU) and improve the targeted use of antibiotics (antibiotic stewardship). The mainstay of bronchiolitis management in the PICU and NICU is supportive, comprising fluid management, oxygen supplementation and/or respiratory ventilatory support, and antipyretics if needed. Non-invasive nasal continuous positive airway pressure and high-flow nasal cannula oxygen therapy are increasingly being used in children with severe bronchiolitis, and may reduce the need for intubation. Infants with bronchiolitis may have a variety of clinical presentations, which may require different ventilatory approaches. Children may present predominantly with apnoeas, air trapping and wheeze, atelectasis and parenchymal disease (in acute respiratory distress syndrome), or a combination of these. Lung-protective ventilation, using a low tidal volume pressure-limited approach, is essential to limit ventilator-induced lung injury.

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It is estimated that 2 - 3% of children will be hospitalised with viral bronchiolitis during their first year of life, and a small proportion of them will have a severe course of the disease (Table 1), requiring intensive care and ventilatory support.[1-3] Risk factors for severe disease include a history of prematurity; underlying chronic conditions such as bronchopulmonary dysplasia, neuromuscular disease, and congenital heart diseases; lack of breastfeeding; poor socioeconomic circumstances; and immunosuppression, including HIV/AIDS.[4]

Table 1. Assessment of bronchiolitis severity in infants[4]

Observations	Mild bronchiolitis	Moderate bronchiolitis	Severe bronchiolitis
Feeding	Normal	Less than usual	Not interested
Respiratory rate, breaths/min	<2 mo, >60 >2 mo, >50	>60	>70
Chest wall recessions	Mild	Moderate	Severe
Nasal flare or grunting	Absent	Absent	Present
Oxygen saturation, %	>92	88 - 92	<88
General behaviour	Normal	Irritable	Lethargic

Aetiology and co-infection

In South Africa (SA), 20% of children admitted to a paediatric intensive care unit (PICU) were reported to have positive respiratory viral isolates, with symptomatic respiratory disease.[5] The most common viruses occurring in the PICU context in SA are human rhinovirus, respiratory syncytial virus (RSV), adenovirus, influenza and para-influenza viruses, and human metapneumovirus (hMPV).[5,6]

The importance of human rhinovirus has previously been underestimated, but is now known to be a pathogen with the potential to cause severe disease in both PICU and neonatal ICU (NICU) populations, with a prevalence of up to 40% in emergency department and hospital settings.[7,8] In a case controlled study of children after cardiac surgery, human rhinovirus infection was associated with a twelvefold increase in the probability of extubation failure, a threefold increase in duration of PICU stay, and a twofold increase in length of hospital stay.[9] It has been suggested that when human rhinovirus is detected by polymerase chain reaction (PCR) in symptomatic individuals, it is likely to represent true infection.[10]

hMPV has been reported in up to 19% of hospitalised SA children with respiratory tract infections (RTIs).[11,12] hMPV is associated with significant morbidity, with similar presentation and outcome to RSV infection.[12]

In the PICU, co-infection with bacteria and other potential pathogens (e.g. fungi, *Pneumocystis jirovecii*) is common.[5] Recently, nosocomial acquisition of viral RTI has been highlighted as a potentially serious problem, particularly in the context of limited cohorting and isolation facilities in SA and other developing countries.[5,6,13,14] The importance of infection control measures, including hand washing, surface cleaning, isolation, and cohorting must be emphasised to prevent nosocomial spread of respiratory viruses.[15]

Rapid laboratory-based diagnosis using multiplex PCR is recommended to reduce overall antibiotic use in the PICU and NICU and to improve the targeted use of antibiotics (antibiotic stewardship), as well as early identification of potential outbreaks to ensure containment and limit nosocomial transmission.[16,17]

Management of bronchiolitis in the PICU and NICU

The mainstay of bronchiolitis management in the PICU and NICU is supportive, compris-

ing fluid management, oxygen supplementation and/or respiratory ventilatory support, and antipyretics if needed.[17,18]

Ventilatory support

Mechanical ventilation for bronchiolitis was first described in the 1960s, when it markedly decreased mortality associated with respiratory failure.[19] However, numerous complications of intubation and mechanical ventilation are now described, including ventilator-induced lung injury, ventilator-associated pneumonia, and tracheal stenosis.[20] In a prospective observational multicentre study,[21] endotracheal intubation and mechanical ventilation were shown to cause a marked increase in pulmonary inflammation in infants with severe RSV bronchiolitis. The avoidance of intubation and invasive mechanical ventilation as far as possible is therefore optimal in terms of lung protection, but they may be necessary in severe disease.

Non-invasive nasal continuous positive airway pressure (nCPAP) and high-flow nasal cannula (HFNC) oxygen therapy are increasingly being used in children with severe bronchiolitis, and may reduce the need for intubation.[22–24] Furthermore, these technologies may provide the only form of ventilatory support in areas where children with severe bronchiolitis cannot access mechanical ventilation.[23] nCPAP may reduce the work of breathing by preventing dynamic airway collapse, thereby potentially reducing air trapping and improving gaseous exchange, although there may also be a risk of overinflation.[25] HFNC has been shown to increase end-expiratory lung volumes and reduce respiratory rate in infants with bronchiolitis, and may be better tolerated than nCPAP.[26,27] However, systematic reviews have not yielded conclusive results as to whether either technique reduces intubation rates, largely due to a lack of prospective randomised controlled trials.[22,28]

Even though there have been varying reports, there has been no consensus with regard to appropriate invasive mechanical ventilation strategies for infants with severe bronchiolitis. Pressure control or pressure-regulated volume-controlled ventilation compared with volume-controlled ventilation, may deliver lower tidal volumes than those programmed in high resistance situations, leading to hypoventilation;[29] therefore, volume-controlled modes should be considered in children with bronchiolitis.

Lung-protective ventilation, using a low tidal volume pressure-limited approach, is essential to limit ventilator-induced lung injury.[30] In an animal model of RSV RTI, low tidal volume mechanical ventilation caused less ventilation-induced cellular and cytokine influx into the bronchoalveolar space.[31] The key features of lung-protective ventilation are:

- controlled oxygen exposure
- permissive hypercapnia
- low tidal volumes (4 - 6 mL/kg)
- adequate (but not excessive) positive end-expiratory pressure
- maintaining peak inspiratory pressures of <30 cmH_2O.

Infants with bronchiolitis may have a variety of clinical presentations, which may require different ventilatory approaches (Fig. 1).[25,29,32] Children may predominantly present with apnoeas, air trapping and wheeze, atelectasis and parenchymal disease (in acute respiratory distress syndrome), or a combination of these.[25]

Other therapies

Recombinant human deoxyribonuclease (rhDNAse (Pulmozyme))[33] and glucocorticoids[34] are not recommended in the management of infants and children with bronchiolitis. Recommendations for the use of exogenous surfactant and heliox therapy are presented in Table 2.

Conclusion

Most cases of bronchiolitis in young infants and children are mild enough to manage conservatively at home or in general hospital wards. In exceptional cases, acute viral bronchiolitis may be so severe that it warrants admission of patients to the PICU for respiratory support and medical care.

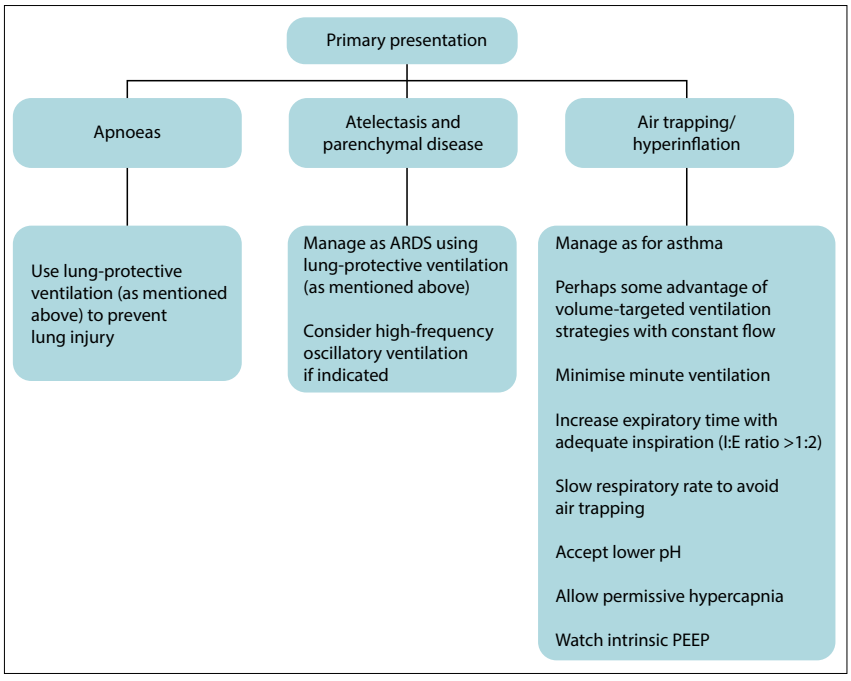

Fig. 1. Invasive ventilation strategies for different presentations of severe bronchiolitis. (ARDS = acute respiratory distress syndrome; PEEP = positive end-expiratory pressure; I:E = inspiration:expiration.)

Table 2. Additional therapy in severe bronchiolitis

Therapy	Effect	Practice recommendation
Exogenous surfactant[34]	Reduces PICU length of stay Favourable effects on oxygenation and CO_2 elimination	Exogenous surfactant may be useful in selected patients Larger trials needed before surfactant can be recommended as standard treatment
Heliox[35]	If delivered effectively (only with tightly fitted facemask or CPAP), heliox therapy significantly reduced length of hospital treatment at different points of care (wards, PICU) Nasal cannula heliox therapy is ineffective RSV-positive infants responded better to heliox therapy	Heliox therapy could be considered for hospitalised infants with bronchiolitis, hypoxaemia and/or respiratory distress If heliox therapy needs to be rationalised, it could be targeted to those who are RSV positive Heliox therapy should only be delivered via a tight-fitting non-rebreathing facemask or CPAP

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