When should you use mechanical ventilation in children's respiratory care?

Examining the importance of mechanical ventilation and why there is a move to non-invasive treatment

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Ventilators play an essential role to support the respiratory system and breathing at several stages in a child's life.

The purpose of a ventilator is to ensure a child's lungs receive sufficient air flow for gaseous exchange, to deliver oxygen and remove carbon dioxide, while reducing the effort required by the child to move air in and out of their lungs (Tobin and Manthous 2017).

In premature infants, for example, Schmalisch (2016) explains that respiratory failure is common due to the structural and functional immaturity of their respiratory systems, so ventilation allows time for immature lungs to develop and grow.

Ventilation in childhood presents many challenges not seen in adult care

Ventilation also supports children with long-term conditions who are unable to breath effectively or independently (Nawaz et al 2020), such as Duchenne muscular dystrophy and similar diseases affecting children's muscles. Most ventilators, however, are used as a temporary measure in paediatric intensive care units to support children due to disease, injury or surgery.

Ventilation in childhood presents many challenges not seen in adult care, due to continued lung development and growth. From infancy to about eight years, ongoing respiratory development results in smaller airways and a flexible chest wall lacking muscle mass (Rimensberger et al 2018).

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This influences the approach taken to ventilate children. Ventilators have many settings to control the pressure, volume and flow of air the child receives. They also control the temperature, humidity and concentration of oxygen given.

'Using positive pressure to push air into a child's lungs can damage the lungs'

In general, settings fall into two distinct approaches, depending on illness and lung development.

In invasive mechanical ventilation the child is sedated, allowing the ventilator to deliver all breaths through a tube placed in the child's airway. The concern with this approach is that using positive pressure to push air into a child's lungs can damage the lungs (Tobin and Manthous 2017).

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Alternatively, the child remains awake and supported to breathe independently with no invasive tube. The difference between these approaches is important.

In normal breathing, children pull air into their lungs by generating negative pressure in their chest and the chest muscles drive respiration. In invasive mechanical ventilation the opposite happens – air is pushed into the child's lungs using positive pressure and chest muscles offer no support.

Non-invasive ventilation can provide positive pressure to assist a child's breathing

For this reason, the preferred approach – if the child's condition allows – is to avoid mechanical ventilation and use non-invasive ventilation to mirror normal breathing (Russell 2016).

Non-invasive ventilation, delivered through nasal prongs or a face mask, refers to assisted ventilation without the need for a tube in the child's airway.

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Commonly, non-invasive ventilation provides positive pressure to assist a child's breathing. This pressure can be continuous support, as with continuous positive airway pressure, or tailored to provide additional pressure, or volume of air, to complete a breath the child initiates (Wickham et al 2010).

' If the child becomes tired and cannot initiate a breath, invasive mechanical ventilation is used'

The flow of air reduces the effort the child uses to breathe, but importantly removes the need to sedate. Non-invasive ventilation cannot breathe for the child like invasive mechanical ventilation. If the child becomes tired and cannot initiate a breath, invasive mechanical ventilation is used.

Early application of non-invasive positive pressure ventilation improves the child's breathing pattern, eases the work of respiratory muscles and improves gaseous exchange. Mikalsen et al (2016) maintain that non-invasive ventilation in children is a relatively safe, well-tolerated and feasible method for delivering oxygen.

During COVID- 19, Privitera et al (2020) have reported that non-invasive ventilation has successfully supported adult patients, removing the need for invasive mechanical ventilation in many cases.

Mike Stephenson is a senior lecturer at Northumbria University, Newcastle upon Tyne

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