

High Flow Nasal Cannula In the Neonatal Population

Robert Juretschke, BS, RRT and Robert Spoula, MBA, RRT

Delivery of supplemental oxygen to the newborn in respiratory distress has been practiced for decades. Common approaches to non-invasive delivery of oxygen include: oxygen hood, face mask, nasal cannula, and flooding incubators with oxygen.¹ Patients with ventilatory defeats may require more aggressive respiratory support such as nasal CPAP or mechanical ventilation. While mechanical ventilation improves survival, it is not without risk.² Pre-term infants that develop lung disease, such as bronchopulmonary dysplasia, are at a higher risk for rehospitalization during their first year of life.³

Chronic lung disease of the neonate sometimes occurs as a residual condition following respiratory distress in preterm infants.⁴ The chronic lung disease can be iatrogenic by nature and can follow life saving measures such as long term positive pressure ventilation. Non-invasive ventilatory pressure support such as nasal CPAP, while less invasive than intubation, can lead to nasal deformities.^{5,6} Nasal CPAP also creates noise levels up to 102 dB SPL that may cause cochlear damage and hence hearing loss.⁷

Less intrusive respiratory support has included nasal cannula with a bubble humidifier. High flow nasal cannulas have been recommended for infants in the management of apnea of prematurity.⁸ It is important to understand, however, that bubble humidifiers cannot provide adequate humidification for premature infants.⁹ Nasal cannulas with bubble humidifiers have been associated with decreased airway patency, nasal mucosal injury, and coagulase-negative staphylococcal sepsis.^{10,11}

Recently, a development in high flow nasal cannula support has been commercialized. The device, Vapotherm 2000i, helps manage gas F_iO₂%, temperature, flow, and relative humidity

delivered via nasal cannula. Oxygen concentration with the Vapotherm can be set using a traditional oxygen blender. The temperature range is selectable from 33°C to 43°C. The system can provide supplemental gas flow from 1 lpm to 40 lpm at a relative humidity of 100%.¹² Unlike bubble humidifiers or pot style humidifiers, the Vapotherm provides molecular phase humidity by transpiration through a microporous membrane material with a pore size of <0.01 microns.¹³ The small pore size of the membrane and vapor phase humidity minimize risk of particle borne infection.

In a bacteria challenge test of the Vapotherm system with a suspension of *Brevundimonas diminuta* (the organism name was recently changed from *Pseudomonas diminuta*), the Vapotherm was effective in retaining the bacteria. This was demonstrated by zero colony forming units present on the assay membranes.¹⁴ In a study of 109 neonates treated for 5.7 years of time equivalents, no nosocomial infection has been associated with Vapotherm.¹⁵ Again, this is an important technological improvement when considering the risks of infection associated with other humidification systems.¹¹

In clinical practice infants less than 500 grams and as low as 306 grams have been successfully managed using Vapotherm. In the case of a 306 gram infant the Vapotherm was used following short term of mechanical ventilation. This 306 gram patient required no subsequent intubation or nasal CPAP.¹⁶ In this 306 gram infant flow rates of 4 lpm were used with a nasal cannula having a 2 mm OD. The Vapotherm has also been used extensively in a neonatal population of 109. In this group the babies' weights were 3 babies less than 500 grams to 17 babies greater than 1500 grams.¹⁵ In this population, flow rates from 2 – 8 lpm were applied without evidence of barotrauma, CPAP belly, or nosocomial infection. In this group, while on the Vapotherm, there was no noted nasal mucus plugging.

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The clinical and bench testing data on the VapoTherm 2000i indicates this respiratory assist device may improve the outcome of patients with respiratory compromise. Its application in place of bubble or pot style humidification devices may help reduce respiratory mucosal and sub-mucosal injury.¹⁷ It is a less intrusive medical intervention and may reduce exposure to iatrogenic injuries such as those associated with nasal CPAP or mechanical ventilation.^{2,5-7} Other benefits that may be recognized with future research include improved growth and development as a result of improved sleep architecture, less insensible water loss, and better thermoregulation.¹⁸⁻²⁰ It is our conclusion and experience that the VapoTherm 2000i is clinically safe and efficient and in many cases may provide superior therapy to support breathing in neonates having respiratory compromise or insufficiency.

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