Minding the Gap: Desired Versus Delivered Respiratory Support

Respiratory distress and varying degrees of lung pathology are well-documented issues associated with premature delivery.[1] Advances in respiratory technology have facilitated a change of practice in the delivery of respiratory support to premature infants. Noninvasive ventilation strategies have now become a main stay of treatment in these infants.[1,2] The increasing use of noninvasive strategies, such as CPAP for respiratory distress, has been associated with reduced rates of invasive ventilation as well as a potential mortality benefit.[1] In addition to the noninvasive strategy itself, various interfaces have been developed to deliver this form of respiratory support. A popular interface in the neonatal population has been the nasal prongs, which also vary in their design and intended use. One type of nares-prong interface that has been introduced is the Neotech RAM cannula (Neotech, Valencia, California), one that has grown in popularity due to the non-occlusive fit and perceived increase in comfort. Unfortunately, there is a paucity of data that examines the physiologic effects of this interface on the airway, which raises concerns of its efficacy as an interface for delivery of nasal CPAP.

In a bench simulation study, Napolitano et al[3] presented their results with regard to the ability of an acute care ventilator to deliver a set PEEP by using 2 types of the nares-prong interfaces, the Neotech RAM cannula and the Dräger baby flow system (Dragerwerk AG, Lübeck, Germany) nasal prongs. In particular, the investigators sought to determine the amount of PEEP generated compared with the set PEEP when using the manufacturers' recommended nares occlusion of 60 - 80% with the RAM cannula when using the Dräger prongs that have an occlusive fit as a control. Previous studies focused more so on the relationship between various percentages of leak and effective pressure delivery rather than maintaining the manufacturers' recommended fit.[4,5,6] An important secondary objective of the study by Napolitano et al[3] was that the investigators measured the flow generated by the ventilator to deliver the goal PEEP.

The results of this study are similar to a previous study by Iyer et al[7] that examined the difference in the desired or goal PEEP and the delivered PEEP during noninvasive ventilation with a nares-prong interface.[7] The delivered PEEP with the RAM cannula was significantly lower than that of the goal PEEP set on the ventilator, with an average of only 27% of the desired PEEP delivered. The occlusive-fit Dräger prongs, however, were able to deliver the goal PEEP consistently at different levels of the goal PEEP. Not surprisingly, in the RAM model, as the goal PEEP was up titrated, the delivered PEEP also increased. However, the gap between the goal and the delivered PEEP increased as the goal PEEP increased. The investigators also identified the set PEEP at which a delivered PEEP of ≥ 5 cm H_2O was reached. With the RAM cannula, this was at least a set PEEP of 14 cm H_2O when using the preemie-sized cannula and 18 - 20 cm H_2O with the newborn and infant cannulas.[3]

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An interesting finding of this study was the secondary objective of measured flow. In both models, the flow generated rarely exceeded 2 L/min, with a maximum flow of 2.08 for both prong models.[3] The delivered PEEP and flow were both measured after the nares-prong interface within the nares model. It is possible that the resistance within the RAM cannula itself limited the amount of flow and pressure that reached the nares model. This may have led to the ventilator detecting a higher pressure within the circuit even though this pressure was not reaching the desired target. Also, the level of flow found here was far less than what is used in other noninvasive strategies, for example, high-flow nasal cannula.

The present study was not without its limitations. The most obvious limitation would be that this was a bench simulation design and the inherent difficulties in translating results to direct bedside care.[3] However, these study designs have been used previously and validated clinically.[5] Moreover, using a bench model approach allows for an isolated evaluation of ventilator and interface performance with an accuracy and precision that is nearly impossible to capture clinically. Another

The author has disclosed no conflicts of interest.

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DOI: 10.4187/respcare.09545

limitation is that the delivered pressure and flow were measured just past the nares-prong interface, which likely is best represented as the nasopharynx clinically. This is important to note because the usual goal of noninvasive respiratory support is to support the distal airways and beyond. In a spontaneously breathing patient with an open mouth, the pressure that reaches the distal airways, let alone the alveoli, is potentially even less than what has been demonstrated here.

Despite these limitations, this study adds valuable information to the existing literature with regard to noninvasive respiratory support delivered via a nares-prong interface, and the investigators should be commended for executing a well-designed thoughtful study. These bench simulation studies are important because they offer the bedside clinician a deeper understanding of the ventilator-interface interaction and the support it may provide. With the increasing use of noninvasive respiratory support, both in neonates and in pediatric patients, these results should implore the bedside clinician to examine the clinical efficacy of this noninvasive interface compared with other interfaces and types of support. These results also present an opportunity for further research, both clinical and bench, to better understand and recognize important discrepancies between delivered and desired noninvasive respiratory support.

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