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CASE REPORT

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Adult-size interface during non-invasive ventilation for a child with pediatric acute respiratory distress syndrome: Maintaining principle on a different population

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Abstract

Acute respiratory failure is a common pediatric condition requiring respiratory support invasively or non-invasively. Limited access to proper size interface in pediatrics causes a significant drawback from using non-invasive ventilation. We report a successful use of an adult-size nasal interface by fitting a child's oro-nasal area to ventilate him non-invasively.

KEYWORDS

NIV in PARDS, NIV mask, pediatric NIV

1 | BACKGROUND

Acute respiratory failure occurs more quickly in neonates and children than in adults. This rapidness is due to many factors, including the size and shape of their airway, alveoli size and numbers, collateral ventilation mechanism, respiratory system and musculature development, and chest wall compliance.[1] With these factors, infants with pneumonia and bronchiolitis may require respiratory support to overcome respiratory system failure. This support includes positive pressure ventilation that can be delivered invasively or non-invasively.

Previously, many children requiring respiratory support were intubated and invasively ventilated. However, some adult studies showed that ventilating patients non-invasively might reduce the need for intubation and lower ICU mortality.[2] This evidence was further supported by some studies on infants and children showing the effectiveness of NIV in conditions like pediatric acute respiratory syndrome (PARDS), apnea, and respiratory failure.[3,4] Lindelauer et al. reported that adults with chronic obstructive pulmonary disease (COPD) patients have a better outcome when ventilated non-invasively than invasively.[5] Nowadays, the use of NIV in pediatrics has increased remarkably. However, one of the significant limitations to this use in the pediatrics field is the availability of appropriate-size interfaces since children require different sizes as they grow. Besides, it might be cost-ineffective to provide all sizes in large quantities for each institute. Over the years, the PICU teams refrained from using the NIV unless the appropriate interface was available in their units. We faced the same limitation; therefore, we report this successful use of an adult-size nasal mask to a 2-year-old child as an oro-nasal NIV interface. This case report might shed light on conducting more studies on using mixed adult/pediatric-size interfaces that simultaneously cover different areas for ages.

2 | CASE PRESENTATION

A 2-year-old boy known case of intermittent asthma and eczema was brought to Ahmadi hospital with 5 days

history of cough associated with fever, poor oral intake, and rhinorrhea. His neonatal history was inconsistent with the diagnosis of chronic lung disease of prematurity as he had a short period of mechanical ventilation and oxygen needs. The boy initially presented to a primary health care clinic, which provided him with supportive asthma treatment. His condition progressed and required an emergency department (ED) visit. At the presentation to our ED, the child was in moderate respiratory distress in the form of tachypnea (respiratory rate reaching 70–75 breaths per minute) and increased work of breathing. A trial of salbutamol nebulization and systemic steroid was used with no improvement. The diagnosis of asthma exacerbation was excluded in the absence of wheezing, prolonged expiratory phase, and failure to respond to bronchodilator therapy. On the other hand, with the presence of fever and grunting, the differential diagnoses were narrowed down to pneumonia or bronchiolitis. The chest x-ray finding and the respiratory nasal swab panel detecting Respiratory Syncytial Virus (RSV) supported these differential diagnoses later.

As his condition progressed, he was transferred to the pediatric intensive care unit (PICU), where he initially started on a high-flow nasal cannula (HFNC) with a flow rate of 2.0 L/kg/min and FiO_2 of 60%–70%, which maintained his oxygen saturation level between 90%–91%. As there were no signs of hyperinflation and air trapping; but granting and atelectasis with worsening of chest x-ray picture and hypoxic respiratory failure, the diagnosis of viral pneumonia was confirmed. Frequent blood gas analysis confirmed the state of primary respiratory acidosis. His condition worsened to type-2 respiratory failure, which mandates the need for positive pressure ventilation. A trial of non-invasive positive pressure ventilation was considered; however, as in many centers, the appropriate-size interface was unavailable for his age. A preparation for intubation and invasive ventilation was arranged. During that time, the PICU team thought to try an adult-size nasal non-vented mask to seal the whole oro-nasal area for our patient using a circuit-compatible NIV machine (Figures 1 and 2 are an example of the application of this interface on adult and pediatric manikins, as photos could not be obtained during child illness). The NIV support was started with moderate ventilatory settings of PEEP 8 (cmH_2O), PIP 16 (cmH_2O), and FiO_2 60%; during of which, we noticed an initial improvement in his respiratory condition. The child's condition and clinical findings fit the pediatric acute respiratory syndrome definition based on the Acute Lung Injury Consensus Conference definition.[6] His initial SpO_2/FiO_2 (SF) ratio was 245, which confirmed the diagnosis (SF ratio ≤ 264 with other PARDS criteria confirm the diagnosis).[6] This ratio improved, reaching up to 380 on the NIV. As the child was closely monitored in the PICU with a readiness to intubate at any time, we cautiously continued the non-invasive ventilation using the adult-size nasal mask. Also, a nasogastric tube (NGT) was inserted and kept open to ensure stomach deflation during the NIV support. Given his low inflammatory markers, hemodynamics stability, chest x-ray pictures, and the typical course of RSV infection, Antibiotics were not started with maintaining a low threshold to cover a superimposed bacterial infection whenever suspected.

On the fourth day of his PICU stay, the child improved on the NIV support and was weaned off gradually to a nasal cannula. His condition continued to improve, and he was discharged from the hospital in good general condition with a close follow-up with his pediatrician.

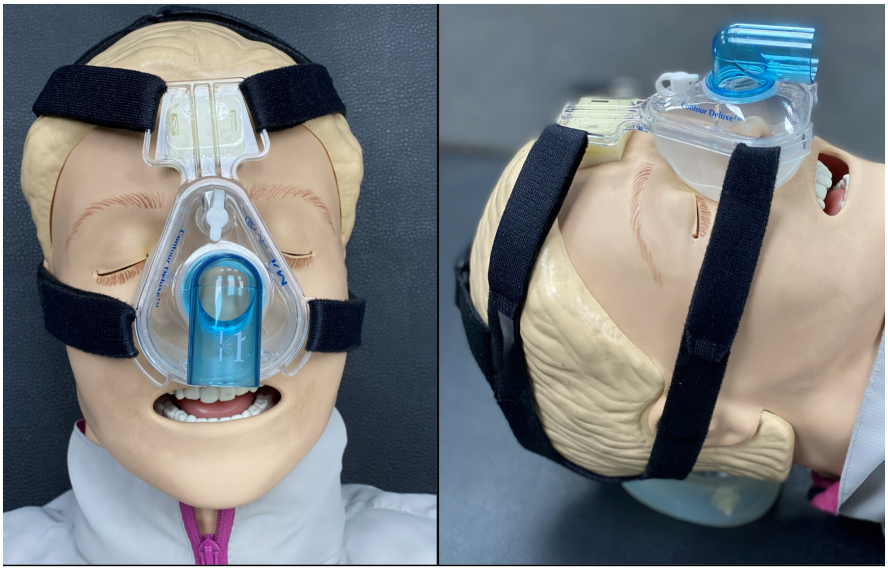

FIGURE 1 Application of adult-size nasal interface (Contour Deluxe™ with headgear—M/L size) on an adult training manikin (fitting nasal area only). This was the same mask used in our patient. Pictures obtained by Abdulla Alfraij in the simulation lab using a 12 MP, f/2.0 telephoto camera.

FIGURE 2 Application of adult-size nasal interface (Contour Deluxe™ with headgear–M/L size) on a child training manikin (covering oro-nasal area). This was the same mask used in our patient. Pictures obtained by Abdulla Alfraij in the simulation lab using a 12 MP, f/2.0 telephoto camera.

3 | DISCUSSION

The PICU team faces many challenges when considering NIV in pediatrics, which can be divided into patient-related, staff-related, and equipment-related challenges. The patient-related challenges include oro-nasal breathing pattern and their tolerance to the interface.[7,8] On the contrary, staff-related challenges include their experience and knowledge of NIV therapy and its troubleshooting.[7] Lastly, the most important challenge is equipment-related. It is meant for patient-specific interfaces that must fit the child's face shape, which is limited in some centers.[8] What makes things even harder is that the appropriate-size mask differs as the child grows. So, supplying these different-sized pediatric interfaces in large quantities is considered cost-ineffective for some centers. Not only are the sizes considered an issue, but also the type and area to cover. In acute respiratory failure, an oro-nasal interface is preferred over a nasal-type interface due to the effect of the large leak from the mouth on NIV efficacy.[7]

Furthermore, intubation carries its own risks and complications, although sometimes it is easy to be performed. These risks and complications can be subdivided into immediate, during ventilation, and post-extubation complications. The immediate risks include injury to soft tissue and vocal cords, hypoxia, severe bradycardia leading to arrest, or esophageal intubation. As well, during mechanical ventilation, the patient might have ventilator-induced lung injuries, ventilator-associated pneumonia (VAP), or high doses of sedation requirement with its complications. The post-extubation complications include muscle weaknesses, upper airway edema/obstruction, and post-extubation laryngitis.[9] Due to these reasons, some centers prefer to start with NIV support to avoid these complications and leave intubation as a last resort or if necessary.

One of the main concepts for successful NIV pressure delivery is having a properly sealed interface.[7] In our case, we considered this principle and used an adult-size nasal mask to fit the child's mouth and nose area. Muller et al. reported a case of the effectiveness of using an invented 3D Printed Adaptor with a simple anesthetic mask applying the same concept of a properly sealed mask.[10] Putting children on NIV support sometimes ease the handling of the patient by the nursing staff. Also, the parents will be more comfortable when dealing with their NIV-supported kids. The uniqueness of this approach is that instead of using the nasal adult-size interface to cover the same nasal area in pediatrics, we fit both the mouth and nose of the child in this nasal adult-size interface with maintaining a good seal concept. Another essential concept we applied was ensuring the child's stomach deflation because having a distended abdomen will affect the diaphragm, transmitting this effect to the lung and ventilation. This was achieved by ensuring that the NGT was placed and kept open to the air.

Though this maneuver cannot be generalized via this type of report, it may be considered a last resort that may be tried with close monitoring, especially if the pediatric-size interfaces are limited or unavailable in the unit. Moreover, this report might generate a thesis for new researches in this matter to study the cost-effectiveness and safety of having a standard size covering a different area for adults and children in regards to the NIV interfaces.

4 | CONCLUSION

Having an appropriate age-size NIV interface in pediatrics is challenging. We report a successful use of an adult-size nasal interface to cover the whole mouth and nose area of

the child diagnosed with PARDS due to RSV pneumonia. Given case report limitations and weaknesses, further researches are required to study the feasibility, safety, and cost-effectiveness of having a standard-size NIV interface for adults and pediatrics with a different facial area to cover.

AUTHOR CONTRIBUTIONS

Abdulla Alfraij: Conceptualization; data curation; methodology; project administration; supervision; writing – original draft; writing – review and editing. **Mohsen Alajmi:** Conceptualization; methodology; writing – review and editing.

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CONFLICT OF INTEREST

The authors declare no financial or other conflict of interest to disclose.

DATA AVAILABILITY STATEMENT

The authors confirm that the data supporting the findings of this study are available within the article.

CONSENT

Written informed consent was obtained from the patient to publish this report in accordance with the journal's patient consent policy.

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