Case Report

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High Pressures in Non-Invasive Ventilation in Children, Where is the Limit?

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Abstract

Non-invasive positive pressure ventilation (NPPV) refers to the delivery of mechanical respiratory support without the use of endotraqueal intubation. It has been proposed as a valuable alternative to invasive mechanical ventilation (MV) in selected children with acute respiratory failure (ARF). The pressures usually employed in NPPV are lower than those in MV, but in some cases high pressures are needed.

We present two patients that needed NPPV.

Keywords: Non-invasive ventilation; Acute respiratory failure; Postoperative respiratory failure

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First Case

9 year old girl who arrived at our hospital with acute respiratory distress. She presented with a history of high-grade fever for 4 days, dry coughing and respiratory fatigue. At emergency box, she was markedly polypneic (Respiratory Rate (RR): 80, Heart Rate (HR): 160, Blood Pressure: 120/60, Temperature: 39.5°C) and fatigued, but alert and reactive. Diffuse subcrepitant rales were presented and chest radiograph showed diffuse alveolar infiltration in both lungs.

It was decided to be admitted in Pediatric Intensive Care Unit for respiratory support. NPPV was started on this girl. We use BiPAP Vision Respironics© and facial mask as interface. Initial parameters were; inspiratory positive airway pressure (IPAP): 22 cm H_2O, expiratory positive airway pressure (EPAP): 7 cm H_2O and fraction of inspired oxygen (FiO_2): 1. We did not observed improvement in the first hour, so intubation was required. (PaO_2/FiO_2: 110, in the first hour decreased to 80).

After 6 days, she was extubated to NPPV. She needed high pressures (IPAP: 32 cm H_2O, EPAP: 8 cm H_2O, FiO_2: 0,3) during the first 48 hours with good evolution, and without any complications.

Second Case

10 year old boy admitted in our Pediatric Intensive Care Unit after abdominal surgery (complicated peritonitis that needed resection of part of the colon). He was extubated in the first 24 hours to high flow nasal cannula, but the following day he presented respiratory failure with hipoxemia. Radiograph chest showed complete atelectasis of right lung, so NPPV was started. The ventilator used was BiPAP Vision Respironics© and full-face mask. He needed high pressures to achieve acceptable ventilation (IPAP: 30 cm H_2O, EPAP: 10 cm H_2O, FiO_2: 1). NPPV was kept during 48 hours and it was well tolerated **(Table 1)**.

Conclusion

The frequency of ARF is higher in infants and young children than in adults. This difference can be explained by defining anatomic compartments and their developmental differences in pediatric patients that influence susceptibility to ARF [1, 2].

The main goals of NPPV in patients with parenchymal lung disease are to improve oxygenation, to unload the respiratory muscles and to relieve dyspnea. The first goal can be achieved by using EPAP to recruit and stabilize previously collapsed lung tissue. IPAP allows a better respiratory system muscle unloading and CO_2 washout improvement [3].

In children, the use of NPPV for the treatment of acute respiratory distress syndrome (ARDS) was associated with a failure rate of 78%, that´s why if the patient conditions deteriorated, he should be promptly intubated, as in our first case.

It has been reported that 5-10% of all surgical adult patients experience postoperative pulmonary complications, like atelectasis, postoperative pneumonia or ARDS. Several authors report that NPPV compared with standard treatment after major abdominal surgery improved hypoxemia and reduced the need of intubation in adult population. NPPV application in children with postoperative respiratory failure was associated with improved respiratory effort, gas exchange, oxygen saturation and reduced need of intubation [2, 4-6]. It is also reported that exit of NPPV in atelectasis after extubation is near 100 % like in the second patient we referred.

Some authors have referred that postextubation NPPV seems to be useful in avoiding reintubation in high-risk children when applied immediately after extubation. NPPV was more likely to fail when ARF has already developed, when RR at 6 hours did not decrease and if oxygen requirements increased [7-9].

In some patients with ARF, high pressures are needed to get good ventilation. Several authors described maximum values (IPAP 20 cm H_20, EPAP 10 cm H_20) in their studies. They referred that higher pressures are not well tolerated by their patients or might cause complications, being the most frequent, skin injury and discomfort [7, 10]. In our cases, the patients needed high pressures in order to get good ventilation, and they didn´t showed any complications, so we thought that the limit should be established depending on the patient, the cause of ARF and the experience of the personal who attends these patients.

Increased intrathoracic pressure may limit diastolic filling by several mechanisms. These include increased external constraint to the heart, redistribution of blood from the thorax to the periphery, and direct ventricular interaction. The effects of high pressures in non-invasive ventilation in children on left ventricular preload are closely related to mean airway and filling pressures and not to the mode of ventilation. The left ventricular preload similarly decreases with increased airway pressure and consequently cardiac output [11, 12]. In this context the echocardiography, color-flow Doppler and tissue Doppler imaging may provide further important information about cardiac function [13, 14].

Table 1 Shows ventilation timings for treatment of patients.

	0 hour	1 hour	168 hours	176 hours	0 hour	24 hours	36 hours	42 h
RR	80	70	45	35	30	2	60	50
HR	160	150	105	100	130	110	140	125
BP	120 / 60	120 / 65	120 / 60	115 / 60	115 / 55	120 / 65	120 / 66	115 / 60
Sat O_2	85%	85%	95%	96%	96%	98%	87%	93%
PaO_2 / FiO_2	110	80	270	280	> 300	> 300	150	210
Treatment	NPPV	MV	NPPV	NPPV	MV	Extubation	NPPV	NPPV
	S / T IPAP:22 EPAP: 7 FiO_2: 1		S / T IPAP:32 EPAP:8 FiO_2: 0,3	S / T IPAP:28 EPAP: 7		High Flow nasal canula	S / T IPAP: 30 EPAP:10 FiO_2: 1	S / T IPAP: 27 EPAP:8 FIO_2:0,4
Sedation	M + F				M + F			

First case

Second case

RR: Respiratory Rate (rpm); HR: Heart Rate; BP: Blood Pressure; M: Midazolam; F: Fentanyl; NPPV: Non Invasive Positive Pressure Ventilation; S / T: Spontaneous-Timed; IPAP: Inspiratory Positive Airway Pressure (cm H_2O); EPAP: Expiratory Positive Airway Pressure (cm H_2O).

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