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BRIEF REPORT

ACTA PÆDIATRICA NURTURING THE CHILD WILEY

Retrospective study found that helmet continuous positive airway pressure provided effective support for severe bronchiolitis

Infants with critical bronchiolitis who are admitted to a paediatric intensive care unit (PICU) are very likely to receive invasive mechanical ventilation.[1]

We performed a retrospective review of children with bronchiolitis admitted to the PICU at the Bambino Gesù Children's Hospital, Rome, Italy, from 1 November 2011 to 29 February 2015. Ethical approval was provided by the hospital's institutional review board in October 2017 (number 1483/2017).

Early helmet continuous positive airway pressure (H-CPAP) was administered to all patients admitted to PICU after 24-72 hours of ineffective high flow nasal cannula (HFNC) support in the emergency and paediatric wards. We studied the intubation rate, PICU length of stay (LOS), the bronchiolitis severity score, infections and the positive end-expiratory pressure (PEEP) level. Patients were managed according to the hospital's standard protocol for bronchiolitis in the PICU.[2]

Patients were divided into high PEEP (HP-10.0 cm H_2O) and low PEEP (LP-5.0-7.5 cm H_2O) H-CPAP. The primary outcome was intubation for two or more clinical signs: persistent chest and intercostal muscle efforts, a rising BSS, a pH of <7.10, a partial pressure of carbon dioxide of >70 mm Hg, an arterial partial pressure of oxygen (PaO_2)/fraction of expired oxygen (FiO_2) of <100 and rising lactate levels. The secondary outcomes were reduced heart and respiratory rates and improvements in the PaO_2/FiO_2 after one and 24 hours of CPAP.

We studied 85 patients (57.6% male) with a median age of 55 days:18 were <1 month and 84 survived to discharge. The median LOS was 6 days and 14.1% needed intubation. Of the 85 patients, 62 received high positive end expiratory pressure (HP) and 23 received LP. The children were significantly younger in the LP subgroup than the HP subgroup (mean 44.2 ± 26 vs 111.6 ± 79.8 days) and significantly smaller (mean 4.2 ± 0.9 vs 5.3 ± 1.5 kg). No differences in prematurity or comorbidity were reported. The main diagnosis was bronchiolitis, due to exclusive viral aetiology, with a significantly worse bronchiolitis severity score in the HP subgroup.

Outcome data after one and 24 hours of H-CPAP (Table 1) showed significantly lower intubation in the HP than LP subgroups (1.6% vs 47.8%). The LOS was significantly lower in the HP subgroup (6.0 days vs 10.3 days). After an hour of H-CPAP, the HP group showed significant reductions in respiration and heart rate. A significantly greater improvement in oxygenation was observed in the HP than HP subgroup. After 24 hours of H-CPAP the systolic and diastolic blood pressures were significantly lower in the HP subgroup.

Logistic Cox regression analysis showed that the significant risk factors for intubation were multiple viral and bacterial infections and elevated heart and respiratory rates after one hour of treatment. HP values were associated with a lower risk of intubation (odds ratio 0.30, 95% confidence interval 0.17-0.53; $P < .001$). The heart and respiratory rates progressively fell after one and 24 hours of CPAP, and PaO_2/FiO_2 rose after the first hour of treatment, which was also protective (data not shown).

HP maintained its significance in multiple regression models (odds ratio 0.288, 95% confidence interval 0.084-0.988; $P = .048$) when corrected for viral and bacterial infections, reductions in heart rate and improvements in PaO_2/FiO_2 after the first hour of H-CPAP (data not shown).

The reduced LOS may save money that could be used to develop early H-CPAP programmes in PICUs and paediatric wards to improve bronchiolitis outcomes.[3,4] We have learnt about paediatric H-CPAP using adult acute respiratory failure studies, as the few paediatric studies have mainly dealt with the device interface, reductions in intubation and sedations requirements. It seems that the patients in HP group actually had a more severe illness on admission but benefited from adequate pressures used, while infants in LP were younger and cautious use of positive pressure led to inadequate support and treatment failure.[5]

PaO2 and respiratory and heart rates improved after the first hour of HP CPAP support and highlights how effect H-CPAP is for critically ill patients with bronchiolitis.

The HP is associated in lower risk for intubation, due to falling heart and respiratory rates and rising PaO_2/FiO_2 after one and 24 hours of CPAP.

The study's main limitations were its retrospective design, the lack of time spent on HFNC and the lack of a Paediatric Index of Mortality version 3 score, because we only started recording that in 2014.

TABLE 1 Comparison of outcome data between patients treated with low and high PEEP H-CPAP

	High PEEP H-CPAP	Low PEEP H-CPAP	*P* value
Outcome data			
[1]PICU survival, n (%)	61.0 (98.4)	23.0 (100.0)	1.000
[2]LOS, (d)	6.0 ± 2.2	10.3 ± 6.6	.001
[1]Pneumothorax, n (%)	0.0	0.0	n.a.
[1]Endotracheal intubation, n (%)	1.0 (1.6)	11.0 (47.8)	<.001
Haemodynamic and respiratory data after 1 h of treatment			
[2]Systolic blood pressure, mm Hg	87.0 ± 3.3	90.0 ± 12.7	.482
[2]Diastolic blood pressure, mm Hg	45.0 ± 4.2	50.8 ± 10.3	.192
[2]Heart rate, beats/min	146.0 ± 5.5	153.6 ± 14.4	.131
[2]Change in heart rate, beats/min	−31.2 ± −14.4	−21.4 ± −22.4	.036
[2]Respiratory rate, breaths/min	52.0 ± 1.8	56.2 ± 10.7	.053
[2]Change in respiratory rate, breaths/min	−14.0 ± 5.1	−5.8 ± −13.6	.005
[2]pH	7.31 ± 0.02	7.27 ± 0.07	.083
[2]$PaCO_2$, mm Hg	54.0 ± 3.3	58.1 ± 13.9	.274
[2]PaO_2/FiO_2	178.0 ± 13.2	149.2 ± 23.9	<.001
[3]Change in PaO_2/FiO_2	44.5 [34.5;53.0]	34.0 [22.0;39.2]	.001
Haemodynamic and respiratory data after 24 h of treatment			
[2]Systolic blood pressure, mm Hg	85.0 ± 5	94.8 ± 11.2	.012
[2]Diastolic blood pressure, mm Hg	45.0 ± 3.4	52.6 ± 10.9	.024
[3]Heart rate, beats/min	140.0 [134.0;145.0]	140.0 [134.0;144.5]	.847
[2]Change in heart rate, beats/min	−39.9 ± 16.7	−32.6 ± 17.0	.174
[3]Respiratory rate, breaths/min	44.0 [38.0;46.0]	45.5 [38.5;60.0]	.091
[2]Change in respiratory rate, breaths/min	−22.0 ± 4.7	−13.1 ± 11.7	.006
[3]pH	7.40 [7.36;7.41]	7.42 [7.38;7.43]	.223
[3]$PaCO_2$, mm Hg	46.0 [44.0;50.0]	46.0 [39.0;46.0]	.391
[2]PaO_2/FiO_2	220.0 ± 12.4	205.8 ± 42.6	.042
[3]Change in PaO_2/FiO_2	90.0 [77.0;101.5]	66.0 [57.7;94.5]	.040

Note: Values are given as [1]numbers and percentages, [2]means and standard deviations, or [3]medians and interquartile range. Analyses SPSS, version 15.0 (SPSS Inc, Illinois, USA): Shapiro-Wilk test (normality of data), Student *t* test (normally distributed continuous variables), Mann-Whitney test (non-normally distributed variables), chi-square test (categorical variables).

This retrospective study highlights the effective role of early and high PEEP H-CPAP in supporting critically ill patients with bronchiolitis.

However, larger randomised studies on H-CPAP are required.

CONFLICT OF INTEREST

None.

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