Clinical research

Success or failure of non-invasive positive pressure ventilation in children with acute respiratory failure. Could it be predicted?

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Abstract

Introduction: Noninvasive ventilation (NIV) has been developed to reduce complications associated with invasive ventilation (IV). Failure of NIV and delay in endotracheal intubation can increase patients' morbidity and mortality. Thus early determination of patients who are unlikely to benefit from NIV is crucial for their management. We aimed in this study to identify the early predictors of success of NIV in children with acute respiratory failure (ARF).
Material and methods: Fifty patients with ARF who fulfilled the study selection criteria were ventilated non-invasively and were assessed initially for their severity of critical illness by the Pediatric Logistic Organ Dysfunction (PELOD) score. Clinical, gasometric, respiratory mechanics and oxygenation indices were assessed at 0, 30 and 60 min and 4 and 24 h from the start of NIV. The success group was identified by reduction in respiratory effort, reduction in oxygen demand, improvement in gasometric parameters, and avoidance of intubation.
Results: Sixty-two percent of patients had successful NIV. Neither type of ARF nor patients' demographics affected the outcome of NIV. The success rate was 80% among patients with mild to moderate acute respiratory distress syndrome (ARDS), 20% with severe ARDS, and 71.8% in patients with bronchopneumonia. Multivariate analysis revealed that baseline PELOD score of less than 14.5 ±2.7, SpO_2/FiO_2 ratio more than 208 ±57, oxygenation index (OI) 7 ±3.4 and mean airway pressure (MAP) 8.6 ±1.3 are independent predictors for success of NIV.
Conclusions: The NIV is a promising respiratory support modality in pediatric ARF. Baseline degree of critical illness and saturation oxygenation indices together with MAP change after the 1st h from the NIV trial represented the best predictors of success of the trial in the current study.

Key words: predictors, pediatrics, non-invasive ventilation, acute respiratory failure.

Introduction

Acute respiratory failure (ARF) is the main cause in almost 50% of admissions to pediatric intensive care. Invasive mechanical ventilation (IMV) is a critical intervention in many cases of acute respiratory failure, yet research has shown a clear association between IMV and lung injury, also known as ventilator-induced lung injury (VILI) [1]. Two major com-

ponents account for lung injury in invasively ventilated infants: tracheal intubation and the direct mechanical force on the lung parenchyma during invasive ventilation [2]. Noninvasive positive pressure ventilation (NIV) refers to the provision of mechanical ventilation (MV) through the patient's upper airway by means of a face or nasal mask without the use of an invasive artificial airway. The NIV works by providing pressure support that gives ventilatory assistance during inspiration, allows respiratory muscles to work less, increases the volume inspired per minute and improves gas exchange. It could provide lung protection by allowing the naturally occurring regulation of end-expiratory lung volume and prevention of atelectasis, as well as avoiding the complications associated with having an endotracheal tube in plac [3]. However, in some patients, NIV is inadequate and eventually invasive ventilation is required. Failure of the initial trial of NIV and delay in endotracheal intubation can increase patients' morbidity and mortality.

Thus, the aim of this study was to identify the early predictors of success of NIV in children with acute respiratory failure based on clinical, gasometric and respiratory mechanics analysis during an early trial of NIV in our ICU-based setting.

Material and methods

Patients' selection

A prospective observational cohort clinical study was carried out over 18 months from January 2014 to June 2015 in the Pediatric Intensive Care Unit (PICU) of the Children's Hospital, Ain Shams University. This unit is a medical PICU composed of 12 beds at a tertiary university hospital. The study was approved by the Ethical Review Board and informed written consent was obtained from the child's caregiver on the day of admission to the PICU.

All children admitted to the PICU with acute respiratory failure during the period of study were included when they met the clinical and physiological parameters required for mechanical ventilation. Diagnostic criteria for hypoxemic respiratory failure included difficulty in spontaneous breathing as expressed by increased respiratory rate for age with moderate to severe respiratory distress, partial pressure of oxygen (PaO_2) less than 60 mm Hg, or arterial oxygen saturation less than 90% with fraction of inspired oxygen (FiO_2) more than 50% [4]. Hypercapnic respiratory failure was diagnosed when respiratory distress was associated with pH < 7.35, and PaO_2 > 50 mm Hg [5].

Acute respiratory distress syndrome was defined and classified according to the Berlin definition developed by the American Thoracic Society and the Society of Critical Care Medicine [6]. We excluded patients with shock with hemodynamic instability and on vasopressor supports, serious cardiac arrhythmias, unconsciousness and inability to fit the face mask due to skeletal deformity, facial trauma or burn, or when an endotracheal tube was needed due to serious upper airway obstruction or abundant respiratory secretions [7].

Study protocol

All patients were managed in the pediatric intensive care unit of Ain Shams University Children's Hospital. Patients were ventilated on BiPAP spontaneous mode (using GE Healthcare/Engstrom Carestation, Datex, Omeda, UK or Neoport e360, Neoport medical instrument, USA), through fitting non-vented silicon oro-nasal masks. Bilevel positive airway pressure (EPAP and IPAP) was the non- invasive mode applied to our patients. Expiratory positive airway pressure (EPAP) was set at 5 cm H_2O. The inspiratory positive airway pressure (IPAP) was initially set at 10 cm H_2O above EPAP. Both pressures were adjusted gradually according to the patient's response. Oxygen was administered through the mask with adjustment of FiO_2 until oxygen saturation (spO_2) was more than 90%. A nasogastric tube was placed in all patients to prevent gastric distention. The patient's ECG, oxygen saturation, blood pressure and respiratory rate were continuously monitored. The mask was examined for leak, skin abrasion and patient satisfaction.

Determinants of NIV success or failure

Treatment with NIV was considered successful if improvement of work of breathing, oxygenation and ventilation were achieved without the need for endotracheal intubation. If there was not a satisfactory degree of patient's work of breathing, ventilation or oxygenation, NIV was discontinued and conventional mechanical ventilation was provided, and this was considered to be NIV failure.

The following variables were analyzed to predict success or failure of NIV:

1. Age and sex of patients.
2. Type of respiratory failure.
3. Pediatric Logistic Organ Dysfunction (PELOD) [8] mortality score for assessment of severity of patients' critical illness.
4. Clinical assessment including respiratory rate, heart rate, systolic and diastolic blood pressure.
5. Blood gas analysis initially by arterial sample to diagnose ARF, then by capillary samples to follow the patient's progress. Arterial samples are not routine in our center because they are invasive and carry the risk of infection, arterial spasm and bleeding.

6. Oxygenation indices: The oxygenation index (OI) was determined initially to diagnose and classify the type of ARF (which expresses the relation between mean airway pressure, applied FiO_2 and PaO_2 measured by arterial blood gas analysis (OI = MAP × FiO_2 × 100/PaO_2). Follow-up was done by the saturation oxygenation index using percutaneous pulse oxygen saturation instead of arterial oxygen tension (sat OI = MAP × FiO_2 × 100/SpO_2).

   S/F ratio (it represents the best percutaneous oxygen saturation level of the patient using pulse oximetry achieved by the lowest fraction of inspired oxygen; spO_2/FiO_2), SF/EPAP (which reflects the relation between the applied EPAP and the patient's SF ratio).
7. Degree of respiratory assistance including EPAP, IPAP, mean airway pressure (MAP).
8. Respiratory work of breathing by assessment of tidal volume to predicted body weight (TV/PBW).

Clinical, gasometric and oxygenation indices together with degree of respiratory assistance and work of breathing were assessed early after initiation of NIV and after 30 min, 60 min, 4 h and 24 h.

Statistical analysis

Data were analyzed using SPSS. Before initiating NIV, age, gender, underlying diseases, RR, HR, SpO_2, FiO_2, SF ratio, pH, pCO_2 and PELOD were measured in the whole sample and compared between the final successful and failed NIV groups. Qualitative variables were expressed as a percentage and compared using the χ^2 test. Continuous variables were described with the mean ± SD. For all statistical analyses, a p-value < 0.05 was considered statistically significant, and 95% confidence intervals (CI) were calculated. Specificity 100%, lowest value without NIV failure and sensitivity 100%, highest value with NIV failure. Measured values of selected predictors (PELOD score, respiratory mechanics variables, oxygenation indices and gasometric changes) at 0 h, 1 h, 4 h and 24 h from NIV trials were compared between success and failure groups. To identify independent predictors of NIV failure, a multivariate logistic regression model was adjusted using a forward stepwise procedure based on the likelihood ratio (enter probability $p < 0.05$). Variables having $p < 0.2$ in the univariate analysis and/or those considered clinically important for controlling confusion were included at the beginning of the multivariate analysis. The effect of the variables included in the final model was estimated using the odds ratio (OR), with 95% CI. The diagnostic accuracy was assessed with receiver operating characteristic (ROC) curve analysis, using optimal cutoff values for computing the sensitivity and specificity.

Results

During the period of study we had 118 admissions with acute respiratory failure. Sixty-eight patients required early endotracheal intubation and invasive ventilation. Fifty patients fulfilled the study selection criteria and were ventilated non-invasively (Table I). Thirteen (26%) patients had hypoxemic ARF, 17 (34%) patients had hypercapnic ARF, while 20 (40%) patients had mixed type of acute respiratory failure. Sixty-two percent were male and 38% were female. The cause of ARF was bronchopneumonia in 58% of patients, and ARDS in 20%.

Thirty-one (62%) patients showed improvement and success with the NIV trial, while 19 (38%) patients failed the NIV trial and eventually the endotracheal tube with invasive ventilation was used. Worsening of respiratory failure and eventual intubation in the failure group occurred within 6:50 h from NIV. A higher success rate was found among patients with mild ARDS (4/5 patients; 80%) or bronchopneumonia (23/32; 71.5%), while a higher failure rate was seen among patients with moderate to severe ARDS (4/5; 80%) or heart failure (3/4; 75%).

There was no difference in age, weight or type of ARF between success and failure groups, while the extent of critical illness as detected by pretrial PELOD scoring was significantly more severe in the failure group compared to the success group (PELOD 16.6 ±4.6 in failure group versus 14 ±2.7 in success group; $p = 0.031$).

Clinical improvement was not marked in the success group compared to the failure group in the first few hours. But after 4 h, RR and HR started to be significantly reduced in patients who responded well to NIV, while being even worse in the failure group.

Blood gas analysis showed early prompt significant improvement of capillary oxygen tension after 30 min of NIV in the success group compared to negligible changes in the failure group, while capillary CO_2 tension showed significant worsening in the failure group along the NIV compared to the success group (Figure 1).

Oxygenation indices showed early significant improvement in the success group (Table II). SF ratio (Figure 2) was initially higher in the success group before NIV (208 ±57 compared to 139 ±55), and further improved during the NIV to a maximum of 312 ±65 after 24 h from the start of NIV. The failure group showed improvement as well but not to the extent of the success one. With the ROC curve analysis, an initial cutoff value of SF of 163 or more has 74% sensitivity and 72% specificity in predicting success in this trial (area under

Table I. Characteristics of study population

Parameter	Total study population (n = 50)	Success group 31 (62%)	Failure group 19 (38%)
Age, mean ± SD [months]	19 ±33	17.3 ±28	22.1 ±41
Weight [kg]	8.3 ±6.6	8 ±5	8.9 ±8.6
Male/female	31/19	17/10	14/9
Acute respiratory failure:			
Hypoxemic	13 (26%)	9 (69%)	4 (31%)
Hypercapnic	17 (34%)	11 (64.7%)	6 (35.3%)
Mixed	20 (40%)	11 (55%)	9 (45%)
Underlying cause of ARF:			
Bronchopneumonia	32 (64%)	23 (71.8%)	9 (28.2%)
ARDS:			
Mild	5 (10%)	4 (80%)	1 (20%)
Moderate to severe	5 (10%)	1 (20%)	4 (80%)
Heart failure	4 (8%)	1 (25%)	3 (75%)
Guillain-Barre syndrome	1 (2%)	1 (100%)	–
ARF on top of ILD	3 (6%)	1 (33.3%)	2 (66.7%)
PELOD Score	15 ±3.2	14 ±2.7	16.6 ±4.6

ILD – interstitial lung disease, PELOD score – pediatric logistic organ dysfunction.

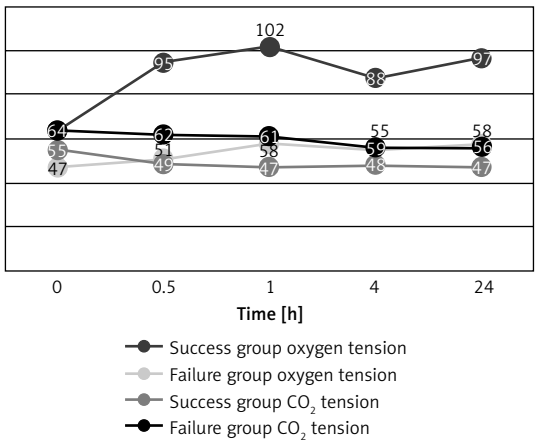

Figure 1. Gasometric changes of study groups during NIV trial

the curve (AUC) 0.82, $p < 0.001$) and a cutoff value of 248 or more after 1 h of initiating NIV carried 87% sensitivity and 56% specificity in predicting success (AUC = 0.73, $p = 0.01$).

We also observed early initial improvement in SF/EPAP values in the success group when compared to the failure group (37 ±14 vs. 25 ±14; $p = 0.004$), and continued to observe higher values in the success group during all interval examination points. At 24 h of NIV, the SF/EPAP ratio did not significantly differ from the failure group but without an effect on the NIV trial outcome (Figure 3).

After ROC curve analysis, an initial cutoff value of SF/EPAP of 26.5 or more has 81% sensitivity and 72% specificity in predicting success in this trial (AUC = 0.75, $p < 0.001$) and a cutoff value of 34.5 or more after 1 h of initiating NIV carried 81% sensitivity and 67% specificity in predicting success (AUC = 0.78, $p < 0.001$).

Significant initial improvement in the calculated saturation oxygenation index was observed in the success group compared to the failure group (7 ±3.4 vs 14.8 ±6.1; $p < 0.001$).

Throughout the NIV, saturation OI continued to show highly significant improvement, reaching 3.3 ±1 after 24 hours compared to 10.5 ±1.3 in the failure group.

An initial cutoff value of OI of 9.5 or less has 100% sensitivity and specificity in predicting success in this trial (AUC = 1, $p < 0.001$), and a cutoff value of 6.1 or less after 1 h of initiating NIV carried the same sensitivity and specificity in predicting success (AUC = 1, $p < 0.001$).

Mean airway pressure showed early improvement in the success group after 1 h of NIV, while it continued to increase in the failure group, which signified their need for more respiratory assistance (Table III).

With the ROC curve analysis, we found that a cutoff value of MAP less than 9.3 after 1 h from

Table II. Clinical, gasometric, and oxygenation parameters at baseline, 30 min, 1st h, 4th h and 24th h after initiation of NIV in both success and failure groups by univariate analysis

Parameter (mean ± SD)	Success group	Failure group	*P*-value
RR [beat/min]:			
Baseline	43 ±13	43 ±11	0.69
30 min	45 ±12	43 ±12	0.67
1st h	42 ±11	47 ±12	0.12
4th h	39 ±10	49 ±7	0.035
24th h	38 ±10	49 ±7	0.034
HR [beat/min]:			
Baseline	121 ±56	138 ±25	0.1
30 min	144 ±20	139 ±24	0.4
1st h	137 ±20	137 ±24	0.9
4th h	126 ±18	150 ±22	0.02
24th h	127 ±17	149 ±19	0.02
Oxygen tension [Torr]:			
Baseline	64.3 ±32.8	46.6 ±11.7	0.29
30 min	94.8 ±38.6	51.5 ±9.5	0.001
1st h	102.3 ±51.5	58.1 ±13.5	0.001
4th h	88.5 ±25.5	54.8 ±11.2	0.001
24th h	97 ±26	57.8 ±18.8	0.007
CO_2 tension [Torr]:			
Baseline	55 ±15	64 ±2	0.125
30 min	49 ±12	62 ±17	0.003
1st h	47 ±11	61 ±19	0.011
4th h	48 ±9	56 ±10	0.007
24th h	47 ±7	56 ±6	0.021
SF ratio:			
Baseline	208 ±57	139 ±55	0.001
30 min	236 ±42	192 ±44	0.001
1st h	256 ±46	218 ±51	0.01
4th h	276 ±40	240 ±47	0.01
24th h	312 ±65	213 ±97	0.01
SF/EPAP:			
Baseline	37 ±14	25 ±14	0.004
30 min	43 ±12	32 ±11	0.001
1st h	47 ±14	34 ±16	0.003
4th h	52 ±16	39 ±19	0.025
24th h	58 ±22	39 ±31	0.131
Saturation oxygenation index:			
Baseline	7 ±3.4	14.8 ±6.1	0.001
30 min	4.6 ±1.9	10.7 ±3.6	0.001
1st h	3.9 ±1.4	10.3 ±4.7	0.001
4th h	3.7 ±1.1	9.5 ±2.9	0.001
24th h	3.3 ±1	10.5 ±1.3	0.001

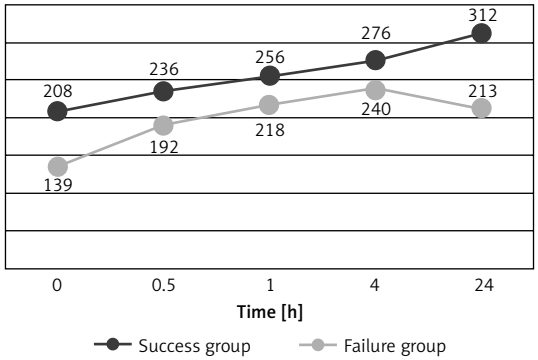

Figure 2. SF ratio changes in both patient groups

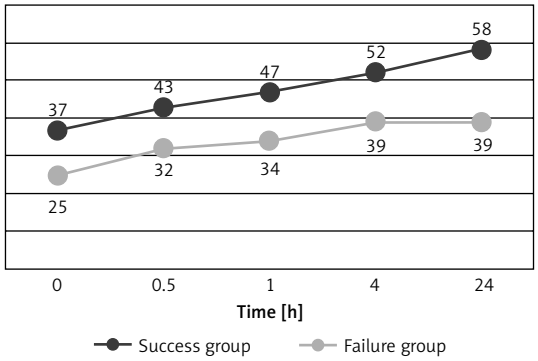

Figure 3. SF/EPAP changes in both patient groups during NIV trial

NIV yielded 100% sensitivity and specificity in predicting success of NIV.

Multivariate analysis by a logistic regression model of significant variables revealed that the best model for prediction of success is achieved by assessing the PELOD score (p = 0.1, OR = 1.26), initial OI (p = 0.04, OR = 1.76) and MAP changes after the first hour (p = 0.03, OR = 2.96).

Recorded complications with NIV were minimal and mainly were facial abrasions through contact with the interface. None of our patients interrupted NIV due to these complications.

Discussion

Noninvasive ventilation aimed at improving acute respiratory failure with avoidance of endotracheal intubation and its complications. In our study, NIV was effective in supporting 62% of patients with acute respiratory failure without the need for endotracheal intubation. Patients with less severe critical illness and better initial oxygenation indices needed less pressure support while on NIV and had a better outcome. Neither age, sex, nor type of respiratory failure affects NIV outcome. Our success rate is acceptable among other studies, where the success rate with NIV as an initial mode of respiratory support in ARF ranges from 57% [9] to 75% [10], and the highest rate of success was 81%, reported by Muñoz-Bonet

Table III. Respiratory assistance during non-invasive ventilation

Parameter (mean ± SD)	Success group	Failure group	*P*-value
IPAP:			
Initial	15.6 ±2	15.6 ±2.2	0.92
30 min	15.7 ±1.7	16.3 ±2.2	0.30
1st h	15.5 ±1.7	17 ±2.7	0.01
4th h	15.5 ±1.9	17.3 ±4.1	0.13
24th h	15.1 ±2.5	18.3 ±4	0.03
EPAP:			
Initial	5.9 ±1.5	6.2 ±1.7	0.55
30 min	5.8 ±1.4	6.5 ±1.6	0.09
1st h	5.7 ±1.5	7.2 ±2.2	0.02
4th h	5.7 ±1.7	7.2 ±2.8	0.08
24th h	5.9 ±1.5	8 ±3.7	0.33
MAP:			
Initial	8.9 ±1.5	9.2 ±1.6	0.57
30 min	9 ±1.5	10.1 ±2.7	0.06
1st h	8.6 ±1.3	11 ±2.8	0.002
4th h	8.6 ±1.6	11.3 ±3.1	0.009
24th h	8.6 ±1.6	11.3 ±3.5	0.24
TV/PBW:			
Initial	10.1 ±5.2	10.6 ±4.7	0.6
30 min	10.7 ±3.1	12 ±5.9	0.6
1st h	11.5 ±4.5	11.1 ±4.6	0.9
4th h	9.9 ±4.6	10.6 ±3.7	0.3
24th h	10.7 ±4.6	10 ±4.4	0.8

et al. [5]. We assumed this overall success rate to be acceptable because most of our patients had a moderate PELOD score which signifies an appreciable degree of critical illness. Moreover, about 20% of our patients had variable degrees of ALI. The type of ARF did not significantly affect the outcome of the NIV trial in our study, though we had better improvement with type 1 and this was in agreement with Muñoz-Bonet *et al.* [5], but in contradiction to the findings of Abadesso *et al.* [11] and Essouri *et al.* [12], who achieved lower success with type 1 ARF compared to type 2. Perhaps this disparity is due to the inability to quantify the severity of either type of ARF in any of the previous studies together with the wide variability of the cause of ARF rather than its type. Most of our patients (54%) had pneumonia as a cause of ARF, which is higher than the observed diagnosis in other studies [5, 10, 11]. Yet, this percentage is a real reflection of the general high rate of pneumonia in Egyptian children compared to other countries [13]. Interestingly, the success rate of NIV amongst patients with pneumonia in this study was 74%, which is comparable and even higher than other studies [11]. Though the use of NIV in ARDS/ALI is controversial in adults [14–17], trials with its application in some pediatric studies are evolving. Yet, variable outcomes were obtained by different pediatric studies, from Essouri *et al.* [18], who reported a failure rate of 78% of NIV in ALI and considered ALI to be an independent risk factor for NIV failure, to 50% reported by Muñoz-Bonet *et al.* [5]. Bernet *et al.* [9] and Lum *et al.* [10] excluded patients with ALI from their NIV trials. In this study, the rate of success among ALI patients was 50%, which is similar to the study by Muñoz-Bonet *et al.* [5]. We agree with these authors, in considering NIV as an accepted option for respiratory assistance in ALI, especially with mild to moderate ALI, with the emphasis on careful monitoring of patients to avoid delay in endotracheal intubation whenever necessary.

Avoidance of endotracheal intubation is the main benefit of NIV, and delay in intubation might worsen patients' outcome. So early prediction of whether this patient will respond to NIV or will need invasive ventilation and when to intubate is the cornerstone issue in applying NIV, and this was another main objective in this study.

Clinical evaluation of both failure/success groups of patients revealed no significant change in either heart rate or respiratory rate during the early few hours of NIV, while the success group showed significant appreciable improvement after 4 h from NIV. The lack of early clinical improvement in both groups may be attributed to the co-existence of other factors than the direct effect of NIV on ARF. These factors are related to efficacy of sedation, the capabilities of patients to adapt to the applied interface together with other systemic effects of the underlying systemic disease such as sepsis. After 4 h of NIV, significant improvement was noted in the success group compared to the NIV failure group, which started to show even worsening of RR and HR. This effect though was late but seemed to reflect the direct effect of NIV on patients' respiratory failure, as it correlated significantly with NIV outcome. Our data are in agreement with Lum *et al.* [10], who noted significant improvement in both RR and HR after 6 h. Muñoz-Bonet *et al.* [5] found significant improvement in RR and HR in both patient groups after 4 h and explained it by early adaptation with sedation or initial success followed by more disease progression to result in NIV failure, and hence concluded that clinical changes are important to observe in patients to assess progression but are not considered as sole indicators or predictors of success or failure.

Concerning gasometric changes in our study, O_2 tension showed marked improvement along the

course of NIV in the success group patients, who benefit most from NIV. On the other hand, CO_2 tension changes were unremarkable in both the success group and the failure group. Blood gas parameters are ambivalent in different pediatric studies [5, 10, 12]. So we believe that continuous monitoring of blood gas analysis, though it is helpful in predicting the outcome of NIV and can enable us to modify the degree of respiratory assistance during NIV, is considered an invasive tool that may not be convenient enough for continuous monitoring.

The pulse oximetric saturation to fraction of inspired oxygen (SF ratio) is a new and reliable surrogate for monitoring patients' oxygenation and degree of acute lung injury, with the advantage of replacing the invasive arterial blood sampling and correlating patients' oxygenation with the important ventilatory support tool which is FiO_2. Many studies have correlated SF ratio with PF ratio and acute lung injury, yet few studies have started to search its utility to predict success or failure for NIV [19]. In this study initial SF ratio values of 163 with further increase after one hour of NIV to 248 had appreciable ability in predicting success of NIV. We support the use of this simple index not only as an initial assessment of patients' readiness for NIV, but along the NIV course to emphasize patients' response and outcome. Patients with successful NIV showed lower EPAP needs and a faster decrease in FiO_2 while maintaining appropriate pulse oximetry saturation, and so the SF/EPAP ratio was an attractive tool in combining two important ventilatory support parameters (EPAP and FiO_2) and patients' oxygen saturation. So when combining SF/EPAP to SF measures, after 1 h from NIV we can achieve modest sensitivity and even better specificity in predicting success of NIV than using the SF ratio alone. On the other hand, the oxygenation index (OI) was the best predictor for NIV success with levels below 7 in both univariate and multivariate analysis in our study. OI has been used in some adult studies and showed comparable results. We encourage the wide and frequent use of OI for its value in assessing both the ventilatory parameters (MAP, FiO_2) and patients' PaO_2. Unfortunately, it is not preferred by practitioners due to its complexity of calculations and the use of frequent arterial blood gas sampling, so we started to use the saturation oxygenation index instead, to avoid inconvenient, repetitive, invasive arterial sampling.

In conclusion, NIV is a promising initial respiratory support modality in pediatric acute respiratory failure. Proper selection of patients without delay can ensure success of NIV. Oxygenation indices together with mean airway pressure change after the first hour from NIV trial represented the best predictors of success of NIV in the current study.

Key messages

Selection of patients who will tolerate noninvasive ventilation is enormously important and can be determined by patients' PELOD scoring. Meticulous observation of patients for the first 4 h on NIV is of paramount importance in determining tolerability and success of NIV and can be better done by observing the oxygenation indices rather than the clinical assessment alone.

What is already known?

Invasive ventilation is associated with many ventilator-associated complications such as infection and barotrauma. Non-invasive positive pressure ventilation carries much less risk of ventilation-associated complications. Delay in tracheal intubation while the patient is on noninvasive positive pressure ventilation may worsen patients' mortality and morbidity.

What does this study add?

We tried to find early predictors of response to noninvasive trial, and we found that the initial critical illness scoring, PELOD score (not studied before in such settings) and oxygenation indices (saturation oxygenation index and SF ratio and SF/EPAP – not studied before collectively in a single study, but only one parameter at a time, and the last one is not yet well known to pediatric intensivists), can help pediatric intensive care physicians to decide which patient will benefit from noninvasive ventilation and when to move into invasive ventilation and abort the noninvasive trial.

Conflict of interest

The authors declare no conflict of interest.

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