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Title:

Is nasopharyngeal tube effective as interface to provide bilevel non-invasive ventilation?

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Potential confilcts of interest:

Dr Pons has been a speaker for Maquet several times, receiving honoraria on one occasion. No conflicts of interests are declared by the other authors.

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Abstract

Velasco Arnaiz E, MD, Cambra Lasaosa FJ, PhD, Hernández Platero L, MD, Millán García del Real N, MD, Pons Òdena M, MD. Is nasopharyngeal tube effective as interface to provide bilevel non-invasive ventilation?

Background: The nasopharyngeal tube (NT) is an interface for non-invasive ventilation (NIV) potentially available in all healthcare centers. The aim of the study was to describe our experience in the use of the NT for bilevel NIV in infants and its effectiveness.

Methods: Prospective observational study from 01/2007 to 12/2010, including all patients aged 6 months or less admitted to Intensive Care (PICU) and treated with NIV with two levels of pressure using the NT. Clinical data collected before starting NIV, at 2, 8, 12 and 24 hours were analyzed according to the moment NIV was started: first-line or initial (i-NIV), elective post-extubation (e-NIV) and rescue post-extubation (r-NIV). The need for intubation was considered as NIV failure.

Results: 151 episodes were included, 65% bronchiolitis. The most frequent use was e-NIV (48%) (i-NIV 44%, r-NIV 8%), and the failure rate, 27% in total, was highest in the i-NIV group (37%) (e-NIV 18%, r-NIV 25%). Successful cases had shorter PICU (8.5 vs. 13 days, p 0.001) and hospital (17 vs. 23 days, p 0.031) stays. The NT needed to be changed for another interface in only 5 cases, few complications (4/151) were observed and the mortality (2/151) was unrelated to NIV.

Conclusions: NT showed 73% effectiveness, with few complications. The effectiveness was higher in e-NIV than i-NIV.

Key words

airway extubation, bronchiolitis, infant, noninvasive ventilation, pediatric intensive care units, respiratory insufficiency

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Introduction

Using non-invasive ventilation (NIV) as a treatment for respiratory failure requires the availability of appropriate material and well-trained personnel.

Interface selection is fundamental to optimize the interaction between patient and ventilator [1]. When nasal prongs cannot be used in small infants, it is occasionally necessary to adapt some interfaces designed for older patients, like the nasal interface used as oronasal [2-4], as there are few commercially-available interfaces which fit well in this age group. The nasopharyngeal tube (NT) or single long nasal prong, which has been in use since the 70s, could be another alternative [5]. Although double nasal prongs have been shown to be more effective than single nasal devices for CPAP in premature babies [6], no studies to date have analyzed the results with the NT in the pediatric population.

From 1998 to 2006, all the infants in our Unit failing with CPAP were intubated without a previous trial with bilevel pressure, mainly due to the lack of appropriate ventilators and interfaces. The present study aims to describe our experience in introducing the use of the NT as a single nasal interface for NIV with 2 levels of pressure in infants up to 6 months of age in a Pediatric Intensive Care Unit (PICU) and analyze its effectiveness.

Patients and Methods

A prospective observational study was carried out in the PICU of a tertiary-care hospital with 14 beds for critical patients from 0 to 18 years, from January 2007 to December 2010. All patients aged 6 months or less who were treated with bilevel pressure NIV using the NT were included. Approval from the Ethics Board of the Hospital was obtained for collecting NIV data. As NIV is a routine treatment in the PICU, specific informed consent was not considered necessary.

NIV strategy: A shortened endotracheal tube inserted through a naris and secured in a way where 7 centimetres were introduced into the hypopharynx was used as the

interface. As almost 75% of the patients were younger than three months, the length of the NT used was 7cm.

Ventilator selection was based on patient age, ventilator availability, our previous experience and the published data of trigger sensitivity of each device: Giulia® (Ginevri) was used for infants younger than 1 month [7], Servo-i® (Maquet) for infants between 1 to 3 months [4], and BiPAP Vision® (Respironics) and Carina® (Dräger) for those over 3 months. A heated humidifier (Fisher Paykel® Healthcare) was used in all cases.

The ventilation strategy was applied in accordance with the protocol of the Respiratory Group of the Spanish Society of Pediatric Intensive Care [8]. Starting positive inspiratory pressure (PIP or IPAP) was set between 6 and 8cmH_2O and positive end-expiratory pressure (PEEP or EPAP) was set at 4cmH_2O. At the clinician's criteria, if inspiratory volume was inadequate or work of breathing or hypercapnia did not diminish, the IPAP was increased progressively to a maximum of 22cmH_2O and the EPAP was increased to a maximum of 8cmH_2O to improve alveolar recruitment and oxygenation. In the cases where any signs of NIV treatment failure was observed (transcutaneous hemoglobin saturation (SpO2) less than 85%, partial pressure of blood CO2 (pCO2) greater than 65mmHg or increase in the signs of respiratory difficulty [greater respiratory/heart rate or work of breathing]) in spite of maximum parameters of support, and whenever any exclusion criteria for NIV [9] appeared, endotracheal intubation was performed and conventional mechanical ventilation (CMV) was started.

To overcome the presence of leaks, both inspiratory and expiratory asynchrony were reduced using the A/C (assisted/controlled) pressure mode with a fixed inspiratory time [10].

In patients where non-pharmacological methods were insufficient to favour patient adaptation to the interface, the following sedatives were used, alone or in combination, depending on the physician's criteria: oral levomepromazine (1mg/kg/dose), and, more commonly for patients being weaned from invasive ventilation, intravenous midazolam

(0.05-0.1mg/kg/h) was maintained or switched to propofol (1-2 mg/kg/h) for short periods of time.

A nasogastric tube was placed to avoid gastric distension and vomiting during the course of NIV, and for feeding when the clinical situation permitted.

All patients were continuously monitored for heart rate (HR), respiratory rate (RR) and SpO2. Blood gases were obtained when deemed necessary by the physician.

Variables: Patients' age, gender and weight were documented for each episode, as were the Pediatric Risk of Mortality Score II (PRISM II) in the first 24 hours of admission [11], the presence of underlying conditions, the days and parameters of CMV in previously-intubated patients, and the clinical variables of NIV support: the pathology which led to respiratory failure; type of ventilator and ventilation mode; ventilation parameters (fraction of inspired oxygen (FiO_2), IPAP, EPAP); and physiological variables (HR, RR, SpO2 and SpO2/FiO_2ratio [SF]) prior to starting NIV, at 2, 8, 12 and 24 hours; blood gases (pH, pO2, pCO2 and bicarbonate) at physician's criteria; need to change ventilation mode, ventilator and/or interface; use of pharmacological sedation; appearance of complications or contraindications; mortality; NIV duration; success/failure of NIV; and duration of PICU and hospital stay.

To calculate SF, SpO2 values greater than 97% were excluded, and SF values were correlated to PaO2 (Partial pressure of oxygen in arterial blood)/FiO_2 ratio (PF) values in accordance with the results published by Khemani et al [12].

The patient population was subgrouped according to the moment NIV was started:

- First-line or initial NIV without previous CMV (i-NIV): in the initial phase of respiratory failure, after failure of CPAP trial in the cases where CPAP was indicated (apneas and type 1 respiratory failure). In the study period, CPAP was provided in most cases with the Benveniste® device with a NT. This device does not allow ongoing pressure monitoring and has an effectiveness of 54%.

- Elective post-extubation NIV (e-NIV): immediately after extubation due to previous extubation failure or not meeting the standard extubation criteria.

- Rescue NIV (r-NIV): after extubation, due to appearance of respiratory failure.

NIV was considered successful when the patient avoided endotracheal intubation. Episodes where NIV was withdrawn due to appearance of contraindications were excluded from failure analysis.

Statistical analysis: Analysis was carried out with the statistics program SPSS version 18.0 (Chicago, IL, USA). Descriptive statistics are shown through proportions with 95% confidence intervals for categorical variables; with means and medians as measures of central tendency; and standard deviation and p25-p75 interquartile range as measures of dispersion for quantitative variables. In view of the limitations arising from the small sample size of the r-NIV group and the diverse character of the e-NIV group which complicates the analysis of post-extubation NIV as a whole, we decided, *a posteriori*, to exclude r-NIV episodes from statistical hypothesis tests, which were only performed in the i-NIV and e-NIV groups. NIV outcome was correlated to the distinct variables analyzed using the chi-squared test, the Student's t-test and Mann-Whitney U test accordingly. Multivariate analysis was performed with the Cox regression model. Statistical significance was established as a p-value < 0.05.

Prior data indicate that the failure rate among controls is 0.24 [13]. If the true failure rate for experimental subjects were 0.4, we would need to study 144 experimental subjects to reject the null hypothesis that the failure rates for experimental and control subjects are equal with a probability (power) of 0.8. The Type I error probability associated with the test of this null hypothesis is 0.05. We used a continuity-corrected chi-squared statistic or Fisher's exact test to evaluate this null hypothesis.

Results

Out of 170 admissions of infants younger than 6 months who received NIV treatment with 2 levels of pressure during the study period, the NT was used in 151 (89%). The

yearly distribution of the episodes is shown in Figure 1. Twenty five per cent had been previously treated with CPAP.

The most frequent causes were bronchiolitis (98/151; 65%), cardiac surgery (14/151; 9.5%) and other respiratory infections (13/151; 8.5%) such as pertussis (3/13; 23%).

NIV was used on 66/151 (44%) occasions as i-NIV and on 85/151 (56%) occasions after extubation, 72/85 (85%) as e-NIV and 13/85 (15%) as r-NIV. The baseline characteristics of the episodes are summarized in Table 1.

The most frequently-used ventilator was Servo-i® (136/151; 90%) and the most frequently-used mode was assisted/controlled pressure (A/C pressure) (113/151; 75%).

In 58/151(38%) episodes, the mode was changed: in 43/58 (74%) to CPAP as the preceding step to withdrawal of ventilatory support. In 28 out of these 58 episodes, the ventilator was also changed, most commonly to Giulia® (13/28, 46%) and the Benveniste® device (10/28, 36%). Interface change was only necessary in 5/151 (3%) cases, one to binasal prongs and the rest, to a nasal interface applied as oronasal.

In 100 (66%) episodes, some type of sedative was used, alone (85/100; 85%) or in combination (15/100; 15%). The most commonly-used medication was oral levomepromazine (64/100; 64%), followed by propofol in a continuous drip (32/100; 32%) for short periods and midazolam (19/100; 19%).

Complications were observed in 4/151 (3%) cases, 3 in the e-NIV group and 1 in the i-NIV one. One of them, a case of bronchoaspiration, caused the failure of NIV in a 5-month-old baby girl with meningococcal sepsis who suffered clinical deterioration on the third day of e-NIV due to a nosocomial infection. The remaining episodes were interface obstruction due to secretions.

In 2/151 (1%) cases, NIV was suspended due to the need for intubation for surgery.

Two patients died, unrelated to NIV: a newborn girl admitted at 11 days of life for bronchiolitis, after 14 days on extracorporeal membrane oxygenation (ECMO); and a 3-month-old girl with decompensated, complex congenital heart disease a week after intubation following i-NIV due to progression of hepatic failure.

Analysis of NIV efficacy: The distribution of the included episodes and NIV outcomes are summarized in Figure 2.

The success rate was 109/149 (73%), with no differences based on the year, presence of underlying conditions, PRISM II score, pathology which caused the respiratory failure, type of ventilator and ventilation mode, or the use of sedatives. In the cases where NIV failed, the duration of support was shorter (12 [2.2; 28] vs. 75.5 [46.5; 113.5] hours, p 0.001) and the PICU and hospital stays were longer than in the successful cases (13 [9; 23.5] vs. 8.5 [5; 14] days, p 0.001; and 23 [16; 37] vs. 17 [12; 30.5] days, p 0.031, respectively).

The rates of failure and the duration of ventilatory support and admission are shown in Table 2. In Table 3, the variables for which statistically significant differences were observed between episodes where NIV was successful or failed in each group are detailed.

In the Cox regression analysis, decrease in HR and RR at 2 hours, and IPAP value at 12 hours were entered and the analysis was adjusted to the type of NIV used (initial, elective or rescue), showing IPAP at 12 hours (Hazard ratio 0.980 IC95% [0.961-0.999], p 0.04) and decrease in HR at 2 hours (Hazard ratio 1.298 IC95% [1.046-1.611], p 0.018) as independent predictive factors for NIV failure.

Discussion

Few studies have analyzed the effectiveness of interfaces in pediatrics [14-16] and, to our knowledge, this is the first one focused on the NT for bilevel NIV in infants. The observational design of the study and the fact it was carried out over a short period of time, in a single centre, without variation in protocol nor materials used, and without a control group, confer homogeneity to our sample but may limit the generalization of some of the results obtained.

The lack of evidence in favour of one or another interface, the availability of material and the practical experience of the PICU staff conditioned the use of the NT in the large majority of cases in this age range during the study period. With the current

protocol, the success rate, nearly 75% of the episodes included, was similar to other studies about pediatric NIV [2-4, 13, 17-19], few complications were documented and the mortality observed was not attributable to NIV *per se*.

The separate analysis of i-NIV, e-NIV and r-NIV is common in adult studies as the baseline characteristics, responses and outcomes are different in each group. In our study, the small sample size of the r-NIV group hindered comparisons with the other two groups. Nevertheless, without trying to draw conclusions, we have shown the descriptive analysis of the r-NIV group where the success rate was similar to what has been described in the literature. Similar to other studies [20], elective NIV was more effective than initial NIV, with half the number of failures. This observation is probably related to the difference in the severity of respiratory distress at the time NIV was started, with significantly lower RR, HR and FiO_2 requirements and a significantly higher SF ratio in the e-NIV group at baseline. Having had invasive ventilation first could lead to a faster recovery from the acute phase in the e-NIV group and consequently, to a higher NIV success rate.

In both i-NIV and e-NIV groups, the main cause of failure was considered to be the progression of the illness which had caused the admission. Sedatives were required more frequently than previous reports which predominantly used CPAP [21] (Mayordomo et al described a sedation rate of about 45%). But, as previously demonstrated by Essouri [22], leaks are not as influential on asynchrony in patients receiving CPAP as they are in patients receiving bilevel pressure. However, although intolerance to the interface and/or adaptation problems to NIV were documented, asynchrony was not quantified and this could have influenced some of the failures. Unfortunately, the comfort level of our patients was not monitored, not unlike previous reports. The need for pharmacological sedation in up to 2/3 of episodes may reflect the inherent difficulty in the adaptation and synchronization of this age group to bilevel support, but it can also be pointed out that 56% of our patients had been previously intubated, so the sedatives were still being withdrawn. Regarding the use of propofol in

almost 1/3 of the episodes where sedatives were administered, we did not observe any associated adverse events. However, even though it can be used for short periods in pediatric patients, we are not promoting it as a first-line drug in all cases and other alternatives may be considered.

In the i-NIV group, a maintained hypoxemia with a greater FiO_2 requirement, a lower SF at 12 and 24 hours, and a greater increase of HR at 12 hours were associated with a higher failure rate.

In the e-NIV group, failure was higher in girls, a fact for which we have no hypothesis, in patients who received more sedation, possibly due to greater adaptation problems after sedation was decreased during the weaning process of CMV, and in the cases with a greater increase of RR at 2 hours.

Multivariate analysis, as in other studies, indicated that a smaller decrease in HR is the most important predictive factor for failure [3, 4]. A mean airway pressure (MAP) value higher than 11 cmH_2O [17] was also identified in a study using conventional ventilators. As this value is not measurable in NIV-specific ventilators, we found that a higher IPAP value at 12 hours was a predictive factor for failure in our sample.

As a whole, the success of NIV in the episodes included in the study, with less than 5 days of maximum support, meant a shorter PICU admission. The decrease in hospital stay and the rates of intubation/re-intubation and CMV could influence the associated morbidity and mortality, making it crucial to develop properly-designed studies to determine the predictive factors for success and failure which would contribute to a better selection of patients who would benefit from starting and maintaining NIV.

Although the ideal interface does not exist, selecting an inappropriate one could contribute to NIV failure. Therefore, besides developing and commercializing appropriate interfaces for diverse ages and situations, it is essential to know the advantages and disadvantages of the ones currently available. The NT is a cheap and easily available interface which could be obstructed by secretions. It also has a predictable presence of leaks as a limiting factor for synchronization, especially if a

pressure support mode is selected. In spite of all this, we believe that due to the continuous care and respiratory hygiene measures, tube change was required on very few occasions, complications were rare and pressure sores from interfaces frequently described in the literature [3, 4, 13, 18, 23, 24] were not observed.

We would like to stress that clinicians should be cautious about using the NT interface with ventilators other than Servo-i or BiPAP Vision. Their superiority to compensate leaks has been shown in a bench study [25], so it must be pointed out that different ventilators may offer different results.

Conclusions

In infants failing with CPAP or receiving bilevel pressure as a first step according to the Respiratory Group of the Spanish Society of Pediatric Intensive Care protocol [8], the NT is an alternative interface capable of providing effective NIV with two levels of pressure and with few complications in 73% of infants aged 6 months or less. Using the same ventilators and an appropriate protocol of care, we believe it could be applicable to other healthcare centers.

The effectiveness of NIV varies according to the moment it is started, being higher in the e-NIV group.

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Figure legends

Figure 1. Yearly distribution of the NIV episodes where nasopharyngeal tube was used.

Figure 2. Distribution of the episodes according to the moment NIV was started and their outcomes (success/failure). Episodes excluded from analysis due to sample size (r-NIV excluded from statistical hypothesis tests) and appearance of contraindications are indicated.

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Table 1.Baseline characteristics of the episodes according to the moment NIV was started.

		i-NIV (n=66)	**e-NIV** (n=72)	**P***	**r-NIV** (n= 13)
Age (months)		1.6 [0.8; 2.9]	1.4 [0.8 ;3.1]		2.4 [1.2; 4.3]
Sex, n (%)	Female	27 (41)	25 (35)		4 (31)
	Male	39 (59)	47 (65)		9 (69)
Weight (Kg)		4.4 [3.4; 5.3]	4.9 [3.3; 5.7]		3.4 [3.2; 4.6]
PRISM II		4 [0; 8.7]	9 [4; 9.5]	0.032[c]	9 [7; 9]
Underlying condition, n (%)		22 (33)	31 (43)		9 (69)
Prematurity		9 (41)	11 (35)		2 (22)
Cardiopathy		5 (23)	10 (32)		6 (67)
Down´s syndrome		1 (4)	3 (10)		-
Neuromuscular		2 (9)	3 (10)		-
Oncological		-	1 (3)		-
Others		5 (23)	3 (10)		1 (11)
Admitting pathology, n (%)					
Bronchiolitis		51 (77)	44 (61)	0.018[a]	5 (38)
Cardiac post-op		-	9 (13)	0.001[a]	4 (31)
Respiratory infections		6 (9)	7 (10)		-
Sepsis		-	1 (1)		-
Acute pulmonary edema		3 (5)	1 (1)		2 (15)
Bronchospasm/Wheezing		2 (3)	2 (3)		1 (8)
Apnea		3 (5)	3 (5)		-
Atelectasis		1 (1)	2 (3)		1 (8)
Bronchoaspiration		-	1 (1)		-
Myopathy with insufficientrespiratory effort		-	1 (1)		-
Post-extubation croup		-	1 (1)		-
Vital signs:					
RR (breaths/min)		42 [33; 51]	32 [28; 36]	0.001[c]	30 [25; 36]
HR (beats/min)		167±23	142±24	0.001[b]	147±26
SpO2 (%)		98 [94; 100]	96 [94; 98]		99 [97; 100]
Support prior to NIV:					
Intubation (days)		-	7 [4; 10]		2 [1; 5.5]
FiO_2 (%)		50 [30; 61]	30 [27; 35]	0.001[c]	35 [30; 50]
PIP (cmH_2O)		-	16 [14; 22]		17 [12; 21]
PEEP (cmH_2O)		-	5 [5; 6]		5 [4.5; 6.5]
SF		234 [147; 330] (n=20)	310 [269; 323] (n=47)	0.020[c]	277 [194; 277] (n=3)
Blood gases:					
paO_2 (mmHg)		89 [64; 143] (n=10)	67 [59; 108] (n= 5)		116 [114; 116] (n=3)
pH		7.38 [7.26; 7.42](n=17)	7.40 [7.37; 7.42] (n= 17)		7.32 [7.19;7.41](n=4)
pCO_2 (mmHg)		42 [37; 66] (n=18)	45 [38; 51] (n=16)		50 [36; 68] (n=4)
Bicarbonate (mmol/L)		25 [24; 26] (n= 15)	26 [23; 29] (n=16)		23 [20; 24] (n=4)

PRISM: Pediatric Risk of Mortality Score. RR: respiratory rate. HR: heart rate. SpO2: transcutaneous hemoglobin saturation. FiO_2: fraction of inspired O2. PIP: positive inspiratory pressure. PEEP: positive end expiratory pressure. paO2: partial pressure of arterial oxygen. pCO2: partial pressure of carbon dioxide.
*variables for which statistically significant differences between i-NIV and e-NIV were obtained are indicated. Chi-squared test[a] was used for the analysis of categorical variables and Student's t-test[b] and Mann-Whitney U test[c] for the analysis of cuantitative variables.

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Table 2. NIV failure rate, duration of NIV and admissions according to the moment NIV was started.

	i-NIV (n=65)	**e-NIV** (n=72)	**P***	**r-NIV** (n= 12)
Failure, n (%)	24 (37)	13 (18)	0.013[a]	3 (25)
NIV duration (hours)	61 [12; 93]	58 [33; 96]		34 [16; 76]
Success	82 [63; 116]	68 [39; 102]		23 [14; 86]
Failure	8 [2; 17]	28 [10; 60]	0.007[a]	38 [30; 38]
Stay (days)				
PICU:	7 [4; 10]	14 [9; 22.7]	0.001[a]	10 [4.7; 12.7]
Success	5 [4; 8]	11 [8; 19]		10 [3.5; 12]
Failure	10 [8.2; 13.7]	29 [18.5; 68]	0.001[a]	12 [7; 12]
Hospital:	16 [10.5; 24]	24 [15; 37]	0.001[a]	15 [12.2; 22.2]
Success	13 [9; 24.5]	18 [14; 35]		15 [10; 19.5]
Failure	17 [14.2; 23.7]	37 [27; 101]	0.001[a]	20 [12; 20]

*variables for which statistically significant differences between i-NIV and e-NIV were obtained are indicated. Chi-squared test was used for the analysis of categorical variables and Mann-Whitney U test[a] for the analysis of cuantitative variables.

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Table 3. Differences between successful and failed episodes of i-NIV and e-NIV.

		Success	Failure	P
i-NIV*	PRISM II	4 [0; 5.2]	9 [2; 10]	0.047[b]
	FiO_2 at 2h (%)	35 [10; 50] (n=40)	46 [40; 51] (n=17)	0.040[b]
	FiO_2 at 12h (%)	39 [30; 42] (n=39)	42 [37; 59] (n=9)	0.036[b]
	FiO_2 at 24h (%)	35 [30; 43] (n=39)	47 [45; 47] (n=3)	0.017[b]
	IPAP at 12h (cmH2O)	14 [11; 15] (n=39)	16 [13; 18] (n=9)	0.042[b]
	SpO2 at 24h (%)	98 [96; 99] (n=39)	94 [84; 94] (n=3)	0.029[b]
	Variation in HR at12h (beats/min)	-1 [-15; 9] (n=39)	13 [2; 20] (n=9)	0.029[b]
	SF at 12h	273 [230; 318] (n=22)	176 [142; 256] (n=6)	0.031[b]
	SF at 24h	242 [223; 317] (n=15)	206 [168; 238] (n=3)	0.008[b]
	pH at 0h	7.42 [7.41; 7.42] (n=3)	7.31 [7.26; 7.36] (n=6)	0.020[b]
	pCO_2 at 0h (mmHg)	38 [33; 43] (n=4)	58 [44; 59] (n=6)	0.019[b]
	NIV duration (h)	82 [63; 116]	8 [2; 17]	0.001[b]
	PICU stay (days)	5 [4; 8]	10 [8 ; 13.7]	0.001[b]
e-NIV†	Sex, n (%)			
	Female	17 (29)	8 (62)	0.025[a]
	Male	42 (71)	5 (38)	
	Sedation, n (%)	43 (73)	13 (100)	0.039[a]
	IPAP at 12h (cmH2O)	13 [12; 15] (n=54)	16 [14; 18] (n=9)	0.037[b]
	RR at 0h (breaths/min)	32 [26; 37]	38 [33; 43]	0.005[b]
	RR at 2h (breaths/min)	32 [26; 43] (n=59)	40 [34; 52] (n=12)	0.029[b]
	Variation in RR at 0h	-0.5 [-5; 5]	5 [-1; 14]	0.039[b]
	NIV duration (h)	68 [39; 102]	28 [10; 60]	0.005[b]
	PICU stay (days)	11 [8; 19]	29 [18; 68]	0.001[b]
	Hospital stay (days)	18 [14; 35]	37 [27; 101]	0.001[b]

*i-NIV: 41 successful and 24 failure episodes. †e-NIV: 59 successful and 13 failure episodes. h: hours. Chi-squared test[a] was used for the analysis of categorical variables and Mann-Whitney U test[b] for the analysis of cuantitative variables.

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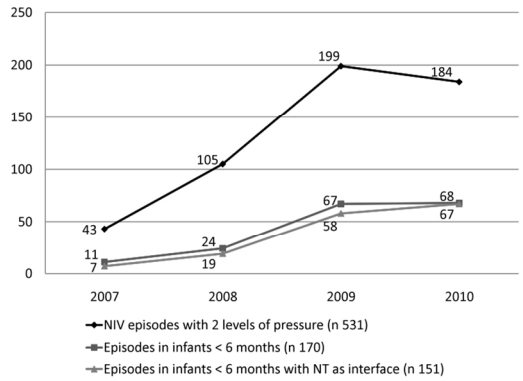

Figure 1.

Distribution of the NIV episodes where nasopharyngeal tube was used by year.
210x297mm (150 x 150 DPI)

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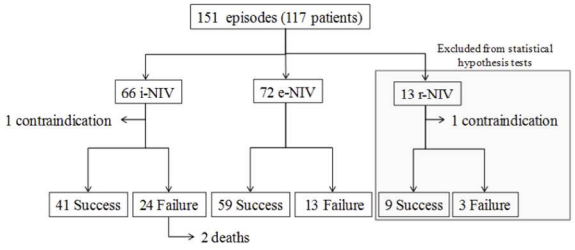
Figure 2.



Distribution of the episodes according to the moment NIV was started and their outcomes (success/failure). Episodes excluded from analysis due to sample size (r-NIV excluded from statistical hypothesis test) and appearance of contraindications are indicated.
210x297mm (150 x 150 DPI)