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Practices of use of nasal intermittent positive pressure ventilation (NIPPV) in neonatology in northeastern Brazil

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Abstract

Objective: To investigate the use of nasal intermittent positive pressure ventilation (NIPPV) in level three neonatal intensive care units (NICU) in northeastern Brazil.

Methods: This observational cross-sectional survey was conducted from March 2009 to January 2010 in all level three NICUs in northeastern Brazil that are registered in the Brazilian Registry of Health Establishments (Cadastro Nacional de Estabelecimentos de Saúde, CNES) of the Ministry of Health. Questionnaires about the use of NIPPV were sent to the NICU directors in each institution. Statistical analysis was conducted using the software Epi-Info 6.04 and double data entry. A chi-square test was used to compare variables, and the level of statistical significance was set at $p \leq 0.05$.

Results: This study identified 93 level three NICUs in northeastern Brazil registered in CNES, and 87% answered the study questionnaire. Most classified themselves as private institutions (30.7%); 98.7% used NIPPV; 92.8 % adapted mechanical ventilators for NIPPV and used short binasal prongs as the interface (94.2%). Only 17.3% of the units had a protocol for the use of NIPPV. Mean positive inspiratory pressure and positive end-expiratory pressure were 20.0 cmH_2O (standard deviation [SD]: 4.47) and 5.0 cmH_2O (SD: 0.84).

Conclusion: NICUs in northeastern Brazil use nasal intermittent positive pressure ventilation, but indications and ventilation settings are not the same in the different institutions.

J Pediatr (Rio J). 2012;88(1):48-53: Ventilation, neonatology, intensive care units, infant.

Introduction

The use of mechanical ventilation (MV) ensures higher survival rates among patients with respiratory failure due to several diseases, particularly in newborns that, due to their lung immaturity, are more susceptible to respiratory distress and failure. Despite its importance, it may lead to complications, and its use is one of the main causes of lung lesions, particularly bronchopulmonary dysplasia, in premature infants.[1-3] Although the importance of reducing time receiving invasive MV is well recognized, this procedure is complex and affected by several factors, such as the different stages of lung development, underlying disease, secondary complications, cardiorespiratory interactions and associations between central respiratory control and respiratory muscles.[4]

Noninvasive respiratory support is an important alternative to reduce MV duration and to progress from

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MV to spontaneous breathing. Current scientific and clinical interest in a noninvasive type of support, the nasal intermittent positive pressure ventilation (NIPPV), has increased.[5-7] This type of ventilation is defined as the provision of positive pressure without using an intratracheal tube or tracheotomy. It ensures intermittent and noninvasive inspiratory support at a positive inspiratory pressure greater than expiratory pressure.[8]

Although NIPPV has been widely used, reports recommend further studies to investigate the real function of this ventilation mode and to accurately define the conditions and methods to achieve optimal results when using it. Several aspects of the use of NIPPV in neonates remain unclear. Its actual benefits, indications, mode of use and complications have not been defined in the literature,[7,9,10] and no uniform technique for its use has been established. In addition, it is known that socioeconomic development is directly associated with healthcare promotion and instruments in any geographic region. Therefore, great differences in NIPPV methods may be expected between the practices adopted and discussed worldwide and those put into practice in Brazil, as well as between the uses of this ventilation mode in different Brazilian regions.

This study conducted a survey of the different uses of NIPPV in third level neonatal intensive care units (NICUs) in northeastern Brazil.

Methods

Study design

This observational cross-sectional survey included all third level NICUs in northeastern Brazil that were registered in the Brazilian Registry of Health Establishments (Cadastro Nacional de Estabelecimentos de Saúde, CNES) of the Ministry of Health. A third level NICU was defined as a place where there are high complexity services and qualified human resources in different areas.[11] NICUs were excluded from the study if their directors or representatives refused to answer the questionnaire or sign the informed consent term, if access was denied, and if the units were closed or had no beds available for neonatal care.

Data were collected from March 2009 to January 2010 using questionnaires that were mailed to the directors of the third level NICUs. The material mailed was divided into three parts: (1) guidelines to fill out the questionnaire and mail it back; (2) a list of terms for their uniform use in the study, in which the following terms were described: NIPPV, continuous positive airway pressure, hood, short binasal prong, nasopharyngeal prong, short single prong, face mask, nasal mask; and (3) questionnaire with 20 multiple choice questions about the use of NIPPV. Each question was followed by a blank space for comments.

First, the CNES was reviewed to find out the number, distribution by county and contact person in each NICU in northeastern Brazil. In the first phase of data collection, the questionnaires were mailed to the directors or technical directors of the NICU of the institutions registered in the CNES. The answers were returned by mail in 30 days. After that, in the second phase of the study, phone calls were made to the NICU directors or representatives that did not send back the questionnaire in the first phase. They were told that another envelope would be sent to them and were asked to return the questionnaire in it. The second envelope was expected to be returned in another 30 days after the date when it was posted. In the first phase of data collection, one of the authors visited the institutions that did not return the questionnaire. During the visits, the questionnaire was handed to the participants, but no additional information about how to respond to it was provided. When the ICU director could not be reached, another neonatologist in the same institution answered the questionnaire.

The variables under analysis were: number of NICUs in northeastern Brazil; number of institutions by state; type of institution; number of ICU beds. The variables analyzed to investigate knowledge of the use of NIPPV were: when NIPPV started being used in the institution; pressure source; interface used; nasal septum protection; use of nasogastric tube; newborn positioning during NIPPV; use of synchronized ventilation; frequency of synchronized ventilation use; NIPPV indications; NIPPV protocol; mean parameters of use; associated complications; weaning modes; use of support after NIPPV.

Data analysis and ethical aspects

The Epi-Info 6.04 and double data entry were used for tabulation and statistical analysis. Data were analyzed using descriptive statistics: means, standard deviations and percentiles. A chi-square test was used for comparisons between variables, and the level of significance was set at ≤ 0.05. This study was approved by the Ethics in Research Committees of Universidade Federal de São Paulo (UNIFESP) and Universidade Estadual de Ciências da Saúde de Alagoas (UNCISAL).

Results

The total number of NICUs in northeastern Brazil that are registered in the CNES was 93 at the time of this study. The number of collected questionnaires was 81 (87% of the total). Only 78 institutions met inclusion criteria. Of these, 22/78 (28.2%) answered the questionnaire the first time it was mailed, 19/78 (24;3%), after the phone call and envelope mailed again, and 37/38 (47.5%), only during the visit of one of the authors to the institution. The

questionnaires were answered by the ICU director in 47/78 (60.2%) of the institution and by a neonatologist on duty in 31/78 (39.8%). The institutions were classified as private in 24/78 (30.7%) of the cases; as public, state-run institutions in 23/78 (29.4%); as public, city-run in 12/78 (15.3%); as federal units in 7/78 (8.9%); as non-profit organizations in 8/78 (10.2%); and as mixed units in only 3/78 (3.8%), in which case two or more classifications applied. One of the institutions did not define its nature.

NIPPV was used in 69/78 (88.4%) of the NICUs in northeastern Brazil. The lowest rates of NIPPV use were found in the states of Ceará (50%) and Maranhão (66.7%). The states of Bahia, Sergipe, Alagoas, Paraíba and Rio Grande do Norte had a 100% rate of NIPPV use. There were no statistically significant differences in NIPPV use between the states in northeastern Brazil. Only 2.9% of the units that used NIPPV reported having used it for over five years, whereas 40.6% had started using it 1 to 2 years before. A protocol for its use was followed in 12 (17.4%) institutions, but their protocols were not described.

The ICU distribution according to pressure source, use of synchronized ventilation and type of interface to provide NIPPV is shown in Table 1.

During the application of NIPPV with nasal prongs, 61/69 (88.4%) of the units reported using nasal septum protection. Sixteen (26.2%) used hydrocolloid dressings, 9/61 (14.7%), adhesive tape, 5/61 (8.2%), special adhesive tape, such as Micropore™ tape, and 31/61 (50.8%) did not inform the type of material used. The shape of the septum protector was informed only by 5/61 (8.2%) institutions, which described it as a "pig snout."

The main indications of NIPPV reported by the institutions were after programmed weaning (79.7%), to avoid apneia in preterm infants (78.3%) and to avoid tracheal intubation when there were signs of respiratory failure (69.6%). The least frequent indication was its use for preterm infants after the administration of exogenous surfactant (24.6%).

The distribution of units according to the use of orogastric tube and ideal infant positioning during NIPPV is shown in Table 2.

Table 1 - Distribution of 69 NICUs according to pressure source, use of synchronized ventilation and type of interface in nasal intermittent positive pressure ventilation

Variables	n	%
Pressure source		
Ventilator used for noninvasive ventilation*	3	4.3
Adapted ventilator	64	92.8
Inter 3	50	72.4
Inter 5	34	49.2
Sechrist IV 100B	9	13
Takaoka Smart	3	4.3
Dixtal 3010	1	1.4
Type of mechanical ventilator not informed	9	13
No data	2	2.9
Synchronized ventilation (type)		
No synchronized ventilation	30	43.5
Synchronized ventilation using abdominal sensor	1	1.4
Synchronized ventilation using MV trigger sensitivity	30	43.4
Synchronized ventilation not informed	8	11.5
Interface†		
Short binasal prong	65	94.2
Nasopharyngeal prong‡	8	11.5
Nasal face	5	7.3
Facial mask	5	7.3
Short single prong	-	-

MV = mechanical ventilator; NICU = neonatal intensive care unit.
* Type of mechanical ventilator not informed.
† This variable accepted more than one option.
‡ Adapted prong.

Table 2 - Distribution of NICUs according to use of orogastric tube and ideal infant positioning in nasal intermittent positive pressure ventilation

Variables	n	%
Orogastric tube		
Use of tube not associated with NIPPV	37	53.6
Always uses open system	16	23.2
Always uses closed system	9	13.0
Never uses it	7	10.1
Positioning*		
No preferential position	39	56.5
Supine with head elevated at 30 degrees	15	21.7
Supine	12	17.4
Prone with cushion for elevation	11	15.9
Supine with head elevated at 60 degrees	2	2.8
Another position	20	28.9

NICU = neonatal intensive care unit; NIPPV = nasal intermittent positive pressure ventilation.
* This variable accepted more than one option.

Table 3 shows mean maximum positive end-expiratory pressure, peak inspiratory pressure (PIP), inspiratory flow, respiratory rate and inspiratory time during NIPPV as reported by the institutions.

Complications during the use of NIPPV in neonates in the institutions in northeastern Brazil are shown in Table 4.

The parameters most frequently used for NIPPV weaning were respiratory rate per cycle and fraction of inspired O_2. The values of respiratory rate per cycle reported as adequate for weaning by most units ranged from 10 to 12 per minute, and the fraction of inspired O_2 described by most institutions was 21%.

Table 3 - Maximum peak inspiratory pressure, positive end-expiratory pressure, inspiratory flow, inspiratory time and respiratory rate during nasal intermittent positive pressure ventilation in the 69 institutions included in the study

	Mean	SD
PIP (cmH_2O)	20.0	4.47
PEEP (cmH_2O)	5.0	0.84
RR (ipm)	20.0	8.27
Tinsp (s)	0.45	0.06
Flow (l/min)	10.8	3.21

PEEP = positive end-expiratory pressure; PIP = positive inspiratory pressure; RR = respiratory rate cycle; SD = standard deviation; Tinsp = inspiratory time.

After NIPPV weaning, 60 (87.0%) of the institutions used continuous positive airway pressure, 25 (36.2%) used oxyhoods, and 7 (10.1%) had patients breathe room air. Of all the institutions under study, 26 (37.6%) reported using the 3 types of support and defining the choice according to the clinical conditions of the newborn.

Table 4 - Distribution of NICUs according to complications associated with use of nasal intermittent positive pressure ventilation in neonates

Complications*	n	%
Nasal septum lesion	59	85.5
Abdominal distension	41	59.4
Epistaxis	29	42.0
Increased gastric residues	21	30.4
Gastrointestinal perforation	2	2.9
Pneumothorax	1	1.4

NICU = neonatal intensive care unit.
* This variable accepted more than one option.

Discussion

Currently, there are no published studies that show how third level NICUs in Brazil act in relation to the use of NIPPV. This is the first study to investigate that use, and our focus was on the northeastern region of Brazil because its distance from larger centers and the precariousness of resources assigned to health care may contribute to specific conditions during the care provided to neonates.[12]

This study about NIPPV in northeastern Brazil showed that 88.4% of the units use this ventilation mode. This percentage is higher than those found in similar studies, such as the one conducted by Ryan et al.,[13] who found that, of 17 units studied in Canada, only 9 (53%) used NIPPV, and by Owen et al.,[9] who found that only 48% of the British neonatal units used NIPPV. However, no inference should be made for current users because of the growing number of publications about this topic and their reflections on the increase of the use of this ventilation mode by several national and international institutions.

Our study found differences in the resources available for the use of NIPPV in the NICUs in northeastern Brazil. Only 4.3% had ventilators that are specific for NIPPV. A study conducted in England showed that only 11% of the neonatal care units used NIPPV with ventilators not specifically designed for that purpose. A prospective observational study

about the use of NIPPV in infants and children aged 15 days to 17 years in Spanish institutions found that nonspecific noninvasive mechanical ventilators were used in only 2% of the cases.[8,14] Studies in the literature do not clarify whether this finding may affect the final results of NIPPV, but suggest that non-adapted ventilators demand higher pressures because air leaks cannot be compensated.[15]

In addition, a high number (56.3%) of the institutions included in this study reported that they used synchronized ventilation in NIPPV. Despite that, only one of the units reported using abdominal sensors to detect the inspiratory effort made by neonates; the others used the sensitivity trigger available in conventional ventilators to achieve synchronization. This synchronization mechanism has been classified as inacceptable for newborns, particularly when using NIPPV, because of the difficulty in detecting the respiratory effort in consequence of the substantial leaks at the interface.[16-18] Therefore, most of the institutions in northeastern Brazil seem to face difficulties in the provision of NIPPV that is truly synchronized with the inspiratory effort of newborns, and the results of studies about the efficacy of NIPPV cannot be safely applied because most studies were conducted using synchronized ventilation.[8,19,20]

Almost all NICUs in northeastern Brazil included in this study (94.2%) used short binasal prongs to provide NIPPV, which is in agreement with data in current literature.[7,19,21,22] A systematic review of the literature in this area showed that short binasal prongs, although not free of complications, were easier to use, comparatively less invasive, had lower resistance and were clinically more appropriate.[23] A relatively high number of NICUs in northeastern Brazil (11.5%) also reported using nasopharyngeal prongs. Six of these units (8.7%) described this interface as an adaptation of an aspiration tube inserted from the nostril to the pharynx of the newborn. This type of adaptation was necessary because of the lack of appropriate interfaces available in the NICU. There are no details in the literature about this practice, and future studies about its use should be conducted to define the rate of complications or of success and failure during NIPPV.

Only two NICUs in northeastern Brazil described no complications associated with the use of NIPPV, and 50% reported more than 1 complication. These data contradict those reported in similar studies, which found few complications of NIPPV use.[9,14] The most important complication described by the NICUs in northeastern Brazil were nasal septum lesions, followed by abdominal distension. The institutions included in this study have sought alternatives to prevent nasal septum lesions: 88.4% use hydrocolloid dressings, adhesive tape or Micropore™ tapes to protect the nostrils. The use of non-synchronized NIPPV is associated with the provision of flow into the stomach when the glottis is closed, which increases the amount of air that flows into the abdomen.[18,24] This may explain the high rate of abdominal distension found in this study. One of the units included in this study associated the use of NIPPV with the occurrence of pneumothorax, and two, with gastrointestinal perforation, also reported in similar studies.[18,25]

Currently, the best scientific evidence in favor of the use of NIPPV is the support to reduce intubation rates and avoid apneia.[24,26,27] The NIPPV indications most often mentioned by NICUs in northeastern Brazil were use after extubation (79.7%) and during apneic episodes (78.3%). Less frequent indications suggested its use as a primary support mode to treat respiratory distress syndrome (24.6%). Owen et al. found that only 59% of the English units used NIPPV to avoid extubation failure, whereas 80% indicated this type of ventilation to avoid apneic episodes after the failure in using continuous positive airway pressure, and 16%, as the first ventilation mode.[9]

Despite the high incidence of accidental extubation in neonates,[5,28] no study has been found in the literature about the use of NIPPV in this situation. Our study found that a high percentage of NICUs in northeastern Brazil (53.1%) consider NIPPV a safe procedure after accidental extubation. Further studies should investigate its chances of success in this case.

In the literature, there is no consensus about what are the optimal parameters to keep newborns well adapted or to wean them gradually from NIPPV. Studies about the benefits of NIPPV use many different parameters, which makes it difficult to reproduce their positive results in clinical practice. This study about the use of NIPPV in northeastern Brazil reflected this condition. Although some institution in northeastern Brazil (43.5%) reported using pressures ranging from 16 to 20 mmH_2O, a relatively high number of units use extreme PIP pressures, ranging from 5 to 10 H_2O or from 26 to 30 H_2O. Another reason for the great variation associated with PIP descriptions in this study may be the lack of specification of the questionnaires about the pathology that affected the patient during NIPPV.

About 50% of the NICUs included in this study classified the reduction of respiratory rate and the fraction of inspired oxygen for the gradual weaning from NIPPV as important parameters. Owen et al.[9] found that the English NICUs used PIP reduction and positive end-expiratory pressure as primary weaning parameters.

Data in this study cannot be used as guidelines for NIPPV, but our findings describe what NICUs in northeastern Brazil do when using this noninvasive ventilation mode for newborns. Based on these data, studies with other levels of evidence may be conducted to investigate how aspects of the use of NIPPV in northeastern Brazil affect the end results of this type of ventilation.

The lack of uniformity in the use of NIPPV, confirmed by the rare use of protocols in the institutions included in this

study, as well as the differences between the application methods in northeastern Brazil and other parts of the world, reinforce the need to conduct further investigations to clarify these issues. Further studies should be conducted for that purpose, as well as to find out how the institutions use NIPPV for newborns at specific ages, weights and pathologies, in the search for a safer NIPPV protocol adapted to the conditions and resources available in each place where it is used.

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