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Nasal CPAP in the delivery room for newborns with extremely low birth weight in a hospital in a developing country

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Abstract

The objective of this study was to determine the feasibility of the use of continuous positive airway pressure installed prophylactically in the delivery room (DR-CPAP), for infants with a birth weight between 500 and 1000 g in settings with limited resources. During 23 months, infants with a birth weight between 500 and 1000 g consecutively received DR-CPAP. A total of 33 infants with low birth weight were enrolled, 16 (48.5%) were females. Only 14 (42.4%) received antenatal corticosteroids and only 2 of those 14 (14.3%) infants weighing 500-750 g were not intubated in the delivery room, and apnea was given as the reason for intubation of these patients. Of the 19 infants in the 751-1000 g weight range, 9 (47.4%) were intubated in the delivery room, 6 due to apnea and 3 due to respiratory discomfort. For DR-CPAP to be successful, it is probably necessary for preterm babies to be more prepared at birth to withstand the respiratory effort without the need for intubation. Antenatal corticosteroids and better prenatal monitoring are fundamental for success of DR-CPAP.

Key words: Continuous positive airway pressure ventilation; Preterm infants; Delivery room; Nasal continuous positive airway pressure; Prematurity

Introduction

Extremely low birth weight infants frequently require invasive ventilator support at birth. However, mechanical ventilation has a considerable potential to provoke lung injury, in addition to involving high costs (1,2).

Continuous positive airway pressure (CPAP) installed prophylactically in the delivery room (DR-CPAP) has been proposed as a simple low-cost alternative with few side effects (3). However, questions have been raised about the efficacy of the method, especially for extremely low birth weight infants (3,4).

Recent studies have emphasized the importance of using CPAP in preterm infants in the delivery room, but the question remains whether it would be possible to obtain the same results in other settings. In situations with few resources, with low use of antenatal corticosteroids, which have many benefits for the proposed method, there are still doubts about the viability of CPAP in the delivery room (5-7).

This study evaluated the feasibility of the use of DR-CPAP in infants with a birth weight of $<$1000 g in settings with few resources.

Subjects and Methods

This observational study was performed during a 23-month period at the Hospital das Clínicas of Ribeirão Preto (Brazil), a tertiary-care university hospital. Informed consent was obtained from parents before birth of the infants, and the study was approved by the hospital's institutional review board (#3866/2005).

All infants with birth weight between 500 and 1000 g and without major congenital malformations were eligible. Preterm infants were excluded if they had an antenatal diagnosis of other major diseases such as congenital heart disease or lung diseases such as diaphragmatic hernia or pulmonary hypoplasia. All patients were treated by hospital staff according to the guidelines of the American Heart Association and American Academy of Pediatrics (8).

When an infant was eligible, an attempt was made to install bubble CPAP (5 cmH_2O, Hudson® prongs, 40% oxygen) within less than 15 min after delivery. When the procedure was successful, the proposal was to maintain

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CPAP for at least 72 h. After CPAP installation and stabilization, the newborns were transferred to the local neonatal intensive care unit. When it was not possible to install the DR-CPAP, the attendant doctor was asked for the reasons. Failure occurred when it was not possible to install nasal CPAP in the delivery room or when there was need for intubation before 72 h of life.

Infants receiving CPAP were intubated if they had any of the following symptoms: apnea unresponsive to methylxanthine treatment, severe respiratory distress, arterial blood pH≤7.25 with a partial pressure of arterial carbon dioxide ($PaCO_2$)≥60 mmHg (8.0 kPa), and a requirement of more than 40% oxygen. The criterion for withdrawal of CPAP before 72 h of life was arterial pH>7.4, with $PaCO_2$<40 mmHg (5.3 kPa). Surfactant treatment was indicated when >40% oxygen was required to maintain oxygen saturation between 88 and 92%. Ventilation settings followed local protocols.

The maternal variables analyzed included premature amniorrhexis (>18 h), pregnancy-related arterial hypertension, and prenatal use of steroids (any dose). The neonatal variables studied were birth weight, gestational age, gender, adequate weight for gestational age (9), score for neonatal acute physiology and perinatal extension (SNAPPE) (10), 1st- and 5th-min Apgar score, necessity of surfactant use, and necessity of ventilation during the first 5 days after birth.

Results

A total of 33 infants with birth weights <1000 g were enrolled between January 2006 and November 2007, 16 (48.5%) of the neonates were females. Maternal prenatal data and the characteristics of infants included in the study are shown in Table 1. A high percentage of mothers presented hypertension and prolonged rupture of membranes; a small percentage had received antenatal corticosteroids. Data regarding the need for intubation in the delivery room, use of surfactant, and ventilator support during the first 5 days of life are presented in Table 2.

Only two patients weighing 500-750 g were not intubated in the delivery room, and these infants were not given mechanical ventilation during the first 5 days of life. All the infants in this group who were intubated in the delivery room were kept on mechanical ventilation.

All infants weighing 751-1000 g who were intubated in the delivery room were maintained under ventilation. Of the 10 who received DR-CPAP, 8 required intubation and ventilator support during the first 5 days of life.

When the attendant physician was asked to supply the indication for intubation and DR-CPAP, apnea was given as a reason for the 12 infants born weighing <750 g. Apnea was the reason given for the 9 of 15 intubated infants with a birth weight between 750 and 1000 g; for the 6 others, respiratory discomfort was the justification.

Table 1. Maternal prenatal data and characteristics of the 33 infants enrolled for continuous positive airway pressure installed prophylactically in the delivery room.

Data	n (%)
Maternal prenatal data	
Hypertension	12 (36.3%)
Antenatal steroids	14 (42.4%)
Rupture of membranes >18 h	6 (18.2%)
Infant characteristics	
Birth weight (g)	783.4 ± 129.6
Gestational age (weeks)	27.4 ± 2.5
Female	16 (48.5%)
Small for gestational age	5 (15.1%)
SNAPPE II	18.6 ± 1 9.2
1st-min Apgar >5	11 (33.3%)
5th-min Apgar >5	28 (84.8%)

SNAPPE II: score for neonatal acute physiology.

Discussion

In 2010, 2,861,868 babies were born in Brazil. A total of 21,315 of them died during the first week of life, and 39,853 died within the first year. During this period, 13,129 babies (0.46%) were born weighing between 500 and 999 g. These infants accounted for 46.9% (6159) of the deaths that occurred during the first week of life and 66.7% (8768) of infant deaths in the first year (11). These data clearly demonstrate the enormous importance of pre-, peri-, and immediate postnatal care for reducing infant mortality. Within this context, a low-technology practice such as the application of DR-CPAP could be of great value.

Our initial hypothesis was that DR-CPAP would avoid the need for more invasive and expensive therapies such as mechanical ventilation and the use of a surfactant, with consequent great benefits for preterm infants and for the health system itself. Unfortunately, at our institution, the

Table 2. Intubation in the delivery room, surfactant use and mechanical ventilation during the first 5 days of life.

Data	n (%)
500-750 g	14
Intubation in the delivery room	12 (85.7%)
Surfactant use	8 (57.1%)
Ventilation use	12 (85.7%)
751-1000 g	19
Intubation in the delivery room	9 (47.4%)
Surfactant use	11 (57.9%)
Ventilation use	17 (89.5%)

DR-CPAP: delivery room continuous positive airway pressure.

administration of DR-CPAP to these extreme preterm babies was not feasible due to the large number of infants who were intubated in the delivery room. Of the preterm babies weighing 500-750 g at birth, 85.7% were intubated while still in the delivery room, as opposed to 47.3% of those weighing 750 to 1000 g. In other words, the use of CPAP in the delivery room was not possible in 63.6% of the infants weighing <1000 g. These values are similar to those reported by Finer et al. (12) using the Neonatal Research Network registry data of 2002, when 71% of infants who were born at less than 28 weeks gestation required intubation. However, our data greatly exceeded those reported in studies in which the early application of CPAP was analyzed.

To illustrate, Narendran et al. (13), describing infants with birth weight of 400-1000 g, found that intubation in the delivery room was required in 31.6% of cases. In a prospective study, Finer et al. (12) reported the need for intubation in 49% of babies born at less than 28 weeks gestation. Ammari et al. (4) reported intubation in the delivery room in 27% of preterm infants with a birth weight of <699 g and 11% of infants weighing 700-999 g, a total of 18.3% among those weighing <999 g. Vanpeé et al. (14), in a retrospective study of patients born at less than 28 weeks gestation, showed that 44% required intubation in the delivery room. Finally, Finer et al. (15), in a multicenter study in which the application of DR-CPAP was analyzed, reported that intubation in the delivery room, for any reason, was needed in 34.4% of infants randomized to receive nasal CPAP. A question to be raised is why the infants in the present study were intubated at such a relatively high frequency in the delivery room.

In the present study, the parturients had a high incidence of gestational hypertension (about 30%, as opposed to a normal incidence of 5 to 10%) (16) and of premature rupture of the membranes (23%, as opposed to an estimate of 3% of all pregnancies) (17). If, on the one hand, maternal hypertension confers some degree of protection of a premature baby due to pulmonary maturity, both situations involve a potential risk for the evolution of the infant, due to a higher incidence of neonatal infection and fetal distress.

A maternal characteristic that might have directly influenced the results of the present study was the low use of antenatal corticosteroids. Only 14 of the 33 mothers (42.4%) received antenatal corticosteroids at any dose. These values were also lower than the 54% value available from the Brazilian Network of Neonatal Research Centers (18). Values above 80% have been reported in other studies (13,19). Morley et al. (20) reported a 94% rate of use of antenatal corticosteroids and Finer et al. (15) reported a 96% rate. It has been well established that the antenatal use of a corticosteroid between weeks 24 and 34 of pregnancy can reduce the occurrence of respiratory distress syndrome and the need for respiratory support, and can also reduce peri- and intraventricular hemorrhage, necrotizing enterocolitis, and neonatal mortality among preterm infants. Corticosteroids are also effective when given to women with rupture of the membranes and with hypertension (21).

Another possibility to consider in explaining the high percentage of intubation in the delivery room is the birth condition. When considering the birth conditions based on Apgar score (22), the babies studied here were similar to those described in other investigations. Approximately 60% of the infants in the present study had a 1st-min Apgar score of less than 5. Finer et al. (12) reported a 45% rate of infants with a 1st-min Apgar score of less than 3 and a 78% rate of infants with a score of less than 7, and the same group (15) reported a 23% rate of infants with a 1st-min Apgar score below 3. In the present study, the 5th-min Apgar score was above 5 in 85% of the infants compared to a score above 7 in 55% of the infants reported by Finer et al. (12) and a score above 3 in 96% of the infants reported by Finer et al. (15).

Another possible explanation for the high rate of intubation observed in the delivery room may be related to the medical team rather than to the infants. Because all infants were delivered by staff trained according to the guidelines of the American Academy of Pediatrics and the American Heart Association (8), which emphasize a staged sequence of interventions for neonatal resuscitation, it is possible that our staff was not willing to allow very low birth weight infants to transition without bagging or intubation. As very appropriately stated by Jobe (23) ‘‘there is perhaps nothing more dangerous for the preterm lung than an anxious physician with an endotracheal tube and a bag’’. Aly et al. (3) stated that the success of DR-CPAP is also related to the experience of the staff. Although nasal CPAP has been widely used in our Neonatal Intensive Care Unit over the last 20 years based on a system similar to that used at Columbia University (24), this was the first time it was applied prophylactically in our delivery room.

Patients in conditions similar to those reported here, although theoretically assumed to be those who would most benefit from DR-CPAP (15), are also those for whom DR-CPAP is most difficult to apply. Vanpeé et al. (14) reported that preterm babies who required invasive ventilation presented a higher SNAPPE II and were those less exposed to an antenatal corticosteroid. Ammari et al. (4) described small and sick babies (1st-min Apgar score of 2 and 5th-min score of 7, a mean gestational age of 26 weeks, and presence of severe respiratory distress) as those for whom the use of prophylactic CPAP is least possible. Recent studies have investigated the use of CPAP and surfactant; however, this strategy can be very costly for a developing country without significant benefits (5,15).

This study presents advantages when it proposes to test the method of nasal CPAP in the delivery room in a population not yet studied: very preterm infants born in a

developing country. However, the study was limited by the absence of a control group. In an attempt to better understand the results, we conducted a survey of births that occurred in the 3 years prior to data collection (i.e., January 2003 to December 2005) of patients born at Hospital das Clínicas de Ribeirão Preto who weighed <1000 g. Of the 96 children evaluated, 75 (78.1%) were intubated in the delivery room and 18 additional patients, for a total of 93 (96.8%), were intubated before 5 days of life. Thus, these data indicate that during the study period, a high incidence of intubation (87.8%) was maintained during the first 5 days of life. Therefore, a multicenter study on the subject is needed because a single-center study is not able to recruit an adequate number of patients.

For DR-CPAP to be successful, it is probably necessary for preterm babies to be more prepared at birth, with improved pulmonary and clinical conditions, to withstand the respiratory effort without the need for intubation. Therefore, antenatal corticosteroids and better prenatal monitoring are fundamental to the success of DR-CPAP. The medical team needs to be better trained, and prepared to wait for a longer time for stabilization soon after delivery, with no intervention. Only after these conditions are satisfied, will it be possible to reevaluate the administration of DR-CPAP to infants weighing <1000 g at our institution.

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