EVOLUTIONARY TENDENCY OF NASAL CPAP USE IN TREATMENT OF RDS IN PRETERM INFANTS

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Abstract

Introduction: The non-invasive respiratory support, type CPAP, is widely used to support respiratory function in preterm infants and it is often the first choice in the neonatal intensive care unit.

Aim of the study: The aim of the study is to compare two therapeutic approaches to respiratory distress syndrome due to surfactant deficiency in premature infants.

Material and method: In this study were included all premature infants with gestational age up to 29 weeks, who were treated in the Intensive Care Unit within Oradea Maternity Hospital between 01st of January 2010 and 31st of December 2013. In the study were included 141 infants, divided into two groups: for the infants in the first group the prophylactic surfactant was administered within the first 30 minutes after birth and the infants in the second group received CPAP immediately after birth.

Results and Conclusions: This study presents the fact that the prophylactic surfactant reduces the duration of the CPAP respiratory therapy, of the mechanical ventilation and of the oxygen therapy. Most of these infants, from these two groups, didn't require CPAP conversion into assisted ventilation. The respiratory recovery was good in our study in both groups. The survival rate was of 68% in the first group, respectively 62,12% in the second group and the survival rate in the absence of oxygen at the corrected age of 36 weeks was of 62,66% in the first group and of 56% in the second group. The incidence of bronchopulmonary dysplasia was of 4% in the first group, respectively of 7,5% in the second group. The incidence of pneumothorax and of sepsis was higher in the group of infants with selective surfactant.

In *conclusion*, in premature infants with gestational age between 26-29 weeks with spontaneous breathing movements, the CPAP respiratory support must be used immediately after birth and the surfactant therapy should be introduced at the first clinical, laboratory and radiological signs of respiratory distress. Using this strategy, there are obtained the maximum benefits from this respiratory therapeutic method, reducing the incidence of respiratory morbidity.

Key words: preterm infant, CPAP, surfactant.

Introduction

The non-invasive respiratory support, type CPAP, is widely used to support lung function in premature infants, it is often the first choice in the neonatal intensive care unit.[1,2] In case of extreme preterm infants, CPAP is an alternative to mechanical ventilation and intubation[3], and in premature infants with gestational age over 30 weeks, CPAP is an alternative to oxygen therapy by head box .[4]

CPAP is an attractive option for the treatment of infants with respiratory failure because it keeps the spontaneous breathing, without need for endotracheal intubation, with the reduction of the incidence of pulmonary injuries.[5]

A continuous positive airway pressure (CPAP) can be provided with face mask, nasopharyngeal or endotracheal probes and single or double prongs. The use of positive pressure to the airways implies a great number of benefits, including the stabilization of airways, the increase of lung volume, the reduction in airway resistance, but also in respiratory effort.[6,7] However the increased PEEP values may increase the partial pressure of CO_2, with the reduction of tidal volume and with the increase of dead space. The increase of lung volume may lead to the reduction of the compliance and to the air leak syndrome. The increase of intrathoracic volume may also lead to the reduction of the cardiac activity. CPAP devices may cause skin abrasion and lesions of the nose.[8,9]

Other forms of non-invasive ventilation are IPPV, SIMV, HFOV by nasal prongs.

Currently the optimal time for initiating CPAP and surfactant therapy or for using the mechanical ventilation as a beginning therapy in extremely low birth weight infants is not clearly defined.[10,11] The respiratory support, type CPAP, can be provided with different techniques, as Bubble CPAP system (conventional CPAP) or as some new, modern and sophisticated systems. CPAP pressure is generated by two possible mechanisms: with variable flow and with constant flow. CPAP use involves team effort, experience and permanent medical assistance.[12- 16]

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Aim of the study

The aim of the study is to compare two therapeutic approaches to respiratory distress syndrome due to surfactant deficiency in premature infants: administration of the prophylactic surfactant, followed by extubation and CPAP vs. the administration of the selective surfactant and early CPAP.

Material and method

In this study were included all premature infants with gestational age up to 29 weeks, who were treated in the Intensive Care Unit within Oradea Maternity Hospital between 01st of January 2010 and 31st of December 2013. The information was taken from the consultation sheet and monitoring sheets of the infants. Of a total number of 172 premature infants with a gestational age up to 29 weeks, in this study were included 141 infants:

They were selected by the following criteria:

- infants with gestational age between 25 weeks 0 days and 28 weeks 6 days

- spontaneous breathing movements 5 minutes after birth

- clinical evidence of respiratory distress syndrome: cyanosis, moan, polypnea, indrawing, movement of the nasal wings

- radiological evidence of medium or severe form of RDS (respiratory distress syndrome)

- absence of congenital malformations

Exclusion criteria:

- severe asphyxia or Apgar score of 3 or less at 5 minutes

- endotracheal intubation for resuscitation

- ineffective respiratory movements

- genetic disease.

The infants in the first group received prophylactic surfactant in the first 30 minutes after birth and the infants in the second group received CPAP therapy immediately after birth.

Method

All infants were resuscitated in the delivery room using 100% O_2, which was administrated in free flow or by ventilation with positive pressure by using a balloon and a mask. After they were stabilized and fulfilled the criteria of study groups, they were distributed in one of the two groups.

The infants *in the first group* were intubated and received a single surfactant dose in the first half an hour after birth, after that they were ventilated by using a balloon for 5 minutes, then they were extubated and it was continued the CPAP respiratory therapy.

The infants *in the second group* were treated only by early CPAP. In case of CPAP therapy failure and after pulmonary radiological examination, the infants received selectively a single surfactant dose that was administered by endotracheal probes.

The CPAP respiratory support was provided by Infant Flow System by nasal cannula, using the following parameters: initial FiO_2= 40%, PEEP= 4, MAP= 7, based on the hemoglobin oxygen saturation (HbO2Sat) values. The second dose of surfactant was administered to those infants that still have clinical and radiological RDS criteria.

Criteria of CPAP conversion into assisted ventilation:

- FiO_2 demand over 40% to maintain hemoglobin oxygen saturation (HbO2Sat) between 85%-92%,

- apnea, defined by over 4 spontaneously reversible apnea episodes in an hour or by 2 apnea episodes in an hour, which need ventilations by using a mask and a balloon.

- respiratory acidosis, defined as PCO_2 over 65mmHg and pH < 7,2 in capillary blood

Detubation criteria and continuation of CPAP respiratory ventilation:

- FiO_2 under 40% to maintain hemoglobin oxygen saturation (HbO2Sat) between 85-92%

- low ventilation pressure (PIP, PEEP, mean arterial pressure < 7cm H_2O)

-PCO_2 under 65mm/Hg and pH >7,2 in capillary blood

The results were evaluated at the corrected age of 1 week, 28 days, 36 weeks and then at their discharge from hospital.

At one week age the infants were evaluated regarding the necessity of orotracheal intubation and of assisted ventilation in the first 7 days of life. In this category are the infants who couldn't be detubated in an hour after surfactant administration and those who fulfilled the criteria of CPAP conversion into assisted ventilation in first hours after birth.

The evaluation at the discharge from hospital includes:

- death

- at corrected age of 28 days or 36 weeks: survival by respiratory support of CPAP-type, survival in the presence of O_2 with FiO_2>21%, survival in the presence of atmospheric air,

- incidence of pulmonary bronchodysplasia,
- air leak syndrome,
- pulmonary hemorrhage,
- intraventricular hemorrhage
- retinopathy of prematurity,
- necrotizing ulcerative enterocolitis,
- sepsis,
- total duration of mechanical ventilation,
- hospitalization period.

Results

172 premature infants with gestational age up to 26-29 weeks, cared for within the Intensive Care Unit between 01st of January 2010 and 31st of December 2013

Establishment of the group of infants eligible for the study:

- total number 172**;**

- eliminated - 31: infants intubated in the delivery room - 9, transferred infants from other hospitals - 12, other causes- 10.

- infants admitted in the study - 141

- first group – received prophylactic surfactant, then CPAP -75.

- second group – received early CPAP, then selective surfactant - 66

Clinical and demographic criteria are presented in Table 1:

Table 1: Clinical and demographic criteria.

	Prophylactic Surfactant	Early CPAP
G mean	955 grams	962 grams
GA mean	27,2 weeks	27.4 weeks
Apgar Score mean	3,98	4.07
Male	35	32
Female	40	34
Multiple pregnancy	6	5

Our study results concerning the infants present that the prophylactic treatment with surfactant immediately after birth isn't better than CPAP treatment regarding the necessity for the initiation of the assisted ventilation in first week of life. In our study 6 infants from the first group, who were treated by prophylactic surfactant need intubation and mechanical ventilation versus 8 infants from the second group treated with early CPAP. Multiple doses of surfactant needed 11 children in the first group, respectively 13 children in the second group. This study reveals that the prophylactic surfactant reduces the period of CPAP respiratory therapy, of mechanical ventilation and of oxygen therapy (Figure 1, 2).

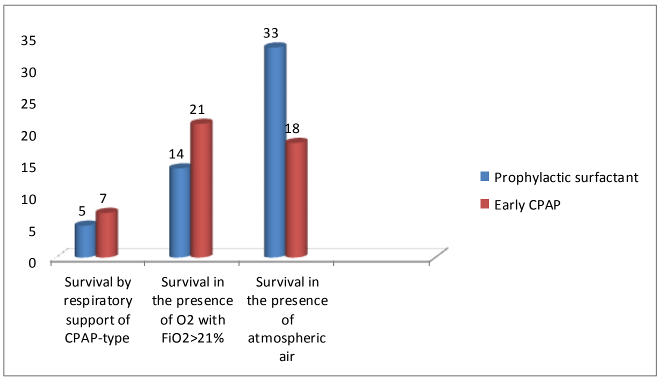

Figure 1: Results at the age of 28 days.

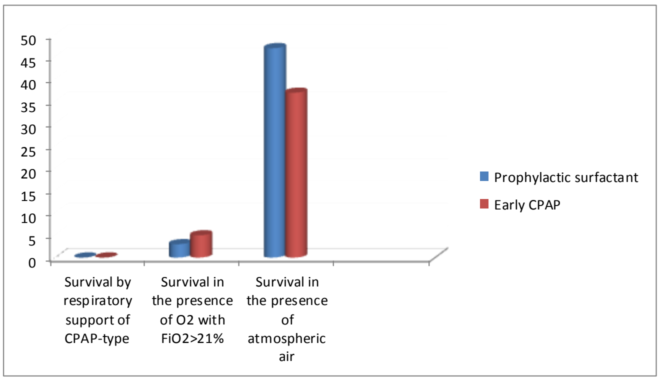

Figure 2: Results at the corrected age of 36 weeks.

Most of the infants of the two groups didn't need CPAP conversion into assisted ventilation. The difference between the two groups was according to the selected parameters. The group with early CPAP and selective surfactant needed the use of higher ventilation parameters than the first group (initial mean FiO2 42 % versus 34%; initial mean PEEP 4,1 versus 2,8) and the necessity for the CPAP respiratory support was longer (19,8 days versus 14,5 days).Only about half of infants in the second group needed surfactant administration (Table 2).

Table 2: Used ventilation parameters CPAP INFANT FLOW.

	Prophylactic Surfactant	Early CPAP
FiO2 initial mean	34%	48%
PEEP initial mean	2,8	4,1

The respiratory recovery was good in our study regarding the both groups. The survival rate was of 68% in first group and of 62,12% in the second group and the survival rate in the absence of oxygen at a corrected age of 36 weeks of life was of 62,66 % versus 56%. The incidence of pulmonary bronchodysplasia was of 4%, respectively of 7,5% in the second group. The incidence of pneumothorax and sepsis was higher in the group of infants with selective surfactant. The stabilization of the digestive tolerance occurred later in this group. Other complications of preterm birth weren't significantly different in the two groups (Figure 3). The duration of hospitalization was slightly lower in the group with prophylactic surfactant (Table 3).

The number of deaths was approximately equal in the two groups, 32% and 38%. The first causes of death were: intraventricular hemorrhage, infection and pulmonary hemorrhage (Figure 4, 5).

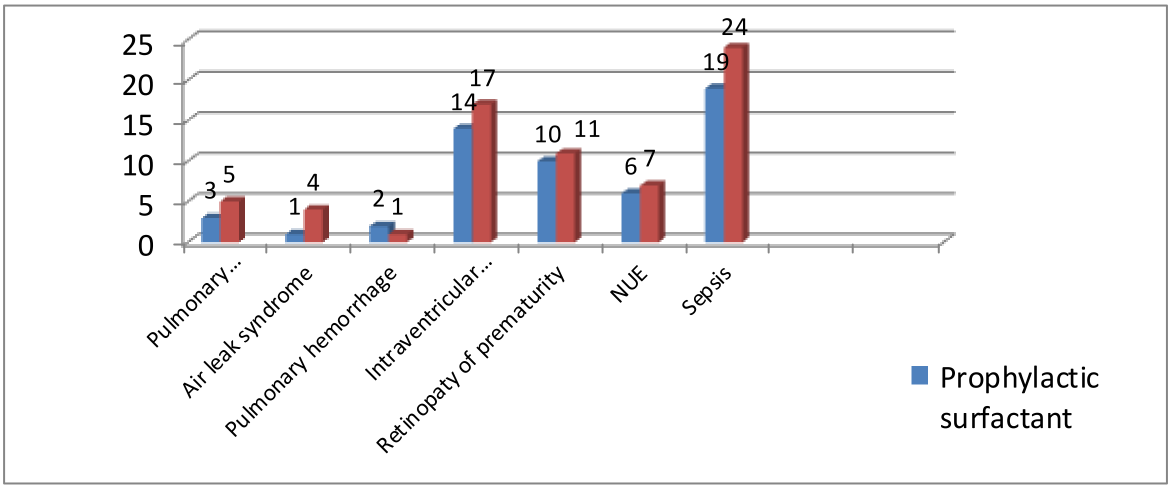

Figure 3: Differences of complications between the two groups.

Table 3: Mean duration of CPAP and hospitalization:

	Prophylactic Surfactant	Early CPAP
Mean duration of CPAP	14,5 days	19,8 days
Mean duration of hospitalization	56,2 days	62,5 days

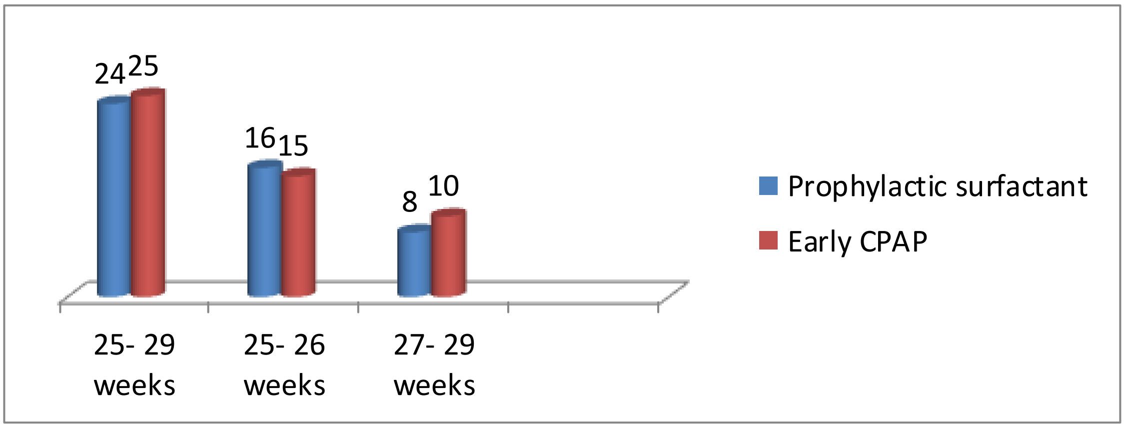

Figure 4: Deaths.

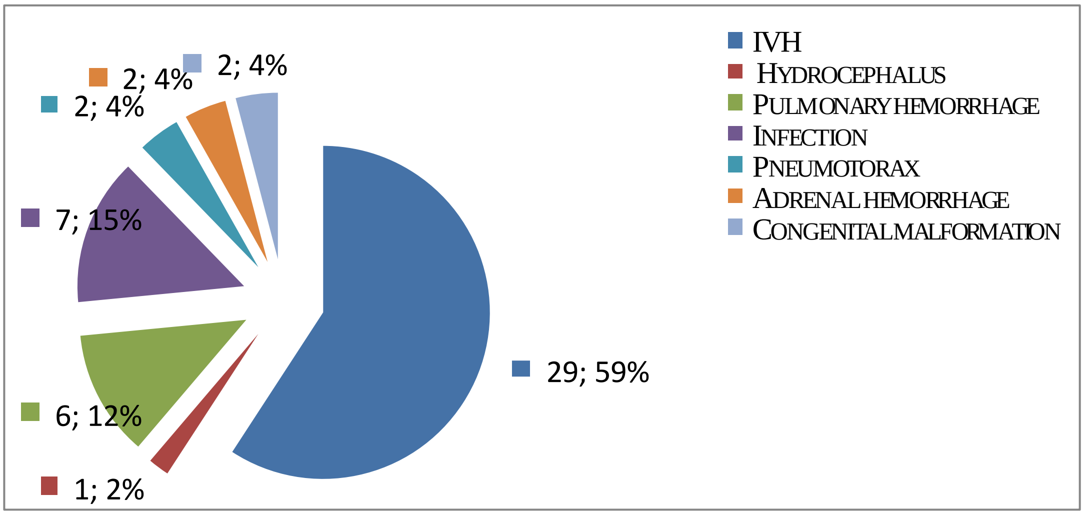

Figure 5: Causes of death - total number of deaths.

Discussions

The optimal time for the initiation of the CPAP therapy remains an unsolved problem. In COIN trial (CPAP versus orotracheal intubation)17, an international multicentre study, it was demonstrated, that the infants treated early with CPAP needed less ventilation days and had an oxygen dependence of more than 28 days, but less than 35 weeks of corrected age. However, these infants had a higher rate of air leak syndrome. In a subgroup selected at random from the above mentioned patients Roehretal demonstrated the improvement of the pulmonary mechanics in 8 weeks after birth in infants who benefit by early CPAP respiratory support versus those who were intubated and mechanically ventilated. In a review published by Verder and his collaborators, medium or severe RDS was treated by using INSURE technique (intubation, surfactant, detubation), followed by CPAP. They noticed that this technique improves the oxygenation, reduces the pulmonary bronchodysplasia rate and diminishes the period of mechanical ventilation in about 50% of cases.

A recent meta-analysis of 6 clinical studies, of that 3 randomized controlled clinical studies compares the results of two strategies of surfactant administration in infants with RDS or with SDR risk: the infants in the first group were treated with INSURE method then with CPAP, the infants in the second group were treated with selective surfactant, followed by intubation and continuous mechanical ventilation. The INSURE method was associated with a lower need for mechanical ventilation, with a lower incidence of pulmonary bronchodysplasia and a lower frequency of pneumothorax. However the number of surfactant doses per patient is significantly higher in those infants treated by INSURE procedure.18 The immediate detubation after the surfactant administration, followed by SNIPPV, which replaces the usual ventilation, was associated with the reduction of the need for oxygen, with the reduction of the period of intubation, of parenteral nutrition and of hospitalization.19 Another study presents that the detubation followed by SNIPPV is associated with the reduction of the need for oxygen and with an lower incidence of bronchodysplasia (73% versus 40%).20

Conclusions

In conclusion, in premature infants with gestational age between 26-29 weeks with spontaneous breathing movements, the CPAP respiratory support should be used immediately after birth and the surfactant administration must be performed at the first clinical, paraclinical and radiological signs of RDS. Using this strategy the benefits of this respiratory option are maximal, reducing the respiratory morbidity.

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