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Original Research Article

Early CPAP in the Management of Preterm Neonates with Respiratory Distress Syndrome: A Prospective Observational Study

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Abstract:

Background: The mainstay in the management of preterm neonates with respiratory distress syndrome (RDS) includes early Continuous Positive Airway Pressure (CPAP), timely surfactant replacement and mechanical ventilation.

Objective: This study sought to examine the need for ventilation and surfactant therapy in preterm neonates <34 weeks when CPAP is initiated early-at birth compare the same with historical controls- preterm neonates <34weeks with respiratory distress after birth and initiated CPAP after admission to NICU and to study the mortality and morbidity associated with early use of CPAP.

Materials and Methods: A two-year-long prospective and observational study was carried out in the Neonatal Intensive Care Unit (NICU) of M.V.J Medical College and Research Hospital, Bengaluru, Karnataka, India. The study was approved by the Ethical Committee of M.V.J. Medical College and Research Hospital. Inclusion criteria constituted all preterm neonates <34weeks breathing spontaneously with clinical suspicion of mild to moderate respiratory distress as per Silverman Anderson score 3-5. Exclusion criteria constituted all neonates with congenital heart disease, congenital anomalies, requiring mechanical ventilation, neonates with Silverman Anderson score > 6, severe birth asphyxia, shock, apnea, and, neonates already intubated for any clinical indication at labour room. A total of 100 neonates (50 neonates in control group-group 1-the study group and 50 neonates in historical cohort group-group 2) were considered in the current study. Primary outcome was to assess the need for mechanical ventilation and the need for surfactant, secondary outcome was to assess the mortality and morbidity associated with CPAP in both the study group and control group.

Result: The data of total 100 neonates were analysed during the study period. There was no statistically significant difference between group 1 and group 2 for Weight (in grams), mean gestational age (in weeks) and mean Silverman Anderson score. The CPAP failure rate was recorded as 22% and 80% in group 1 and group 2, respectively, which was statistically significant. There were two complications (CPAP Belly and Nasal Crusting) due to CPAP and were recorded as 8% for CPAP belly in both group 1 and group 2, and 4% and 6% for Nasal Crusting in group 1 and group 2. Mean duration of CPAP (in hours) was recorded as 35.44 hours and 9.36 hours in group 1 and group 2, respectively, which was statistically significant. There was no statistically significant difference between group 1 and group 2 for recorded five complications (IVH, BPD, IVH+PDA, PDA and ROP) during hospital stay. The current study recorded no death in group 1 while 7 deaths were recorded in group 2, and there was no statistically significant difference.

Conclusion: Early initiation of CPAP at birth was associated with lesser complications in preterm babies, lesser morbidity and mortality, reduction toward the need for intubation, surfactant therapy, duration of mechanical ventilation, hospital stay, and risk of sepsis.

Keywords: CPAP; Neonate; Sepsis; Mechanical ventilation; Mortality.

Introduction

Complications of prematurity account for a significant proportion of the under 5 mortalities globally. The majority of these preterm babies are delivered in low- and middle-income countries (LMICs). [1] India is among the countries with high preterm birth rates hence addressing the

causes of death in this population is crucial in reducing the childhood mortality rates for India as well as the world at large. [2] One of the first complications preterm neonates encounter is respiratory distress syndrome (RDS) from lack of surfactant. [3] The mainstay in the management of RDS involves early Continuous Positive Airway Pressure (CPAP), surfactant replacement and mechanical ventilation if needed; such therapies are scarce in LMIC's. Although early use of CPAP among preterm neonates with RDS has been shown to reduce the need for surfactant therapy, mechanical ventilation and death. [4] Some of the predictors of CPAP therapy failure include lower gestational age, severe RDS, high fraction of inspired oxygen and delay in CPAP initiation. In settings like ours, where antenatal steroid uptake is very low, CPAP initiation is delayed and surfactant is not readily available, CPAP failure rate may be very high. [5]

The objectives of the current study were to examine the need for ventilation and surfactant therapy in preterm neonates <34 weeks when CPAP is initiated early, to compare the same with historical controls- preterm neonates <34weeks with respiratory distress after birth and initiated CPAP after admission to NICU and to study the mortality and morbidity associated with early use of CPAP.

Method

A two-year-long prospective and observational study was carried out in the Neonatal Intensive Care Unit (NICU) of M.V.J Medical College and Research Hospital, Bengaluru, Karnataka, India. The study was approved by the Ethical Committee of M.V.J. Medical College and Research Hospital.

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Exclusion criteria constituted all neonates with congenital heart disease, congenital anomalies, requiring mechanical ventilation, neonates with Silverman Anderson score > 6, severe birth asphyxia, shock, apnea, and, neonates already intubated for any clinical indication at labour room. A total of 100 neonates (50 neonates in control group-group 1-the study group and 50 neonates in historical cohort group-group 2) were considered in the current study.

Data collection

All the babies who cried immediately after birth and who were spontaneously breathing, with a SAS score between 3-5, they were connected to CPAP in labour room and shifted to NICU. The initial Fio2 was set at 50 and PEEP of 6. The babies who failed CPAP, required ventilator support and surfactant was given. Babies who did not worsen, they were continued with CPAP support and Fio2 was adjusted to maintain Spo2 between 92-94%. Vital parameters were monitored continuously. Bubble CPAP was considered to be successful if the respiratory distress improved and the baby could be successfully weaned off from CPAP. The criteria for weaning was absence of respiratory distress (minimal or no retractions and respiratory rate between 30cpm and 60cpm) and SpO2>92%.

However, the control group was a group of historical cohorts. The data of the babies in the historical cohort group was taken from the medical records section. These babies were started on CPAP after their arrival to NICU. Primary outcome was to assess the need for mechanical ventilation and the need for surfactant, secondary outcome was to assess the mortality and morbidity associated with CPAP in both the study group and control group.

Statistical Analysis

Data was entered into Microsoft Excel data sheet and was analyzed using SPSS 22 version software. Categorical data was represented in the form of Frequencies and proportions. Chi-square test was used as test of significance for qualitative data. Continuous data was represented as mean and standard deviation. Independent t test was used as test of significance to identify the mean difference between two quantitative variables and qualitative variables respectively.

Results

The data of total 100 neonates were analysed during the study period in the hospital and all the 100 of the subjects had complete data, and are included in the results. Subject baseline information is listed in Table 1.

Table 1: Subject baseline details

Group					
	Group 1		**Group 2**		**p value**
Parameters	**Count**	**Percentage**	**Count**	**Percentage**	
Gender distribution					
Gender Male	26	52	27	54	NA
Gender Female	24	48	23	46	NA
Mode of Delivery					

LSCS	32	64	30	60	NA
NVD	18	36	20	40	NA
Parameters	**Mean**	**SD**	**Mean**	**SD**	**p value**
Weight (in grams)	1506.64	330.849	1447.44	342.234	0.381
Mean gestational age (in weeks)	32.32	0.91	32.06	0.890	0.153
Mean Silverman Anderson score	4.36	0.693	4.56	0.5	0.101

Table 1 above tabulate the subject baseline details which include the gender distribution details (male and female), followed by the mode of delivery which include LSCS and NVD. Also, this table recorded data over weight of neonates (in grams), the mean gestational age and the mean Silverman Anderson score. As noted from the above table 1, majority of the neonates in the study were males (52%) followed by females (48%). This was comparable to the control population where the majority of the neonates were males (54%) followed by females (46%). Similarly, majority of the neonates in the study were delivered via LSCS (64%) followed by NVD (36%). This was comparable to the control population where the majority of the neonates were delivered via LSCS (60%) followed by NVD (40%).

There was no statistically significant difference between group 1 and group 2 for Weight (in grams), mean gestational age (in weeks) and mean Silverman Anderson score.

The details over continuous positive airway pressure (CPAP) were recorded in Table 2.

Table 2: Details of the CPAP

Group					
	Group 1		**Group 2**		**p value**
Parameters	**Count**	**Percentage**	**Count**	**Percentage**	
CPAP Failure					
Yes	11	22	40	80	< 0.001
No	39	78	10	20	
Complication of CPAP					
CPAP Belly	4	8	4	8	0.9
Nasal Crusting	2	4	3	6	
No complication	44	88	43	86	
Parameters	**Mean**	**SD**	**Mean**	**SD**	**p value**
Mean duration of CPAP (in hours)	35.44	20.25	9.36	16.91	<0.001

The Table 2 above tabulate the details of CPAP including CPAP failure, complication of CPAP and mean duration of CPAP (in hours).

The CPAP failure rate was recorded as 22% and 80% in group 1 and group 2, respectively, which was statistically significant. There were two complications (CPAP Belly and Nasal Crusting) due to CPAP and were recorded as 8% for CPAP belly in both group 1 and group 2, and 4% and 6% for Nasal Crusting in group 1 and group 2. Mean duration of CPAP (in hours) was recorded as 35.44 hours and 9.36 hours in group 1 and group 2, respectively, which was statistically significant.

The details over mechanical ventilation, surfactant use, hospital stay, sepsis and mortality were recorded in Table 3.

Table 3: Tabulated data for ventilation and surfactant therapy in preterm neonates < 34 weeks and mortality and morbidity associated with early use of CPAP

Group					
	Group 1		**Group 2**		**p value**
Parameters	**Count**	**Percentage**	**Count**	**Percentage**	
Need for mechanical ventilation					
Yes	11	22	40	80	< 0.001
No	39	78	10	20	
Surfactant use distribution					
Yes	11	22	40	80	< 0.001
No	39	78	10	20	

Complications during hospital stay					
IVH	10	20	14	28	0.369
BPD	0	0	2	4	
IVH+PDA	5	10	3	6	
PDA	4	8	6	12	
ROP	3	6	5	10	
NIL	28	56	20	40	
Complications of mechanical ventilation					
Ventilator Associated Pneumonia	1	2	11	22	0.002
No complications	49	98	39	78	
CRP distribution					
Positive	25	50	42	84	< 0.001
Negative	25	50	8	16	
Blood culture (sepsis) distribution					
Positive	6	12	25	50	< 0.001
Negative	44	88	25	50	
Mortality (Death)					
Yes	0	0	7	14	0.006
No	50	100	43	86	
Parameters	**Mean**	**SD**	**Mean**	**SD**	**p value**
Duration of mechanical ventilation	11	3.90	40	5.90	<0.001
Mean duration hospital stay (in days)	12.28	4.03	15.6	5.44	0.001

The Table 3 above tabulate the details of need for mechanical ventilation, duration of mechanical ventilation and its complications, surfactant use distribution, mean duration hospital stay (in days) and complications during hospital stay, CRP distribution, blood culture (sepsis) distribution, mortality (death). There were 22% cases in group 1 that needed mechanical ventilation whereas in group 2, 80% cases needed mechanical ventilation which was statistically significant difference. The mean (SD) duration of mechanical ventilation in group 1 was 11 (3.90) days while in group 2 was 40 (5.90) days which was statistically significant difference. Group 1 recorded single case of Ventilator Associated Pneumonia while Group 2 recorded 11 cases and this difference was statistically significant.
There were 22% cases in group 1 that needed surfactant use whereas in group 2, 80% cases needed surfactant use which was a statistically significant difference.

The mean (SD) duration hospital stay (in days) in group 1 was 12.28 (4.03) days while in group 2 was 15.6 (5.44) days which was statistically significant difference. This study recorded five complications (IVH, BPD, IVH+PDA, PDA and ROP) during hospital stay. There was no statistically significant difference between group 1 and group 2 for recorded five complications (IVH, BPD, IVH+PDA, PDA and ROP) during hospital stay.

CRP positivity rate in group 1 was 50% while in group 2 was 84%, and there was a statistically significant difference. Similarly, Blood culture (sepsis) positivity rate in group 1 was 12% while in group 2 was 50%, and there was a statistically significant difference. The current study recorded no death in group 1 while 7 deaths were recorded in group 2, and there was no statistically significant difference.

Discussion

Our study demonstrated a CPAP failure rate of 11% among infants of less than 34 weeks' gestational age and weighing around 1500 g. The lower rates could be attributed to the standard of care in all these studies which included antenatal corticosteroids, early initiation of CPAP in the delivery room and early rescue surfactant therapy. [6]

The failure rate found in our study is in line with findings from a systematic review looking at the safety and efficacy of CPAP in low- and middle-income countries, where CPAP failure rates of between 20 and 40% were reported. [7-11] The CPAP failure threshold varies from one institution to another and it is one subject that needs an urgent consensus especially for low resource settings.

In the current study, out of 50 newborns, 26 belonged to 1000-1500gms category and fell into CPAP failure requiring ventilator support. Also, greater number of babies had CPAP failure and required ventilator support in control group compared to study group. Two studies (Aly H [12] et al and Narendra et al [13]) shown better outcome in newborns with birth weight < 1000gms. Out of the 50 babies studied, 48.00% were female babies and

52.00% were male babies. There was no statistical difference between the outcome on the basis of gender in both the study group as well as control group. Hence the present study infers that the success of bubble CPAP is independent of gender. These finding were found to be similar in other studies. Urs et al [14] conducted a study on 50 neonates comprising of 33 male babies and 17 female babies and a study conducted by Koti et al [15], on 56 infants comprising 31 male babies and 25 female babies.

In the current study, the CPAP failure rate was recorded as 22% and 80% in group 1 and group 2, respectively, which was statistically significant. Our results are in agreement with Ashvinkumar Desai et al [16] who showed that the success of CPAP in their study group was 70 % as early CPAP was initiated. There were 22% cases in group 1 that needed surfactant use whereas in group 2, 80% cases needed surfactant use which was a statistically significant difference. Badiee et al [17] showed that the need for surfactant administration was significantly reduced in the early CPAP group. The most common complications noted in the present study including both the study and control group is CPAP belly and nasal crusting. Our results are in agreement with studies undertaken by Balaji et al [18], Robertson et al [19] and RM do Nascimento et al [20]

In the study group there were no deaths whereas in the control group, 7 (14%) neonates died. Our results are in agreement with study undertaken by Bandiee et al [21].

Conclusion

Based on the current investigation, it is clear that early initiation of CPAP was associated with lesser complications in preterm babies, lesser morbidity and mortality, reduction toward the need for intubation, surfactant therapy, duration of mechanical ventilation, hospital stay, and risk of sepsis. The implication of this study can be found beneficial when used in a resource limited set-up where early CPAP reduces the disease burden of preterm babies thereby paving the way for a holistic reduction of the perinatal mortality of the country in the days to come.

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