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Usefulness of Downe Score as Clinical Assessment Tool and Bubble CPAP as Primary Respiratory Support in Neonatal Respiratory Distress Syndrome

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Abstract:

Background: In preterm neonates respiratory distress syndrome (RDS) is one of the common causes of morbidity and mortality. Application of Bubble CPAP has been shown to be beneficial in terms of reduced need of invasive ventilation and prolonged hospital stay in newborns with RDS.

Objective: Present study was conducted to assess the outcome of Bubble CPAP in newborns and usefulness of Downe score in predicting outcome and use as an assessment tool by medical/ nursing staff in resource limited setup.

Method: We conducted this prospective study to evaluate effectiveness of Bubble CPAP as primary mode of respiratory support in resource limited setup of periphery with Downe score used as one of the tool to assess response to treatment. The study was conducted from November 2010 to February 2012 and based on inclusion criteria a total of 75 newborns were enrolled.

Results: CPAP failure was observed in 37.3% of preterm babies with RDS. Chest X ray suggestive of severe RDS, Downe score > 6 at 15-20 minutes of starting CPAP and sepsis/pneumonia was significantly associated with CPAP failure and also were independent predictors of outcome. Area under curve (AUC) for Downe score at 15-20 minutes of starting CPAP was 78.5% (95% CI = 67.9 to 89.1)

Conclusion: Bubble CPAP was found to be effective and safe mode of treating mild to moderate RDS and Downe score can be used at periphery to monitor response and to decide about referral in absence of sophisticated test.

Keywords Bubble CPAP, Downe score, Predictors of CPAP failure

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Introduction

Prematurity is a major cause of morbidity and mortality in India. Respiratory distress syndrome (RDS) in newborn is the commonest cause for morbidity and mortality, and indication for ventilation in preterm babies.[1-2] Typically RDS is diagnosed by combination of features like early onset of respiratory distress in premature newborn, history of absent or inadequate antenatal steroids, maternal

complications such as diabetes mellitus or ante partum hemorrhage. Diagnosis of RDS is supported by positive postnatal gastric aspirate shake test and x-ray chest which may be delayed many times for logistic reasons in developing countries like India.[3-5] Similarly sophisticated biochemical test like lecithin/sphingomyelin ratio are not routinely available. So diagnosis of RDS is primarily based on clinical presentation and its severity can be assessed by clinical score like Downe score.

Newborn with RDS are typically managed with oxygen therapy, nasal continuous positive airway pressure (CPAP), surfactant administration and ventilation depending upon severity of respiratory distress and response to treatment. Among various CPAP devices and delivery systems Bubble CPAP is one of the low cost nasal CPAP delivering systems with underwater seal. Lee et al [6] has demonstrated superiority of Bubble CPAP as compared to ventilator derived CPAP in premature infants. Bubble CPAP is less expensive method of respiratory support more suitable to neonatal intensive care unit (NICU) with resource limited setup in developing countries.[7-9] Administration of surfactant while on CPAP known as INSURE (Intubate-Surfactant-Extubate) technique is also becoming accepted method of respiratory support compared to surfactant and conventional ventilation in premature infants with RDS but timely administration of surfactant and its availability is still a concern in level II NICU and referral units.[10-11] If these newborns that require surfactant and/or ventilation are referred timely to the well equipped centers then morbidity and mortality among them can be further reduced with better long term outcome. Downe scoring system, Alveolar-Arterial Oxygen Tension (A-aDO₂) gradient, arterial blood gas (ABG) as well as product of FiO₂ and CPAP pressure ≥ 1.28 to achieve SaO₂ in range of 87-93% at initiation of CPAP have been used to assess severity of respiratory distress and ongoing management as well as to predict response to treatment.[7] Unfortunately these test are not feasible everywhere in resource limited set up except Downe score which is clinical bedside tool to assess severity and response to respiratory support. In present study we tried to analyze sensitivity and specificity of Downe score at its various score values affecting immediate outcome of RDS treated with CPAP, so the newborns that might require surfactant administration and/or ventilation might be timely referred to higher centers.

Material and Methods

This prospective analytical study was carried out at neonatal intensive care unit (NICU) in Pediatrics department at P.D.U. Medical College, Rajkot, India. The study was conducted from November 2010 to February 2012 with prior approval from institutional ethical committee. Written consent was obtained from either father or guardian of a newborn patient. NICU where the study was conducted caters both intramural as well as extramural newborns. Based on following criteria a total of 75 neonates were enrolled in the study.

Inclusion criteria: Preterm newborns with gestation age between 28 to 34 weeks admitted with respiratory distress (Downe score ≥ 4) and chest x-ray suggestive of respiratory distress syndrome were included in the study.

Exclusion criteria: Those infants who had major malformation or have left against medical advice were excluded from the study.

Gestational assessment was done with help of mother's last menstrual period, early antenatal ultrasound whenever available and new Ballard score. Newborns were assessed for severity of respiratory distress by Downe score at the beginning of CPAP and the same was also used for monitoring while on CPAP along with other parameters. Eligible babies were started on Bubble CPAP device manufactured by indigenous company of India and supplied by state government with short binasal Hudson prongs. Fixation of nasal interface was done as per guidelines provided in All India Institute of medical Sciences (AIIMS) booklet of neonatal protocols.[12] Positive End Expiratory Pressure (PEEP) was started at 5 cm of water and adjusted to minimize chest retractions. FiO₂ was adjusted to maintain SPO₂ between 87-95%. Flow was titrated so as to produce bubbling in bubble chamber. As surfactant was not routinely available from government hospital supply free of cost to all the patients and majority of patients were not affording, even in intramural babies most of the time surfactant could not be given.

Criteria for weaning from CPAP: absence of respiratory distress (respiratory rate between 30-60/minute and minimal or no chest retractions) and SpO₂ > 90% on FiO₂ < 30% and PEEP < 5 cm of water. [12]

Bubble CPAP was considered successful if the respiratory distress improved and baby could be successfully weaned off from CPAP. Infants failing CPAP within the first 1 week of life were considered to be CPAP failure and were started on mechanical ventilation. Criteria to consider CPAP failure were (a) remained hypoxemic i.e. SpO₂ < 87% despite FiO₂ > 70% and PEEP > 7 cm of water, (b) had severe retractions on PEEP > 7 cm of water, (c) had prolonged (> 20 seconds) or recurrent apnea (> 2 episodes in 24 hours with bradycardia) requiring bag and mask ventilation; and (d) shock requiring inotropic support of dopamine and/or dobutamine ≥ 20 mcg/kg/min.

Data was also collected for use of antenatal steroids, multiple births, pregnancy induced hypertension and premature rupture of membrane or caesarian section as per the details available for referred newborns. Infants variable

included in study were birth weight (digital scale with accuracy of 10 gm), gestational age, presence of intra-uterine growth retardation (IUGR) (weight < 10th centile on Lubchenko percentile charts), need for resuscitation at the time of birth. x ray chest (was possible most of the time), FiO₂ requirement and Downe score at 15-20 minutes of starting CPAP. Severity of RDS based on x-ray finding was graded as (i) mild - mild granularity of lungs, (ii) moderate - generalized granularity of lungs with air bronchogram with preserved cardiac borders, and (iii) severe - white out lungs with loss of cardiac borders. The other clinical data recorded were occurrence of pneumothorax, sepsis, shock, pneumonia and necrotizing enterocolitis.[13]

Outcome variables: CPAP failure, incidence of pneumothorax, duration of hospital stay, predictors of

CPAP failure as well as sensitivity and specificity of Downe score in predicting the outcome.

Analysis of data was performed with Epi info version 7. Continuously distributed variables were represented as mean \pm SD and the others as median (range). Data was compared between infants who succeeded CPAP with CPAP failures. P value < 0.05 was considered to be significant. Receiver operating characteristics (ROC) curve was generated using WIN PEPI software [14]

Results

Based on inclusion criteria a total of 75 newborns were enrolled in the study. The mean gestation was 31.6400 \pm 1.7056 weeks and the birth weight was 1.5538 \pm 0.3653 grams.

Table 1: Maternal and neonatal variables among neonates with CPAP success and CPAP failure

Variable	CPAP success	CPAP failure	P value
Birth weight (g) (mean \pm SD)	1.6457 \pm 0.360	1.3996 \pm 0.324	0.004
Gestation (wk) (mean \pm SD)	31.9787 \pm 1.6	31.0714 \pm 1.8	0.02
Birth weight<1500 g	16(34%)	15(53.5%)	0.09
Gestation<32 wk	25(53.2%)	21(75%)	0.06
Male sex	30(63.8%)	21(75%)	0.31
History of Resuscitation	9(19.1%)	9(32.1%)	0.20
Chest X-ray S/O severe RDS	4(8.5%)	11(39.3%)	0.001
Downe Score >6 at 15-20 min Of CPAP	2(4.3%)	10(35.7%)	0.0003
Sepsis/pneumonia	8(17%)	12(42.9%)	0.014

Table 2: Factors independently associated with CPAP Outcome

Variable	RR	95% CI
Score>6 at 15-20 min. of CPAP	4.30	1.20-15.33
Chest X ray s/o Severe RDS	2.68	1.14-6.31
Sepsis/pneumonia	1.77	1.01-3.11

Eleven (14.7%) mother had received two doses of antenatal steroids as per available records. Median age of starting CPAP was 95 minutes of life. Forty four (58.6%) had Chest X ray findings suggestive of mild RDS where as 16(21.3%) had moderate and 15(20%) had severe RDS based on x-ray findings. The median duration of CPAP was 48 hours (range 1-181 hours). Forty seven (62.6%) babies on CPAP succeeded where as 28 (37.3%) of babies failed CPAP during first week of life. Clinical variables independently associated with outcome have been depicted in Table 2.

Downe score was used to assess the course of RDS. Score at 15-20 minute of starting CPAP was further analyzed with Receiver operating characteristic curve (ROC Curve) which has been shown in figure 1.

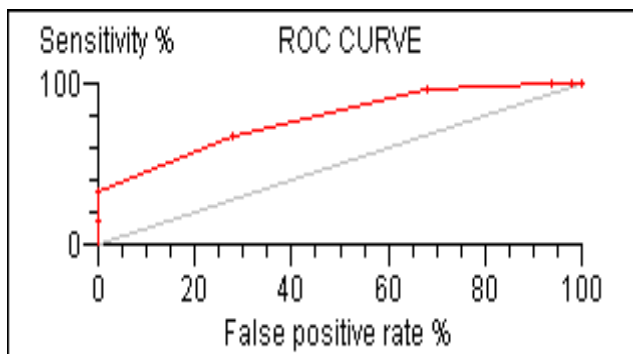


Figure 1: ROC curve analysis for use of Downe score in RDS (Area under the ROC curve = 78.5% (S.E. = 5.41%) 95% CI = 67.9 to 89.1%)

Area under curve was 78.5%. Youden's Index was maximum with Downe score of 5 at 15-20 minute of starting CPAP with both maximum sensitivity and specificity for the score as shown in Table 3.

Table 3: Reliability of Downe score by Youden's index.

Downe score	Sensitivity (%)	Specificity (%)	Youden's Index (%)
2	100	2.1	2.1
3	100	6.4	6.4
4	96.4	31.9	28.3
5	67.9	72.3	40.2
6	32.1	100	32.1
7	14.3	100	14.3

Discussion

Most of the studies on Bubble CPAP are from either developed countries or from level III neonatal units of developing countries where facility of ABG, x-ray chest and/or surfactant is available round the clock. This is one of few prospective studies from medical college attached government referral NICU of peripheral part. Present study was conducted with aim to assess the immediate outcome of Bubble CPAP in newborns with respiratory distress syndrome as well as sensitivity and specificity of Downe score in predicting outcome in government set up NICU so as to use it as a tool for assessment to response to treatment by medical/ paramedical staff in resource limited setup.

In present study 37.3% of babies failed CPAP in first week of life. Failure rate of Bubble CPAP varies from 24-40% among various studies. In study by Boo et al[14] around 38% of newborn with RDS failed CPAP, where as in study by Jagdish Koti et al 25% of patients failed CPAP during first week of life.[8] In study by Ammari et al[15] around 24% of newborns with Birth weight < 1.25 kg failed CPAP. This difference may be attributed to birth weight and gestation of infants enrolled, use of Antenatal steroids, type of nasal interface used, Age of starting CPAP, Use of surfactant and CPAP device. Presently in developing countries like India surfactant replacement therapy is not possible everywhere [11] and in present study use of surfactant was not possible that might also be significant reason to affect outcome. Similarly difference in cut off time period for outcome like success or failure of CPAP would also affect outcome. We studied CPAP outcome within first seven days of life as majority of events in early neonatal period directly or indirectly signifies care and support in first few days of life.

Use of antenatal steroids has been shown to be very important in predicting success of CPAP in premature babies with RDS. Use of antenatal steroids varies significantly from 34-91% in different studies conducted in developing countries and in different regions of same country and might also have differences between rural and urban areas in same region. In present study antenatal steroids were used in 14.7% of newborn babies. This study was conducted in peripheral part of India which caters booked as well as unbooked cases and among referred newborns, details regarding antenatal and/or intranasal care were inadequate where as other studies were conducted in level III NICU with majority were booked cases. This finding signifies that there is need to encourage appropriate use of antenatal steroids even in peripheral

parts to have better outcome for RDS in preterm newborns that will positively affect outcome and will help to bring down Neonatal Mortality Rate (NMR).

Bubble CPAP is effective in management of mild to moderate RDS. In study by Boo et al[14] moderate RDS was one of predictor of failure of CPAP where as in study by Prasanth S et al[8] moderate RDS was successfully managed by bubble CPAP as they initiated Bubble CPAP at Downe score of 4. In present study severe RDS on chest x-ray, Downe score > 6 after 15-20 minutes of starting CPAP and incidence of sepsis /pneumonia were independently associated with adverse CPAP outcome and the same has been observed in other studies.[7-8]

In absence of availability of sophisticated test like lecithin/Sphingomyelin ratio, arterial blood gas analysis and even chest x-ray in resource limited set up clinical assessment becomes more important to assess severity and ongoing management of RDS in preterm babies. Prediction model of CPAP treatment has also been devised by using weighted scores combining product of CPAP pressure and fraction of inspired oxygen of ≥ 1.28 at initiation of CPAP to maintain oxygenation saturation between 87-93%, use of antenatal steroids, preterm premature rupture of membrane and gestation age < 28 week.[17] Unfortunately proper information regarding use of antenatal steroids or other risk factors during pregnancy or at the time of delivery is not available to the referral unit many times as newborn babies are transported without optimum care and information especially from peripheral parts of most of developing countries. In this context we tried to analyse outcome regarding CPAP success or failure on assessment of Downe score at 15-20 minutes of starting treatment with Receiver operating characteristics curve as Area under curve (AUC) is an effective and combined measure of sensitivity and specificity for assessing inherent validity of score and it showed AUC Value of 78.5% (S.E. = 5.41%, 95% CI = 67.9 to 89.1%) signifying that it can be used to predict outcome. It can be used till more sophisticated tests/prediction models become available in the peripheral health care system, Downe score could be a helpful simple assessment tool to take decision regarding continuing treatment at the same centre or to refer early to advance neonatal care unit for better outcome.

Conclusion

We conclude that Bubble CPAP for RDS is effective and safe mode of treating mild to moderate RDS. Nearly 37.3% Newborn with RDS failed CPAP. Chest x-ray suggestive of severe RDS, Downe score >6 at 15-20 minutes of starting CPAP and sepsis/pneumonia were

associated with CPAP failure and also independent predictors of outcome. Downe score can be used at periphery to monitor response and to decide about referral in absence of sophisticated test by the medical and paramedical nursing staff.

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