ORIGINAL RESEARCH PAPER
Volume - 14 | Issue - 12 | December - 2025 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

CLINICAL EFFICACY OF CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) IN PRETERM NEONATES WITH RESPIRATORY DISTRESS SYNDROME: A PROSPECTIVE OBSERVATIONAL STUDY

Paediatric Medicine

Dr. Dinai Lalnghinglovi Solo Post Graduate Student, Department of Paediatrics, Regional Institute of Medical Sciences, Imphal, Manipur, India

Dr. Thongam Satyakumar Assistant Professor, Department of Paediatrics, Regional Institute of Medical Sciences, Imphal, Manipur, India

Prof. Sunilbala Keithellakpam Professor, Department of Paediatrics, Regional Institute of Medical Sciences, Imphal, Manipur, India

Dr. Don William K. Muti Post Graduate Student, Department of Paediatrics, Regional Institute of Medical Sciences, Imphal, Manipur, India

Dr. Lita N Jimo Post Graduate Student, Department of Paediatrics, Regional Institute of Medical Sciences, Imphal, Manipur, India

ABSTRACT

Background: Respiratory Distress Syndrome (RDS) remains a leading cause of morbidity and mortality in preterm neonates due to surfactant deficiency and lung immaturity. Continuous Positive Airway Pressure (CPAP) is widely used as a non-invasive respiratory support to prevent alveolar collapse and improve oxygenation. **Aim:** To assess the clinical effectiveness of CPAP in preterm neonates diagnosed with RDS and to identify predictors of therapeutic success. Procedure: A prospective observational study was conducted in NICU settings among 246 preterm neonates diagnosed with RDS. Consecutive sampling was used. Clinical outcomes, CPAP response, need for mechanical ventilation, complications, hospital stay, and mortality were recorded. **Results:** Out of 246 neonates, 162 (65.8%) showed clinical improvement with CPAP alone. CPAP failure occurred in 84 neonates (34.1%), requiring mechanical ventilation. Neonates with gestational age ≥32 weeks demonstrated significantly better success ($p < 0.05$). Higher APGAR scores (≥7 at 5 minutes) were associated with faster recovery and shorter NICU stay. The overall mortality rate was 6.9%, lower than reported in similar cohorts. Conclusion: CPAP is a safe and effective first-line therapy for preterm neonates with RDS, significantly reducing the need for invasive ventilation and improving survival outcomes. Early initiation, adequate monitoring, and gestational maturity predict better prognosis.

KEYWORDS

Preterm Neonate, Respiratory Distress Syndrome, CPAP, NICU, Non-invasive Ventilation, Neonatal Outcomes

INTRODUCTION

Respiratory Distress Syndrome (RDS) is a major cause of neonatal morbidity, especially in preterm neonates due to surfactant deficiency and structural lung immaturity[1,2]. Without early intervention, affected neonates may progress to respiratory failure, requiring mechanical ventilation, which increases the risk of complications such as bronchopulmonary dysplasia (BPD), pneumothorax, and hospital-acquired infections[6].

Continuous Positive Airway Pressure (CPAP) has become a cornerstone of neonatal respiratory care[3,11] due to its ability to improve oxygenation while avoiding complications associated with invasive ventilation. However, variability exists in response based on gestational age, weight, and initial physiological status[13,14]. This study evaluates CPAP effectiveness and identifies clinical predictors of successful outcomes.

Objectives

1. To evaluate clinical improvement in preterm neonates with RDS treated with CPAP.
2. To determine predictors of CPAP success including gestational age and APGAR scores.
3. To assess hospital stay, complication rates, and mortality outcomes.

Procedure

CPAP was initiated using nasal prongs with starting pressures 5–6 cm H_2O. Fraction of inspired oxygen (FiO_2) was titrated to maintain SpO_2 90–95%. Monitoring included RR, retractions, ABG analysis, and radiological evaluation.

CPAP Failure[2,11] Criteria Included:

Persistent hypoxia despite FiO_2 >60%
pH <7.20 or rising $PaCO_2$
Severe apnea episodes
Hemodynamic instability

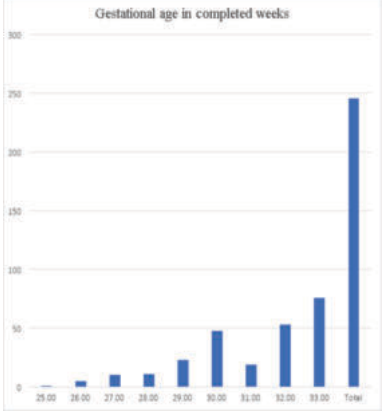
Outcomes Documented:

Improvement on CPAP
Need for intubation/ventilation
Complications (apnea, pneumothorax, sepsis)
Duration of NICCU stay
Mortality

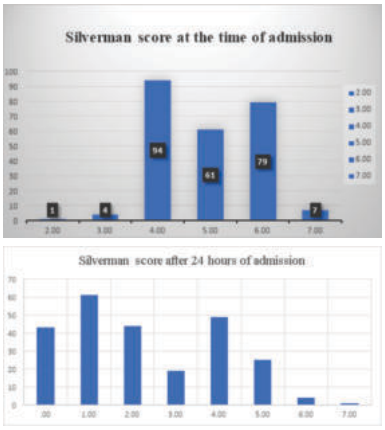
RESULTS

The study included 246 preterm neonates and their mothers. Most mothers were aged 26–30 years (51.6%), and over half of the babies were born at 32–33 weeks of gestation. Male infants slightly outnumbered females (58.5% vs. 41.5%).

A considerable proportion of mothers (66.7%) had high-risk pregnancies, with premature rupture of membranes (PROM) and maternal infections being the most common risk factors. Almost all deliveries occurred in health institutions (96.4%), with normal vaginal delivery being the predominant mode (70.3%). The mean APGAR score at birth was favorable (most scoring 6–7), while the initial Silverman scores indicated moderate respiratory distress in the majority of neonates.



Distribution of Patients' Gestational Age in Completed Weeks.

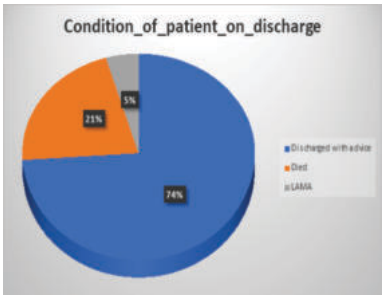


Comparison of Mean Silverman Scores at Admission and After 24 Hours of CPAP Therapy.

RDS outcome	No. of Patients	Percent (%)
Improvement	167	67.9
No Improvement	79	32.1
Total	246	100.0

Outcome of Respiratory Distress Syndrome (RDS) Among Study Participants

Following 24 hours of Continuous Positive Airway Pressure (CPAP) therapy, a marked clinical improvement was observed—Silverman scores significantly decreased from a mean of 4.96 ± 0.96 at admission to 2.27 ± 1.75 ($t = 26.641$, $p < 0.001$). Improvement in respiratory distress syndrome (RDS) was achieved in 67.9% of neonates, while 32.1% did not show improvement. Factors significantly associated with better RDS outcomes included higher gestational age, lower Silverman scores at admission, higher APGAR scores, absence of maternal high-risk conditions, and no need for ventilator support after 24 hours. The mean hospital stay was longer for improved cases (33.8 days) than for those without improvement (26.0 days), suggesting that extended hospital care supports recovery.



Condition of Neonates on Discharge.

At discharge, 73.98% of neonates were discharged in good condition, while 21.14% succumbed to complications. The leading cause of death was prematurity with respiratory distress syndrome (RDS) and related comorbidities such as congenital heart disease, disseminated intravascular coagulation (DIC), and sepsis. ANOVA analysis confirmed that gestational age, Silverman scores, APGAR score, ventilator requirement, and duration of hospital stay were key predictors of patient outcomes (all $p < 0.001$). Overall, the findings highlight the effectiveness of CPAP in managing neonatal RDS, particularly among those born at higher gestational ages and with fewer maternal or neonatal complications

Clinical Outcomes

Outcome	n (%)
Responded to CPAP	162 (65.8%)
CPAP failure (needed intubation)	84 (34.1%)

Mortality 17 (6.9%)

Sample size 246

Parameter	Mean ± SD / n (%)
Mean gestational age	32.4 ± 2.1 weeks
Birth weight <1.5 kg	118 (47.9%)
APGAR ≥7 at 5 min	158 (64.2%)

Baseline Neonatal Characteristics

Neonates ≥32 weeks: 78% CPAP success
Neonates <32 weeks: 52% CPAP success
Mean NICU stay among survivors: 12.8 days
Most common complications: apnea of prematurity and sepsis
Pneumothorax was rare (<2%)

DISCUSSION

The study demonstrates that CPAP is an effective early intervention for RDS, preventing invasive ventilation in nearly two-thirds of cases[12,19]. Success rates were significantly higher among neonates with greater gestational maturity[14,24] and better APGAR scores, highlighting the role of lung development and initial physiological stability.

This study evaluated the outcomes of respiratory distress syndrome (RDS) in preterm neonates managed with CPAP using the Silverman scoring system. Overall, 67.9% of neonates showed clinical improvement, while 32.1% did not. Similar improvement rates have been reported internationally—Rijal P et al.[29], Sahil SA et al.[30], Moshiro R et al.[31], and Abdul-Mumin A et al.[32]—though some studies, such as Bacha et al.[33], found higher rates of poor outcomes. Variations across studies likely reflect disparities in healthcare infrastructure, access to non-invasive ventilation, perinatal care quality, and delayed presentation of out-born neonates.

Male predominance observed in this study (58.54%) aligns with findings by Bacha et al.[33], Niesłuchowska-Hoxha et al.[34], Qari et al.[35], and Luerti et al.[37], all of whom reported higher RDS incidence among males. This gender difference is biologically plausible, as female fetuses demonstrate earlier surfactant production due to estrogen, while androgens delay fibroblast-pneumocyte factor secretion, as described by Liu et al[36].

APGAR scores were significantly higher in the improvement group (mean 6.81 vs. 6.25), reinforcing the predictive value of early neonatal condition. Bacha et al.[33] similarly noted poorer outcomes in neonates with APGAR <7 at the fifth minute. This association reflects the impact of birth asphyxia on cardiopulmonary stability, consistent with earlier observations by Wennergren M et al.[38]

Hospital stay was longer in the improvement group (33.76 days vs. 25.96 days), suggesting that extended inpatient support contributes to stabilization and recovery. In contrast, Bacha et al.[33] reported that most poor outcomes occurred within the first seven days—highlighting the need for early intervention and strengthening referral pathways for out-born neonates, especially during the critical early hours.

Gestational age played a pivotal role in RDS outcomes, with higher gestational age significantly associated with improvement (31.53 vs. 29.97 weeks). This finding is supported by Manuck T et al.[39], who noted global evidence that each additional week of gestation substantially improves pulmonary maturity and reduces respiratory complications. Infants born at lower gestational ages predictably have higher surfactant deficiency and greater need for respiratory support.

Mortality trends demonstrated remarkable improvements over time. Historically, mortality from extreme prematurity and RDS was as high as 90%, as highlighted by Battin et al.[40], but has progressively declined with improvements in neonatal respiratory care. Abdul-Mumin A et al.[32] reported a mortality rate of 39.27%, whereas Bulimba M et al.[41] found early neonatal mortality of 31.3% among preterm infants. In comparison, the current study's mortality rate of 21.1% reflects significant progress, driven largely by increased accessibility and timely initiation of CPAP.

Gestational age remained a powerful predictor of mortality and discharge outcomes. Abdul-Mumin A et al.[32] and Bhutta ZA et al.[42] reported substantially reduced survival in extremely preterm infants (<28 weeks), while Bacha et al.[33] showed mortality was four times higher in extremely preterm infants. This pattern confirms the global understanding that improved survival correlates strongly with advancing gestational maturity, as reaffirmed by Manuck T et al.[39].

APGAR scores further reinforced predictive value for survival in this cohort. Bacha et al.[33] reported that neonates with APGAR scores 4–7 had mortality of 40%, compared with 25.6% in those with higher scores. Thus, low APGAR scores in preterm neonates with RDS serve as independent predictors of adverse outcomes, reflecting their

compromised cardiopulmonary function at birth.

CONCLUSION

In this study, Silverman scores at admission and after 24 hours significantly predicted respiratory progress, emphasizing the role of early CPAP, initiated within the first hour for 65.45% of neonates. This aligns with Hedstrom et al.[43], who showed first-hour Respiratory Severity Scores predict escalation in respiratory support. CPAP remains central to RDS management, as supported by Halim et al.[16], Abdel et al.[26], Stevens et al.[5], and Verder et al.[8], all demonstrating reduced morbidity with early CPAP and surfactant. Additional determinants—including maternal high-risk factors, ventilator requirement beyond 24 hours, and prolonged hospitalization—were significant in recovery trajectories, consistent with broader findings from Rego MA et al.[44] and McAdmas RM[45].

This study highlights the critical role of Continuous Positive Airway Pressure (CPAP) therapy in improving outcomes for preterm neonates with respiratory distress syndrome (RDS). Nearly two-thirds of the infants showed clinical improvement, demonstrating CPAP's effectiveness in enhancing respiratory function.

Gestational age and higher APGAR scores were strong predictors of recovery, underscoring the importance of lung maturity and early stabilization. Extended hospital care also contributed to better outcomes. The notably lower mortality rate further supports CPAP as a key intervention in reducing complications associated with RDS. Overall, these findings reinforce the value of early CPAP initiation and comprehensive neonatal care in improving survival and respiratory outcomes in preterm infants.

REFERENCES

1. Susan G. Respiratory distress syndrome. In: Eric C, Anne R, Camilia R, Ann R, editors. Cloherty and Stark's Manual of Neonatal care. 8th edition. Gurgaon Haryana. Wolters Kuwer; Lippincott Williams and wilkins;2017;p 384-91.
2. Shawn KA. Respiratory Distress Syndrome. Nelson textbook of Pediatrics. 21st Edition. Elsevier. Philadelphia, Pennsylvania.2019.p3997-4018.
3. Hosny MA et al Comparative Study between Continuous Positive Airway Pressure with or without Surfactant in Management of Preterm Babies with Respiratory Distress Syndrome. Am. J. Med; 2017(July);7(2):37-46.
4. NakhshabA, MehdiTA, Comparison of the Effect of Surfactant Administration During Nasal Continuous Positive Airway Pressure with that of Nasal Continuous Positive Airway Pressure Alone on Complications of Respiratory Distress Syndrome. PEDN 56, no. 2; (2015); 88-94.
5. Stevens, Timothy P., Mats B, Eliza H. Myers, and Roger S. Early surfactant administration with brief ventilation vs. selective surfactant and continued mechanical ventilation for preterm infants with or at risk for respiratory distress syndrome. CDSR (2007). October.
6. Jeffrey AW, Amy TN, Shawn KA, Gloria SP and Paul SK. Acute Pulmonary Disorders Avery & MacDonald's Neonatology Pathophysiology and Management of the Newborn. Eight Edition. Wolters Kluwer. Philadelphia.2021.p364-85.
7. Silverman WA, Dorothy H, Andersen. A controlled clinical trial of effects of water mist on obstructive respiratory signs, death rate and necropsy findings among premature infants. Pediatrics 17, no. 1 (1956)June; 1-10.
8. Verder, Henrik, Albertsen P Nasal continuous positive airway pressure and early surfactant therapy for respiratory distress syndrome in newborns of less than 30 weeks' gestation. Pediatrics 103, no. 2 (1999); e24-e24.
9. Sadeghnia, Alireza, Marzieh Z F, and Zohreh B. A comparative study of the effect of nasal intermittent positive pressure ventilation and nasal continuous positive airway pressure on the regional brain tissue oximetry in premature newborns weighing< 1500 g. Int. J. Prev. Med; (2017).8.
10. Manandhar, Sunil Raja. "Outcome of respiratory distress in neonates with bubble CPAP at neonatal intensive care unit of a tertiary hospital." JNMA: Journal of the Nepal Medical Association 57, no. 216 (2019): 92.
11. Balaji RJ, Rajiv PK, Patel VK, Kripail M. Outcome of early CPAP in the management of respiratory distress syndrome (RDS) in premature babies with≤ 32 weeks of gestation, A prostpective observational study. Indian Journal of Neonatal Medicine and Research. 2015 Apr;3(2):1-6.
12. Urs PS, Khan F, Maiya PP. Bubble CPAP-a primary respiratory support for respiratory distress syndrome in newborns. Indian pediatrics. 2009 May 1;46(5).
13. Kribs A, Vierzig A, Hünseler C, Eifinger F, Welzing L, Stützer H, Roth B. Early surfactant in spontaneously breathing with nCPAP in ELBW infants--a single centre four year experience. Acta Paediatr. 2008 Mar;97(3):293-8. doi: 10.1111/j.1651-2227.2007.00617.x. PMID: 18298776.
14. Dargaville PA Minimally-invasive surfactant therapy in preterm infants on continuous positive airway pressure. Arch Dis Child Fetal Neonatal Ed. 2013 Mar;98(2):F122-6. doi: 10.1136/archdischild-2011-301314. Epub 2012 Jun 9. PMID: 22684154.
15. Kandraju, Hemasree, Srinivas M, Sreeram S Early routine versus late selective surfactant in preterm neonates with respiratory distress syndrome on nasal continuous positive airway pressure: a randomized controlled trial. Neonatology 103, no. 2 (2013); 148-54.
16. Halim, Alia, Haider S, Sadia R, Syeda S G, and Wahid A. Less invasive surfactant administration in preterm infants with respiratory distress syndrome. J Coll Physicians Surg Pak 29, no. 3 (2019); 226-330.
17. Oncel, Mehmet Y, Sema A, Nurdan U, Evrim A D, Nasal continuous positive airway pressure versus nasal intermittent positive-pressure ventilation within the minimally invasive surfactant therapy approach in preterm infants: a randomised controlled trial. Arch. Dis. Child. Fetal Neonatal Ed. ARCH DIS 101, no. 4 (2016); F323-28.
18. Ramanathan R, Sekar K C, Rasmussen M, Bhatia J and Soll R F. Nasal intermittent positive pressure ventilation after surfactant treatment for respiratory distress syndrome in preterm infants< 30 weeks' gestation: a randomized, controlled trial. Journal of Perinatology, 2012; 32(5), pp.336-43.
19. Meneses, Jucille, Vineet B, and Joao G. Alves. Nasal intermittent positive-pressure ventilation vs nasal continuous positive airway pressure for preterm infants with respiratory distress syndrome: a systematic review and meta-analysis. Arch. pediatr. adolesc. med. 166, no. 4 (2012); 372-76.
20. Gupta, Samir, Sunil K. Sinha, Win T, and Steven M. Donn A . randomized controlled trial of post-extubation bubble continuous positive airway pressure versus Infant Flow Driver continuous positive airway pressure in preterm infants with respiratory distress syndrome. J. Pediatr. J PEDIATR-US 154, no. 5 (2009); 645-50.
21. Esmaeilnia, Tahereh, Fatemeh N, Roya T, Mamak S, and Faezeh M B. Comparison of complications and efficacy of NIPPV and nasal CPAP in preterm infants with RDS. Iran. J. Pediatr.2016; 26, no. 2
22. Dunn, Michael and Vermont Oxford Network DRM Study Group. Randomized trial comparing 3 approaches to the initial respiratory management of preterm neonates. Pediatrics 128, no.5 (2011); e1069-76.
23. Kayvan, Mirnia, Heidarzadeh M, Hosseini M B, Sadeghnia A, Balila M, and Ghojazadeh M. Comparison outcome of surfactant administration via tracheal catheterization during spontaneous breathing with insure. (2013); 143-8.
24. Raschetti, Roberto, Roberta C. Estimation of early life endogenous surfactant pool and CPAP failure in preterm neonates with RDS. Respir. Res 20, no.1 (2019); 1-8.
25. Roberts, Kari D, Roland B, Rich et al. Laryngeal mask airway for surfactant administration in neonates: a randomized, controlled trial. J. Pediatr. 193 (2018); 40-46.
26. Abdel L, Mohamed E, and David A O. Laryngeal mask airway surfactant administration for prevention of morbidity and mortality in preterm infants with or at risk of respiratory distress syndrome. CDSR reviews 7 (2011).
27. More, Kiran, Pankaj S, and Prakesh S. Minimally invasive surfactant administration in preterm infants: a meta-narrative review. JAMA pediatrics 168, no.10 (2014); 901-08.
28. Isayama, Tetsuya, Hiroko Iwami, Sarah McDonald, and Joseph Beyene. Association of noninvasive ventilation strategies with mortality and bronchopulmonary dysplasia among preterm infants: a systematic review and meta-analysis. JAMA pediatrics 316, no.6 (2016); 611-24.
29. Rijal P, Shrestha M. Analysis of neonatal respiratory distress in neonatal intensive care unit at Nepal medical college. J Nepal Health Res Counc 2018; 16(2): 2.
30. Salih SA, A/Gadir YS. Early outcome of pre-term neonates delivered at Soba University Hospital. Sudan Paediatr 2013; 13(2): 37–44. [PMC free article] [PubMed] [Google Scholar]
31. Moshiro R, Perlman JM, Mdoe P, et al. Potential causes of early death among admitted newborns in a rural Tanzanian hospital. PLoS One 2019; 14(10): e0222935
32. Abdul-Mumin A, Owusu SA, Abubakari A. Factors associated with treatment outcome of preterm babies at discharge from the neonatal intensive care unit (NICU) of the tamale teaching hospital, Ghana. Int J Pediatr 2020; 2020: e5696427.
33. Bacha LT, Hailu WB, Tesfaye Geta E. Clinical outcome and associated factors of respiratory distress syndrome among preterm neonates admitted to the neonatal intensive care unit of Adama Hospital and Medical College. SAGE Open Med. 2022 Dec 25;10:20503121221146068. doi: 10.1177/20503121221146068. PMID: 36600978; PMCID: PMC9806403.
34. Niesłuchowska-Hoxha A, Cnota W, Czuba B, et al. A retrospective study on the risk of respiratory distress syndrome in singleton pregnancies with preterm premature rupture of membranes between 24+0 and 36+6 weeks, using regression analysis for various factors. BioMed Res Int 2018; 2018: e7162478.
35. Qari SA, Alsufyani AA, Muathin SH, et al. Prevalence of respiratory distress syndrome in neonates. Egypt J Hosp Med 2018; 70(2): 257–264.
36. Liu J., Yang N., and Liu Y., High-risk Factors of Respiratory Distress Syndrome in Term Neonates: A Retrospective Case-control Study, Balkan Medical Journal. (2014) 33, no. 1, 64–68,
37. Luerti M, Parazzini F, Agarossi A, et al. Risk factors for respiratory distress syndrome in the newborn: a multicenter Italian survey. Acta Obstet Gynecol Scand; 1993; 72(5): 359–364.
38. Wennergen M, Krantz M, Hjalmarson O, et al. Low Apgar score as a risk factor for respiratory disturbances in the newborn infant. J Perinat Med 1987; 15(2): 153–160.
39. Manuck T. A., Rice M. M., Bailit J. L., Grobman W. A., Reddy Uand Seguin J., Preterm neonatal morbidity and mortality by gestational age: a contemporary cohort, American Journal of Obstetrics and Gynecology. (2016) 215
40. Battin M. R., Knight D. B., Kuschel C. A., and Howie R. N., Improvement in mortality of very low birthweight infants and the changing pattern of neonatal mortality: the 50-year experience of one perinatal centre, Journal of Paediatrics and Child Health. (2012) 48, no. 7, 596–599, https://doi.org/10.1111/j.1440-1754.2012.02425.x, 2-s2.0-84863454922, 22409276.
41. Bulimba, M., Cosmas, J., Abdallah, Y. et al. Early outcomes of preterm neonates with respiratory distress syndrome admitted at Muhimbili National Hospital, a prospective study. BMC Pediatr 22, 731 (2022). https://doi.org/10.1186/s12887-022-03731-2
42. Bhutta Z. A., Das J. K., Bahl R., Lawn J and Walker N., Can available interventions end preventable deaths in mothers, newborn babies, and stillbirths, and at what cost?, Lancet. (2014) 384, no. 9940, 347–370, https://doi.org/10.1016/S0140-6736(14)60792-3, 2-s2.0-84904857686.
43. Hedstrom AB, Gove NE, Mayock DE, Batra M. Performance of the Silverman Andersen Respiratory Severity Score in predicting PCO2 and respiratory support in newborns: a prospective cohort study. J Perinatol. 2018 May;38(5):505-511. doi: 10.1038/s41372-018-0049-3. Epub 2018 Feb 9. PMID: 29426853; PMCID: PMC5998375.
44. Rego MA, Martinez FE. Comparison of two nasal prongs for application of continuous positive airway pressure in neonates. Pediatr Crit Care Med. 2002;3:239–43. doi: 10.1097/00130478-200207000-00007.
45. McAdams RM, Hedstrom AB, DiBlasi RM, Mant JE, Nyonyintono J, Otai CD, et al. Implementation of bubble CPAP in a rural Ugandan neonatal ICU. Respir Care. 2015;60:437–45. doi: 10.4187/respcare.03438.