Use of nasal intermittent positive pressure ventilation to avoid intubation in neonates

Shabih Manzar, *MD, FAAP,* ***Arun K. Nair,*** *FRCPCH,* ***Mangalore G. Pai,*** *MD,* ***Jose Paul,*** *MD, MRCPCH,* ***Prakash Manikoth,*** *MD, MRCPCH,* ***Mariam Georage,*** *MD,* ***Saleh M. Al-Khusaiby,*** *FRCPCH, PhD.*

ABSTRACT

Objective: Nasal intermittent positive pressure ventilation (NIPPV) has widely been used in neonates to prevent extubation failure and apnea. This pilot study was carried out to look at the early use of NIPPV to avoid intubation.

Methods: The study was carried out over a period of 3 months from August 2003 to October 2003 at the Royal Hospital, Muscat, Sultanate of Oman. The neonates with clinical signs of moderate to severe respiratory distress were given a trial of early NIPPV based on the avoid-intubation protocol. Inclusion, exclusion and failure criteria with general procedure were made clear to all medical and nursing staff and the protocol was posted in the unit for further time to time referral.

Results: A total of 16 neonates met the inclusion criteria for early NIPPV trial. Out of these, 13 (81%) had a successful NIPPV. The mean age of entry was 0.95 hours; however, the mean duration of NIPPV was 23 hours. No NIPPV related complications were noted in the study group.

Conclusion: We concluded that NIPPV is an appropriate mode of ventilation in neonates requiring respiratory support. The major advantage of NIPPV is the non-invasive mechanics. It is also less expensive and less labor intensive. Further randomized controlled trials with larger sample size are warranted to confirm our findings.

Saudi Med J 2004; Vol. 25 (10): 1464-1467

Use of nasal intermittent positive pressure ventilation (NIPPV) is gaining interest as an effective modality in treating respiratory problems in neonates.[1,2] It has shown to be more effective than nasal continuous positive airway pressure (NCPAP) in preventing extubation failure and apnea in premature neonates.[3-7] These studies have looked at the late (post-extubation) use of NIPPV mode. However, early (pre-intubation) use of this promising modality in neonates with respiratory failure has not been looked at. The present pilot study was conducted with the aim to look at the early use of NIPPV in newborn infants with respiratory failure.

Methods. The study was carried out at the Neonatal Intensive Care Unit (NICU) at Royal Hospital, Muscat, Sultanate of Oman, with 30 beds and provides level III-IV care for all high-risk neonates including general and cardiac surgery. All newborn infants, irrespective of the birth weight or gestational age, with early clinical signs of moderate to severe respiratory distress (tachypnea with respiratory rate of >60 per minutes, grunting, nasal flaring, subcostal or and intercostal recessions) were given a trial of NIPPV based on the avoid-intubation protocol (**Figure 1**). Inclusion, exclusion and failure criteria were made clear to all medical and nursing staff and the protocol was

From the Neonatal Intensive Care Unit, Department of Child Health, Royal Hospital, Muscat, *Sultanate of Oman*.

Received 14th March 2004. Accepted for publication in final form 31st May 2004.

Address correspondence and reprint request to: Dr. Shabih Manzar, Department of Neonatology, John H. Stroger Jr. Hospital, 1901 West Harrison Street, Chicago, IL 60612, *United States of America*. Tel. +1 (312) 8644043. Fax. +1 (312) 6336705. E-mail: shabihman@hotmail.com

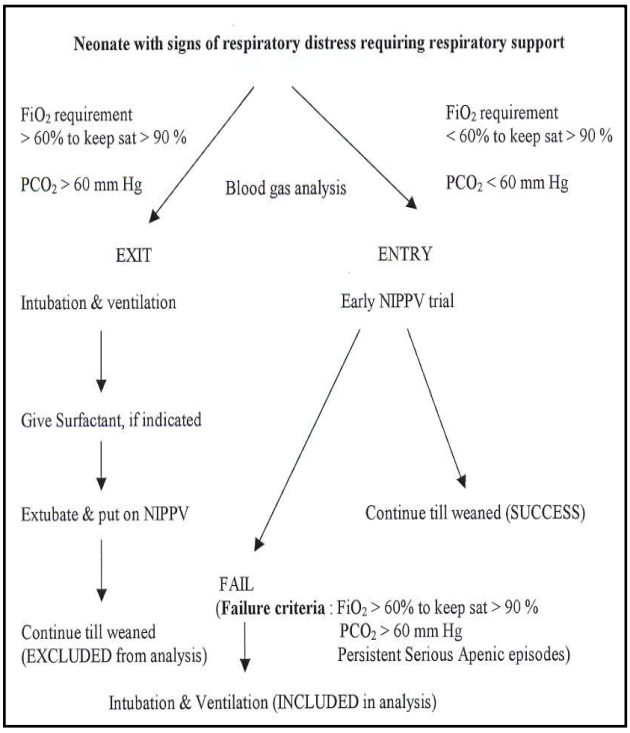

Figure 1 - Avoid-intubation protocol. PCO_2 - partial pressure of carbon dioxide, NIPPV - Nasal intermittent positive pressure ventilation, FiO_2 - fraction of inspired oxygen

Table 1 - Details of infants who failed Nasal intermittent positive pressure ventilation trial.

Variables	Infant 1	Infant 2	Infant 3
Birth weight (grams)	1030	1400	1930
Gestational age (weeks)	32	31	36
Gender	Male	Female	Male
Mode of delivery	CS	CS	CS
Apgar score at 1 minute	4	2	4
Apgar score at 5 minute	8	8	7
Need for resuscitation	Yes	Yes	Yes
Trial time	30 minutes	30 minutes	8 hours
Reason for failure	Persistently high PCO_2	Increasing FiO_2 requirements	Frequent desaturations

CS - cesarean section, PCO_2 - partial pressure of carbon dioxide, FiO_2 - fraction of inspired oxygen

posted in the neonatal intensive care unit (NICU) for further time to time referral. The study protocol was approved by the ethic committee and parental consent was taken for the trial.

General procedure. The NIPPV was given through the Drager ventilator (Babylog 8000) selecting NIPPV mode using Argyle nasal prongs (Argyle, Sherwood Medical Co, St. Louis, MO). Blood gas analyses were performed using the automatic analyzer (Ciba-Corning 850, MA, USA) before and after NIPPV administration. Infants were continued to receive NIPPV as per the protocol until improvement or failure. The failure criteria were set forth in the protocol: partial pressure of carbon dioxide (PCO_2) >60 mm Hg, fraction of inspired oxygen (FiO_2) >60% to keep saturation of >90% or recurrent serious episodes of apneas or need for intubation for any other reason. The initial ventilator settings were established in the protocol as: peak inspiratory pressure was 18, positive end expiratory pressure was 4, rate was 25, FiO_2 was 50%, and flow was 8-10 L/minute. The settings were decreased based on clinical improvement and post NIPPV blood gas. The increase in requirement of ventilatory settings resulted in the exit of the infant from the trial. During NIPPV infants were cared in high dependency area of the NICU with 24-hour monitoring of vital signs, saturations and signs of clinical improvement or deterioration in the respiratory status. Big bore orogastric tube was inserted in all infants to deter the unwanted effect of abdominal distension during NIPPV. Infants were fed through the same tube kept in burp position.

Data collection. The baseline data including the medical record number, birth weight, gestational age, gender, type of delivery, Apgar score, mode of resuscitation, age at entry, duration of NIPPV and pre and post NIPPV blood gas (arterial or capillary) were entered into the data collection proforma sheets. Infants with congenital anomalies, those requiring intubation (extreme prematures, very low birth weight infants) and those needing rescue surfactant replacement therapy were excluded from the study. The pilot study was conducted over a period of 3 months from August 2003 to October 2003. Statistical Package for Social Science (SPSS) version 7.5 was used for basic statistical analysis including mean, mode and frequencies.

Results. During the study period, a total of 16 neonates met the inclusion criteria for early NIPPV trial. Out of these, 13 (81%) had a successful NIPPV. The mean age at entry was 0.95 ± 1.76 hours. The mean Apgar score at one minute was 6 while the mean 5-minute Apgar score was 8. The mean birth weight was 1992 ± 549 grams with the mean gestational age of 33 ± 2.4 weeks. The mean

duration of NIPPV was 23 hours with a range of 0.5 to 71 hours. Most of the babies were born by cesarean section (CS). The vaginal deliveries were 2 (12.5%) while CS were 14 (87.5%). The majority of the babies (82%) required active resuscitation (13 out of 16). The male to female ratio was 3:1. As the number of cases in failed and successful groups was small, 3 versus 13, no statistical analysis were performed. The details of the failed cases are shown in **Table 1**.

Discussion. In the present study, we were able to show the successful use of early (pre-intubation) NIPPV in neonates with respiratory distress. Previous investigators have used NIPPV mode only as a weaning mode after extubation or for the treatment of apnea in neonates.[3-7] Nasal intermittent positive pressure ventilation has major advantages over intubation. It is non-invasive, less expensive and less labor intensive. Also, the potential complications of NIPPV are less as compared to intubation. Recently, a case of esophageal perforation has been reported in a surgical patient with the use of non-invasive ventilation.[8] While, tracheal intubation has shown to be associated with risk of tracheal and laryngeal damage and with increase incidence of nosocomial infection.[9,10] Thus, being a non-invasive mode of ventilation and relatively less damaging as compared to intubation, NIPPV has a promising prospect, as evident from the findings of our study.

The rational behind using NIPPV instead of nasal continuous positive airway pressure (NCPAP) needs clarification. One could argue about the use of mandatory rates provided through NIPPV that could be avoided by using the NCPAP. There is no doubt on the effectiveness of NCPAP in neonates with respiratory failure. Previous studies have demonstrated that convincingly.[11-14] However, the problems in lung recruitment and work of breathing have been shown with the use of different types of NCPAP devices.[15,16] Also, the respiratory mechanics are more in synchrony with the use of NIPPV as compared to NCPAP.[17] Continuous positive airway pressure provides only a single level of airway pressure, which is maintained above the atmospheric pressure throughout the entire respiratory cycle.

Nasal intermittent positive pressure ventilation, on the other hand, provides an inspiratory positive pressure for ventilatory assistance and lung recruitment and an expiratory positive pressure to help recruit lung volume and adequate lung expansion.[6,7] The other expected advantage of NIPPV over NCPAP is the elimination of PCO_2 by providing rates. We noted (data not shown) that in 10 neonates (62.5 %), the pre NIPPV blood gas PCO_2 were greater than 55 mm Hg, which came down considerably after the use of NIPPV, as reflected in the post NIPPV blood gas analysis. As the PCO_2 of 60 mm Hg was preset as cutoff point for NIPPV trial, permissive hypercapnia was not considered, as described in literature.[18-20] Nasal intermittent positive pressure ventilation was noted to be unsuccessful in 3 babies. Looking into the profile of these failed cases, we noted that all 3 babies had low birth weight (<2.5 kg) and all were preterm (<37 weeks). The other common variables among these infants were low Apgar score, need for resuscitation and CS. However, gender, weight and gestational age were different among the cases. To correlate these variables with failure, ideal method would be the multiple logistic regression analysis, as shown earlier with the use of NCPAP.[21] But in view of the small numbers, statistical analysis was not performed. Being an observational pilot study with small sample size these limitations are expected. In the present study, we only looked at the short-term outcome, the success or failure of NIPPV. Long term outcome such as incidence of chronic lung disease, cost of care, length of hospital stay was not looked at, as suggested earlier.[6,11] The other 2 limiting factors were the fact that relatively mature groups of babies were noted to have success with NIPPV and no control group was used for comparison. However, further studies are warranted to look into these critical points and to provide answers for the queries raised. A randomized control trial with specified cause for the respiratory distress and further stratification based on gestational age or birth weight would be ideal.

In conclusion, the findings of our study suggest that early NIPPV could be successfully used in neonates requiring respiratory support. The major advantage of NIPPV is its non-invasive mechanics. It is less expensive and less labor intensive. Early intervention with NIPPV may result in preventing undue intubation and risk associated with it. Although our study has projected NIPPV to have a promising prospect, randomized control trials with larger sample size are warranted to confirm further on our findings before embarking on the extensive use of early NIPPV in neonates, especially the premature very low birth weight infants.

Acknowledgment. We wish to extend our thanks to all the residents and nursing staff at Royal Hospital, Muscat, Sultanate of Oman, for their consistency in following the protocol and their sincere assistance in blood gas analysis needed for the study.

References

1. Jackson JK, Vellucci J, Johnson P, Kilbride HW. Evidence-based approach to change in clinical practice: introduction of expanded nasal continuous positive airway pressure use in an intensive care nursery. ***Pediatrics*** 2003; 111: e542-e547.

2. DePaoli AG, Davis PG, Lemyre B. Nasal continuos positive airway pressure versus nasal intermittent positive pressure ventilation for premature neonates: a systemic review and meta-analysis. ***Acta Paediatr*** 2003; 92: 70-75.
3. Davis PG, Lemyre B, De Paoli AG. Nasal intermittent positive pressure ventilation versus nasal continuos positive airway pressure for premature neonates after extubation. Update Software. Issue 1. Oxford (UK): The Cochrane Library; 2002.
4. Lemyre B, Davis PG, De Paoli AG. Nasal intermittent positive pressure ventilation versus nasal continuos positive airway pressure for apnea of prematurity. Update Software. Issue 1. Oxford (UK): The Cochrane Library; 2002.
5. Friedlich P, Lecart C, Posen R, Ramicone E, Chan L, Ramanathan R. A randomized trial of nasopharyngeal-synchronised intermittent mandatory ventilation versus nasopharyngeal continuos positive airway pressure in very low birth weight infants after extubation. ***J Perinatol*** 1999; 19: 413-418.
6. Barrington KJ, Bull D, Finer NN. Randomized trial of nasal synchronized intermittent mandatory ventilation compared with continuos positive airway pressure after extubation of very low birth weight infants. ***Pediatrics*** 2001; 107: 638-641.
7. Khalaf MN, Brodsky N, Hurley J, Bhandari V. A prospective randomized controlled trial comparing synchronized nasal intermittent mandatory ventilation versus nasal continuos positive airway pressure as modes of extubation. ***Pediatrics*** 2001; 108: 13-17.
8. Van de Louw A, Brocas E, Boiteau R, Perren-Gachadoat D, Tenaillon A. Esophageal perforation associated with non-invasive ventilation. A case report. ***Chest*** 2002; 122: 1857-1858.
9. Guerin C, Girard R, Chemorin C, DeVarax R, Fourneir G. Facial mask noninvasive mechanical ventilation reduces the incidence of nosocomial pneumonia. ***Intensive Care Med*** 1997; 23: 1024-1032.
10. Stoll BJ, Gordon T, Korones SB, Shankaran S, Tyson JE, Baner CR, et al. Late-onset sepsis in very low birth weight neonates: a report from the National Institute of Child Health and Human Development Neonatal Research Network. ***J Pediatr*** 1996; 129: 63-71.
11. Morley CJ, Davis P, Doyle L. Continuous positive airway pressure: randomized, control trial in Australia. ***Pediatrics*** 2001; 108: 1383.
12. Bassiouny MR, Gupta A, El-Bualy M. Nasal continuous positive airway pressure in the treatment of respiratory distress syndrome: an experience from a developing country. ***J Trop Pediatr*** 1994; 40: 341-343.
13. Aly HZ. Nasal prongs continuous airway positive pressure: a simple yet powerful tool. ***Pediatrics*** 2001; 108: 759-761.
14. De Klerk AM, de Klerk RK. Use of continuous airway positive pressure in preterm infants: comments and experience from New Zealand. ***Pediatrics*** 2001; 108: 76-73.
15. Courtney SE, Pyon KH, Saslow JG, Arnold GK, Pandit PB, Habib RH. Lung recruitment and breathing pattern during variable versus continuous flow nasal continuous airway positive pressure in premature infants: an evaluation of three devices. ***Pediatrics*** 2001; 107; 304-308.
16. Pandit PB, Courtney SE, Pyon KH, Saslow JG, Habib RH. Work of breathing during constant-and variable- flow nasal continuous airway positive pressure in preterm neonates. ***Pediatrics*** 2001; 108; 682-685.
17. Kiciman NM, Andreasson B, Bernstein G, Mannino FL, Rich W, Henderson C, et al. Thorocoabdominal motion in newborn during ventilation delivered by endotracheal tube or nasal prongs. ***Pediatr Pulmonol*** 1998; 25: 175-181.
18. Mariani G, Cifuentes J, Carlo WA. Randomized trial of permissive hypercapnia in preterm infants. ***Pediatrics*** 1999; 104: 1082-1088.
19. Thome UH, Carlo WA. Permissive hypercapnia. ***Semin Neonatol*** 2002; 7: 409-419.
20. Ambalavanan N, Carlo WA. Hypocapnea and hypercapnea in respiratory management of newborn infants. ***Clin Perinatol*** 2001; 28: 517-531.
21. Boo NY, Zuraidah AL, Lim NL, Zulfiqar MA. Predictors of failure of nasal continuous positive airway pressure in the treatment of preterm infants with respiratory distress syndrome. ***J Trop Pediatr*** 2000; 46: 172-174.