MECHANICAL VENTILATION OF NEW BORNS: EXPERIENCE FROM A LEV EL II NICU

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ABSTRACT

***Objectives**: To analyse the indications, clinical profile, complications and outcome of the babies requiring mechanical ventilation*

***Design**: Retrospective study.*

***Setting**: NICU of a teaching hospital.*

***Subjects**: One hundred and twenty one neonates requiring assisted ventilation during three years.*

***Results:** Of 121 babies 59(48.76%) survived. Hyaline membrane disease (HMD) was the commonest indication for ventilation followed by birth asphyxia, apnea of prematurity, meconium aspiration syndrome (MAS) and septicemia. Infants with HMD whose birth weight was more than 1.5 kg and those who required ventilation after 24 hours of birth had better outcome. Survival rates increased with increasing birth weight and gestational age. Prolonged ventilatory support was needed for HMD (mean 117.3 hr) and MAS (mean 82.6 hr). Pneumonia was the commonest complication, followed by sepsis, air leak syndromes and intracranial and pulmonary hemorrhage.*

***Conclusions:** Ventilatory facilities must be focussedfor neonates weighing > 1000 g. Assisted ventilation may not be cost-effective in patients weighing <1000 g and those with complex heart diseases and other congenital anomalies.*

Keywords: *Mechanical ventilation, Hyaline membrane disease, Developing countries.*

Prolonged mechanical ventilation of the newborn infant was first described by Donald and. Lord(l). Since then mechanical ventilation of the neonate has been used widely and has become a routine procedure in neonatal intensive care units (NICU) in the Western world(2). Neonatal mechanical ventilation is probably the single most important factor contributing to the rapid decrease in neonatal mortality within the last two decades(3).

This modality of treatment has not been incorporated in most centers in India owing to the high cost, lack of trained personnel and equipments required. Hence the reports on mechanical ventilation in neonates are scanty in Indian literature(4-6). We report the indications, clinical profile, complications and outcome of neonates requiring mechanical ventilation during the last three years.

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Subjects and Methods

One hundred and twenty one neonates admitted to the NICU at M.S. Ramaiah Medical College (mainly a referral center) who required assisted ventilation during January 1991 to September 1993 were included in the study, The NICU is staffed by two postgraduate students, two lecturers and 11 trained staff nurses and supervised round the clock by a professor and an associate professor. Three infants (one each of tracheo-esophageal fistula, severe[1] birth asphyxia (BA) and severe hyaline membrane disease (HMD) ventilated for less than 5 hr were excluded from this analysis.

All cases were carefully analyzed and a detailed antenatal, intranatal and postnatal history obtained. The neonate's birth weight, gestational age and age of onset of respiratory distress were recorded. Standard clinical, laboratory and/or radiologic criteria were used for diagnoses of hyaline membrane disease (HMD)(7), apnea(8), meconium aspiration syndrome (MAS)(9), BA(10), transient tachypnea of the newborn(11), sepsis(12), pneumonia, congenital heart disease, and congenital anomalies.

The indications for ventilation were arterial blood pH of <7.20, $PaCO_2$ of >60 mm Hg, PaO_2 <50 mm Hg with FiO_2 of 0.7 to 1.0 or persistent apnea. As most of the babies were referred late and required assisted ventilation on admission, they were directly put on the intermittent mandatory ventilation (IMV) mode. The babies were ventilated with Bear Cub (Pressure limited, time cycled, continuous flow) ventilator with IMV and continuous positive airway pressure (CPAP) mode with varying settings, depending on underlying disease and arterial blood gas analysis. Efforts were made to ventilate effectively with minimal settings.

All babies were nursed under servocontrol open-care systems with inbuilt phototherapy units. Arterial blood gas analysis using radial artery puncture was done as and when necessary. Oxygen saturation was continuously monitored with pulse oximeter. Chest X-ray was done before and after extubation and whenever required.

Sepsis screening (CRP, total and differential leucocyte count, band cell count, micro ESR, blood culture), serum chemistry and routine hematological investigations were done in all the babies. The initial antibiotics were cefotaxime and amikacin; other drugs were used if required. Cranial ultrasound, CT scan and echocardiography were done when needed. Babies with patent ductus arteriosus (PDA) not responding to fluid restriction and diuretics received oral indomethacin.

All babies received intravenous fluids initially; nasogastric drip feed with expressed breast milk was commenced once they were stable. Pulmonary physiotherapy was given during and after mechanical ventilation.

Weaning was attempted when the babies showed clinical and radiological improvement with almost normal blood gas on minimal ventilatory settings (rate 10-15/min, PIP 12-14 cm, PEEP 2-3 cm, FiO_2 0.4). Before extubation they were put on CPAP and extubated when arterial blood gas on CPAP was within acceptable limits. Dexamethasone and

theophylline were administered to assist weaning.

Twenty nine babies underwent autopsy studies to ascertain the cause of death.

Results

One hundred and twenty one babies out of 782 total admissions to the NTCU during 3 years required assisted ventilation. This accounted for 15% of 1991, 17% of 1992 and 14% of 1993 admissions. Ninety four babies (78%) were outborn and 27(22%) were born in the same hospital.

Table I shows the indications for mechanical ventilation and the survivals. HMD was the commonest indication in both intramural and extramual babies. Other patients were those with congenital heart disease (CHD) and other congenital anomalies. The survival rate for HMD was 56.3% (9/16) in 1991, 50% (12/24) in 1992 and 33.3% (5/15) in 1993. The survival in patients without HMD was 50% (5/10) in 1991, 60% (15/25) in 1992 and 41.9% (13/31) in 1993.

Table II shows the survival in relation to birth weight. Babies weighing less than 999 g had a survival of 20%, which gradually increased with higher birth weight. *Table III* shows the disease wise

Table I – *Indication for Mechanical Ventilation*

Indications	Intramural No.	Extramural No.	Survival No.
HMD	16(59.3)	39(41.5)	26(47.3)
Apnea/asphyxia	6(22.2)	16(17.0)	7(31.8)
MAS	2 (7.4)	16(17.0)	10(55.6)
Sepsis	-	7(7.4)	7(100)
Pneumonia	1 (3.7)	5(5.3)	6(100)
TTNB	-	1(1.0)	1(100)
Others	2 (7.4)	10(10.6)	2(16.7)

TTNB: transient tachypriea of newborn; figures in parentheses indicate percentage.

Table II- *Survival in Ventilated Babies in Relation into Birth Weight*

Birth Weight (g)	No. Admitted	No. Ventilated	Survival of Ventilated babies (%)
<1000	28	10	20.0
1000-1499	151	29	37.9
1500-1999	205	30	60.0
2000-2499	188	23	52.2
>2500	317	29	52.2

mean birth weight, gestational age, age at ventilation and duration of ventilation. The gestational agewise survival was 18.8% (3/16) for <28 weeks, 53.3% (16/30) for 29-32 weeks, 57.5% (19/33) for 33-36 weeks and 50% (21/42) for >37 weeks.

Babies with birth weight of <1.5 kg and requiring ventilatory support within 24 hr of birth had a survival of 34.3% (11/32) and for those with weight of >1.5 kg and requiring assisted ventilation after 24 hr of birth showed 100% survival.

The most important complications of prolonged ventilation was pneumonia (25.2%); 13.7% of these neonates died. Other complications included septicemia (14 patients, 10 died), air leak syndrome (4 patients), collapse of the lung (7 patients), pulmonary hemorrhage (4 patients), bronchopulmonary dysplasia (3 patients) and PDA (8 patients). The causes of death, some of which use confirmed on autopsy, included intracranial hemorrhage (24.2%), septicemia (16.1%), shock (9.7%), BA *(9.7%),* pulmonary hemorrhage (8.1%), pneumonia *(6.5%),* renal failure (6.5%), congenital anomalies (4.8%) and -air leak syndromes (3.2%).

Discussion

Fifteen per cent of the babies who were admitted to the NICU during the study period required mechanical ventilation. Seventy eight percent of the babies were outborn and this is important when considering survival. HMD was the chief indication for ventilation. Similar observations are reported previously(2,4,6). Other indications included birth asphyxia, apnea and MAS. The overall survival rate was 48.8%; comparable results are reported from other centers in India(6). Similar success rate had been achieved in the West in the early 198O's(13).

The survival rate for HMD was 47.3%. Singh *et al.(6)* have reported 53% survival for these babies. Exogenous surfactant therapy has been shown to reduce the mortality rate, requirements for mechanical ventilation and air leak com-

TABLE III- Mean Birth Weight, Gestational Age and Duration of Ventilation

Disease	No.	Weight (g)	Gestation (week)	Duration of ventilation (hours)
HMD	55	1375 (700-3200)	31(24-37)	117.3(3-264)
Asphyxia/apnea	22	2273 (1050-3500)	38(30-40)	56.3(2-96)
MAS	18	2784(1820-3975)	40(5-42)	82.6(15-360)
Sepsis	7	1836(1150-2500)	34(32-40)	110.0(20-360)
Pneumonia	7	1565(1130-2750)	33(32-40)	68.0(24-96)
TTN B	1	2280	38	24
Others	12	2279(1800-3960)	39(32-40)	44.6(2-103)

Figures in parentheses indicate range.
TTNB: transient tachypnea of newborn.

plications in HMD(14). We could not use it in any of our patients because of the high cost and difficulty in procuring it on time.

It is observed that the survival of infants with HMD increases with increase in birth weight and increasing age at initiation of ventilation(15,16). Our results are consistent with this. Neonates whose birth weight was less than 1.5 kg and those who required mechanical ventilation before 24 hours of age had reduced chances of survival compared to those with birth weight <1.5 kg and who did not require mechanical ventilation until after 24 hr of age. These results may be related to greater severity of the disease in the former patients. There was a decline in the survival of patients with HMD from 1991 to 1993. This is probably attributed to ventilation of more number of sick neonates and increase in associated complications like intracranial and pulmonary hemorrhage and pneumonia during the last two years.

There was a steady increase in survival with increasing birth weight and gestational age. However the survival rates were comparatively lower in neonates with birth weight of >2 kg and gestation >37 weeks. Most of these patients had severe BA, complex heart diseases and other congenital anomalies. The poor survival observed for babies with weight <1000 g is comparable to recent Indian experienced).

Pneumonia, sepsis and air leaks were the common complications of mechanical ventilation followed by intracranial hemorrhage and PDA. Pulmonary air leaks were the commonest complication in Western literature(2). High CPAP(17), peak and mean airway pressures and prolonged inspiratory time(18) are implicated as important factors causing air leaks. Pulmonary air leaks were, however, uncommon and found only in four neonates.

It was often difficult to determine whether complications like pneumonia and airleaks in MAS are related to mechanical ventilation *per se* or occur as a part of the natural course of the disease. As the complications are important causes of death, early diagnosis and judicious management of these complications is important. PDA which occurred in 8 babies responded to oral indomethacin. Bronchopulmonary dysplasia, a known complication of prolonged ventilation(19), occurred in 3 patients.

Since the outcome was poor for babies with birth weight <1 kg, it may not be cost-effective to ventilate these babies. Our data suggests that mechanical ventilation should be focused on those weighing more than 1000 g in view of their better survival. Babies with severe BA, with or without MAS may also require stringent criteria for ventilatory support owing to their poor survival and longterm sequelae.

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REFERENCES

1. Donald I, Lord J. Augmented respira-

tion. Studies in atelectasis neonatorum. Lancet 1953,1: 9-17.

2. William JR Daily, Sunshine P, Smith PC. Mechanical ventilation of the new born infants. Five years experience. Anesthesiol 1971, 34: 132-136.
3. Vidyasagar D, Ghai V. Respiratory care. *In:* Textbook of Neonatology, Ed. Vidyasagar D. Delhi, Interprint, 1987, pp 142-150.
4. Bhakoo ON, Narang A, Ghosh K. Assisted ventilation in neonates: A experiences with 120 cases. Paper presented at IX Annual Conference, National Neonatology Forum, Manipal, 1990.
5. Murali MV, Ray D, Paul VK, Deorari AK, Singh M. Continuous positive airway pressure (CPAP) with a face mask in infants with hyaline membrane disease. Indian Pediatr 1988, 25: 627-631.
6. AK Deorari, M Singh, Paul VK , *et al.* Three years experience with neonatal ventialtion from a tertiary care hospital in Delhi. Indian Pediatr 1993, 30: 783-789.
7. Rudolph AJ, Smith CA. Idiopathic respiratory distress syndrome. J Pediatr 1960,57:905-921.
8. Singh M, Paul VK, Bhakoo ON. Neonatal nomenclature and data collection. New Delhi, National Neonatology Forum. 1989, p 64.
9. Narang A. Definition of major illnesses as applicable at different levels of the health care delivery system. *In:* Neonatal Nomenclature and Data Collection. New Delhi, National Neonatology Forum, 1989, 27-35.
10. Carter BS, Haverkamp AD, Merenstein GB. The definition of acute perinatal asphyxia. Clin Perinat 1993, 20: 287-305.
11. Gotoff SP. Neonatal sepsis. *In:* Nelson Textbook of Pediatrics, 14th edn. Eds. Behrman RE, Kliegman RM, Nelson WE, Vaughan VC. Philadelphia, WB Saunders, 1992, pp 501-504.
12. Kliegman RM, Behaman RE. Transient tachypnea of the new born. *In:* Nelson Textbook of Peidatrics, 14th edn. Eds. Behrman RE, Kliegman RM, Nelson WE, Vaughan VC. Philadelphia, WB Saunders, 1992, p 469.
13. Lindroth M, Svennigsen NW, Ahlstrom H, Jonson B. Evaluation of mechanical ventilation of new born infants—I. Techniques and survival rates. Acta Paediatr Scand 1980, 69: 143-149.
14. Pramanik AK, Holtzman RB, Merritt TA. Surfactant replacement therapy for pulmonary disease. Pediatr Clin North Am 1993,40: 913-936.
15. Stahlman MT, Malan AF, Shepard FM, *et al.* Negative pressure assisted ventilation in infants with hyaline membrane disease. J Pediatr 1970, 76: 174-182.
16. Murdock Al, Linsao I, Reid MM, *et al.* Artificial mechanical ventilation in the respiratory distress syndrome. A controlled trial. Arch Dis Child 1970, 45: 624-633.
17. Hall RT, Rhodes PG. Pneumothorax and pneumomediastinum in infants with idiopathic respiratory distress syndrome receiving continuous positive airway pressure. Pediatrics 1975, 55: 493-496.
18. Herman S, Reynolds EOR. Mehtods for improving oxygenation in infants mechanically ventilated for severe hyaline membrane disease. Arch Dis Child 1973, 48: 612-617.
19. Northway WH, Rosen RC, Porter DY. Pulmonary disease following respiratory therapy of hyaline mebrane disease: Broncho pulmonary dysplasia. New Eng J Med 1967,276: 357-359.