INVITED PAPER

Respiratory Support in the Newborn

by

RUSEPNO HASSAN, IMRAL CHAIR and ABDUL LATIEF

(From the Department of Child Health, Medical School University of Indonesia, Jakarta)

Introduction

The prognosis of newborn infants with acute respiratory failure is much better in recent years, due to changes in the methods of and the indications for mechanical ventilation. Several years ago there has still hesitation to use mechanical ventilation in newborn infants. Stock (1973) for example suggested to reserve mechanical ventilation for patients unlikely to survive without it. It seemed that the uncertainty was due to the lack of an appropriate ventilator for newborn infants.

The relatively higher respiratory rate, the small tidal volume and the frequent occurrence of pressure changes within the thoracic cavity make the application of mecdanical ventilation in newborn infants more diffficult (Rashad, 1970).

In Jakarta mechanical ventilation in the newborn infants has been used since 1977, one year after the opening of the Pediatric Intensive Care Unit of Dr. Cipto Mangunkusumo Hospital.

The present study reports our experience in using mechanical ventilation in the newborn infants.

Material and methods

All newborn infants who required mechanical ventilation admitted to the Pediatric Intensive Care Unit Dr. Cipto Mangunkusumo Hospital from January 1980 to December 1980 were included in the study.

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Indications for mechanical ventilation were respiratory failure and postoperative respiratory support after major surgery.

The diagnosis of respiratory failure was based on the criteria described by Downes et al., (1972) using arterial pH and blood gas tensions.

All patients were nursed in incubators to maintain a body temperature between 36 - 37°C. Heart rate, respiratory rate and temperature were monitored by the nurses every hour and noted in the patients records.

Fluid and electrolyte were given intravenously with microdrip infusion 60 ml/kg BW/day during the first 24 hours and then increased to maintain the water balance. Other treatment were given in accordance with the primary diagnosis.

Mechanical ventilation was delivered via nasotracheal tube of 2.5, 3.0 or 3,5 mm inernal diameter, using time cycled, pressure limited infant ventilator (Babybird-respirator, Bird Corp, Palm Springs, California) that has initially set at IMV mode, a flow of 10 L/min and FiO2 suficient to relieve cyanosis.

PaO2 was maintained around 70 torr by adjusting the FiO2 and was regulated by an oxygen blender and measured with an oxygenanalyzer. The inspiratory pressure ranged between 25 - 30 cm H20 and the end expiratory pressure ranged between 5 - 10 cm H20.

Arterial pH and blood gas tensions were measure during arterial blood samples with a computerize and base analyzer (ABL2 Radiometer, Copenhagen) periodically according to the clinical changes.

If this method did not give satisfactory results i.e. PaO2 remains low under 50 torr, PaCO2 remain high with FiO2 o.6e the respiration was entirely shifted to the ventilator (controlled ventilation).

Weaning from the ventilator was done after clinical symptoms and laboratory finding have shown improvement by the CPAP method (Gregory et al., 1971) prior to extubation.

Follow up of the survivors has not been done yet and no autopsy was done on the death cases.

Results

Data concerning the study population, indication of admission to ICU, diagnosis and results of treatment, associated diagnosis and birth weight were shown on table 1, 2, 3, 4 and 5.

Table 1 showed that during the year 1980, there were 76 (44 males, 32 females) newborn infants who required mechanical ventilation ranged in age from 1 day to 1 month. Seventy one (40 males and 31 females) were less than one week of age. Out of 76 patients only 29 survived. Twenty six cases died in the first 48 hours.

Table 2 showed the indication of admission to the ICU i.e. 37 patients with respiratory failure and 14 patients with a very severe condition (apnea).

Twelve patients were referred for postoperative care, 8 patients because of severe asphyxia, dehydration and 2 patients with anemia/shock.

The diagnosis of the patients referred for postoperative care were as follows : 3 cases with anal atresia, 2 cases with esophageal atresia, 1 case of annular pancreas, 2 cases with hernia of the diaphragm, 2 cases with necrotizing enterocolitis, 1 case with pulmonary cyst and 1 case with Hirschprung disease.

Table 3 showed the diagnosis of the patients and the results of treatment with mechanical ventilation. There were 23 patients with IRDS, of which 16 died and 29 patients with other repiratory distress (meconium aspiration, bronchopneumonia, severe asphyxia, etc) of which 18 died. Of the 12 postoperative patients, 7 died mostly due to septicemia and only one case out of 5 patients with purulent meningitis survived. Other cases were severe dehydration with severe acidosis (pH 6.9) with one survivor, while patients with neonatal tetanus and anemia/shock were all survived.

Table 4 showed the relationship between weight and mortality. Thirty out of the 47 nonsurvivors weighed less than 2,5 kg while 7 patients weighed less than 1,5 kg.

Table 5 showed the associated diagnosis of the newborn infants requiring mechanical ventilation. All patients have acid base and electrolyte imbalance, 68 suffered from respiratory failure and 24 have hyperbilirubinemia. Septicemia were encountered in 12 patients with 4 positive blood cultures (2 pseudomonas, 1 salmonella paratyphi and 1 coliform bacteria). Only 3 of these patients with septicemia survived and this septicemia was the primary cause of death in patients who died after 48 hours.

There were 14 patients with hypoglycemia of which two had persistent hypoglycemia and died afterwards. Two patients with pulmonary hemorrhage and with pneumothorax were all died

No significant complication due to the longterm use of nasotracheal tube were found in this study and the longest period of mechanical ventilation was 20 days.

TABLE 1 : *Patients population*

Age (days)	Male/ Female	Survived	Died <84 h>
7	40/31	28	24/19
7 — 30	4/ 1	1	2/ 2
Total	44/32	29	26/21

TABLE 2 : *Indication of admission to ICU*

Respiratory failure	37
Severe anemia/shock	2
Postoperative care	12
Apnea	14
Severe asphyxia	8
Severe dehydration	3
Total	76

TABLE 3: *Patients diagnosis and result of treatment*

	Total	Died	Survived
IRDS	23	16	7
RDS (others)	29	18	11
Postop. care	12	7	5
Neonatal tetanus	2	—	2
Anemia/shock	2	—	2
Meningitis	5	4	1
Gastroenteritis	3	2	1

TABLE 4: *Weight vs death*

Body weight (Kg)	Died
<1.5	7
1.5 — 2.0	11
2.0 — 2.5	12
2.5	17
Total	47

TABLE 5: *Associated diagnosis*

Septicemia	12
Acid base imbalance	76
Respiratory failure	68
Hyperbilirubinemia	24
Pulmonary hemorrhage	2
Hypoglycemia	14
Pneumothorax	1

Discussion

Considering the anatomic and physiologic conditions, acute respiratory distress in the newborn infants could easily occur. Acute respiratory failure is a primary cause of death in neonates. Shannon (1977) reported that 30% of the mortality in the newborn were caused by acute respiratory failure.

Due to the structural immaturity of the respiratory system and the narrowness of the airways, the respiration of the newborn is almost entirely diaphragmatic and may easily be embarassed by abdominal distension (Stock, 1973).

Efforts in overcoming respiratory failure in the newborn have stimulated the use of mechanical ventilation with the use of infant ventilator and the method of IMV (Kirby, 1977).

Although many difficulties have been encountered and the results were not yet satisfactory the use of mechanical ventilation in the newborn infants have influenced the treatment of respiratory failure or respiratory distress in the newborn. The high mortality rate in our study population was due, inpart, to the severity of the patients condition on admission to ICU, besides the difficulties in handling the ventilator.. Up till now there are still opinions among the medical and nursing staff that ICU is terminal place in treating the patient.

Idiopathic respiratory distress syndrome (IRDS) is the major cause of respiratory failure in the newborn. In this study only 7 infants with IRDS survived while Barr and Milliken (1980) reported a mortality rate of 14% in 35 infants with severe IRDS.

They used pressure controlled ventilation with low peak airway pressure, square pressure waveform, PEEP, low ventilator frequency and prolonged inspiratory time. Whether these ventilator settings (increasing the I : E ratio and lo-

wering the ventilation frequency) have influenced the mortality remained to be proven as other authors (Spahr et al., 1980) found that increasing the I : E ratio improved oxygenation but did not alter morbidity and mortality.

The use of mechanical ventilation and total paralysis in the treatment of neonatal tetanus has been widely reported in the literature i.e. by Adams et al. (1979). We have succesfully treated two cases of neonatal tetanus with mechanical ventilation and total paralysis using pancuronium bromide.

Further investigation will be necessary to evaluate this method because of the high cost in providing this treatment.

The postoperative respiratory support after major surgery is suggested to prevent postoperative complications due to acidosis, hypothermia, residual effects of anesthetic agents and muscle relaxants. In this study 7 patients died because of septicemia which were difficult to overcome.

Infection and septic complication were frequent problems which we had encountered in this study. It might be caused by the great deal of invasive and noninvasive procedure in the OR and intensive care besides the role of immaturity of the immunologic system.

The high mortality of meningitis patients and severe dehydration were in fact due to the severity of the disease. Considering the prognosis, in accordance with the Triage criteria (Grenvik et al., 1978) these patients should not receive maximal treatment in ICU, but frequently we are forced to face the social indications, to treat these cases in the ICU.

Several complications that we had encountered were those which are generally found in critically ill neonates such as hyperbilirubinemia, hypoglycemia, acid base and electrolyte imbalance.

Only one complication was related to the use of mechanical ventilation in this study i.e. pneumothorax, a common complication due to the application of high inspiratory and expiratory pressure (Hall and Rhodes, 1975).

As a conclusion we would support the opinion that every physician interested in neonatology and intensive care should have a clear understanding of the capabilities and limitations of mechanical ventilation in newborn infants.

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