Mechanical Ventilation In Pediatric Surgery In The First Years Of Life: Spectrum And Mortality

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Abstract

Background/aim: Congenital diaphragmatic hernia (CDH), abdominal wall defects, esophageal atresia and congenital gastrointestinal anomalies are major indications for mechanical ventilation (MV) in the pediatric surgery. The aim of this study was to determine the spectrum and the results of MV treatment of in the surgical neonatal intensive care unit (NICU) .

Patients and method: We did a retrospective analysis of all consecutive admissions of children to our pediatric NICU between 1995 and 2001 with various diagnoses on admission. The cases were examined for age, gender, duration of hospitalization, medication used, yearly distribution of cases that underwent MV and in regard to the effected system and mortality.

Results: In this study charts of 692 cases were evaluated. The mean birth weight and the mean age of patients were 2732 g (900g-12 kg) and 3,6 days (1 day-12 months) respectively. The male: female ratio was 2,2: 1. Total 230 patients (33,2%) were mechanically ventilated. The most common indication for the MV was CDH (74%). Mean ventilation time was found to be 6,9 days (1 day-1 year), mean hospitalization time 11,4 (1 day-1 year). The overall mortality was found 53,1%. The highest mortality was 60,7%, in patients with CDH respectively. This mortality rate decreased in recent years.

Conclusion: The results of this study showed, that the experience of pediatric surgical medical staff with MV improved and the mortality rate decreased with the use of MV.

INTRODUCTION

The main indications for mechanical ventilation (MV) are immaturity of lungs in preterm newborns and congenital or acquired lung infections. In the modern indications for respiratory support prophylactic mechanical ventilation, particularly in postoperative cases, finds also a very significant place.

First application of MV in neonates was in the late 1960s and used widely in 1970's ([1,2]). Neonatal surgical mortality has decreased with the establishment of NICU and use of MV ([3,4]). MV of newborns is a very complex and invasive procedure. It is applied in infants with insufficient or no respiratory function, to provide oxygenization of lungs with alveolar ventilation and consequently of all tissues mainly the vital organ, clean up the accumulated carbondioxide and sometimes to relive the respiration load ([1,5]). Although significant developments were made in ventilation technique and mechanics, conventional ventilators maintain their properties of being the most frequenly and most easily used ventillators([1]). This study was intended for determining the spectrum and the requirement for MV in pediatric surgery cases, reviewing applications and results.

PATIENTS AND METHOD

There are 10 beds in the surgical neonatal intensive care (SNICU) unit and 4 ventilators (Drager-Babylog 1HF & Newport 150) with pressure limiting propery is used for MV. CPAP is rarely used as primary therapy, only used before extubation. Respiratory rate, PIP, PEEP, I:E ratio adjusted in each case's demand. Blood gases must follow all adjustments in MV applications and parameters must be adjusted so that arterial PCO2 is 40-50mmHg, PO2 50-80mmHg, and pH 7,30-7,45.

Muscular blockage agents (vecuronium bromide) for controlled ventilation, narcotic analgesics and sedatives (midazolam) during MV for elimination of disharmony with the mechanical ventilator and postoperative analgesia were

used as additional medication.

In this study out of 692 cases hospitalized between 1995 and 2001 for surveillance and treatment, 230 cases that underwent MV were reviewed retrospectively. The cases were examined for age, gender, duration of hospitalization, medication used, yearly distribution of cases that underwent MV and in regard to the effected system and mortality.

RESULTS

In the SNICU approximately 100 (87-124) cases are diagnosed and treated every year. Approximately 33,2% of these cases require mechanical ventilation. Mean age of application between 1995-2001 was 3,6 days (1 day-12 months), mean weight 2732 g (900g-12 kg), male: female ratio 2,2: 1. Among the 692 cases 537 (77,6%) were made subject to surgical intervenion during the course of their therapy. Mean hospitalization time was 11,4 days (1 day-1 year). MV requirement was 44,1% in abdominal wall defects, 41,8 in esophageal atresia, 36,1% in thorax, 24,6% gastrointestinal sytem and 16,5% in other (urinary, extremities, etc.) pathologies (Table I). Mean ventilation time was found 6,9 days (1 day-1 year), mean hospitalization time 11,4 (1 day-1 year). Additional medication most frequently used in the cases were midazolam (Dormicum®) in the sedatives group, vercuronium bromide (Norcuron®) in curare group and meperidin (Dolantin®) as narcotic-analgesic, in the form of bolus and/or continuous infusion depending on the case.

Distribution of mortality according to systems, in the study is given in Table II. General distribution of cases and mortality are given in Table III. A total of 122 (53.1%) of 230 cases made subject to MV were lost. Highest rate of mortality (60,7%) was found in cases with congenital diaphragmatic hernia (CDH), and the lowest rate of mortality in cases with thorax pathology. The majority of deaths were due to respiratory-circulation system failure (51,6%) and septicemia (22%). The ratio of cases given MV and lost to total cases was 17,6%. Causes of death of these cases are summarized in Table IV.

Figure 1

Table I: Distrubution of MV cases

	1995 n	1995 (n/%)	1996 n	1996 (n/%)	1997 n	1997 (n/%)	1998 n	1998 (n/%)	1999 n	1999 (n/%)	2000 n	2000 (n/%)	2001 n	2001 (n/%)	Total n	Total (n/%)
AWD	13	5 (%38,4)	10	7 (%70,0)	9	5 (%55,6)	11	3 (%27,3)	8	3 (%37,5)	9	5 (%55,5)	8	2 (%12,5)	68	30 (%44,1)
GIS	37	7 (%18,9)	30	7 (%23,3)	29	10 (%34,5)	35	6 (%17,1)	24	7 (%29,2)	33	10 (%30,3)	40	9 (%22,5)	228	56 (%24,6)
CDH	9	6 (%66,7)	6	4 (%66,7)	14	11 (%78,6)	11	10 (%90,9)	8	6 (%75,0)	12	8 (%66,6)	13	9 (%69,2)	73	54 (%74)
EA	11	4 (%36,4)	14	8 (%57,1)	13	6 (%46,2)	21	9 (%42,9)	13	5 (%38,5)	18	6 (%33,3)	8	3 (%37,5)	98	41 (%41,8)
TP	8	2 (%25,0)	6	2 (%33,3)	6	1 (%16,7)	10	8 (%80,0)	8	3 (%37,5)	12	4 (%33,3)	11	3 (%27,2)	61	22 (%36,1)
O	9	2 (%22,2)	28	5 (%19,2)	28	7 (%25,0)	36	5 (%13,9)	26	3 (%11,53)	21	3 (%14,2)	18	2 (%11,1)	184	27 (%16,5)
TOTAL	87	26 (%29,9)	92	34 (%36,9)	99	40 (%40,4)	124	39 (%31,5)	87	27 (%31,0)	105	36 (%34,3)	98	28 (%28,6)	692	230 (%33,2)

AWD: Abdominal Wall Defect,
GIS: Gastrointestinal Sistem Anomaly,
CDH: Congenital Diaphragmatic Hernia,
EA: Esophageal Atresia,
TP: Thoracic Pathology, O: Other

Figure 2

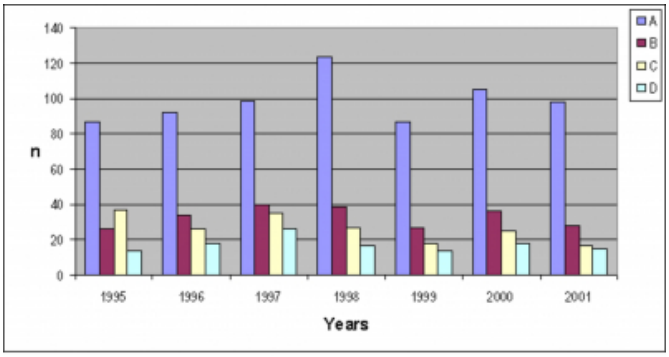
Table II: Distribution and mortality among the cases with MV

	1995 n	1995 (n/%)	1996 n	1996 (n/%)	1997 n	1997 (n/%)	1998 n	1998 (n/%)	1999 n	1999 (n/%)	2000 n	2000 (n/%)	2001 n	2001 n/%)	Total n	Total (n/%)
AWD	5	3 (%60,0)	7	4 (%57,1)	5	3 (%60,0)	3	2 (%66,7)	3	1 (%33,3)	5	3 (%60)	2	1 (%50)	30	17 (%56,6)
GIS	7	5 (%71,4)	7	5 (%71,4)	10	6 (%60,0)	6	3 (%50,0)	7	2 (%28,6)	10	6 (%37,5)	9	7 (%77,7)	56	34 (%60,7)
CDH	6	3 (%50,0)	4	2 (%50,0)	11	9 (%81,8)	10	7 (%70,0)	6	2 (%33,3)	8	4 (%62,8)	9	5 (%54)	54	32 (%59,3)
EA	3	2 (%66,7)	8	3 (%37,5)	6	4 (%66,7)	9	3 (%33,3)	5	4 (%80,0)	6	2 (%0)	3	1 (%33,3)	40	19 (%47,5)
TP	3	1 (%33,3)	3	2 (%66,7)	1	- (%0)	6	- (%0)	3	2 (%66,7)	4	2 (%100)	3	1 (%33,3)	23	8 (%44,4)
O	2	- (%0)	5	2 (%40,0)	7	4 (%57,1)	5	2 (%40,0)	3	3 (%100)	3	1 (%0)	2	- (%0)	27	12 (%44,4)
TOTAL	26	14 (%53,8)	34	18 (%52,8)	40	26 (%65,0)	39	17 (%43,6)	27	14 (%51,9)	36	18 (%40,6)	28	15 (%53,5)	230	122 (%53,1)

AWD: Abdominal Wall Defect, GIS: Gastrointestinal System Anomaly, CDH: Congenital Diaphragmatic Hernia, EA: Esophageal Atresia, TP: Thoracic Pathology, O: Other

Figure 3

Table III: General distribution of cases and mortality.



A: Total number of admission
B: Total number of cases with MV
C: Total number of deaths
D: Total number of deaths among MV group

Figure 4

Table IV: Causes of death

	Respiratory - Circular Insufficieny		Septicemia	Other
	Respiratory	Circular		
AWD	5	3	5	4
GIS	6	9	8	11
CDH	19	7	4	2
EA	5	3	5	6
TP	2	1	2	3
O	-	3	3	6
TOTAL	37 (30,3%)	26 (21,3%)	27 (22,1%)	32 (26,3%)
	63 (51,6%)			

AWD: Abdominal Wall Defect, GIS: Gastrointestinal Sistem Anomaly, CDH: Congenital Diaphragmatic Hernia, EA: Esophageal Atresia, TP: Thoracic Pathology, O: Other

DISCUSSION

Mechanical ventilation is one of the most important supporting treatments used in neonatal intensive care ([1,2]). In neonatal intensive care units, MV is performed with volume and pressure controlled ventilators in many centers ([3,6]). Both application forms have advantages and disadvantages over each other ([3,6,7]). In our clinic we apply MV with pressure and time adjusted ventilators.

Clinical MV application is correlated to properties of ventilators on which the unit is experienced. Considering that technological developments are reflected on ventilators continuously, each clinic determines their ventilator strategies without any major change in basic rules. Despite that, application may differ even in the same disease ([8,9,10,11,12]).

Although sedatives, muscular blockage, narcotic analgesics were used as additional medication during MV for elimination of disharmony in our cases with mechanical ventilator, controlled ventilation and postoperative analgesia, the details of use were not discussed here since they are beyond the scope of the study.

In the SNICU the main MV indications are leaded by incomplete pulmonary maturation due to prematurity, respiratory problems due to pulmonary infections of the newborn ([1,3]). However literature regarding MV applications in surgical neonates is rare. Only surgical cases are followed up in our clinical series and it was determined that the need for MV among these cases CDH was the first with 74% followed by abdominal wall defects with 44,1%. Another subject needing attention is that approximately 24,6% of cases with gastrointestinal system anomaly required MV. It is observed that MV indications in surgical newborns are higher than those in non-surgical newborn indications. MV indications mainly consist of pulmonary hypoplasia (CDH, primary pulmonary hypoplasia) and cystic lesions of the lungs, inability to swallow and the need for aspiration of secretions and respiratory insufficiency related to pneumonia as in esophageal atresia, aspirations secondary to vomiting in gastrointestinal pathologies, diaphragmatic elevation of intraabdominal and intrathoracic masses.

In this study the duration of MV is found similar compared with MV used for nonsurgical neonatal intensive care units ([1,6]). We think, that the indications of MV are mainly supportive in surgical group and the conditions of primary respiratory insufficiency, and conditions, which resulted with chronic respiratory insufficiency and longer MV supports, rarely exist in surgical patient population.

Complications of mechanical ventilation are divided into two groups, being early and late complications. Main early complications are septicemia, atelectasis, pulmonary infections, pneumothorax, intracranial hemorrage, and necrotisan enterocolitis particularly in preterm infants. Main late complications are premature retinopathy and bronchopulmonary dysplasia ([3,11]). These complications lead occasionally to mortality. Rates of mortality and morbidity in MV applied infants in neonatal intensive care units reduced significantly during the last 20 years. The rate of mortality was 60-65% in 1960's, whereas reduced to 5% in 1980's ([3,5,7]). However, the literature has limited sources regarding MV related mortality and morbidity in surgical newborns. This is because MV treatments are applied in neonatal intensive care units rather than pediatric surgery clinics. The success of the person to apply MV is directly correlated to a well knowledge of fetal circulation, pulmonary physiology, pathophysiology of newborn pulmonary diseases, pathophysiology of surgical diseases to which MV is applied and the properties it shows in MV. In addition, it is directly related to choosing the form of ventilation by taking into consideration basic mechanical principles of ventilators used in clinics and the physiological and pathological condition of the case to which ventilation is to be applied and the experience and knowledge in manipulating the device whenever necessary.

Although the rate of mortality in MV applied cases in our unit reduced to 51% in recent years, it is still high compared to publish results. This review covers a wide time range. The overall mortality rate of disease groups reviewed in this period was also high. Mortality rate is high since MV is

applied to this high-risk group for supportive purposes in many cases. Most of the deaths originate from respiration-circulation system and septicemia. Deaths are due to problems related to the underlying primary disease, rather than MV application. However, our findings suggest that when the application was new, additional respiratory problems (pneumothorax, atelectasis), that may develop frequently, causing elongation of MV time (RDS, pneumonia, resuscitation, and primary septicemia), influence morbidity and mortality.

In conclusion, due to the lack of sufficient numbers of child hospitals, in many pediatric surgical clinics pediatric surgeons handle MV in their own institution. The success of MV is directly related to condition of cases, knowledge and experience of physician, who applies mechanical ventilation, technical properties of ventilators and neonatal intensive care units, experience, knowledge, interest and attention of nurses and technical personnel employed in the unit. The clinical application and the results obtained show that mortality and morbidity in MV applications have been reduced with increasing knowledge and experience in pediatric surgery.

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References

1. Vural M, Ilikkan B, Kamburoglu A, Ilter Ö. Mechanical ventilation in neonates: Cerrahpasa experience. Türk Pediatri Arsivi 1999; 34: 120-124 (Turkish with english abstract)
2. Slagle T, Bifano EM, Wolf JW, Gross SJ. Routine endotracheal cultures for the prediction of septicemia in ventilated babies. Arch Dis Child 1989; 64: 34-38
3. Atici A, Satar M, Narli N, Türkmen M. Assisted ventilation of the neonate. Ç. Ü. Tip Fak Der 1996; 21:128-132 (Turkish with english abstract)
4. Spitzer AR, Fox WW: Positive-Pressure Ventilation: Pressure-Limited and Time Cycled Ventilators. In Assisted Ventilation of the Neonate, 3th Edition. Goldsmith JP, Karotkin EH (eds), Saunders, Phideladelphia, USA, 1996; p: 167-186
5. Delivorior-Papadopoulos M, Levision H, Swyer PR. Intermittant positive pressure respiration as a treatment in severe respiratory distress syndrome. Arch Dis Child 1965; 40:474 -481
6. Yurdakök M. Respiratory distress sydrome and principles of ventilation therapy. Katki Pediatri Dergisi 1991; 12: 299-369 (Turkish with english abstract)
7. Johson JD, Malachowsky BA, Grobstein R. Prognosis of children surviving with the aid of mechanical ventilation in the newborn period. J Pediatr 1974; 84: 272-276
8. Bland RD, Kim MH, Light MJ. High frequency mechanical ventilation of low birth weight infants with respiratory failure from hyaline membrane disease. Pediatr Res 1977;11: 531-535
9. Fox WW, Berman LS, Dinwiddie R. Tracheal extubation of the neonate at 2-3 cmH20 continiuous positive airway pressure (CPAP). Pediatrics 1977; 59: 257-261
10. Reynolds EOR, Taghizadek A. Improved prognosis of infants mechanically ventilated for hyaline membrane disease. Arch Dis Child 1974; 49: 505-509
11. Ozata ES, Gregory GA, Kitterman J. Pneumothorax in the respiratory distress sydrome: Incidence and effect on vital signs blood gases and pH. Pediatrics 1976; 58: 177-180
12. Meyanci G, Öz H, Torun MM. Ventilatory-associated pneumonia. Cerrahpasa Tip Derg 1999; 30: 214-220 (Turkish with english abstract)

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