EVALUATION OF CLINICAL PROFILE AND FINAL OUTCOME OF NEONATES REQUIRED MECHANICAL VENTILATION

By

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ABSTRACT

Background: *Advances in perinatal and neonatal care have decreased morbidity and mortality. Due to enhanced intensive care and robust respiratory and cardiovascular support in neonatal intensive care units (NICU), the prognosis for sick infants has improved. [Mechanical ventilation depends on the underlying condition, gestational age, birth weight, and clinical circumstances. To increase the survival of mechanically ventilated infants, it is necessary to identify and address prognostic markers.*

Aim: *To detect the causes of morbidity and mortality in mechanically ventilated neonates and to correlate the neonatal morbidity and mortality with gestational age, birth weight and duration of MV.*

Patients and Methods: *This study was conducted in NICU at Mansoura University Children Hospital. Our study took part from October 2021 to April 2023. The study was done on one hundred (100) neonates who needed mechanical ventilation.*

Results: *There was significant increase in ventilator associated pneumonia (VAP) and Bronchopulmonary Disease (BPD) prevalence in non-survived neonates in comparison to survived neonates and in Septic shock & Multiple Organ Failure (MOF), Disseminated Intravascular Coagulation (DIC) and Necrotizing Enterocolitis (NEC) prevalence in non-survived neonates in comparison to survived neonates. There was no significant difference between survived and non-Survived neonates according to maternal general characteristics.*

Conclusion: *The most common reason for neonatal ventilation was congenital heart disease, according to the study. VAP and BPD were prevalent in ventilated newborns. There was positive correlation between birth weight and gestational age improved outcomes. VAP, BPD, Septic shock, MOF, DIC, NEC, ROP grade III, and ABR were related with worse outcome. To confirm our results and identify more adverse event risk variables, we need multiple conditional study.*

Key words: *Neonatal; Mechanical; Ventilation; Morbidity; Mortality .*

INTRODUCTION

Mechanical ventilation may be defined as the movement of gas into and out of the lung by an external source connected directly to the patient by way of a tracheostomy or an endotracheal tube.[1]

Advances in perinatal and neonatal care have significantly reduced neonatal morbidity and mortality rates. Outcome in sick infants has improved significantly, mostly due to more effective newborn intensive care and aggressive respiratory and cardiovascular support using mechanical ventilation in (NICU).[2]

Mechanical ventilation is a proper intervention to increase the survival rate of the neonates and one of the essential components of NICU However mechanically ventilated neonates have a high fatality. Variation in the mortality among mechanically ventilated neonates has been attributed to more biomedical technological advancements in the developed countries. Various studies in developing countries have shown a mortality rate in the range of 40% - 60%.[3]

The need for mechanical ventilation relies on various elements, like primary disease, gestational age, birth weight and related clinical conditions. In order to improve the survival in mechanically ventilated neonates, identification of prognostic factors and their treatment is mandatory.[4]

Despite that MV provide a lifesaving modality in NICU its use is associated with high-risk mortality.[5]

AIM OF THE STUDY

The main aim of this study was to detect the causes of morbidity and mortality in mechanically ventilated neonates and to correlate the neonatal morbidity and mortality with gestational age, birth weight and duration of MV.

Ethical consideration:

1. A written informed constant was obtained from patients or their legal guardians.
2. An approval by the local ethical committee was obtained before the study. **Ethical Code: 000449**.
3. The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.
4. All data of the patients and results of the study are

confidential and the patient have right to keep it.

5. The author received no financial support for, authorship, and/or publication of this article.
6. The patients have the right to withdraw the study at any time.

PATIENTS AND METHODS

This prospective observation analytical study was conducted in NICU at Mansoura University Children Hospital.

All neonates were followed up till 6months from discharge with record of any complications during and after mechanical ventilation.

The study was done on one hundred (100) neonates who needed mechanical ventilation.

Inclusion Criteria: Neonates within neonatal age range (0 - 28) days after birth, Gestational age: both preterm and full-term neonates, Sex: both male and female, delivered either by vaginal delivery or caesarean section and Sick neonates admitted to NICU who need conventional mechanical Ventilation.

Exclusion criteria: Neonates with multiple congenital anomalies. Neonates with surgical conditions and Neonates who died within 12 hours of initiation of ventilation.

Study design:

All the studied neonates subjected to the following:

Complete history including (Maternal antenatal history, Natal history and post-natal history),

General and Systemic examination of the neonate examination.

Radiological & laboratory investigations.

ABR Evaluation: The auditory brainstem response test (ABR) was used for testing hearing thresholds and assessing the functional status of the auditory neural pathway.

ROP Evaluation: The babies were fed 30 min before the procedure and the eyes were dilated with ROP dilating medications (2.5% phenylephrine and 0.5% tropicamide). The baby's head lies in a lateral position and hence fundus examination becomes very difficult.

Statistical Analysis:

Data were checked, entered and analyzed using SPSS version 23 for data processing. The following statistical methods were used for analysis of results of the present study.

Data were expressed as number and percentage for qualitative

variables and mean + standard deviation (SD) for quantitative one.

The used tests were:

1. **Chi-square test:** Used to find the association between row and column variables.
2. **Mann Whitney test:** was used to calculate difference between quantitative variables in not normally distributed data in two groups.
3. **T-Test:** for comparison of means of two independent groups.

RESULTS

All results will be demonstrated in the following tables and figures:

Table (1): Distribution of demographic characteristics among enrolled neonates (N=100)

Parameters	Value (N = 100) (%)
Sex: Male Female	 52 (52%) 48 (48%)
Gestational age (week)	35.03 ± 4.4
Early pre-term [28 - 32 wks]	37 (37%)
Late pre-term [33 - 36 wks]	20 (20%)
Full term [37 - 42 wks]	43 (43%)
Birth weight (g)	2147.19 ± 942.16
Extremely Low birth weight (less than 1000 gm)	8 (8%)
Very low birth weight [1000 gm to less than 1500 gm]	30 (30%)
Low birth weight [1500 gm to less than 2500 gm]	23 (23%)
Normal birth weight [2500 gm to less than 4000 gm]	39 (39%)

Regarding basal characteristics, 52 were males and 48 were females. Mean GA was 35.03ws. and mean BWt. was 2147.19 g. Most patients were early preterm.

Table (2): Indication of MV and outcome of the studied neonates

Parameters	Value (N = 100) (%)
Apnea	14 (14%)
Congenital Heart diseases	32 (32%)
Meconium aspiration syndrome	11 (11%)
Perinatal asphyxia	9 (9%)
Persistent pulmonary hypertension	13 (13%)
Respiratory distress syndrome	20 (20%)
Sepsis	9 (9%)
Mixed indications	6 (6%)

Congenital Heart diseases was the most prevalent indication (32%) for MV. Apnea, meconium aspiration syndrome, Perinatal asphyxia, Persistent pulmonary hypertension, respiratory distress syndrome and Sepsis prevalence reached 14, 11, 9, 13, 20 and 9 percent respectively.

Table (3): Comparison between survived and Non-Survived neonates according to neonatal baseline characteristics.

	Survived neonates (N = 62) (%)	Non-Survived Neonates (N = 38) (%)	P. Value
Sex: Male Female	 33 (53.23%) 29 (46.77%)	 19 (50%) 19 (50%)	0.75[2]
Gestational age (week)	36.35±4.2	32.87±3.88	**<0.001[1]**
Early P.T. [28 - 32 wks]	12 (19.35%)	25 (65.79%)	**<0.001[2]**
Late pre-term [33 - 36 wks]	14 (22.58%)	6 (15.79%)	
Full term [37 - 42 wks]	36 (58.06%)	7 (18.42%)	
Birth weight (g)	2422.77±933.92	1697.55±776.04	**<0.001[1]**
Extremely Low birth weight (less than 1000 gm)	3 (4.84%)	5 (13.16%)	**0.0003[2]**
Very low birth weight [1000 gm to less than 1500 gm]	12 (19.35%)	18 (47.37%)	
Low birth weight [1500 gm to less than 2500 gm]	13 (20.97%)	10 (26.32%)	
Normal birth weight [2500 gm to less than 4000 gm]	34 (54.84%)	5 (13.16%)	

There was significant difference between survived and non-survived neonates regarding gestational age and Birth weight.

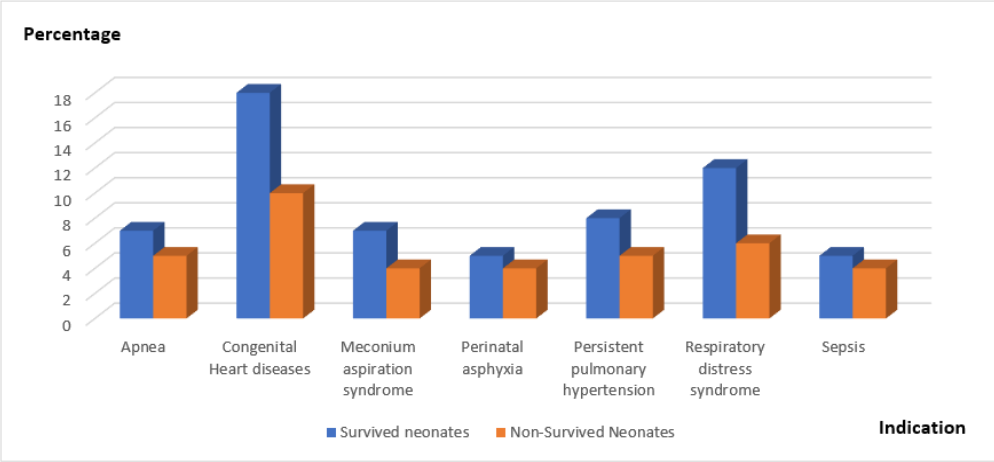

Figure (1): Comparison between survived and non-Survived neonates according to Indication of MV

Table (4): Comparison between survived and Non-Survived neonates according to Complications related to mechanical ventilation

	Survived neonates (N = 62) (%)	Non-Survived Neonates (N = 38) (%)	P. Value
Ventilator Associated Pneumonia (VAP)	6 (9.68%)	15 (39.47%)	**0.0004[2]**
Bronchopulmonary Disease (BPD)	4 (6.45%)	10 (26.32%)	**0.005[2]**
Devices associated blood born infection	2 (3.23%)	3 (7.89%)	0.298[2]
Air leak syndromes	3 (4.84%)	3 (7.89%)	0.53[2]
Extubation Failure	2 (3.23%)	1 (2.63%)	0.87[2]

P>0.05 no significant difference, P<0.05 significant difference, P<0.001 high significant difference.
[1]: T Test, [2]: Chi square test, [3]: fisher exact test

There was significant increase in VAP and BPD prevalence in non-survived neonates in comparison to survived neonates.

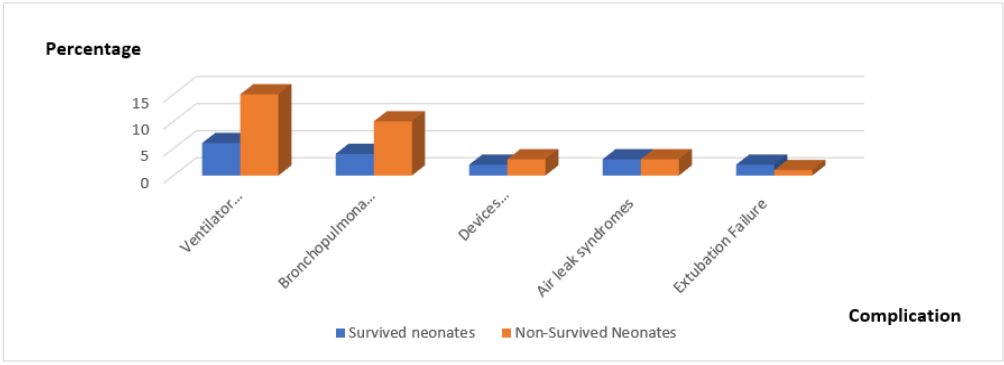

Figure (2): Comparison between survived and Non-Survived neonates according to Complications related to mechanical ventilation

Table (5): Follow up of ROP related to complication of mechanical ventilation in survived group

	3 months	6 months	P. Value
Total	8 (12.9%)	13 (20.97%)	0.231[2]
Grade			
I	4 (6.45%)	6 (9.68%)	0.51[2]
II	2 (3.23%)	4 (6.45%)	0.403[2]
III	1 (1.61%)	5 (8.06%)	0.094[2]
IV	1 (1.61%)	3 (4.8%)	0.31[2]
V	0 (0%)	1 (1.61%)	0.842[3]

P>0.05 no significant difference, P<0.05 significant difference, P<0.001 high significant difference
[1]: T Test, [2]: Chi square test, [3]: fisher exact test

There was no significant difference in ROP when compare 3months follow up with 6 months.

Table (6): Follow up of ABR related to complication of mechanical ventilation in survived and non-survived neonates

	3 months (N = 62)	6 months (N = 38)	P. Value
Total impaired infants	5 (8.06%)	13 (34.21%)	**0.041[2]**
Absolute latency of I wave	1.36±0.1	1.38 ± 0.13	0.48[1]
Absolute latency of III wave	3.57±0.17	3.61 ± 0.18	0.27[1]
Absolute latency of V wave	5.36±0.36	5.39 ± 0.38	0.69[1]

P>0.05 no significant difference, P<0.05 significant difference, P<0.001 high significant difference.
[1]: T Test, [2]: Chi square test, [3]: fisher exact test

There was significant increase in ABR prevalence after 6 months compared with 3 months follow up.

DISCUSSION

The neonatal period is a very critical period in life due to high possibility of acquiring potential life-threatening diseases and the complexity of the adaptive process of the neonate. According to the American Academy of Pediatrics, approximately 10% of neonates need some assistance to begin breathing at birth, with up to 1% requiring extensive resuscitation.[6]

Regarding the demographic data of the study, total 100 neonates 52 were males and 48 were females. Mean GA was 35.03 week and mean BW was 2147.19 g. Most patients were preterm. It was found that the overall recovery was 62% among studied neonates. Comparison between survived and non-survived neonates showed that there was significant difference between survived and non-survived neonates regarding gestational age and Birth weight and non-significant difference as regard sex.

It was well-established that lower gestational age and birth weight of neonate was associated with higher rate of neonatal complications which in role lead to higher rate of mortality. The high rate of mortality of the current study (38%) may be related to the fact that the majority of cases were preterm.

The present study was supported by Othman et al.7 who enrolled 100 neonates 64 (58.2%) were males and 46 (41.8%) were females. 45.4% were full term while 16.3% and 38.1% were late

and early preterm respectively. 58.2% were low.

Also, the study by **Baseer et al.**[8] enrolled 312 neonates, they were 81 (55.9%) males, 61 (42%) females and 3 (2.1%) undefined sex. The mean neonatal age at admission was 4.33 ± 7.19 days, mean gestational age was 34.49 ± 3.31 weeks, and mean maternal age was 27.6± 6.8 years. Most patients were early preterm, most deliveries 76.55% were CS. The most common maternal risk factors were PROM, Antepartum hemorrhage and Diabetes mellitus. Also, in logistic regression analysis reported that no association between comorbidities and vaginal delivery and survival of MV neonates. However, CS was significantly correlated with mortality.

In addition, **Iqbal et al.**[9] reported that there was a significant negative association between gestational age, birth weight and mortality in mechanically ventilated neonates. Also, there was no significant difference between survived and non-Survived neonates according to maternal age.

The current study showed that congenital heart diseases was the most prevalent indication (28%) for MV. Apnea, meconium aspiration syndrome, perinatal asphyxia, Persistent pulmonary hypertension, respiratory distress syndrome and Sepsis prevalence reache.

Regarding Complications related to mechanical ventilation among enrolled neonates VAP was the most prevalent among neonates (21%). Regarding Complications related to disease pattern among studied neonates, Septic shock & MOF, DIC, NEC, and Pulmonary hemorrhage reached 25, 22, 15, 7 and 2 percent respectively.

VAP was the commonest ventilator complication in pediatrics as it has several risk factors including Inoculation of the formerly sterile lower respiratory tract typically occurs from aspiration of secretions, colonization of the aero-digestive tract, use of contaminated equipment, medications, presence of a genetic syndrome, re-intubation, enteral feeding, transport out of the pediatric intensive care unit (PICU) and duration of mechanical ventilation.

However, **Othman et al.**[7] reported that the most common indication for MV in the studied cases was respiratory distress syndrome (RDS) in 30% neonates. Ventilator associated pnemonia and Devices associated infection were the most common

complications related to MV (19.1% and 11.8% respectively). While septic shock and multiorgan failure were the most common complications related to the underlying disease (24%).

Also, **Lategan et al.**[10] reported that respiratory distress syndrome of prematurity followed by congenital pneumonia, Sepsis and Apnea were the most common causes of MV. Regarding reported complications of studied groups, the incidence of complications related to MV was estimated at 104 (43.3%), and VAP observed an increase (20%). Furthermore, the complications related to disease patterns were reported to be 56.7% and 22.5% for sepsis and septic shock.

As well, **Monsef et al.**[11] reported that RDS, neonatal surgeries, asphyxia and maternal anomalies were the most common indications for mechanical ventilation.

Comparison between survived and non-survived neonates according to complications related to mechanical ventilation showed that there was significant increase in VAP and BPD prevalence in non-survived neonates in comparison to survived neonates. As mentioned before, our results indicated that the mortality was related to the complications related to disease but not related to the indication for MV.

In agreement with the present study **Othman et al.**[7] reported that there was significant increase in VAP prevalence in non-survived neonates in comparison to survived neonates' other complications were none significantly differed.

The same result was reported by **Lategan et al.**[10] who revealed that there was significant increase in VAP prevalence in non-survived neonates in comparison to survived neonates' other complications were non significantly differed.

Follow up of Retinopathy of prematurity (ROP) related to complication of mechanical ventilation, showed that there was significant increase in ROP prevalence specially grade III in non-survived neonates in comparison to survived neonates. Retinopathy of prematurity may reflect the neurological immaturity and this may explain the increased mortality.

Risk factors for the development of ROP are reported to include: hyperoxia and long-term oxygen therapy, artificial ventilation (especially that which lasts longer than 7 days), periods of hypoxemia after completion of oxygen therapy,

bronchopulmonary dysplasia (BPD), respiratory failure, numerous blood transfusions, anemia, sepsis, necrotizing enterocolitis, metabolic acidosis, low Apgar scores, asphyxia, intraventricular hemorrhage, abnormalities apneas, congenital heart disease, abnormal glucose, hypotension, pneumothorax, prenatal and postnatal steroid therapy, use of antibiotics and xanthine compounds such as aminophylline and theophylline, treatment of patent ductus arteriosus with indomethacin, phototherapy for jaundice, poor nutrition, and parenteral nutrition.[12,13]

Also, regarding Follow up of auditory brainstem response (ABR) related to complication of mechanical ventilation in survived and non-survived neonates, we found that there was significant increase in ABR prevalence in non-survived neonates in comparison to survived neonates. Furthermore, there was significant increase in absolute latency of I & III wave in neonates complicated with ABR impairment.

It was found that a significantly increased ABR interpeak latencies of infants born preterm are related to lower gestational age and the need for neonatal intensive care treatment and consequently higher rate of mortality.

Auditory brain stem responses (ABRs) reflect the neural activity along the auditory pathway in the brain stem. Auditory brain stem responses can be used to (1) indirectly evaluate hearing (especially in small children) and (2) evaluate the intactness of the brain stem in patients with, eg, tumors, trauma, or infections involving the brain stem.[14]

RECOMMENDATION

Maternal diabetes and hypertension control are important to avoid adverse neonatal respiratory complications that need mechanical ventilation.

Pre-natal cardiac evaluation is essential for diagnosis of any congenital heart diseases that may obligate mechanical ventilation.

Intensive care protocols must focus on prevention and management of ventilator associated pneumonia, Septic shock, Multiple Organ Failure, DIC and NEC as they frequently develop with prolonged ventilation.

Specific care for low birth weight and preterm infants due to high mortality rate.

Additional investigations with larger sample sizes are required to corroborate our results and

identify additional adverse event risk variables.

CONCLUSIONS

The present study showed that the survival rate of ventilated neonates was the most common indication for ventilation was congenital heart diseases. The commonest complications encountered in ventilated neonates were VAP and BPD.

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