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ORIGINAL ARTICLE

Indications, complications and short term outcomes of mechanical ventilation in NICU.

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ABSTRACT… Objective: To determine the indications, complications and outcome of neonates requiring mechanical ventilation in neonatal intensive care unit (NICU). **Study Design:** Cross-sectional study. **Setting:** The NICU of National Institute of Child Health (NICH), Karachi, Pakistan. **Period:** February 2024 to July 2024. **Methods:** A total of 89 neonates who required mechanical ventilation for at least 6 hours were analyzed. At the time of enrollment, gender, age (day of life), gestational age (weeks), birth weight (grams), place of birth, and mode of delivery were noted. Main cause influencing need for mechanical ventilation was also documented. During the course of mechanical ventilation, associated complications were recorded. Outcome was noted in the form of survival or death. **Results:** In a total of 89 neonates, 54 (60.7%) were boys. The mean age was 10.64±9.67 days. The most common causes behind the need for mechanical ventilation were sepsis, perinatal asphyxia, tetanus, and RDS, noted in 26 (29.2%), 22 (24.7%), 14 (15.7%), and 12 (13.5%) neonates, respectively. The most frequent mechanical ventilation associated complications were pneumonia, pulmonary hemorrhage, atelectasis, and pneumothorax, observed in 23 (25.8%), 12 (13.5%), 6 (6.7%), and 2 (2.2%), respectively. The mean duration of mechanical ventilation was 6.97±5.87 days (ranging between 2 to 25 days). Mortality was reported in 44 (49.4%) neonates. **Conclusion:** The most common causes behind the need for mechanical ventilation were sepsis and perinatal asphyxia. The most frequent mechanical ventilation associated complications were pneumonia, and pulmonary hemorrhage, while overall mortality was very high.

Key words: Mechanical Ventilation, Mortality, Perinatal Asphyxia, Pneumonia, Sepsis.

INTRODUCTION

Out of 130 million neonates born every year, 4 million do not pass on the initial twenty-eight days of life.[1] Around two third of the world's entire neonatal mortality occur in only 10 nations, generally in Asia. Pakistan ranks 3rd in neonatal mortality rates where mortality rate is hovering around 42/1,000 live-births. Pakistan alone reported approximately 7% of global neonatal mortality.[2,3] In Pakistan, the most common causes of neonatal mortality are birth asphyxia, congenital pneumonia, immaturity, hyaline membrane disease, intraventricular hemorrhage as well as infections.[4-6] Numerous critically ill children, who foster life-threatening apnea or on the other hand cardiovascular collapse from an assortment of causes, require cardiopulmonary resuscitation.[5,6] Supported ventilation has become a vital piece of the neonatal intensive care.[7] Newborns with reformist respiratory pain with looming respiratory failure can be upheld and protected through supported ventilation.[5,6] With the introduction of modern NICUs, mechanical ventilation (MV) has gone through consistent development. Epidemiological and environmental factors in the ICU are imperative to basic consideration since they can influence care and mortality.[8,9]

The MV is described as the exchange of gas into and out of the lungs by an outside source that is associated directly to the patient via a tracheostomy or by means of endotracheal tube.[10] Regional data showed respiratory distress syndrome (RDS), sepsis, and birth asphyxia were the most common causes behind MV in neonates, affecting 31.1%, 22.7%, and 18% neonates,

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respectively.[11]

It was expected that this study may assist in identifying the profile and severely sick neonates requiring MV care in NICU. This study was aimed to determine the indications, complications and outcome of neonates requiring MV in NICU.

METHODS

This cross-sectional study was conducted in NICU of National Institute of Child Health (NICH), Karachi, Pakistan from February 2024 to July 2024. Approval from Institutional Ethical Review Board was obtained (IERB-41/2021, dated: 22-12-2021). Taking the proportion of birth asphyxia as cause of mechanical ventilation in 18% neonates with 95% confidence level and 8% margin of error, the sample size was calculated to be 89. Non probability, consecutive sampling technique was adopted. Inclusion criteria were neonates who required MV for at least 6 hours**.** Neonates who died within 6 hours of life were excluded. Neonates born with gestational age below 26 weeks were not included. Birth weight below 2500 grams was defined as low birth weight (LBW). Those neonates who required immediate termination of ventilator support due to any reasons were also excluded. Informed and written consents were obtained from the patents/ guardians.

At the time of enrollment, gender, age (day of life), gestational age (weeks), birth weight (grams), place of birth, and mode of delivery were noted. Main cause influencing need for MV was also documented. Neonates born before 37th week were labeled as preterm. During the course of MV, associated complications were recorded. Outcome was noted in the form of survival or death. Total duration of MV was also noted.

All the gathered data were managed and analyzed using IBM-SPSS Statistics, version 26.0. The quantitative data were shown as mean and standard deviation. Frequency and proportions were shown for qualitative data. Comparison of quantitative data were made employing independent sample t-test, whereas, chi-square test was used to analyzed categorical data. For all inferential statistics, $p<0.05$ was taken as significant.

RESULTS

In a total of 89 neonates, 54 (60.7%) were boys. The mean age was 10.64±9.67 days, ranging between 1-28 days. Delivery place of 50 (56.2%) neonates was hospital. There were 71 (79.8%) neonates who were delivered through normal vaginal delivery. The mean gestational age, and birth weight were 36.84±1.19 weeks, and 2577±476.91 grams, respectively. Table-I is showing baseline demographics and clinical characteristics of neonates.

Characteristics		Number (%)
Gender	Boys	54 (60.7%)
	Girls	35 (39.3%)
Age (days)	1-7	52 (58.4%)
	>7	37 (41.6%)
Delivery place	Clinic	7 (7.9%)
	Home	32 (36.0%)
	Hospital	50 (56.2%)
Delivery mode	Elective cesarean section	7 (7.9%)
	Emergency cesarean section	11 (12.4%)
	Normal vaginal delivery	71 (79.8%)
Gestational age	Term	19 (21.3%)
	Pre-term	70 (78.7%)
Low birth weight		25 (28.1%)
Residence	Rural	31 (34.8%)
	Urban	58 (65.2%)

Table-I. Demographical and clinical characteristics of neonates

The most common causes behind the need for MV were sepsis, perinatal asphyxia, tetanus, and RDS, noted in 26 (29.2%), 22 (24.7%), 14 (15.7%), and 12 (13.5%) neonates, respectively. Figure-1 is showing major causes requiring MV among neonates.

The most frequent MV associated complications were pneumonia, pulmonary hemorrhage, atelectasis, and pneumothorax, observed in 23 (25.8%), 12 (13.5%), 6 (6.7%), and 2 (2.2%), respectively. The mean duration of MV was 6.97±5.87 days (ranging between 2 to 25 days). Mortality was reported in 44 (49.4%) neonates.

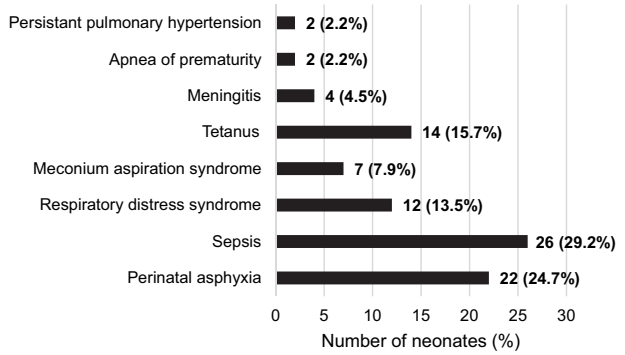

Figure-1. Major causes requiring mechanical ventilation

The mean duration of MV was significantly high among neonates who survived in comparison to those who died (8.93±7.01 vs. 4.95±3.53 days, p=0.001). Delivery place as home (p=0.002), and causes of MV as RDS (p<0.001), or meningitis (p=0.043) were linked with neonatal mortality. Mechanical ventilation associated pneumonia (p<0.001), and persistent pulmonary hypertension (p<0.001) were associated with mortality. Table-II and III are sowing details about the association of final outcome with various demographics, clinical findings, indications and complications of neonates who underwent MV.

Variables		Survivors (n=45)	Non-survivors (n=44)	P-Value
Gender	Boys	27 (60.0%)	27 (61.4%)	0.895
	Girls	18 (40.0%)	17 (38.6%)	
Age (days)	1-7	30 (66.7%)	22 (50.0%)	0.111
	>7	15 (33.3%)	22 (50.0%)	
Delivery place	Clinic	7 (15.6%)	-	0.002
	Home	10 (22.2%)	22 (50.0%)	
	Hospital	28 (62.2%)	22 (50.0%)	
Delivery mode	Elective cesarean section	4 (8.9%)	3 (6.8%)	0.252
	Emergency cesarean section	8 (17.8%)	3 (6.8%)	
	Normal vaginal delivery	33 (73.3%)	38 (86.4%)	
Gestational age	Term	35 (77.8%)	35 (79.5%)	0.839
	Pre-term	10 (22.2%)	9 (20.5%)	
Low birth weight		36 (80.0%)	28 (63.6%)	0.086
Residence	Rural	12 (26.7%)	19 (43.2%)	0.102
	Urban	33 (73.3%)	25 (56.8%)	

Table-II. Association of demographics and clinical findings of neonates undergoing mechanical ventilation with final outcome

Variables		Survivors (n=45)	Non-survivors (n=44)	P-Value
Indications of mechanical ventilation	Perinatal asphyxia	15 (33.3%)	7 (15.9%)	0.057
	Sepsis	14 (31.1%)	12 (27.3%)	0.691
	Respiratory distress syndrome	-	12 (27.3%)	<0.001
	Meconium aspiratory syndrome	4 (8.9%)	3 (6.8%)	0.717
	Meningitis	4 (8.9%)	-	0.043
	Tetanus	6 (13.3%)	8 (18.2%)	0.530
	Apnea of prematurity	2 (4.4%)	-	0.157
	Persistent pulmonary hypertension	-	2 (4.5%)	0.148
Complications of mechanical ventilation	Atelactasis	4 (8.9%)	2 (4.5%)	0.414
	Pneumothorax	2 (4.4%)	-	0.157
	Pneumonia	20 (44.4%)	3 (6.8%)	<0.001
	Persistent pulmonary hemorrhage	-	12 (27.3%)	<0.001

Table-III. Association of indications and complications of mechanical ventilation with final outcome

DISCUSSION

In this study, the most common indications for MV were sepsis (29.2%), perinatal asphyxia (24.7%), tetanus (15.7%), and RDS (13.5%). Regmi et al.[12], found that sepsis and birth asphyxia were the most common indications for MV among 119 neonates. Srinivas et al.[13], reported that 280 neonates were ventilated, with RDS (26.7%), sepsis (26.7%), and birth asphyxia (12%) being the most frequent indications.[13] Abdelrazic et al found that non-respiratory causes, particularly apnea after status epilepticus and central apnea, were the primary indications for MV, followed by respiratory failure due to pneumonia.[14] They reported a significant relationship between the indications for MV and age groups. This contrasts with our study where sepsis and RDS were the predominant indications. Othman et al. observed that RDS was the most common indication for MV in their study of 110 neonates, with ventilator-associated pneumonia and device-associated infections being the most frequent complications.[15] Iqbal et al analyzing 300 neonates reported that RDS (31.1%), sepsis (22.7%), and birth asphyxia (18%) were the leading indications for MV.[11] Asrar et al. included 320 ventilated neonates and identified

Diagnostic and Treatment-related Variables		Outcome		P-Value
		Discharged (n=68)	Mortality (n=11)	
Blood culture	Positive	8 (11.8%)	-	0.230
	Negative	60 (88.2%)	11 (100%)	
Electrocardiogram	Normal	61 (89.7%)	7 (63.6%)	0.007
	Sinus bradycardia	4 (5.9%)	4 (36.4%)	
	Prolonged PR Interval	3 (4.4%)	-	
Chest x-ray	Normal	55 (80.9%)	7 (63.6%)	0.005
	Effusion	6 (8.8%)	1 (9.1%)	
	Infiltrate	7 (10.3%)	1 (9.1%)	
	Collapse	-	2 (18.2%)	
Dengue diagnosis	Dengue fever without a warning sign	29 (42.6%)	-	<0.001
	Dengue with warning sign	25 (36.8%)	2 (18.2%)	
	Severe dengue fever	14 (20.6%)	9 (81.8%)	
Ventilatory support		-	9 (81.8%)	<0.001
Hospital stay (days)	1-3	25 (36.8%)	8 (72.7%)	0.064
	4-7	33 (48.5%)	3 (27.3%)	
	>7	10 (14.7%)	-	

Table-II. Association of diagnostic and treatment related variables with outcome (N=79)

Laboratory Parameters	Outcome		P-Value
	Discharged (n=68)	Mortality (n=11)	
Hemoglobin (g/dl)	10.45±2.55	8.02±1.37	0.045
Total Leukocytes Count (10^9/L)	7.29±3.61	5.91±3.49	0.387
Platelets (10^9/L)	75.19±78.53	28.73±14.83	0.007
Hematocrit (%)	37.70±12.05	44.55±12.14	0.638
Alanine Transaminase (IU/L)	71.02±78.00	60.00±8.16	0.293
Urea (mg/dl)	22.89±14.83	47.64±33.10	<0.001
Creatinine (mg/dl)	0.71±0.46	1.44±0.50	0.281
Sodium (mEq/L)	136.11±5.80	135.09±8.29	0.087
Potassium (mEq/L)	3.90±0.70	4.16±1.21	0.003
Chlorine (mEq/L)	105.38±10.08	111.18±5.95	0.494
HCO3 (mEq/L)	21.06±3.30	21.09±5.82	0.055
International normalized ratio (sec)	1.13±0.30	2.34±1.24	<0.001
Activated Partial Thromboplastin Clotting Time (sec)	28.57±7.32	77.30±86.21	<0.001

Table-III. Association of baseline laboratory parameters with outcome (n=79)

Study Variables		Dengue Fever Without Warning Signs (n=29)	Dengue With a Warning Sign (n=27)	Severe Severe Dengue Fever (n=23)	P-Value
Gender	Male	14 (48.3%)	15 (55.6%)	14 (60.9%)	0.657
	Female	15 (51.7%)	12 (44.4%)	9 (39.1%)	
Age (years)		4.14±3.37	5.53±3.94	4.01±2.82	0.216
Blood culture	Positive	3 (10.3%)	3 (11.1%)	2 (8.7%)	0.960
Electrocardiogram	Normal	26 (89.7%)	23 (85.2%)	19 (82.6%)	0.478
	Sinus bradycardia	2 (6.9%)	4 (14.8%)	2 (8.7%)	
	Prolonged PR Interval	1 (3.4%)	-	2 (8.7%)	
Chest x-ray	Normal	29 (100%)	22 (81.5%)	11 (47.8%)	<0.001
	Effusion	-	4 (14.8%)	3 (13.0%)	
	Infiltrate	-	1 (3.7%)	7 (30.4%)	
	Collapse	-	-	2 (8.7%)	
Ventilatory support		-	2 (7.4%)	7 (30.4%)	0.002
Hospital stay (days)	1-3	17 (58.6%)	6 (22.2%)	10 (43.5%)	0.022
	4-7	12 (41.4%)	15 (55.6%)	9 (39.1%)	
	>7	-	6 (22.2%)	4 (17.4%)	
Mortality		-	2 (7.4%)	9 (39.1%)	<0.001

Table-IV. Association of dengue classification with demographics, diagnostic variables and outcomes (N=79)

RDS (28.7%), HIE (26.6%), and neonatal sepsis (14.1%) as the most common indications for MV.[16] Fatima et al. analyzed 227 neonates and found that pneumonia, RDS, and sepsis were the leading indications for MV.[17]

In the present study, mortality was reported in 49.4% neonates. Othman et al noted the overall recovery rate of 59.1% in their study.[15] Regmi et al described an overall survival rate of 37.8%.[12] Shaikh et al reported a 22% mortality rate in their study of 156 neonates requiring MV.[18] Srinivas et al identified several factors associated with mortality, including low birth weight, gestational age below 32 weeks, sepsis, and hypoglycemia.[13] These findings are consistent with our study, which found that lower gestational age and birth weight, along with conditions like RDS and meningitis, were associated with higher mortality rates. Srinivas and colleagues also exhibited the importance of pulmonary hemorrhage, and shock for the prediction of mortality, which is quite similar to what we observed that pneumonia, and persistent pulmonary hypertension increased the risk of death significantly in this study.[13] Asrar et al found high mortality rates linked with neonatal sepsis (64.4%), and RDS (64%).[16] These death rates are higher than those observed in this study, potentially due to variations in the healthcare resources and management practices. Asrar et al also depicted the significance of factors such as birth weight, prematurity, and the mode of admission in predicting outcomes, which supports our findings regarding the significant impact of gestational age and birth weight on mortality.[16] Regmi et al identified shock and disseminated intravascular coagulation (DIC) as common complications, significantly associated with mortality.[12]

Our study similarly identified pneumonia and persistent pulmonary hypertension as significant complications leading to higher mortality rates. These findings underscore the critical need for early diagnosis and management of sepsis and other complications to improve survival rates in neonates requiring mechanical ventilation. Dutt et al. reported that the survival rate was better in inborn babies compared to outborn babies, with a statistically significant difference.[19] The better outcomes in inborn babies emphasize the importance of ensuring deliveries occur in well-equipped healthcare facilities to reduce neonatal mortality. Fatima et al reported a higher prevalence of complications like ventilator-associated pneumonia and a significant association between complications and mortality.[18]

Our study also noted similar complications, including pneumonia and pulmonary hemorrhage, which were significantly associated with mortality. These findings highlight the importance of preventive measures and vigilant monitoring to reduce the incidence of complications and improve neonatal outcomes. Our study found a significant difference in the duration of MV between survivors and non-survivors, with longer ventilation durations associated with better survival rates. This finding suggests that extended ventilation support may be crucial for the survival of critically ill neonates, allowing more time for recovery and stabilization. The association between conditions like RDS, meningitis, and higher mortality highlights the need for targeted interventions and improved management strategies for these high-risk conditions. These findings underscore the challenges in managing these critically ill neonates and the importance of early intervention and effective management strategies to improve outcomes.

This study accompanied some inherent limitations. Relatively small sample size along with a single center ICU reduce the generalizability of our findings. Lack of laboratory parameters evaluation in the present study might have shadowed some important insights. Still, this study shares in-depth analysis about the causes, complications and outcomes of neonates who required MV from the ICU of a developing country.

CONCLUSION

The most common causes behind the need for MV were sepsis and perinatal asphyxia. The most frequent MV associated complications were pneumonia, and pulmonary hemorrhage, while overall mortality was very high. Our study emphasized the need to ensure deliveries occurring in well-equipped healthcare facilities to improve neonatal outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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2	Muhammad Ashfaq	Concept and design, Critical revisions, Final approval.	
3	Bader-u-Nisa	Interpretation of data, critical revisions, Final approval.	
4	Mariyam Noman	Interpretation of data, critical revisions, Final approval.	
5	Muhammad Hanif	Concept, Design of interpretation of data, critical revisions, Final approval.	
6	Aijaz Ahmed	Concept, Design of interpretation of data, critical revisions, Final approval.	