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ORIGINAL ARTICLE

Evaluating Outcomes of Mechanically Ventilated Neonates: A Single Centered Retrospective Cohort Study

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ABSTRACT

Background: The infant mortality rate is considered a main reflector of the state of a community's public health and social development. Study aimed to find various outcomes observed in neonates receiving mechanical ventilation, investigating different factors such as duration of ventilation, patient demographics, mode of delivery, gestational age group and underlying comorbid conditions.

Methods: This retrospective cohort study was conducted in the NICU of Izzat Ali Shah Hospital, Wah Cantt. Data was collected from January 2022 to May 2023. The participant cohort included 153 neonates of both genders (aged 0 to 28 days) through non-probability/consecutive sampling technique, who were placed on mechanical ventilation during their NICU stay. Data was collected on structured performa and analyzed using statistical software SPSS version 11. The analysis included descriptive statistics, mean, median, and standard deviation for continuous variables; frequencies and percentages for categorical variables.

Results: The results showed that most of the neonates were delivered via C-Section (f=95, 62.1%). Both genders experienced high mortality with an overall mortality rate of 83 (53.6%). Mortality was highest among patients with extended NICU stays, especially beyond 9 days, where mortality reached 100%. This study also showed that survival rate improved with higher gestational age 21 (28.3%) term patients out of 74. Similarly, shorter ventilation durations are linked to better outcomes i.e. 29 (26.1%) patients who were weaned off within first two days of ventilation survived.

Conclusion: The implications of this study advocate the need for initiatives and programs for maximum maternal and neonatal care at government level with multidisciplinary approach in managing ventilated patients as also emphasized in other studies.

Keywords: Neonatal; Ventilator; Mortality; Cohort; Intensive care units

INTRODUCTION

The infant mortality rate is considered a main reflector of the state of a community's public health and social development. Developing countries, like Pakistan, have the highest under-five mortality rate.[1] Most of these deaths happened in the first twenty eight days of life and neonatal deaths accounts for 40% of under-five deaths, globally.[2] The fourth Millennium Development Goal aimed to reduce under-five mortality by two-thirds by 2015.[3] Considerable, efforts have been made to lessen the under-five deaths over the last two decades and a global decline of 35% has been achieved. However, there has been limited advancement in reducing neonatal mortality over the same period. [1, 2, 3]

To counter one of the highest neonatal mortality in the world, Pakistan needs more work done in the field of neonatal ventilation.[1, 2] Mechanical ventilation in neonates is a rapidly progressing field and it has become a necessary part of every neonatal intensive care units (NICU), nowadays.[4] For improvement in neonatal care, including ventilation strategies and supportive care, understanding the outcomes associated with mechanical ventilation is essential.[4, 5]

Neonates, particularly those born prematurely having surfactant deficiency or with hypoxia, pneumonia, sepsis, and meconium aspiration that can complicate their respiratory management.[5] Despite the availability of ventilators, the neonatal mortality is still very high. Neonatal outcomes on ventilators are further complicated by other diseases such as Pneumonia, hypoxic ischemic encephalopathy (HIE), congenital diaphragmatic hernia, respiratory distress syndrome (RDS), prolonged hospital stay.[6, 7] but has better outcome with increased gestational age.[7]

The rationale of this study was to find various outcomes observed in neonates receiving mechanical ventilation, investigating different factors such as duration of ventilation, patient demographics, mode of delivery, gestational age group and underlying comorbid conditions in order to provide an understanding that will shape future of the best practices and improve neonatal mortality rates in a developing country like Pakistan.

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METHODOLOGY

This was a retrospective cohort analysis aimed at evaluating the outcomes of mechanically ventilated neonates irrespective of gender, focusing on the duration of ventilation, prognosis, and influencing factors, including relevant laboratory parameters.

The study was conducted in the Neonatal Intensive Care Units (NICUs) of Izzat Ali Shah hospital, Wah Cantt. Data was collected from the medical records of neonates admitted between January 2022 to May 2023. Izzat Ali Shah hospital is a tertiary care teaching hospital with a dedicated Paediatric ward providing comprehensive healthcare services to a large population in Wah Cantt and its surrounding areas.

The study included all consecutive 153 neonates (aged 0 to 28 days) who were placed on mechanical ventilation during their NICU stay within the specified period. The sample size of 153 was estimated by openepi, version 3, by 95% confidence level with Population size (for finite population correction factor or fpc)(N):10000, Population size(for finite population correction factor or fpc)(N): 40%+/-5, Confidence limits as % of 100(absolute +/- %)(d): 5%, and Design effect (for cluster surveys-DEFF): 1. [3] Exclusion criteria included neonates with incomplete medical records and neonates transferred from other hospitals with incomplete data. Data was extracted from electronic health records (EHR) using a structured data collection form. The following variables were collected: Demographic data, gestational age, birth weight, gender, mode of delivery (vaginal delivery or cesarean section), APGAR score at 5 minutes, cause of respiratory failure e.g. respiratory distress syndrome, meconium aspiration syndrome (MAS), congenital diaphragmatic hernia (CDH), and others, primary diagnosis (including sepsis, hypoxic ischemic encephalopathy (HIE), pneumonia and meningitis). Theses diagnoses were reached by history and following laboratory Data: Hemoglobin (Hb), hematocrit (Hct) , serum creatinine, C-reactive

protein (CRP), white blood cell (WBC) count, platelets, electrolytes (sodium, potassium) and CSF analysis.

Outcome was recorded as NICU mortality, length of NICU stay in days, weaning success or failure. The primary outcome measure was NICU mortality. Secondary outcome measures included hospital mortality, length of NICU stay and weaning success.

Data was analyzed using statistical software SPSS version 11. The analysis included descriptive statistics, mean, median, and standard deviation for continuous variables; frequencies and percentages for categorical variables. Comparative analysis was done by comparison of outcomes based on ventilation duration using t-tests or chi-square tests as appropriate. The results were tabulated to provide a clear overview of the gender distribution, mode of delivery, outcomes, gestational age distribution, primary diagnosis, and NICU/ventilator stay duration observed in the cohort. A p-value ≤0.05 was considered significant.

RESULTS

Our study included 153 neonates with male to female ratio of 2:1. Most of the neonates were delivered via C-Section.

Table 1: showed that both genders experienced high mortality rates. Mortality was highest among patients with extended NICU stays or ventilation durations, especially beyond 9 days, where mortality reached 100%. Sepsis also significantly impacted outcomes. Our data also showed that survival rate improved with higher gestational age. Similarly, shorter ventilation durations are linked to better outcomes. However, patients requiring ventilation for more than 9 days all expired.

		Frequency	Percentage
Gender	Male	107	69.9%
	Female	46	30.1%
Mode of Delivery	Vaginal	58	37.9
	C-Section	95	62.1
Primary Diagnosis	RDS	46	30.1
	MAS	10	6.5%
	CDH	2	1.3&
	Sepsis	9	5.9
	HIE	29	19%
	Pneumonia	35	22.9
	Meningitis	9	5.9
	Others	13	8.5
Outcome	Weaned Off	45	29.4
	Expired	82	53.6
	Left against medical advice	12	7.8
	Referred	14	9.2

Table 2: showing ventilator outcomes by gender, mode of delivery, NICU stay duration, and sepsis status

	Variable	Weaned Off	Expired	LAMA	Referred	Total
Gender	Male	36 (33.6%)	54 (50.5%)	8 (7.5%)	9 (8.4%)	107 (100%)
	Female	9 (19.6%)	28 (60.9%)	4 (8.7%)	5 (10.9%)	46 (100%)
Mode of Delivery	Vaginal	17 (29.3%)	31 (53.4%)	7 (12.1%)	3 (5.2%)	58 (100%)
	C-Section	28 (29.5%)	51 (53.7%)	5 (5.3%)	11 (11.6%)	95 (100%)
NICU Stay Duration	Less than 5 days	20 (16.8%)	75 (63.0%)	11 (9.2%)	13 (10.9%)	119 (100%)
	6 to 10 days	17 (68.0%)	6 (24.0%)	1 (4.0%)	1 (4.0%)	25 (100%)
	11 to 15 days	8 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	8 (100%)
	More than 20 days	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)	1 (100%)
Sepsis	Yes	21 (24.7%)	44 (51.8%)	10 (11.8%)	10 (11.8%)	85 (100%)
	No	23 (34.3%)	38 (56.7%)	2 (3.0%)	4 (6.0%)	67 (100%)
Gestational Age Group	27 to 31 weeks	1 (7.1%)	12 (85.7%)	1 (7.1%)	0 (0.0%)	14 (100%)
	32 to 36 weeks	13 (30.9%)	25 (59.5%)	2 (4.7%)	2 (4.7%)	42 (100%)
	Less than 37 weeks	10 (43.4%)	8 (34.7%)	2 (8.6%)	3 (13.0%)	23 (100%)
	37 to 41 weeks	21 (28.3%)	37 (50%)	7 (9.4%)	9 (12.1%)	74 (100%)
Ventilation Duration	Less than 2 days	29 (26.1%)	61 (55.5%)	12 (10.8%)	9 (8.1%)	111 (100%)
	3 to 4 days	10 (34.5%)	16 (55.2%)	0 (0.0%)	3 (10.3%)	29 (100%)
	5 to 6 days	5 (55.6%)	3 (33.3%)	0 (0.0%)	1 (11.1%)	9 (100%)
	7 to 8 days	1 (33.3%)	1 (33.3%)	0 (0.0%)	1 (33.3%)	3 (100%)
	More than 9 days	0 (0.0%)	1 (100%)	0 (0.0%)	0 (0.0%)	1 (100%)

Table 3: shows that across various primary diagnoses, ventilator outcomes are generally poor, with an overall mortality rate of 53.6%. The highest mortality rates are observed in sepsis and respiratory distress syndrome and congenital diaphragmatic hernia. Pneumonia has the best outcomes, while other conditions like HIE and meningitis showed mixed results.

	Variable	Weaned off	Expired	LAMA	Referred	Total
Primary Diagnosis	Respiratory distress syndrome	11 (23.9%)	30 (65.2%)	2 (4.3%)	3 (6.5%)	46 (100%)
Primary Diagnosis	Meconium aspiration syndrome	2 (20%)	6 (60.0%)	1 (10.0%)	1 (10.0%)	10 (100%)
	Congenital diaphragmatic hernia	0 (0.0%)	1 (50%)	0 (0.0%)	1 (50.0%)	2 (100%)
	Sepsis	1 (11.1%)	7 (77.8%)	0 (0.0%)	1 (11.1%)	9 (100%)
	HIE	5 (17.2%)	15 (51.7%)	5 (17.2%)	4 (13.8%)	29 (100%)
	Pneumonia	18 (51.4%)	14 (40.0%)	0 (0.0%)	3 (8.6%)	35 (100%)
	Meningitis	3 (33.3%)	3 (33.3%)	3 (33.3%)	0 (0.0%)	9 (100%
	Others	5 (38.5%)	6 (46.2%)	1 (7.7%)	1 (7.7%)	13 (100%)
	total	45 (29.4%)	82 (53.6%)	12 (7.8%)	14 (9.2%)	153 (100%)

Figure 1 Showing Patient outcome with regard to APGAR at 1 min (A) and at 5 min (B)

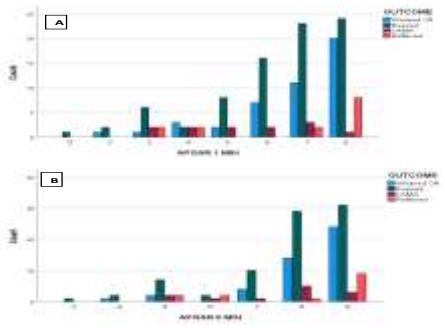

Figure 1: shows that higher APGAR scores at both 1 minute and 5 minutes are associated with better patient outcomes.

DISCUSSION

In our study we observed that several variables have a significant influence on ventilator outcomes, these include patient demographics, mode of delivery, gestational age, underlying comorbid conditions like sepsis, pneumonia, RDS, HIE, meningitis, NICU stay and duration of ventilation. Notably, patients with associated lung conditions had a poorer outcome, as demonstrated in other studies too, underscoring the importance of tailored approaches in these patients.[8] This finding aligns with previous literature indicating that pneumonia, HIE, congenital diaphragmatic hernia, RDS are associated with increased risk of ventilator-associated complications thus affecting neonatal outcomes.[8, 9, 10]

Both genders experienced high mortality rates, 50.5% in male and 60.9% in female babies in our study though other studies showed statistically significant effect of age and gender.[15, 16]

Mortality in neonates is higher but more in ventilated neonates.[11, 12, 13]

Across various primary diagnoses, ventilator outcomes are generally poor, with Pneumonia has the best outcomes with 40% mortality, while other conditions like HIE (51.7%) and meningitis (33.3%) showed mixed results. [14] A study found increased risk of respiratory complications in neonates born with c-section as compared to normal vaginal deliveries.[15] However, we found no difference in mortality among patients delivered via C-section (53.7%) and vaginal delivery (53.4%).

A great amount of research work has shown that outcome improved with increasing gestational age our data also showed that survival rates improved with higher gestational age.[15, 16] Impact of prematurity and low birth weight is well known, as shown by multiple studies.[15, 16, 17, 18]

Moreover, our data suggested that the duration of mechanical ventilation is closely linked to both morbidity and mortality especially beyond 9 days, where mortality reached 100%. Extended ventilation and prolonged ICU stays were associated with a higher incidence of ventilator related complications as other studies also confirmed the same.[18, 19] Associated complications, especially sepsis, significantly impacted outcomes with a mortality rate of 51.8%, were found to be associated with duration of mechanical ventilation. A study reported increased risk of early onset sepsis with ventilation on first day of life ;furthermore, another study showed the association of late onset sepsis with prolonged ventilation. [20, 21] Different studies have mentioned different time duration on ventilator that is associated with poor outcome. For example in one study it was described as 15 days of ventilation associated with poor outcome [22] but in our study patients on average more than 9 days of duration were associated with worst outcomes. These results emphasize the critical need for strategies aimed at weaning patients off ventilation as swiftly and safely as possible.

There was a mismatch of gender with more female babies as compared to male babies. Outcome of patient who were referred and those who left against medical advice (LAMA) was also not known. Since these results were of a single centre so our results may not be applicable to others so there is a strong need for a larger multi-centred study.

CONCLUSION

This study advocates the need for initiatives and programs for maximum maternal and neonatal care at government level with multidisciplinary approach in managing ventilated patients. Early identification of at-risk patients, particularly those with low gestational age, sepsis and other complications should prompt proactive antenatal measures to minimize complications and decreasing the need for mechanical ventilation. Appropriate measures to prolong the gestational age as much as possible to prevent severe prematurity should be taken by the obstetrician, as both higher gestational age and reduced cases of RDS will improve outcome.

List of Abbreviations: Left against medical advice (LAMA), urinary tract infection (UTI), respiratory distress syndrome (RDS), meconium aspiration syndrome (MAS), congenital diaphragmatic hernia (CDH), Statistical Package for the Social Sciences (SPSS), intensive care unit (ICU), hypoxic ischemic encephalopathy (HIE)

Conflict of Interest: The authors declare that they have no competing interests.

Authors' Contributions: FT: Conceptualization, methodology, supervision; JA: Data curation, formal analysis; FK: Investigation, writing—original draft; KIS: Visualization, project administration; AS: Writing—review and editing.

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Ethical Considerations: The study was conducted in accordance with the Declaration of Helsinki. Ethical permission was taken from institutional ethical review committee (ERC) with approval no. 028/Approved/06/2023ERB. All protocols were carried by with college guidelines and regulations.

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