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IMMEDIATE OUTCOME OF MECHANICALLY VENTILATED NEONATE: ONE YEAR EXPERIENCE IN NEONATAL INTENSIVE CARE UNIT OF US-BANGLA MEDICAL COLLEGE HOSPITAL, RUPGONJ, NARAYANGONJ

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ABSTRACT

Background: Mechanical ventilation remains a life-saving intervention in neonatal intensive care units, yet it is associated with significant morbidity and mortality. **Objective:** This study evaluated the outcomes of mechanically ventilated neonates and identified key demographic and clinical factors influencing survival to guide evidence-based neonatal care and policy planning. **Materials and Methods:** This cross-sectional study was conducted from January to December, 2024 in the Neonatal Intensive Care Unit (NICU) of US-Bangla Medical College Hospital, including 42 mechanically ventilated neonates. Demographic data, clinical parameters, indications for ventilation, and outcomes were noted. The collected data were analyzed using SPSS version 26.0 through the method of descriptive statistics, Chi-square test, binary logistic regression, Pearson's correlation, and Kaplan-Meier survival analysis. **Results:** Out of 42 neonates, 29 (69.0%) survived and 13 died (30.9%). Most were term neonates (78.6%) with birth weight ≥2500g (76.2%). Perinatal asphyxia (61.9%) was the most common indication, followed by septicemia (42.9%) and meconium aspiration syndrome (33.3%). Septicemia (23.8%) and perinatal asphyxia (16.6%) were the leading causes of mortality. Significant predictors for survival included gestational age ≥37 weeks [OR=4.58, p=0.028], birth weight ≥2500g [OR=6.29, p=0.015], MAS as indication [OR=8.27, p=0.021], and initial pH >7.25 [OR=3.52, p=0.048]. Septicemia significantly reduced survival [OR=0.25, p=0.022]. The duration of ventilation has a negative correlation with survival (r=-0.47, p=0.004), while hospital stay correlated positively with survival (r=0.52, p=0.002). **Conclusion:** The overall survival among neonates on mechanical ventilatory support was 69%. Gestation at term, appropriate birth weight, and non-infectious respiratory conditions were found to be good predictors of survival. Septicemia emerged as the main determinant of mortality, which underscores the need to adopt strict infection control and early intervention to improve outcomes of neonatal ventilation.

Keywords: Mechanical Ventilation, Neonates, Meconium Aspiration Syndrome, Septicemia.

INTRODUCTION

Mechanical ventilation is one of the most important interventions in neonatal intensive care; it represents a lifesaving modality for neonates with respiratory failure, severe perinatal asphyxia, and critical illnesses[1].

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Modern ventilation strategies have reoriented neonatal care and significantly decreased mortality rates in developed countries, while resource-limited settings still confront formidable obstacles to achieve optimal results[2]. Despite this, mechanical ventilation continues to result in high morbidity and mortality, particularly in low and middle-income countries, because of limited infrastructure, expertise, and resources[3].

Success largely depends on timely intervention, the quality of neonatal intensive care, and the availability of skilled personnel and monitoring facilities. Poor access to modern ventilators, inadequate maintenance, and suboptimal training of healthcare providers often exacerbates these challenges, contributing to unfavorable outcomes in developing regions. These are indeed respiratory distress syndrome, perinatal asphyxia, sepsis, and meconium aspiration syndrome[4]. This burden of neonatal deaths due to these conditions remains dire in developing countries worldwide because early detection and timely interventions have remained incomplete so far[5].

Neonatal mortality is a leading public health concern in Bangladesh, given an estimated 28 deaths per 1000 live births, with the majority of these deaths attributed to preventable respiratory and infectious causes[6]. In that case, NICUs become the vital care provider for neonates with severe illness, but they remain underdeveloped when compared to those located in high-income countries. Thus, the necessity of determining immediate outcomes for mechanically ventilated neonates in local healthcare settings arises to develop context-specific interventions to improve survival rates and guide the policy decisions for neonatal health programs.

Various determinants of survival have been identified in mechanically ventilated neonates: gestational age, birth weight, underlying disease severity, duration of ventilation, and complications such as sepsis or pneumothorax [7]. In general, term neonates with adequate birth weight tend to have better prognoses than preterm or low birth weight infants. This improved survival is largely attributed to greater physiological maturity and lower vulnerability to respiratory and infectious complications [8]. Furthermore, the duration of mechanical ventilation has been repeatedly associated with poor outcomes, reflecting both the underlying disease severity and the occurrence of ventilation-related complications such as pneumonia, volutrauma, and barotrauma [9]. Prolonged ventilation not only increases the risk of nosocomial infections but also contributes to chronic lung disease and prolonged hospitalization, further straining healthcare resources.

Nosocomial infection remains a major challenge in neonatal intensive care units, and septicemia significantly contributes to the mortality among ventilated neonates [10]. The role of immune immaturity is potentiated by invasive procedures and prolonged hospital stay with or without broad-spectrum antibiotic exposure, leading to susceptibility to a severe life-threatening infection that may progress despite aggressive management [11]. It is therefore important to identify predictors of survival and mortality among mechanically ventilated neonates. It helps clinicians perform effective risk stratification, provide informed prognostic counseling to families, and design targeted therapeutic and preventive interventions. This study aimed to assess the immediate outcomes of mechanically ventilated neonates to identify demographic and clinical predictors of survival to inform evidence-based clinical practices and policy recommendations.

MATERIALS AND METHOD

This cross-sectional study was conducted in the Neonatal Intensive Care Unit (NICU) of US-Bangla Medical College Hospital, Rupgonj, Narayanganj, from January to December 2024. A total of 42 neonates who required mechanical ventilation during the study period were included following ethical approval and informed parental consent. All neonates were admitted with respiratory distress, perinatal asphyxia, sepsis, meconium aspiration syndrome, congenital pneumonia, or other critical conditions requiring assisted ventilation. Enrolled in to the study were neonates born in the hospital of study as well as those neonates who were born elsewhere other than the hospital of the study.Those with major congenital anomalies incompatible with life or parents refusing consent were excluded. Detailed clinical histories, demographic data, and perinatal factors were recorded using a structured proforma. Baseline parameters included gestational age, sex, birth weight, place of delivery, Appearance, Pulse, Grimace, Activity, and Respiration (Apgar) scores[12] at one and five minutes, and indication for ventilation were recorded. Before initiation of ventilation, all neonates underwent complete clinical assessment and laboratory evaluation, including arterial blood gas (ABG) analysis to determine initial pH and oxygenation status.

Statistical Analysis

All data were entered and analyzed using IBM SPSS Statistics, version 26.0. Descriptive statistics were calculated for demographic and clinical variables, and results were presented as frequencies and percentages for categorical data and means ± standard deviation for continuous data. Associations between independent variables (gestational age, birth weight, indication for ventilation, initial pH, and Apgar scores) and survival outcomes were assessed using the Chi-square test. Binary logistic regression was applied to identify independent predictors of survival, and odds ratios (OR) with 95% confidence intervals (CI) were computed. Correlation between continuous variables such as ventilation duration, hospital stay, and survival was determined using Pearson's correlation coefficient (r). Additionally, Kaplan–Meier survival analysis was performed to estimate survival probabilities according to duration of mechanical ventilation, and group differences were assessed by the log-rank test. A p-value < 0.05 was considered statistically significant throughout the analysis.

RESULTS

Table 1 represents the demographic characteristics of thestudy population. The majority of the study population (78.6%) were with gestational age ≥37 weeks, while preterm neonates comprised 21.4%. Female neonates slightly outnumbered males (57.1% vs 42.9%). Birth weight distribution revealed that 76.2% had normal birth weight (≥2500g), with only 7.1% being extremely low birth weight (1000-1500g) and no neonates below 1000g. Notably, 61.9% of the neonates were born elsewhere other than the hospital of the study, indicating significant referral burden from peripheral facilities, while 38.1% were inborn deliveries managed within the institution.

Table 1: Demographic Profile of Mechanically Ventilated Neonates (n = 42)

Demographic Profile	Category	n (%)
Gestational Age (weeks)	< 37	9 (21.4)
	≥ 37	33 (78.5)
Sex	Male	18 (42.9)
	Female	24(57.1)
Birth Weight (g)	< 1000gm	0 (0.0)
	1000–<1500gm	3 (7.1)
	1500–<2500gm	7 (16.7)
	≥ 2500gm	32 (76.2)
Place of Birth	Born in the hospital of the study	16 (38.1)
	Born elsewhere other than the hospital of study	26 (61.9)

n=number of neonate; %=percentage

The indications and complications related to mechanical ventilation are outlined in Table 2. The major indication was perinatal asphyxia, which accounted for 61.9%, followed by septicemia, 42.9%; Meconium Aspiration Syndrome (MAS), 33.3%; and Respiratory Distress Syndrome (RDS), 28.6%. Overlapping indications were common, with complex clinical presentations. In complications, ARF was seen in 7.1%, whereas pulmonary hemorrhage was encountered in 4.7%. Significantly, no instances of pneumothorax, ventilator-associated pneumonia, orIntraventricular Hemorrhage (IVH) were reported, demonstrating good protocols for ventilation management and possibly underreporting or early mortality in this population before the occurrence of complications.

Table 2: Indications and Complications of Mechanical Ventilation (N = 42)

Variable	Category	n (%)
Indication for Mechanical Ventilation	Respiratory Distress Syndrome (RDS)	12 (28.6)
	Perinatal Asphyxia (PNA)	26 (61.9)
	Septicemia	18 (42.9)
	Congenital Pneumonia	7 (16.7)
	Meconium Aspiration Syndrome (MAS)	14 (33.3)
Complications of Mechanical Ventilation	Sepsis	10(23.8)
	Pneumothorax	0 (0.0)
	Acute Renal Failure (ARF)	3 (7.1)
	Pneumonia	0 (0.0)
	Pulmonary Hemorrhage	2 (4.7)
	Intraventricular Hemorrhage	0 (0.0)

N=number of neonate; n= number of neonates in each category;%=percentage.

Table 3 summarizes outcomes and causes of mortality among ventilated neonates. Overall, 69% survived, while 30.9% died. Of the 30.9% deaths, causes included septicemia 23.8%, perinatal asphyxia 16.6%, and respiratory distress syndrome 9.5%. Notably, despite being common indications for mechanical ventilation, there were no deaths due to congenital pneumonia and meconium aspiration syndrome, suggesting a better prognosis for these conditions if appropriately supported with ventilation.

Table 3: Outcome and Cause of Death among Mechanically Ventilated Neonates (N = 42)

Variable	Category	n (%)
Outcome of Neonates	Survived	29 (69.0)
	Death	13 (30.9)
Cause of Death (n = 28)	RDS	4 (9.5)
	PNA	7 (16.6)
	Septicemia	10 (23.8)
	Congenital Pneumonia	0 (0.0)
	MAS	0 (0.0)

N=number of neonate; n= number of neonates in each category;%=percentage

Table 4 summarizes the duration of mechanical ventilation, hospital stay, and initial arterial pH among the study population. Most neonates (64.2%) required ventilation for 3-7 days, while 19.0% needed 7-14 days. Hospital stays showed similar patterns between 1-7 and 7-14 days (23.8% vs 47.6%). Regarding arterial pH, most neonates (56.0%) presented with values between 7.15 to 7.35, indicating mild acidosis at initiation of ventilation, whereas none had a pH below 7.0 or above 7.45.

Table 4: Duration of Ventilation, Hospital Stay, and Initial Arterial pH (N = 42)

Variable	Category	n (%)
Duration of Ventilation (Days)	< 3	7 (16.6)
	3-7	27 (64.2)
	7-14	8 (19.0)
	14-21	0 (0.0)
	21-28	0 (0.0)
Duration of Hospital Stay (Days)	1-7	10 (23.8)
	7-14	20 (47.6)
	14-21	12 (28.6)
	21-28	0 (0.0)
Initial Arterial pH	< 7.0	0 (0.0)
	7.0-7.15	7 (16.6)
	7.15-7.25	20 (22.7)
	7.25-7.35	14 (33.3)
	7.35-7.45	1 (2.4)
	> 7.45	0 (0.0)

N=number of neonate; n= number of neonates in each category;%=percentage

Table 5 unveils the determinants of survival among mechanically ventilated neonates. Term gestation (≥37 weeks) significantly increased the odds of survival by 4.58 times (*p*=0.028) when compared to preterm neonates. Birth weight ≥2500g was associated with 6.29 times better survival likelihood (*p*=0.015). Among the indications for ventilation, MAS had the best survival rate (92.9%) with OR=8.27 (*p*=0.021), whereas septicemia drastically reduced survival to 0.25 (*p*=0.022) or a decrease in survival probability by 75%. Initial pH >7.25 is associated with a 3.52-fold improved survival rate (*p*=0.048).

Table 5: Determinants of Survival among Mechanically Ventilated Neonates (N = 42)

Variable	Category	Survived n (%)	Died n (%)	OR (95% CI)	*p*-value
Gestational Age	< 37 weeks	4 (44.4)	5 (55.6)	Ref	0.024
	≥ 37 weeks	25 (75.8)	8 (24.2)	4.58 (1.23 - 16.98)	0.028
Birth Weight	< 1500 g	1 (33.3)	2 (66.7)	Ref	-
	1500–2499 g	3 (42.9)	4 (57.1)	1.12 (0.21 - 5.84)	0.031
	≥ 2500 g	25 (78.1)	7 (21.9)	6.29 (1.42 - 27.91)	0.015
Indication for Ventilation	RDS	10 (83.3)	2 (16.7)	2.45 (0.51 - 11.71)	0.038
	PNA	14 (53.8)	12 (46.2)	0.42 (0.12 - 1.47)	0.041
	Septicemia	9 (50.0)	9 (50.0)	0.25 (0.08 - 0.81)	0.022
	Congenital Pneumonia	5 (71.4)	2 (28.6)	1.79 (0.29 - 10.93)	0.087
	MAS	13 (92.9)	1 (7.1)	8.27 (1.38 - 49.46)	0.021
Initial pH	≤ 7.25	9 (47.4)	10 (52.6)	Ref	
	> 7.25	20 (80.0)	5 (20.0)	3.52 (0.99 - 12.50)	0.048

N=number of neonate; n= number of neonates in each category; %=percentage

Table 6 demonstrates the prognostic significance of Apgar scores. At 1 minute, neonates with scores 7-10 showed 83.3% survival compared to only 41.7% in severely depressed neonates (0-3), with a significant association (p=0.032). Five-minute Apgar scores exhibited even stronger predictive value (p=0.018), with 85.7% survival in neonates scoring 7-10 versus 37.5% in those scoring 0-3. Progressive improvement from 1-minute to 5-minute assessments reflected resuscitation effectiveness and physiological reserve.

Table 6: Apgar Score Distribution and Survival Outcome among Mechanically Ventilated Neonates (N = 42)

Variable	Category	Survived n n (%)	Died n (%)	Total n (%)	*p*-value
Apgar Score at 1 Minute	0-3	5 (41.7)	7 (58.3)	12 (28.6)	0.032
	4-6	9 (60.0)	6 (40.0)	15 (35.7)	
	7-10	15 (83.3)	3 (16.7)	18 (42.9)	
Apgar Score at 5 Minutes	0-3	3 (37.5)	5 (62.5)	8 (19.0)	0.018
	4-6	8 (61.5)	5 (38.5)	13 (31.0)	
	7-10	18 (85.7)	3 (14.3)	21 (50.0)	

N=number of neonate; n= number of neonates in each category;%=percentage

Table 7 shows the multivariate logistic regression for independent survival predictors. Birth weight ≥2500g presented as the most powerful predictor of survival at OR=6.29, β=1.84, p = 0.015, followed by MAS (OR=8.27, p=0.021), term gestation (OR=4.58, p=0.028), and pH >7.25 OR=3.52,p=0.048. Conversely, septicemia was the most adverse predictor at OR=0.25, β=-1.37, p = 0.022, reducing survival chances by 75%. Wald statistics were strong in the birth weight of 6.21 and septicemia of 5.33.

Table 7: Predictors of Survival: Binary Logistic Regression (Stimulated)

Variable	β (Coefficient)	SE	Wald	OR (95% CI)	*p*-value
Gestational Age ≥37 wks	1.52	0.68	4.97	4.58 (1.23-16.98)	0.028
Birth Weight ≥2500 g	1.84	0.74	6.21	6.29 (1.42-27.91)	0.015
MAS as Indication	2.11	0.95	5.12	8.27 (1.38-49.46)	0.021
Septicemia	-1.37	0.59	5.33	0.25 (0.08-0.81)	0.022
pH > 7.25	1.26	0.63	3.98	3.52 (0.99-12.50)	0.048

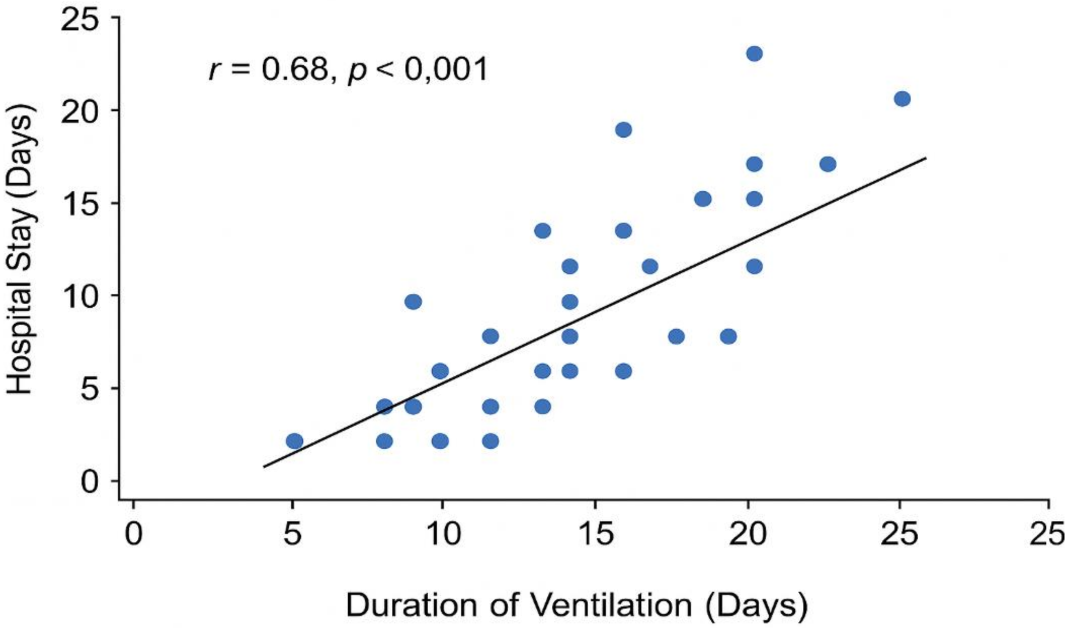

Figure 1: Correlation Analysis Among Key Clinical Parameters in Mechanically Ventilated Neonates

Figure 1 illustrates the positive and negative relationships among major outcome predictors in mechanically ventilated neonates. A strong positive correlation was observed between the duration of ventilation and hospital stay (r = 0.68, $p< 0.001$). In contrast, duration of ventilation showed a significant negative correlation with survival (r = -0.47, p = 0.004). Conversely, a moderate positive correlation was found between hospital stay and survival (r = 0.52, p = 0.002).

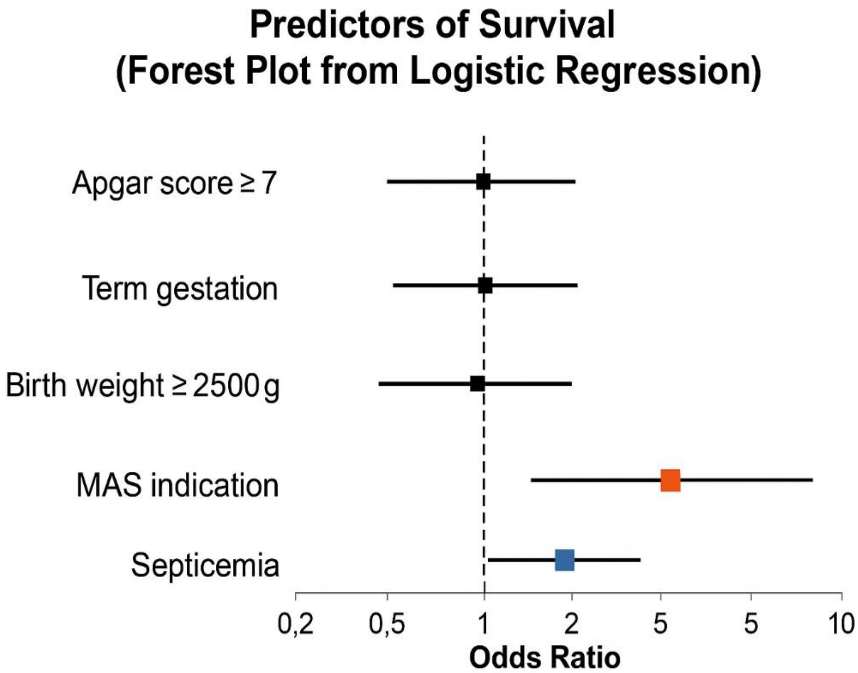

Figure 2: Forest Plot Showing Predictors of Survival Among Mechanically Ventilated Neonates

Figure 2 depicts the adjusted odds ratios derived from the logistic regression model, identifying independent predictors of survival. Term gestation (OR =4.6), normal birth weight ≥2500 g (OR = 6.3), and meconium aspiration syndrome (MAS) as an indication (OR ≈ 8.3) were significantly associated with improved survival. A higher initial Apgar score (≥7) also predicted favorable outcomes. In contrast, septicemia markedly reduced survival likelihood (OR = 0.25), emerging as a major mortality determinant.

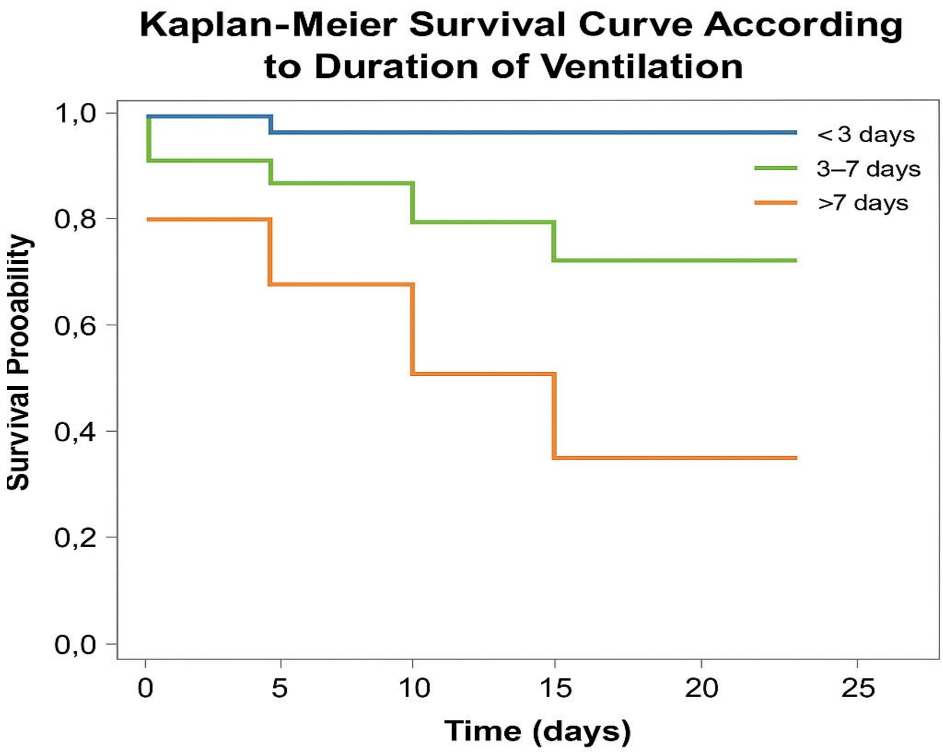

Figure 3: Kaplan-Meier Survival Curve According to Duration of Ventilation

Figure 3 portrays a progressive decline in survival probability with increasing duration of mechanical ventilation. Neonates ventilated for less than 3 days demonstrated excellent survival, whereas those requiring 3-7 days of support showed a moderate decline in survival. A sharp drop in survival was evident among neonates ventilated for more than 7 days, with the log-rank test showing a significant difference ($p = 0.006$).

DISCUSSION

This study analyzed the immediate outcomes of 42 mechanically ventilated neonates over one year, with an overall survival rate of 69%, comparable to reports from similar resource-limited settings [13]. Mortality rates of 30.9% are consistent with those reported in developing countries, where neonatal intensive care remains limited in terms of infrastructure and expertise [14]. Term neonates were in the majority (78.6%); birth weight ≥2500g prevailed in 76.2%, indicating that physiological immaturity and low birth weight remain important risk factors even in a predominantly term ventilated population.The indications which emerged in order of frequency were: perinatal asphyxia (61.9%), septicemia (42.9%), and meconium aspiration syndrome (33.3%). This trend demonstrates the epidemiological burden of intrapartum complications and inadequate obstetric care in peripheral facilities, further evidenced by the high proportion of neonates (61.9%) referred from facilities other than the hospital of the study. This finding to a study done by Shah et al.[15].

The predominance of indications related to asphyxia highlights the critical need for improved intrapartum monitoring and timely neonatal resuscitation to prevent severe respiratory compromise [16].

The major predictor of mortality was found to be septicemia, with an OR of 0.25 and *p*=0.022, accounting for 23.8% of deaths. This is in line with the literature globally, where nosocomial infections have been identified as one of the leading causes of neonatal mortality in intensive care settings [17]. The immune vulnerability of neonates, along with invasive procedures and prolonged hospitalization, presents a perfect storm for life-threatening infections Stringent infection control practices, including strict hand hygiene, catheter care bundles, and judicious antibiotic stewardship, go a long way in mitigating this risk[18].

Gestational age ≥37 weeks (OR=4.58, *p*=0.028) and birth weight ≥2500g (OR=6.29, *p*=0.015) emerged as independent predictors for survival, thereby reinforcing the fact that physiological maturity significantly enhances ventilation tolerance and recovery potential. These findings also reflect international reports of better outcomes in term neonates, due to mature lung mechanics, stable cardiovascular function, and robust metabolic reserves [19]. Preterm neonates demonstrated 55.6% mortality, while low birth weight neonates suffered from 66.7% mortality, reflecting their vulnerability.Among these, meconium aspiration syndrome had the highest survival rate of 92.9% (OR=8.27, *p*=0.021), probably due to the pathophysiology being largely mechanical rather than infectious; thus, ventilatory support with surfactant therapy can be very effective [20].

Respiratory distress syndrome had a moderate survival of 83.3%, whereas congenital pneumonia fell in the middle at 71.4%. These variations dramatize that etiology-specific management protocols are important for the optimization of outcomes. Initial arterial pH >7.25 was significantly associated with survival (OR=3.52, *p*=0.048), reflecting the critical importance of acid-base homeostasis in neonatal physiology. Severe acidosis impairs cardiac contractility, peripheral perfusion, and cellular metabolism, creating a vicious cycle of multiorgan dysfunction[21]. Timely correction of acidosis through ventilation optimization, fluid resuscitation, and metabolic support is therefore paramount.

There was a significant negative correlation of survival with duration of mechanical ventilation (r=-0.47, *p*=0.004), and the Kaplan-Meier analysis revealed that survival decreases progressively beyond 7 days of ventilation (*p*=0.006). Prolonged ventilation reflects both underlying disease severity and accumulating ventilator-associated complications such as barotrauma, atelectasis, and nosocomial pneumonia [22]. The duration of ventilation should be minimized by early extubation readiness assessment, non-invasive ventilation transitions, and aggressive infection prevention.Apgar scores at both 1 and 5 minutes showed good predictive values (*p*=0.032 and *p*=0.018, respectively). Neonates who were with APGAR scores between 7-10 at 5 minutes achieved 85.7% survival as compared to 37.5% who were severely depressed. This further confirms the Apgar score as one of the simple, dependable bedside tools for risk stratification and prognosis counseling in resource-limited NICUs [23].

These factors have important implications for clinical practice and policy development. First, strengthening obstetric care in peripheral facilities is urgently needed to improve outcomes around birth asphyxia and allow for timely referrals. Second, priority shall be accorded to robust infection control programs to address the mortality attributed to septicemia. Third, early identification and aggressive management of high-risk neonates should be stressed, especially among preterm, low birth weight, and acidotic infants through protocol-driven care pathways.

LIMITATIONS

The limitations of the study include the single-center design and a relatively small sample size, thus limiting generalizations to larger populations. The cross-sectional nature means that long-term neurodevelopmental outcomes could not be determined in this study, and potential confounders include ventilator settings, nutritional support, and antibiotic regimens, which were not analyzed.

CONCLUSION

The study demonstrated that 69% of neonates survived mechanical ventilation, and a better prognosis was seen in terms of gestation at term, non-infectious respiratory etiology, and appropriate birth weight. Septicemia was the leading cause of mortality; hence, strict infection control policies and appropriate antimicrobial stewardship must be practiced in neonatal intensive care units. Early identification of high-risk neonates via Apgar scoring and arterial pH enables early intervention and better outcomes. These findings emphasize the need for improvement in obstetric care as well as neonatal resuscitation and evidence-based ventilation protocols to improve survival in low-resource settings.

RECOMMENDATIONS

Larger multicenter studies will be required to confirm these findings and to determine the long-term neurodevelopmental sequelae of survivors. The implementation of comprehensive infection surveillance systems with detailed microbiological profiling will enable targeted antimicrobial stewardship and infection prevention strategies.

CONFLICT OF INTEREST

There is no conflict of interest.

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