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Short-Term Outcome of Ventilated Children in Pediatric Intensive Care Unit: A Retrospective Analysis

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Abstract

Background: The scarcity of literature in the eastern region of India about the indications, clinical profiles, short-term outcomes, and complications of mechanical ventilation (MV) among children aged 1 month–12 years called for this research work. **Methods:** This record-based retrospective study was carried out over one year in the pediatric intensive care unit of Bankura Sammilani Medical College and Hospital. 138 children who received MV for 24 hours or more were enrolled. Data regarding basic demography, clinical profiles, indications, short-term outcomes, and complications of MV were recorded in standard case record proforma. EpiInfo (3.5.1) software was used to analyze data. A continuous variable was expressed in mean, median, and standard deviation, and a categorical one in rate and ratio. A chi-square test was performed to compare categorical variables, and a P value <0.05 was set as statistically significant. **Results:** The incidence of MV was 15.07%. 65.22% of ventilated children belonged to the infant group. The four major clinical conditions, which included pneumonia, sepsis, central nervous system infections, and snake envenomation, accounted for 46.38%, 19.58%, 8.7%, and 5.8% of MV, respectively. The survival rate was higher in non-infectious conditions than the infection one (42.86% vs. 31.82%). The children with snake envenomation and cardiac cause showed the highest and lowest survival rates (75% and 16.67%), respectively. The endotracheal tube block was the most common complication (9.42%). **Conclusion:** The PICU personnel now know a lot more from this study, including how to better evaluate the patients who need MV, avoid iatrogenic consequences, and enhance the effectiveness of MV. An important finding of this study was that, of all the MV cases, snake envenomation accounted for 5.8% and had the greatest survival rate (75%)—a fact that has seldom been reported in the literature.

Keywords: children, mechanical ventilation, pediatric intensive care unit.

Introduction

Science and its inventions have showered blessings on mankind. One such invention is a mechanical ventilator that supports the respiratory physiology of an individual with a critical illness [1]. Since the invention of the ventilator, millions of lives have been saved worldwide, and it is installed in neonatal intensive care units (NICU), pediatric intensive care units (PICU), intensive care units (ICU), and coronary care units (CCU) to manage a critically ill patient with deterioration of cardiorespiratory function.

PICU is a specialized area of a tertiary care hospital where most of the children with critical illnesses were managed to get a better outcome [2]. Bhori NS et al. [3] and Hatti S et al. [4] reported that 20–64% of pediatric patients required mechanical ventilation (MV) during their stay at PICU. MV is an invasive procedure used to provide adequate oxygenation and ventilation to safeguard the tissue's functions until the disease process has resolved. Upon improvement of respiratory function, the ventilatory support should be removed as early as possible; otherwise, it will lead to several complications. Barotrauma, ventilator-associated pneumonia (VP), and tracheal edema are the common complications of MV [5].

PICU is an established medicine in developed countries [6, 7, 8]. Innumerable research articles were published in the Western world, but little data was available from developing countries like India, regarding the uses of MV [5,9]. The scarcity of literature in the eastern region of India about the indications, clinical profiles, short-term outcomes, and complications of MV among children aged 1–12 years called for this research work.

Material and Methods

Study area: PICU, Bankura Sammilani Medical College & Hospital. **Study design:** a record-based retrospective study. **Study Period:** One year (1st December 2022 to 30th November 2023). **Ethical approval:** The Institutional Ethics Committee was permitted to conduct this research work, vide memo number: BSMC/IEC/4735, dated 23.11.2023. **Study subjects:** The children who were admitted to the PICU and mechanically ventilated for 24 hours or more were included. The children who were ventilated for less than 24 hours were excluded from the study. **Sample size:** 138children who were ventilated met the inclusion criteria. **Study tools:** Case record proforma and medical records. **Study technique:** Data about basic demography like age and gender, clinical indication for ventilatory support, mode of ventilation, date of initiation of intubation, date of extubation, duration of intubation, short-term outcome, and complications like ventilator-associated pneumonia (VAP), barotrauma and atelectasis, and accidental extubation, etc. was gathered in the case record proforma. The outcome of the child was recorded as either extubated

successfully and improved or died on the ventilator. **Statistical analysis:** EpiInfo (version 3.5.1) software was used to analyze data. Continuous variables were expressed in mean and standard deviation. Whereas categorical variables were expressed in rate and ratio. The Chi-square test was done to compare the categorical variables and a P value less than 0.05 was set as statistically significant.

Case definition

Ventilator-associated pneumonia: A new and persistent infiltrate, consolidation on the chest radiograph, and at least three of the following symptoms—fever, leucopenia or leukocytosis, purulent sputum, rales, cough, or worsening gas exchange—were to be considered indicators of ventilator-associated pneumonia (VAP) [10].

Atelectasis: When stridor appeared within two hours of extubation, laryngeal edema became apparent, and atelectasis was determined by clinical and radiographic investigation [11].

Short-term outcome: It is extended from the date of admission of a child to the last date of his/her hospital stay, irrespective of outcome status.

Results

A total of 916 children were admitted to the PICU during the study period. Of these, 138 (15.07%) children were ventilated for 24 hours or more. The male children contributed 62.32% of all study subjects, and the rest, 32.68%, were contributed by female children. The male-to-female children ratio was 1.67:1. While considering the age of participants, 65.22% of children were infants. The Chi-Square test was done to compare the gender discrepancy concerning age, and it showed a P value of 0.039, which was statistically significant. Table 1 illustrates the age and gender-wise distribution of study subjects.

Table 1: Age and gender-wise distribution

Age/gender	Male (%)	Female (%)	Total (%)
1 – 12 months	58(42.03)	32(23.19)	90(65.22)
13 -60 months	16(11.6)	14(10.14)	30(21.74)
61-144 months	12(8.7)	6(4.35)	18(13.04)
Total (%)	86(62.32)	52(37.68)	138(100)

Chi Square value=4.253, P value=0.039, M: F=1.67:1

Table 2 displayed the clinical profile of children who were ventilated for their cardiorespiratory support. Infection was the more common condition than the non-infectious one requiring MV (79.71% vs. 20.29%). The two most common conditions

where a ventilator was used are pneumonia and sepsis. Pneumonia and sepsis were accountable for 46.38% and 19.58% of all study subjects, respectively. Pneumonia with congenital heart disease (CHD) (4.35%); central nervous system infections (8.7%), which included meningitis, encephalitis, and meningoencephalitis; neurological (5.07%), which included status epilepticus, Guillain-Barrie syndrome, and acute disseminated encephalomyelitis; cardiac (4.35%); neurotoxic snake envenomation (5.8%); and others (5.07%), which included diabetic ketoacidosis and near drowning, were the clinical condition where a ventilator was used. The difference between infectious and non-infectious conditions was statistically significant, and the Chi-squarevalue and P value were 26.72 and 0.0000024, respectively.

Table 2: Clinical profileof ventilated children

***Variables**	**Subgroup**	**Number**	**Percentages**
Infectious	Pneumonia	64	46.38
	Pneumonia + CHD	6	4.35
	Sepsis	28	19.58
	CNS infections	12	8.7
	Total	110	79.71
Non-infectious	Neurological	7	5.07
	Cardiac	6	4.35
	Snake envenomation	8	5.8
	Others	7	5.07
	Total	28	20.29

*Chi Square value =26.72, P value = 0.00000024

Table 3 showed that 56.52% of study subjects were ventilated for 24-72 hours. Whereas 11.59% of children needed ventilators for 8 days or more, and the rest, 31.88% of study subjects, ventilated for 4-7 days. The mean duration of MV was 4.17 ± 2.94 days. Maximum days were 20 and minimum 1. The range and interquartile range were 19 and 3, respectively.

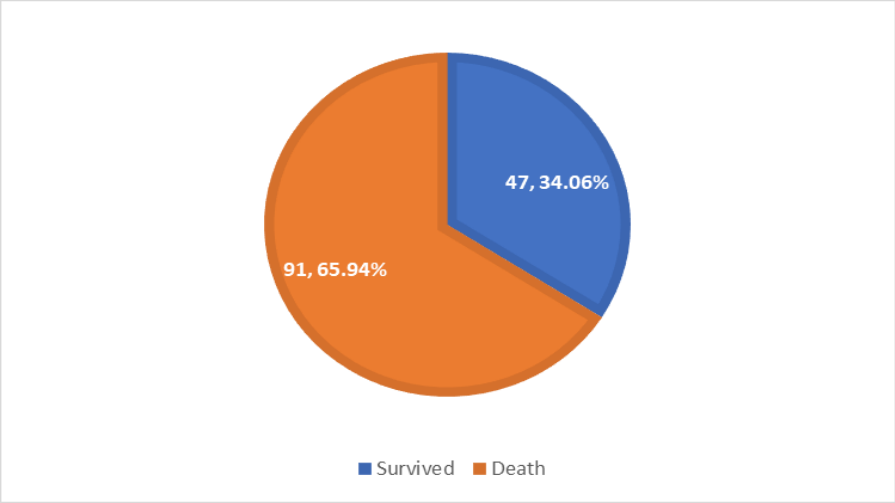
Table 3: Duration of intubation

***Duration (days)**	**Number**	**Percentages**
1-3	78	56.52
4-7	44	31.88
≥8	16	11.59

*Mean-4.17, Standard deviation-2.94, Median = 3, Maximum – 20, Minimum – 1, Range-19, IQR-3

The present study showed that 65.94% of ventilated children died, and the rest, 34.06% of study subjects, were extubated successfully and survived. The difference between the number of survivors and deaths was statistically significant (P value =<0.0000001), as shown in Figure 1.

Figure1: Outcome pattern



Considering the clinical profile, the highest percentage of successful extubation was seen in snake envenomation, and it was 75.0%. The lowest success rate was seen in cardiac conditions (16.67%). 42.86%, 35.71%, 33.33%, 31.25%, 25.00%, and 28.57% of successful extubating were noted in other categories: sepsis, pneumonia with congenital heart disease (CHD), pneumonia, central nervous system infections, and neurological (non-infectious) conditions, respectively. Though the rate of successful extubating was higher in the non-infectious condition than the infectious one (42.86% vs. 31.82%), it was statistically insignificant (P value = 0.272). Table 4 illustrates the success rate of extubating concerning different clinical conditions.

Table 4: Clinical profile-wise successful extubating

***Variables**	**Subgroup**	**Number**	**Survived (%)**	**Death (%)**
Infectious	Pneumonia	64	20 (31.25)	44 (68.75)
	Pneumonia + CHD	6	2 (33.33)	4 (66.67)
	Sepsis	28	10 (35.71)	18 (64.29)
	CNS infections	12	3 (25.00)	9 (75.00)
	Total	110	**35 (31.82)**	**75 (68.18)**
Non-	Neurological	7	2 (28.57)	5 (71.43)

infectious				
	Cardiac	6	1(16.67)	5 (83.33)
	Snake envenomation	8	6 (75.00)	2 (25.00)
	Others	7	3 (42.86)	4 (57.14)
	Total	28	**12 (42.86)**	**16 (57.14)**

*Chi Square value = 1.211, P -value = 0.272

This study showed that the survival rate among ventilated children above the age of 5 years was 61.11%, but in infants (1–12 months) and children (13–60 months) it was 30% each, as shown in Table 5.

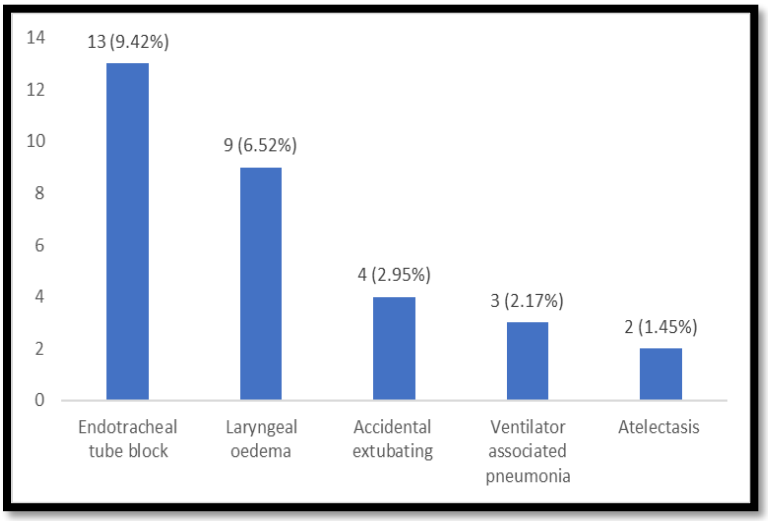
Table 5: Age-wise pattern of outcome

Variables	**Total**	**Survived (%)**	**Death (%)**	***P value**
1 – 12 months	90	27 (30)	63 (70)	
13 -60 months	30	9 (30)	21 (70)	0.0343
61-144 months	18	11 (61.11)	7 (28.89)	

*Chi Square Value =6.746

The preset study showed that the endotracheal tube block was the most common complication, and it was 9.42%. Followed by, in descending order, laryngeal oedema, accidental extubation, ventilator-associated pneumonia (VAP), and atelectasis were 6.52%, 2.95%, 2.17%, and 1.45%, respectively, as shown in Figure 2.

Figure 2: Complication of mechanical ventilation



Discussion

A total of 916 children were admitted to the PICU during the study period. Of which, 15.07% (n = 138) children were ventilated for 24 hours or more. In accordance with the present study, Bhori NS et al. [3] reported that the incidence of MV was 15.93%. In contrast to the present study, the lower incidence (9.11%) was reported by Hatti S et al. [4], and the higher incidence was reported by Vijaykumary T et al. (52%) [5] from Sri Lanka and Khemani et al. (30%) [2] from the United States of America. Infrastructure of a PICU, knowledge and experience of treating pediatricians, and geographical variation of disease pattern and severity may influence the wide variation in the incidence of MV. In the present study, the male to female children ratio was 1.67:1. Similar to the present study, Jamil M et al. [12] reported that the male children to female children ratio was 1.85:1. Contrary, Lodaria B [13] reported a higher male-to-female ratio, which was 2.4. The male preponderance may be due to the gender inequality in the community and parents' preferences toward the care of male children.The lower incidence of infection among female children may be a factor owing to the presence of a two-x chromosome that contains a high density of immune-related genes and regulatory elements that are extensively involved in both the innate and adaptive immune responses [14]. It was found that 65.22% of the ventilated children belonged to 1 month to 1-year age. Metwalley, Kotb A et al. [15] reported that 47.3% of infants were mechanically ventilated, which is lower than the present study. This difference could be due to the difference in demographic pattern and the prevalence of disease. The mortality rate was higher in infants and children aged 2–5 years old than in children aged more than 5 years, and it was statistically significant (P value = 0.0343). Similar to the present study, Kurane AB et al. [16] reported higher mortality in infants. In contrast, Vijaykumary T et al. [5] reported higher mortality in children aged above 5 years. More infectious clinical conditions among infants may explain this difference.

This study showed that infectious conditions were made up of 79.71% MV, and the rest, 20.21%, were non-infectious clinical conditions. The difference between infectious and non-infectious conditions was significant statistically (P value = 0.00000024). Among all ventilated children, pneumonia (46.38%), sepsis (19.58%), CNS infections (8.7%), and snake envenomation (5.8%) were the four most common clinical conditions where MV was used. Similar to the present study, Metwalley, Kotb A et al. [15], Lodaria B [13], and Kurane AB et al. [16] also reported that 46.3%, 42.8%, and 30.09% of their study subjects needed MV for respiratory failure due to the affection of the respiratory system, respectively. In contrast to the present study, Hatti S et al. [4], Wolfler A et al. [7], and Mukhtar B et al. [17] reported that the most common indication of MV was acute neurological conditions. This disparity could be

due to the difference in the prevalence of a particular disease arising out of agent, host, and environmental interaction.

In the present study, the maximum number (n = 78, 56.52%) of study subjects was found to be ventilated for 1–3 days, with a median duration of 3 days. In congruence with the present study, Kurane AB et al. [16] reported that 63.10% of their study subjects put on ventilation for 1-3 days, and the median was 3 days. In contrast, Kendrili T et al. [18] observed that the mean duration of MV in their research work was 18.8±14.1 days. This difference may be due to the difference in clinical conditions requiring MV and complications of MV. This study also showed that 31.88% and 11.59% of the study subjects needed MV for 4–7 days and ≥8 days, respectively. Payen V et al. [19] observed that statistically significant risk factors of prolonged MV in paediatric patients were age less than 12 months, a Paediatric Risk of Mortality Score of ≥15 at admission, a mean airway pressure of ≥13 cmH2O on day 1, use of continuous sedation on day 1, and use of noninvasive ventilation before intubation.

According to the present study, 34.06% of children on ventilation were effectively weaned and were alive, while 65.94% of the children died while on ventilation. Hatti S et al. [4], Shaukat F et al. [9], and Kendirli T et al. [18] found 65.4%, 63%, and 58.3% mortality among ventilated children, respectively, which is comparable to the current study. In contrast, Vijaykumary T et al.'s [5] study showed 27.6% mortality among ventilated children. Randolph et al. [8] reported that advanced nations had the lowest mortality rate (1.6%). The highest level of health awareness among parents and guardians, the availability of medical facilities, the presence of skilled healthcare providers in intensive care units, and technological advancements could all be factors contributing to the dramatic decline in the mortality rates of MV children.

The present study showed 22.46% (n = 31) complications among ventilated children, endotracheal tube blockage being the major one. Comparable to the present study, Lodaria B [13] reported 26.39% of MV-related complications, with VAP being the most frequent consequence. Higher percentages of complications (33.33%) were observed by Bhori NS et al. [3], with laryngeal edema being the most common. Surprisingly, the present study showed 1.45% VAP, which was much lower than the study done by Aina Q et al. (6.78%) [20] and Vijaykumary T et al. (11%) [5]. The different types of complications with varying frequency may be due to different study subjects, biomedical devices used, experiences among doctors and nurses, and duration of MV.

Limitation

It is a record-based retrospective study, which means that it has some restrictions. Firstly, this study was confined to a single PICU and did not include children who had been on ventilators for less than a day. Together, these two variables led to selection bias. Consequently, it was not feasible to generalize the study's observations to the community. Second, a small sample size contributed to a type II error. Finally, there was a lack of information regarding parents' health awareness and socioeconomic status, which may have an indirect impact on the outcome of MV.

Conclusion

The present study showed that the incidence of MV was 15.07%, 65.22% of ventilated children belonged to the infant group, the male-to-female children ratio was 1.67:1, and 79.71% of study subjects were infected. The four major clinical conditions were pneumonia, sepsis, central nervous system infections, and snake envenomation, which accounted for 46.38%, 19.58%, 8.7%, and 5.8% of MV, respectively. The survival rate was only 34.06%. The survival rate among the non-infectious group was higher than the infectious group (42.86% vs. 31.82%). The children above 5 years of age showed a higher survival rate than the children aged up to 5 years (61.11% vs. 30%). The children with snake envenomation and cardiac causes showed the highest and lowest survival rates (75% and 16.67%). The mean and median duration of MV were 4.17 ± 2.94 days and 3 days, respectively. According to the present study, complications occurred in 22.46% of children on ventilation. The most common complication was endotracheal tube block (9.42%). Remarkably, only 1.45% of participants had VAP diagnosed.

Despite having certain limitations, the PICU personnel now know a lot more from this study, including how to better evaluate patients who need MV, avoid iatrogenic consequences, and enhance the effectiveness of MV. An important finding of this study was that, of all the MV cases, snake envenomation accounted for 5.8% and had the greatest survival rate (75%)—a fact that has seldom been reported in the literature.

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Declaration

Nothing to declare

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