

Clinical Profile and Outcomes of Mechanically Ventilated Children in Pediatric Intensive Care Units - A Single Centre Prospective Study

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Abstract: ***Background:** Mechanical ventilation (MV) is a common practice in pediatric intensive care units (PICUs). The overall prevalence of Indication for mechanical ventilation varies according to country and disease pattern in the locality of the health facility. The main aim of our study is to evaluate the demographic profile, indications, and outcome of mechanically ventilated children and to find out the duration of ventilation and complications of mechanical ventilation. **Materials and Methods:** A prospective observational study was conducted for 18 months at a tertiary care hospital. Patients admitted, and mechanically ventilated were monitored by clinical examination, pulse-oximeter, and ABG. Patients were investigated and treated for the primary diagnosis and as per the requirement of the case. **Results:** A total of 120 patients were evaluated and 35% have survived. The highest survival number was seen among age group of 2-12 months. The most common indication for MV was respiratory diseases (40.8%) followed by neurological diseases (30.8%). Among infants, the most common diagnosis for ventilation in survived cases is bronchiolitis, followed by viral meningoencephalitis/Acute encephalopathy. **Conclusion:** To improve the outcome of MV children in our PICU, we need an early referral from peripheral hospitals and adequate ventilation support. There is also need for productive, organized, and structured educational courses for physicians and nurses involved in the care of critically ill children receiving mechanical ventilation.*

Keywords: Pediatrics, Mechanical Ventilation, Bronchiolitis, Pediatric Intensive care units (PICUs)

1. Introduction

Ventilator support is a necessary and common form of therapy in the Pediatric Critical Care Unit. In recent years, this modality has evolved into a highly specialized discipline. The term mechanical ventilation refers to various artificial means used to support ventilation and oxygenation. The goal of mechanical ventilation is to provide adequate oxygenation, provide proper alveolar ventilation, and to avoid alveolar over distension, maintain alveolar recruitment, promote patient-ventilator synchrony, and use the lowest possible FiO₂ [1].

In Pediatric intensive care unit (PICU) patients need intensive care with respiratory support with ventilator devices. Respiratory problems are common in the emergency department, and the need for advanced

respiratory support (mechanical ventilator) represents the most common reason for admission to intensive care units. Therefore mechanical ventilation (MV) is a common practice in pediatric intensive care units (PICUs).

The unique anatomic and physiologic characteristics of the respiratory tract in children and infants make them vulnerable to respiratory failure. Impending respiratory failure characterized by progressive respiratory distress, rapidly rising PaCO₂ or fatigue of respiratory muscles is a relative indication for mechanical ventilation. Rapid assessment of airway, breathing, circulation, and disability is important in a child with suspected respiratory failure and age-specific vitals. It is important to understand that the decision to intubate, is based on clinical signs of respiratory failure such as altered sensorium, increased work of

Volume 11 Issue 1, January 2022

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breathing, bradypnea or apnea, and not on blood gases analysis.

Shock is an acute sign characterized by the inadequate circulatory provision of oxygen so that the metabolic demands of vital organs and tissues are not met [2]. Early recognition and stepwise execution of therapeutic interventions are essential as each additional hour of the persistent shock increases the risk of mortality by two folds [3]. Positive pressure ventilation reduces the work of breathing, decreases lactic acid production by respiratory muscles during circulatory shock, and also decreases the oxygen demand of the heart and thus is utilized in the management of children with shock along with other supportive measures.

Acute neurologic deterioration with numerous causes may require ventilation for many reasons. It may result in decreased ventilatory drive and loss of airway protective reflexes. Thus leading to the reduced ventilatory effort as a result of muscle weakness [4]. Mechanical ventilation may also be provided in disorders with raised intracranial pressure to optimally ventilate the child [7]. The common causes include CNS infections, tumors, head trauma, Acute encephalopathy, Guillain-Barre syndrome, snake envenomation, and poisoning.

The overall prevalence of Indication for mechanical ventilation varies according to country and disease pattern in the locality of the health facility. Respiratory and Cardiovascular causes like Bronchiolitis, pneumonia, and Congenital heart disease, are some of the most common indications for ventilation in developing countries like India.

We have conducted this study to find out the prevalence, indication, outcome, and complications of ventilated children in tertiary care hospitals.

The aims and objectives of our study is to evaluate the demographic profile, indications, and outcome of mechanically ventilated children and to find out the duration of ventilation and complications of mechanical ventilation.

2. Materials and Methods

Type of Study: Hospital-based prospective observational study.

Duration of Study: 18 months, December 1st, 2017 to May 31st, 2019.

Place of Study: Pediatric intensive care unit of Government General Hospital Kakinada.

Study Population: Children from 1 month to 12 years.

Inclusion Criteria: Children more than 30 days and less than 12 years who are ventilated mechanically in the Pediatric Intensive Care Unit.

Sample Size: 120 cases

Exclusion Criteria: Cases expired within 24 hrs of admission and who were ventilated for less than 6 hrs were excluded.

Maneuver

Patients admitted, and mechanically ventilated were monitored by clinical examination, pulse-oximeter, and ABG. Patients were investigated and treated for the primary diagnosis and as per the requirement of the case. Patients were followed till discharge or otherwise from the hospital.

3. Results

In our study, a total of 120 cases were recorded in the study period. Of the total cases (120) admitted, 76 (63.34%) cases are below one year of age. Children in the age group 6 years to 12 years 20 (16.67%) cases. The number of cases in the age group of 1y to 3y of age is 14 (11.67%). In the age group, 3 to 5 years 10 cases (8.33%) cases were ventilated. Of the total cases recorded, 42 have survived (35%). The highest survival number was seen in 2 to 12 months of age 23 cases. Survival is better in age groups 1-3 years and 6-12 years. The number of cases survived according to the age distribution are shown in TABLE 1.

Table 1: Age Distribution And Survival Of Ventilated Cases

Age group	Number ventilated (%)	% of survival in the age group
2m to 12 m	76 (63.34%)	25 (30.26%) of 51
1y to 3y	14 (11.67%)	6 (42.8%) of 14 cases
4y to 5y	10 (8.33%)	3 (30.0%) of 10 cases
6yto 12 y	20 (16.67%)	8 (40.00%) of 20
Total	120 (100%)	42 (35%) of 120

Of the total cases, the male (72) to female (48) ratio is 1: 1.5. Out of the recorded cases, the most common indication was respiratory (40.8%) diseases, next most common indication is neurological diseases (30.8). A better outcome was seen in neurological causes (45.9%) and followed by respiratory cases (34.6%). MODS have a poor outcome (16.67%). The indication for ventilation are shown in the TABLE 2.

Table 2: Indication for Ventilation (System involved)

System involved	Survived (%)	Expired (%)	Total
Respiratory system	17 (34.6%)	32 (65.30%)	49
CNS	17 (45.9%)	20 (54.05%)	37
CVS	2 (25%)	6 (75%)	8
MODS	2 (16.67%)	10 (83.33%)	12
GIT	2 (33.4%)	4 (66.6%)	6
OTHERS	2 (25%)	6 (75%)	8
TOTAL	42 (35%)	78 (65%)	120

Among infants, the most common diagnosis for ventilation in survived cases is bronchiolitis, followed by viral meningoencephalitis / Acute encephalopathy. Among expired infants in this present study, the most common diagnosis for ventilation is also bronchiolitis, followed by bronchopneumonia, viral meningoencephalitis, and congenital heart disease.

Among the age group of 1-3 years, pneumonia and status epilepticus are the indications for ventilation in survived cases and pneumonia, MODS and status epilepticus are the common indications of ventilation in expired cases. Among the age group of 4-5 years, meningitis and MODS were the

indications for ventilation in survived cases and severe asthma and viral encephalitis are common indications for ventilation in expired cases. Among the age group of 6-12 years, the most common indication for ventilation in survived cases of this age group is viral meningoencephalitis and neurotoxic snake bite and the most common indication in expired cases is also viral meningoencephalitis, followed by MODS. The diagnosis of all the ventilated cases is shown in TABLE 3.

Table 3: Diagnosis of Ventilated Cases

Diagnosis	Survived	Expired
Bronchiolitis	10	15
Pneumonia	7	12
ARDS	0	2
LTB	0	1
Acute asthma	0	2
Meningoencephalitis	9	12
Meningitis	2	2
IC bleed	2	0
Status epilepticus	2	5
GB syndrome	0	1
Hypertensive encephalopathy	1	0
TB Meningitis	1	0
CHD	2	5
Anemia&CCF	0	1
MODS	2	9
Snakebite	2	0
Accidental strangulation	0	2
Inborn errors of metabolism	0	1
Spinal muscular atrophy	0	1
Gastroenteritis & dyselectrolytemia	2	2
P. O Hirsprange disease	0	2
Malaria	0	1
RTA	0	1
Hepatic encephalopathy	0	1
Total	42	78

Most of the survived cases were intubated within 12 hrs of admission. Children intubated within 12 hrs had a better outcome when compared to children ventilated later. The p-value is 0.002, which is statistically significant. Most of the cases were weaned off after 24 hrs of ventilation. Survival is better in cases weaned off between 24-48 hours of ventilation. The p-value is 0.008, which is statistically significant. Some cases, like meningitis and meningoencephalitis, had prolonged intubation time. Among survived cases, Respiratory cases were ventilated for less time compared to neurological causes. Survival is better in CNS cases in spite of longer duration of ventilation compared to respiratory cases. Among expired cases also Respiratory cases required ventilation for less time compared to CNS cases. Older the age group more the time of ventilation. Duration of ventilation is less in survived cases compared to expired cases in all age groups.

Of the 42 survived cases, 25 cases had complications related to ventilation. Stridor in 12 cases, Atelectiasis in 9 instances, Ventilator-associated pneumonia in 4 cases. VAP was seen in cases intubated for >72 hrs. Among expired cases Atelectiasis seen in 6 cases, VAP seen in 10 cases

Table 4: Complications in Survived and Expired Cases

Complications	Survived cases	Expired cases	Total
Stridor	12	0	12
Atelectiasis	9	6	15
VAP	4	10	14

The mode of ventilation in survived cases and expired cases is shown in TABLE 5 and TABLE 6 respectively.

Table 5: Mode of Ventilation in Survived Cases

Mode	Initial mode			Ween off mode	
	SIMV	PC	VC	SIMV	CPAP
Cases	28	6	8	30	12

Table 6: Mode of Ventilation in Expired Cases

Cases	Initial mode				Change in mode
	SIMV	VC	PC	A/C	
78	52,	12	6	8	

4. Discussion

The overall prevalence of Indication for mechanical ventilation varies according to country and disease pattern in the locality of the health facility. Respiratory and Cardiovascular causes like Bronchiolitis, pneumonia, and Congenital heart disease, are some of the most common indications for ventilation in developing countries like India.

In our study period from 2017 December 1st to 2019, May 31st, a total of 1830 children were admitted into our Pediatric intensive care unit. Of these, 186 cases (10.1%) required mechanical ventilation. After excluding some admissions according to our exclusion criteria, 120 (6.5%) cases were enrolled in our study. The retrospective study which was done by de silva et al. in Brazil showed 49 cases (20.33%) of the 241 cases admitted were ventilated in the study period [6]. In a retrospective study done by Mukthar et al., in Aga khan hospital Pakistan, of the 605 cases admitted in the study period, 307 cases (50.7%) were ventilated [7]. In the prospective study done by Ayesha Begum et al. at Nilofer hospital in Hyderabad, India of the 627 cases admitted in PICU, 144 cases (22.9%) were intubated [8]. In the retrospective study done by Hemal dave et al. at SBKS medical institute Vadodara, India, of the 1084 cases admitted, 216 cases (19.9%) were ventilated [9]. In the retrospective study done by Kendrili et al. of the 407 cases admitted, 91 cases (22.3%) were intubated [10]. According to a prospective study done by Bassent et al. in Egypt of the 893 cases admitted in PICU, 293 cases (32.8%) were ventilated [11]. These studies show that prevalence mechanical ventilation ranges from 20-50% in children admitted to PICU of developing countries. Our study had a low rate of mechanical ventilation as our hospital is a tertiary care hospital at the district level. Most of the above said studies were done at hospitals that are referral centers at state capitals, to which most of the critically ill children were referred. This might have contributed to a higher number of ventilated cases. Also, patterns and severity of diseases change according to location and time. Our study is comparable to the study done by Sahoo et al [12].

Out of the 120 cases intubated in our study, males are 72, and females are 48, and the Gender ratio is 1.5: 1 which is

same as the prospective observational study done by Nilofer S. Bohori et al. at V. M. S Government medical college (Sholapur) [13].

In our study, out of the 120 cases enrolled, infants are 76 (63.3%), and 1 to 5 years of age cases is 26. Among expired 72 cases, infants are 51 (70.8%). Children who expired below 5 years age were 66 (78%). In the study done by Ayesha Begum et al. out of the 144 cases enrolled, 73 (51%) were infants. Children of 1-5 years of age are 30 (21%) cases. Among infants, 32 cases expired. The mortality of children below 5 years of age was 51 (81%) [8]. In the study done by Hemal dev et al. (n=216) infants are 80 (37.03%) [9]. A study done by Fatima Shirley Anitha et al. (n=111) showed 76 cases (68.46) are infants [14]. A study done by Nilofer S. Bohori et al. showed out of the 72 cases, 49 cases are under 5 [13]. The study done by Sahoo B et al. (n=101) showed infants 42 (41.6%) [12]. Infants form bulk of the cases intubated in the above-said studies. Our study also showed a similar pattern. Mortality below 5 years of age in our study is comparable to studies done by Ayesha Begum et al [8] and Nilofer S Bohori [13].

In our study, the most common indication for Mechanical ventilation was Respiratory failure, Followed by Neurological causes (low GCS). In our study, Respiratory cases were 49 (40.8%). Followed by neurological 37 (30.8%). A study done by Ayesha Begum et al. (n=144) showed neurological 40 (27.8%) followed by respiratory causes 37 (25.6%) [8]. A study done by Fatima Shirley et al. (n=111) showed respiratory cause 57 (51.7%) as the main reason for intubation [14].

A study done by Hemal dave et al. showed (n=216) Respiratory causes 70 (32.4%) followed by CNS causes 63 (29.16%) as the next leading cause [9]. A study done by Nilofer S. Bohori (n=72) showed Respiratory causes 15 (20.83%) followed by CNS causes 14 (19.49%) as the next most cause [13]. In the study done by Sahoo B et al. (n=101) Impending respiratory failure 35 (34.6%) was the most common indication for intubation followed by low GCS 18 (17.8%) [12]. In the study done by Kendirli et al. Respiratory failure 59 (64.8%) is the most common indication for intubation followed by Cardiac failure 18 (19.7%) [10]. In our study, respiratory cases are common indications for ventilation. Our study is comparable with studies done by Kendirli et al. [10] and Sahoo et al. [12]. In study done by Ayesha et al., CNS causes are the common causes of intubation.

In our study, the most common initial mode of ventilation is Synchronised intermittent mandatory ventilation (SIMV) (80) followed by Pressure control mode (18), Volume controlled mode (14), and assist controlled ventilation (8). When the child was hemodynamically stable, and spontaneous efforts were present, weaning was planned by minimizing the ventilatory settings. SIMV mode was the most common mode for wean off, followed by CPAP mode. In the study done by Mukhtar at al SIMV mode is the most common mode of ventilation [7]. The study done by Nilofer S Bohori et al. assist control mode is associated with high mortality [13]. In the study done by Fatima Shirley et al. AC, SIMV, PSV modes are used [14]. According to the

study done by Hemal dave et al., SIMV with AC is the most common mode of initial ventilation in 172 cases (80%). During planned extubation, CPAP/PSV mode is used in 80 cases (75.7%), while HFOV and Non-invasive ventilation were used in 3 cases [9]. In the study done by Bassant Saleh et al. during initiation of ventilation SIMV with PS mode was used in 143 cases (49%), AC/PCV mode in 84 (29%) cases, AC/VCV mode used in 38 (13%) cases while PS mode used in 26 cases (9%). During ween off in survived cases, PS+CPAP mode is used in 115 (75.9%) cases, only CPAP used in 20 (12.9) examples, T tube used in 11 cases (7.1%). Our study is comparable to most of the above studies in using SIMV as the most common mode [11]. In our study, the mean duration of ventilation was 48.09 hrs. In survived cases, it is 44.45 hrs while in expired cases, it is 51.74 hrs. A study done by Hemal dave et al. showed the meantime for ventilation survived cases as 4.3 days and in expired cases as 3.66 days [9]. A study was done by Ayesha Begum et al. showed a mean duration of ventilation for survived cases as 76.3 hrs and in discharged cases as 43.05 hrs [8]. A study done by Nilofer S. Bohori et al. showed the Mean duration of ventilation as 4.2 days. The mean duration of ventilation was higher 7.33 days for cases that have complications [13]. In the study done by Sahoo et al. Mean duration of ventilation was 3.37 days mean length in respiratory cases is 6 days while in CNS cases it is 4 days [12]. In the research done by kendirli et al. (91) mean duration of ventilation is 18.8 days [10]. The low mean duration of ventilation of survived cases when compare to expired cases is due to early elective intubation and early extubation. Some of the expired cases with diagnoses like acute encephalopathy with prolonged ventilation might have contributed to more ventilation duration in expired cases. In our study, we found that most of the cases were intubated for less than 72 hrs. A study was done by Ayesha Begum et al. showed, out of 144 cases, 44 (30%) cases were on ventilator for less than 24 hours, 96 (67%) had ventilator stay between 1 to 7 days and only 4 (3%) cases had a prolonged stay between 8 to 30 days [8]. A study done by Fatima Shirley et al. showed (n=111) 73 cases were ventilated for <72 hrs while 35 cases ventilated for >72 hrs. Cases with longer duration of ventilation had more extended hospital stays and more complications [14]. A study done by Nilofer S Bohori et al. Showed, children ventilated up to 72 hrs 9 cases, 3 to 5 days 9 cases, 5 to 10 days of ventilation duration in 30 cases, and more than 10 days of ventilation in 24 cases [13]. Our study is comparable to the study done by Fatima Sherley et al. [14] and Ayesha Begum et al. [8].

In our study, Respiratory cases (49) form the bulk of the intubated cases. Among the respiratory, most of the cases are Bronchiolitis (25) and bronchopneumonia (19). Next, the most common indication in our study is neurological (37) cases. Among CNS cases, meningoencephalitis/acute encephalopathy (21) is the most common cause, followed by status epilepticus (7). Congenital heart disease with failure constitutes about 8 cases. The next most common indication for ventilation is Multiple organ dysfunction in 12 cases. These are the most common diagnosis in our study. The study done by Ayesha begum et al at Nilofer hospital in Hyderabad showed neurological causes as the main indication for ventilation Pneumonia (32) is the most common diagnosis among intubated cases followed by

Infectious causes (13). The next most common cause is congenital heart disease (18). MODS (11) is the next most common diagnosis followed by meningitis (10) [8]. When compared to this study, our study also showed respiratory cause as the most common diagnosis. Congenital heart disease and MODS also formed the bulk of cases. The study done by Hemal dev et al. showed Respiratory causes like pneumonia and bronchiolitis (85) as the most common cause followed by Epilepsy and Encephalitis. Next most common indication for diagnosis was MODS (48) followed by AKI (24) and CHD (19) [9]. The study done by Sahoo B et al. (n=101) showed epilepsy and encephalitis (30), followed by pneumonia (28). Next, the most common causes are sepsis (28) and Congenital heart disease (11) [12]. In the study done by Nilofer S bhori et al., the most common cause for intubation was pneumonia with respiratory failure (15), followed by low GCS/Acute encephalitis (14), status epilepticus (13), Respiratory muscle paralysis (13) [13]. In the study done by Fatima, Shirley et al. (n=111) showed bronchopneumonia with sepsis (32) (28.8%) as the most common diagnosis of their study [14]. In the study done by kendirli et al. (n=91) most common diagnosis is pneumonia (41) followed by Congenital heart disease (10). The following common diagnoses are Respiratory muscle paralysis (8) and circulatory shock (8) [10]. The study done by Bassant salah et al. showed that the most common indication for ventilation was pneumonia (45) followed by sepsis (34). Next, the most common indication for ventilation is Shock (21) encephalitis (19), and CHD (18) [11]. When compared to the above studies, our study also showed respiratory cause as the most common indication for ventilation, like in studies of Ayesha Begum et al. [8], Fatima Sherley et al. [14]. and Bassent Saleh et al. [11]. In the studies where CNS causes are the most common indication for ventilation, they have used non-invasive ventilation before intubation for respiratory causes. (Sahoo et al. [12]). Congenital heart disease with failure is also common morbidity in ventilated children, as compared to Sahoo et al. [12]. MODS also formed the bulk of the cases in our study, which is comparable to other research of Hemal dave et al. [9].

The most common complication of mechanical ventilation in our study is atelectasis (15), Ventilator-associated pneumonia (14), and post-extubation stridor in (10) survived cases. Overall complications seen in 41 cases (34.1%). Post-extubation stridor was seen in cases extubated after 24hrs of intubation. Atelectasis was seen in cases intubated for more than 36 hrs of intubation. Ventilator-associated pneumonia was seen in cases intubated for more than 72 hrs. In the study done by Sahoo B et al. (n=101), complications were seen in 10 (9.9%) cases. Ventilator-associated pneumonia in 6 cases, Pneumothorax in 3 cases, and Atelectasis in 1 case and others 1 case [12]. In the study done by Fatima Sherley et al. (n=111), overall complications are in 19 (17.1%) cases. Atelectasis in 9 instances, Ventilator-associated pneumonia in 4 cases, post-extubation stridor in 3 cases others 3. All the VAP cases have occurred in cases ventilated for >72 hrs [14].

In the study done by Hemal dave et al. (n=216), overall complications are seen in 75 cases (34.7%), Post-extubation stridor seen in 34 cases, Atelectasis in 5 instances, VAP in 4

cases, Tracheostomy 12 cases others 20 [9]. In the study done by Nilofer S Bhori (n=72), complications were seen in 27 cases (37.5%), Post extubation stridor seen in 8 cases, Ventilator-associated pneumonia seen in 5 cases, Pneumothorax in 3 cases, and Atelectasis in 1 case. Other cases are 10 [13]. In the study done by Kendirli et al. (n=91), overall complications seen in 39 cases (42.85%). Atelectasis seen in 24 cases while Ventilator-associated pneumonia seen in 15 cases [10]. In the study done by Bassant Saleh et al. (n=293), complications seen in 131 cases (44.7%). Ventilator-associated pneumonia in 80 cases, Pneumothorax in 31 cases, Atelectasis in 13 cases, Post extubation stridor in 7 cases [11]. In our study, most of the complications like post-extubation stridor and Atelectasis occurred in cases ventilated for less than 72 hours. In children who were ventilated for more than 72 hours, ventilator-associated pneumonia was seen. A study done by Fatima Shirley et al [14] also showed similar results. Overall complications are seen in 34.1% of the intubated (n=120) cases. Our study showed similar results with Hemal dave et al. [9]. and Nilofer S Bhori et al. [13]. Planned extubation with prior administration of steroids can reduce post-extubation stridor. Atelectasis can be minimized with correct intubation methods, confirming the position with x-rays and the use of sedation to reduce the spasm of muscles. Ventilator-associated pneumonia can be minimized by timely suction of Endotracheal tube, proper usage of ventilator tubing's and Endotracheal tube tip culture to know the sensitivity pattern.

In our study period, 120 cases were enrolled in these 42 cases survived. The percentage of survival is 35%. According to the study done by Ayeshbegum et al. (n=144) 80 cases (56.2%) survived [8]. In a retrospective study done by Mukhtar et al (n=307) 213 cases (69.3%) survived [7]. According to the study done by Nilofer S Bhori et al. (n=72) 49 cases survived (68%) [13]. According to the study done by Sahoo B et al. (n=101), 62 children (61.3%) survived [12]. In the research done by Fatima Shirley et al. (n=111), 70 cases survived (63.1%) [14]. In the study done by Hemal dave et al. (n=216), 107 cases survived (49.53%) [9]. In the study done by kendirli et al. (n=91), 38 cases (41.7%) survived [10]. According to the study done by Bassent Saleh et al. (n=293), 159 cases survived (54.26%) [11]. In a prospective study done by Farias et al (n=49) 32 cases (65%) survived [15]. Our study had a low survival percentage when compared to all the above-said studies. Some of the reasons for higher mortality in our study are as follows:

- 1) Most of the admitted cases are referral cases from peripheral hospitals often in critical stage.
- 2) We also have a high number of admitted cases with sepsis.
- 3) Lack of adequate ventilatory support is also a drawback;

The selection of cases needs to be emphasized so that children must be ventilated before respiratory failure becomes clinically evident. Our study has some similarities in survival with the study done by Kendili et al. [10].

5. Conclusion

To improve the outcome of MV children in our PICU, we need an early referral from peripheral hospitals and adequate

ventilation support. Blood cultures to be sent in all suspected sepsis cases and E. T tip culture whenever E. T was changed. There is also need for productive, organized, and structured educational courses for physicians and nurses involved in the care of critically ill children receiving mechanical ventilation.

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