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Original Article

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A Descriptive Study of Clinical Profile of Children Ventilated in Pediatric Intensive Care Unit of a Tertiary Care Hospital

D.Tamilselvan[1], Shishir Mirgunde[2], Satish Ashtekar[2]

[1]Junior resident, Department of Paediatrics, Government medical College Miraj
[2]Associate professor, Department of Paediatrics, Government medical College, Miraj

ABSTRACT

Background: Mechanical Ventilation (MV) has become frequently used life-supportive management in Pediatric Intensive Care Units (PICU). But very little data is available from developing countries regarding the outcome analysis coupled with clinical profile of children ventilated in PICU. Hence the present study was undertaken to assess the etiological and clinical profile of ventilated children in PICU of tertiary care centre. **Method**: Total number of PICU admissions during the study period from Feb 2021 to Dec 2022 was 678. Out of them a total of 272 (40.11%) PICU admissions satisfied the inclusion and exclusion criteria were studied. **Results**: The average age of infant was 30.42±46.14 months with male preponderance (57.72%). The most common etiology/indication was respiratory diseases (29.77%). Invasive ventilation (98.89%) far exceeded the use than non–invasive ventilation (1.10%) in our PICU. Of the children who were ventilated in the PICU, 76.6% were intubated at the Emergency Department. The commonest cause for intubation was circulatory failure and the most common clinical diagnosis was septic shock. Rapid Sequence Intubation (RSI) was done by the majority of children (53.90%). Maximum cases250(92.93%) were exclusively mechanically ventilated. Nosocomial pneumonia was the most common complication encountered in ventilated children(16.35%). The mortality in the ventilated children was 54.77%. **Conclusion**: Mortality and complications in ventilated children in the PICU can be reduced with increased availability of mechanical ventilators and timely referrals to tertiary care centre. However, to improve the outcome of mechanically ventilated children in PICUs, the early and effectively identification of clinical profile and etiological factors associated with ICU admission.

Key Words: *Mechanical Ventilation; Pediatric Intensive Care Units; Intubation; Septic shock; Pneumonia; Mortality*

***Corresponding Author**
D.Tamilselvan
Junior resident, Department of Paediatrics, Government medical College Miraj

Introduction

Ventilatory support is an essential and a common form of therapy in Pediatric Critical Care Unit. In recent years, this modality has evolved into a highly specialized discipline [1]. The term mechanical ventilation refers to various artificial means used to support ventilation and oxygenation [2]. The use of ventilator in children is based on multifactorial factor such as cardiac failure, respiratory failure, shock, neurological problems, and multi-organ dysfunction syndrome [3].The percentage of mechanical ventilation in PICU ranges from 30-64% [4].

However, mechanical ventilation is a lifesaving intervention to support the cardiorespiratory status, until the underlying disease is cured. Invasive mechanical ventilation is under continuous evolution with introduction of various new modes of ventilator support. Although lifesaving, it is associated with complications especially if ventilator care is prolonged and also with the drawback of limited resources in intensive care units of developing countries [5]. There are still some other side effects for the patients from using ventilator, such as Ventilator Associated Pneumonia (VAP), atelectasis, barotrauma, etc [6]. However, there are only few studies from developing countries regarding the outcome analysis coupled with etiological and clinical profile of children ventilated in PICU. Hence the present study was undertaken to assess the etiological and clinical profile of ventilated children in PICU of tertiary care centre.

Materials and Methods

After obtaining Institutional Ethical Committee approval and written informed consent from all the parents/ guardian, this descriptive clinical study was conducted in the Department of Pediatrics at Tertiary Care Hospital during a period from February 2021 to July 2022. A total of 272 children more than 30 days and less than 12 years who were admitted in accordance with institute admission criteria and were ventilated in PICU with manually or mechanically was included. Children ventilated for less than 12 hours, who were ventilated outside the hospital, went DAMA or were referred to other health care centre for intubation and those parents/Guardian withdrew the consent were excluded from the study.

All sick children were initially evaluated in the Pediatric Emergency Department of the hospital and initial stabilization of the patient including intubation when needed, fluid resuscitation, inotrope initiation was carried out accordingly. According to availability of bed in the PICU, the children were admitted there. When there was no bed available in PICU, the child was shifted to the concerned medical units, and managed there, and later was shifted PICU as and when vacancy arise.

The choice of mechanical ventilation was based on availability of ventilators. If there were no available ventilators, the children were on manual ventilation by the caregivers of the child for variable time, until ventilator become available. Once the ventilators were available, children were managed on mechanical ventilator. The children were monitored clinically, with periodic cardiopulmonary assessment, Oxygen saturation and with arterial blood gases whenever indicated and feasible.

The patient details, cardiopulmonary status prior to intubation (heart rate, respiratory rate, blood pressure, oxygen saturation), intubation details (Whether the child was intubated in Emergency department or in pediatric ward or in PICU), size of ET tube to be used – appropriate size or lower. RSI protocol used or not, need for inotropes, ventilation details: Invasive or noninvasive ventilation, Manual or mechanical ventilation, duration of ventilation, need for re intubation and the reason weaning method were noted. Complications including nosocomial pneumonia, pneumothorax, post extubation stridor collapse / atelectasis, pressure sores were recorded. Outcome of the study was patient discharge, death and discharged against medical advice.

Statistical Analysis

Data was entered in Microsoft office excel and analyzed using SPSS version 21.0 for windows. Descriptive statistics like mean, median, standard deviation and proportions were calculated for all the variables. The association of outcome with other study variables chi square test was used. p value <0.05 was considered as statistically significant.

Observations and Results

Total number of PICU admissions during the study period was 678. Out of them a total of 272 (40.11%) PICU admissions satisfied the inclusion criteria and were included in the study. The most common age group was between 1 to 12 months (124; 45.58%) with the average age was 30.42 ± 46.14 months. Majority of children (57.72%) were males as shown in table 1.

Table 1: Demographic data of patients

Demographic data		No. of patients	Percentage
Age groups in years	1 to 12 months	124	45.58
	1 to 3 years	92	33.82
	4 to 5 years	36	13.23
	6 to 12 years	20	7.35
Gender	Male	157	57.72
	Female	115	42.27

The most common etiology/ indication was respiratory diseases (29.77%), next most common indication is neurological diseases (27.57%) followed by cardiovascular diseases (18.01%) as depicted in figure 1. Miscellaneous category (6.98%) included Guillain-Barre syndrome, submersion injury, status epilepticus, Diabetic keto-acidosis, Intracranial bleed among others.

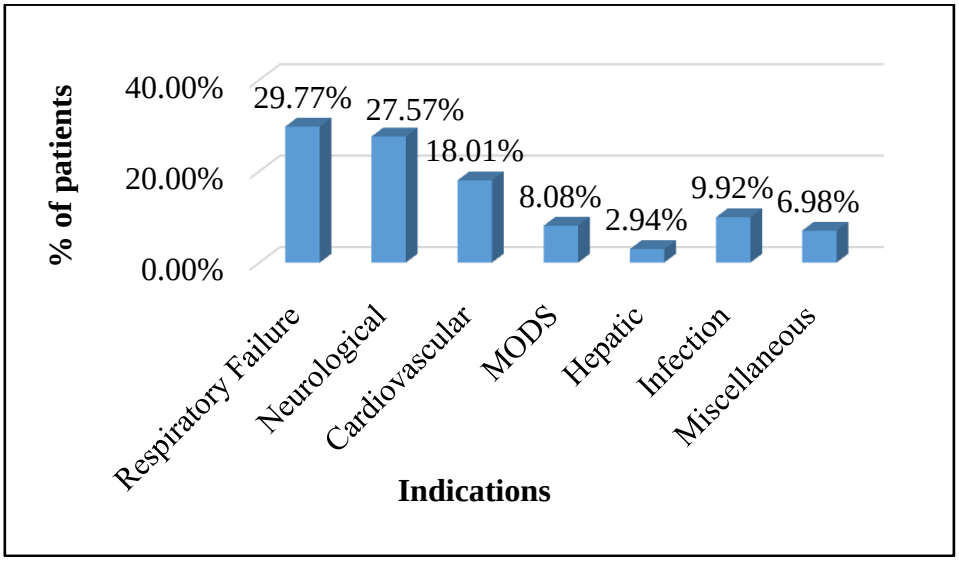

Figure 1: Etiology/Indications for Initiation of ventilator

The invasive ventilation (269; 98.89%) far exceeded the use than the non–invasiveventilation (3; 1.10%) in our PICUas depicted in figure 2.

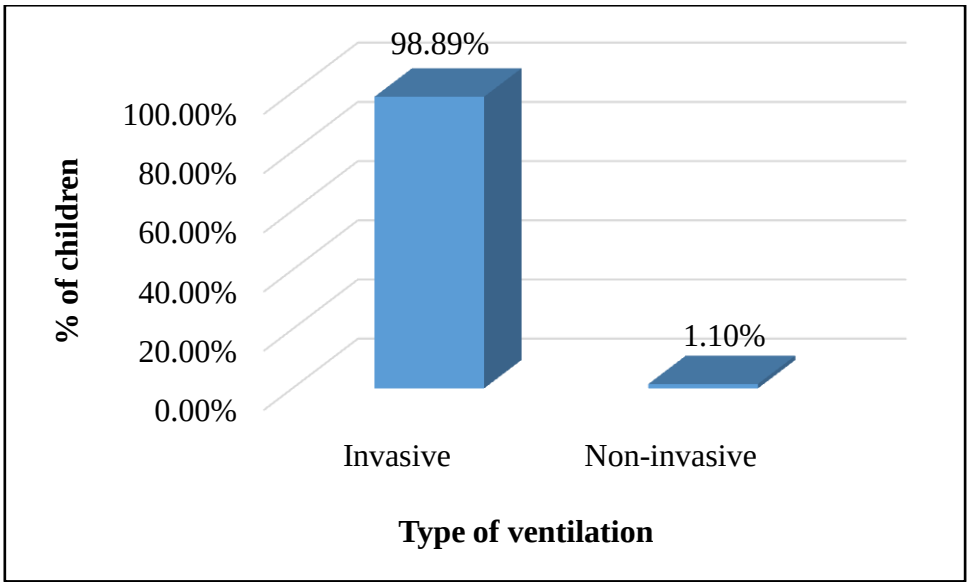

Figure 2: Types of ventilation

Majority of the children (76.6%) who were ventilated in the PICU required intubation on arrival at the Emergency Department itself. The commonest clinical indication for intubation was circulatory dysfunction which included septic shock, congenital heart disease with cardiogenic shock and others (37.91%).RSIwas done in 145 children (53.90%), whenever intensivist was available. All the other children were intubated using a combination of sedative and/or analgesic. Majority of children (98.51%) were intubated using endotracheal tubes that were appropriate for the age. Majority of the children (97.9%) were intubated orally as shown in table 2.

Table 2: Intubation details (n=269)

Intubation details		No. of patients	Percentage
Place of intubation	Emergency Department	207	76.95
	Pediatric ward	30	11.15
	Pediatric Intensive Care Unit	32	11.89
Indications for intubation	Circulatory	102	37.91
	Respiratory	54	20.07
	Neurological	94	34.94
	Circulatory + Respiratory	10	3.71
	Circulatory + Neurological	07	2.60
	Respiratory + Neurological	02	1.0
Drugs used for intubation	RSI used	145	53.90
	RSI not used	124	46.09
Tube size used for intubation	Appropriate	265	98.51
	Small	04	1.48
Route of intubation	Orotracheal	263	97.76
	Nasotracheal	06	2.23

Rapid Sequence Intubation (RSI)

Maximum 250 children (92.93%) were exclusively mechanically ventilated as shown in figure 3. A total of 96.65% of children did not get an access to a ventilator at the time of admission to the PICU.

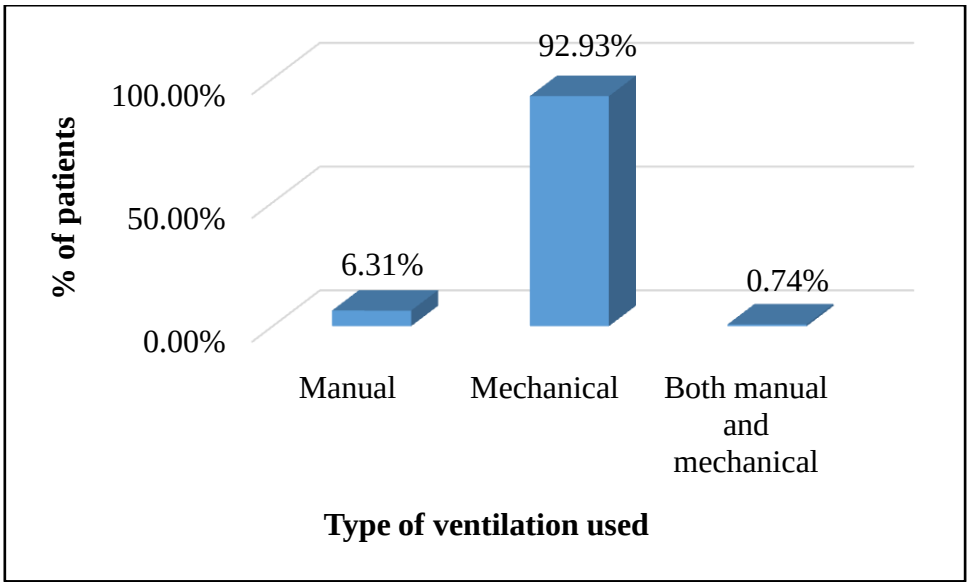

Figure 3: Types of invasive ventilation used.

The duration of ventilation is shown in table 3. The mean duration of ventilation at <48 hours, 48 hours to <7 days and at 7 days and more was 1.57±1.73, 5.4±4.8 and 4.7±5.8 days respectively. Synchronized intermittent mandatory ventilation (SIMV) was the major method of weaning (75; 59.05%) followed by T piece (11; 8.66%) and CPAP (6; 4.72%). However, 32 children (25.19%) extubated spontaneously.Overall, 47 children needed reintubation for various reasons, the commonest cause being tube displacement (46.80%) followed by extubation failure (34.04%) and obstruction (19.14%).

Table 3: Duration of ventilation (n=269)

Type of ventilation	Duration of ventilation		
	<48 hours	48 hours to <7 days	7 days and more
Manual ventilation	11 (64.70%)	05 (29.41%)	01 (5.88%)
Mechanical ventilation	42 (16.8%)	148 (59.2%)	60 (24%)
Manual + MV	00 (0.0%)	01 (50%)	01 (50%)

The various complications encountered in the ventilated children in PICU are shown in table 4. The commonest complication in the ventilated children was nosocomial pneumonia in 16.35% (n=44). 50 children (18.38%) had features of raised intracranial pressure.

Only 4 children (1.47%) out of the 272 children underwent tracheostomy, which was performed in these children for the need for prolonged ventilation. A total of 250 children (91.91%) needed inotropes support.

Table 4: Complications of ventilated children in PICU (n=269)

Complications	No. of cases	Percentage
Nosocomial pneumonia	44	16.35
Air leak	24	8.92
Pressure sores	16	5.94
Post extubation stridor	04	1.48
Collapse	03	1.11
Obstructive emphysema	09	3.34
Equipment failure	11	4.08

Out of the 272 children, a total of 123 children (45.22%) were discharged and 149 died (54.77%), (Figure 4).

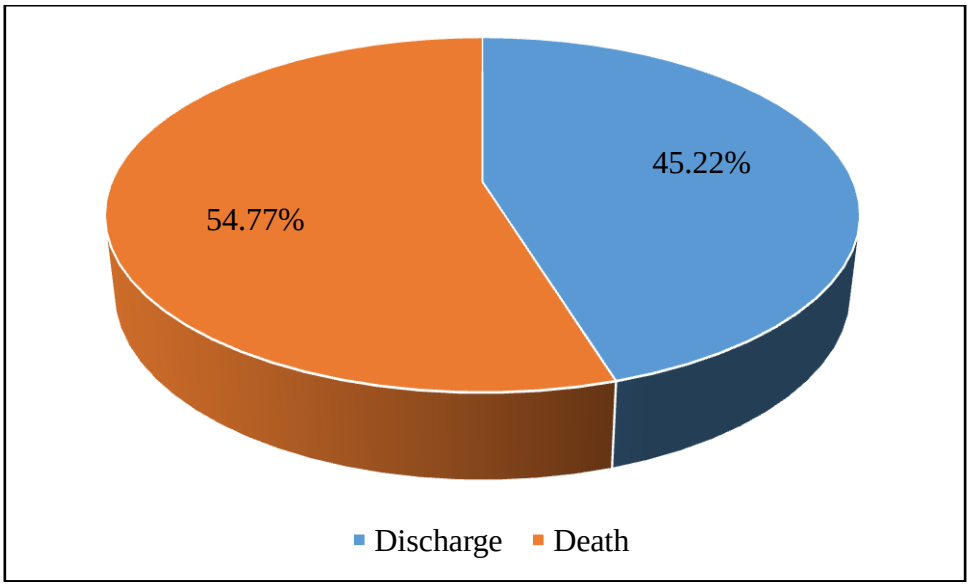

Figure 4: Outcome of ventilated children (n=272)

Among the children who were ventilated for more than 48 hours, there was increased mortality in the manual ventilation group which was statistically significant with p=0.001.The outcome of 3 children could not be assessed as they were discharged against medical advice. Out of 266 children, 26 children had airleak of them 2 (7.69%) children were discharged from the hospital and 24 (92.30%) were died. Airleak was significantly associated with mortality with p value of 0.001. Among the children who were ventilated, 46 had features of raised intracranial pressure out of which 33 (71.73%) died, which was statistically significant with p value of 0.001, (Table 5).There was no significant association between occurrence of airleak and the type of ventilation with p value of 0.776.

Table 5: Association of outcome with other study variables

Variables		Discharge	Death	P value
Types of ventilation	Manual < 48 hours	05 (45.45%)	06 (54.54%)	0.001
	Manual 48 hours or more	02 (33.33%)	04 (66.66%)	
	Mechanical < 48 hours	14 (33.33%)	28 (66.66%)	
	Mechanical ≥48 hours	98 (47.11%)	110 (52.88%)	
	Both < 48 hours	00 (0.0%)	00 (0.0%)	
	Both 48 hours or more	01 (50%)	01 (50%)	
	Non-invasive	03 (100%)	00 (0.0%)	
Airleak	Air leak	02 (7.69%)	24 (92.30%)	0.001
	No Air leak	118 (48.55%)	125 (51.44%)	
ICP	ICP	13 (28.26%)	33 (71.73%)	0.001
	No ICP	107 (47.98%)	116 (52.01%)	

Re-intubation was a significant risk factor for nosocomial pneumonia in ventilated children (63.82%) than No Reintubation (nosocomial pneumonia 6.30%) with a p value of 0.000.

DISCUSSION

In the present study, among 272 patients, 269 (98.89%) required invasive mechanical ventilation and 3 (1.10%) required non-invasive mechanical ventilation which is comparable with the study conducted by Sahoo B et al [7]. The percentage of admissions to PICU requiring mechanical ventilation in present study was 40.11% which is in accordance with the study done by Tigist B et al [8]. However, previous studies show that prevalence of MV ranges from 20-52% in children admitted to PICU of developing countries [9, 10]. Difference in percentage of MV requirement of total PICU admissions in various mentioned studies may depend on various factors like type of institute (government /private / corporate /trusts), type of patients (educated /illiterate, affordable/ poor),referral practices in that area (early/delayed referral, transportation facilities, distance of tertiary care centre from referral centres).

The infants contributed most of the children (45.58%) who were treated with artificial ventilation in PICU during the study period. The average age was 30.42±46.14 months (2.5 years) with male predominance (57.72%). Male: female ratio was 1:1.36; a similar phenomenon was appreciated in related studies [11, 12]. The respiratory disease (29.77%) and neurological (27.57%) causes were found to be the commonest indicators of ventilation which is comparable with the previous studies [7-10, 13]. Study of these causes may help in both directions. May enable primary and secondary care physicians to treat them early and effectively and identify the risk factors associated with ICU admission. It may enable

the critical care physicians to assess the outcome in each cause and specialized care and ventilator settings required for each ailment.

The majority of the children (76.6%) who were ventilated in the PICU required intubation on arrival at the Emergency Department itself. The commonest clinical indication for intubation was circulatory dysfunction which included septic shock, congenital heart disease with cardiogenic shock and others (37.91%). Neurological causes were next common and included status epilepticus, neuromuscular diseases and raised intracranial pressure (34.94%). Respiratory causes including bronchopneumonia and bronchiolitis were the third common cause requiring artificial ventilation (20.07%). Rapid Sequence Intubation (RSI) was done in 145 children (53.90%), whenever intensivist was available. All the other children were intubated using a combination of sedative and/or analgesic. The majority of children (98.51%) were intubated using endotracheal tubes that were appropriate for the age. Two children with airway obstruction required smaller size tubes. However, the majority of the children (97.9%) were intubated orally, and 6 (2.23%) children were intubated through nasotracheal. These findings are comparable with the study conducted by MullaiBaalaaji AR [14].

In a current study, manual ventilation in isolation was employed in 17 children (6.31%), 250 children (92.93%) were exclusively mechanically ventilated, and 02 children (0.74%) were ventilated using a combination of manual and mechanical ventilation. A total of 96.65% of children did not get an access to a ventilator at the time of admission to the PICU. Out of the 154 children who were manually ventilated, 64 (41.55%) survived and remaining 90 (58.44%) were died. None of the studies in available literature have data on manual ventilation.

However, among the children who were ventilated manually, 11 children (64.70%) were ventilated for a period less than 48 hours. The mean duration of manual ventilation was 1.57 days±1.73 days. It was observed that, among the children who were ventilated mechanically, a maximum of 208 children (83.20%) were ventilated for 48 hours or more. The mean duration of ventilation was 5.4 days ± 4.8 days and ranged from 1 day to 15 days. Out of 269 children, 216 children (80.29%) were ventilated for a period of 48 hours or more. The mean duration of manual ventilation prior to being mechanically ventilated was 1.4 days ±1.5 days and the duration of mechanical ventilation ranged from 12 hours to 42 days with a mean duration of 4.7 days ± 5.8 days. These findings are correlated with the study done by Kendirli et al [4] and Silva et al [10].

The most commonly used ventilatory mode was synchronized intermittent mandatory ventilation (SIMV) (59.05%) and several published reports also found that SIMV was commonly used as initial mode [12, 15]. The various complications encountered in the ventilated children in PICU. The commonest complication in the ventilated children was nosocomial pneumonia in 16.35% (n=44) in the present study which is comparable with the study done by Kendirli et al (17.5%) [4].

Routine change of endotracheal tube is not practiced in the PICU. However, 47 children needed reintubation for various reasons, the commonest cause being tube displacement (46.80%) followed by extubation failure (34.04%). The studies by Rajasekhar et al [16],Ibrahim et al [17] and Kollef et al [18] had come up with similar results.

Air leak was observed in 26 out of 269 children (9.66%) compared to an incidence of 13.1% reported by Kendirli et al [4] and 6.9% reported by Benjamin et al [19]. Tracheostomy was performed in 4 out of 272 (1.47%) patients in the study as compared to 3 out of 86 children who underwent tracheostomy in the study by Da Silva et al [10]. A total of 250 children (91.91%) needed inotropes support. Inotropes were started either in the Pediatric Emergency Department or in the corresponding pediatric ward or the PICU for stabilising the child. The inotropes used were Dopamine, Dobutamine, Epinephrine and Norepinephrine.

The outcome in the present study was also not very different. 54.77% of the patients died despite all the efforts made in the intensive care unit including the ventilatory support. Only 45.22% were discharged and they too were not followed up to look for the final outcome and mortality. Thus, the mortality in the ventilated children was 54.77% which is comparable with the study done by Kokeb M et al where the mortality rate was 54.8% [20].Among the children who were ventilated for more than 48 hours, there was an increased mortality in the manual ventilation group which was statistically significant with p=0.001. The outcome of 3 children could not be assessed as they were discharged against medical advice. A common reason for this was shift to another hospital either due to cost effectiveness or better facilities. Results were similar in the studies done in setups similar to us and were slightly better in the developed countries [21, 22]. Out of 266 children, 26 children had airleak of them 2 (7.69%) children were discharged from the hospital and 24 (92.30%) were died. Airleak was significantly associated with mortality with p value of 0.001. Among the children who were ventilated, 46 had features of raised intracranial pressure out of which 33 (71.73%) died, which was statistically significant with p value of 0.001. Re-intubation was a significant risk factor for nosocomial pneumonia in ventilated children with a p value of 0.000. There was no significant association between occurrence of airleak and the type of ventilation with p value of 0.776.

Limitations

- The major limitation of present study is the lack of generalizability as patients from one PICU of a tertiary care hospital were studied instead of all hospitals of the country.
- Results might be different in tertiary care hospitals which have fewer facilities as compared to private hospitals which have more facilities.
- Lack of severity of scoring of these patients which could have led to a biased favourable outcome in the form of low mortality rate.
- Tertiary care hospitals being a public sector with limited resources, blood gas analysis was not done for our patients.
- Patients were not followed up after the discharge so final outcome could not be determined. We suggest further studies on a broader basis and a more representative sample size involving the hospitals of both public and private sector.

CONCLUSION

Mortality and complications in ventilated children in the PICU can be reduced with increased availability of mechanical ventilators and timely referrals to tertiary care centre. However, to improve the outcome of mechanically ventilated children in PICUs, early and effectively identification of the clinical profile and etiological factors associated with ICU admission, also we need effective, organized, and structured educational courses from basic concept to clinical application for all physicians and nurses involved in the care of critically ill children receiving mechanical ventilation. As we gain experience in the ventilation our complications rate and mortality related to mechanical ventilation would also decrease hopefully.

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