

Research Article

Mechanical Ventilation in Pediatric Intensive Care Unit at Minia University Hospital



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Abstract

Background: Mechanical Ventilation is essential intervention, Every year, MV is administered to thousands of pediatric patients. **The study aimed to** assess the indications and outcomes of Mechanical Ventilation in all ventilated patients aged from 1 Month to 18 years in Minia University PICU. **Methods:** This is a Hospital based cross sectional study at Minia University Hospital PICU during the period October 2019 to May 2022 in Minia governorate, Egypt. **Results:** About 54% were males 46% were females, the mean of age of all mechanically ventilated children was 25.6 ± 33.9 months. Non-Respiratory causes represents the majority of causes that leads to mechanical Ventilation in (54%) and the commonest non-respiratory causes was apnea after status epilepticus (11.6%) and central apnea (7.6%) causing respiratory failure in 48 (19.1%) infants. Pneumonia was the commonest respiratory indication for mechanical ventilation in (33.5%). The mode that was used mostly was PCV in (86.1%) and the mean duration of mechanical ventilation was 4 ± 2.6 days. there is Significant correlation between mortality rate and indication for MV, duration of ventilation, relapse rate and complication rate (Spearman test, $P < .05$) and according to Binary logistic regression model, indication, duration, and complications of mechanical ventilation are the major determinants of the mortality outcome. **Conclusions:** VAP is more likely to be the most common complication of the Mechanical Ventilation. The outcome of mechanically ventilated patients depended on characteristics at the start of MV, as well as on the development of complications and management protocols in the PICU.

Keywords: Mechanical Ventilation, Minia University hospital, Pediatric Intensive Care Unit, Indications, Outcomes.

Introduction

Mechanical ventilation is mostly a lifesaving procedure in pediatric critical care, but many complications in conditions that require intensive care are related to ventilatory support, particularly if it was prolonged. When other simple respiratory support treatments fail to improve oxygenation and/or ventilation, mechanical ventilatory assistance is recommended. Indications of Mechanical Ventilation are divided into three categories: (Respiratory, Non-Respiratory, both Respiratory and Non-

Respiratory). Although Mechanical Ventilation is a widely used in Pediatric intensive care units, usage and particularly Prolonged usage of MV causes many complications such as: Pulmonary Barotrauma related to Mechanical Ventilation, Atelectasis related to Mechanical Ventilation, Ventilator Associated Pneumonia (VAP), Tracheal Edema and Tracheal Stenosis after the extubation Period, Mechanical Ventilator dependence and Broncho-Pulmonary dysplasia.

Patient and methods

This is a Hospital based cross sectional study, which carried out in Minia University Hospital Pediatric Intensive Care Unit during the period October 2019 to May 2022 in Minia governorate, Egypt. The study has two phases; **Phase I**; retrieved health records of registered patients 2-years ago from 1 month to 18 years in Minia University Hospital PICU.

Phase II; all consecutive children aged from 1 month to 18 years admitted to Minia University Hospital PICU with surgical or medical cause from November 2021 to May 2022.

Data collection procedure:

Questionnaire:

The questionnaire includes:

1. Socio demographic data: Age, Sex, Residence, and Educational level.
2. Indication for mechanical ventilation (MV): (Respiratory, Non-Respiratory and both Respiratory and Non-Respiratory).
3. Duration of mechanical ventilation (MV).
4. mode of ventilation.
5. Relapse after weaning.
6. The number of times of Relapse
7. Causes of relapse related to Mechanical Ventilation
8. Ventilator Associated Pneumonia (VAP)
9. Causes of respiratory failure
10. Complications of Mechanical Ventilation.
11. outcome – either (Improved, Improved with Morbidity or Mortality).

Ethical consideration:

Following the ethical guidelines of epidemiological research, a written informed consent form from pediatric patients' mothers was developed and attached to all questionnaires. Each patients' mothers was explained the objectives of the study and details of the data collected. Subjects were also assured

confidentiality which was maintained by removing names of subjects from data collection forms. Only numbers were kept for identification. The researcher was the only person having access to link numbers to persons' names.

Statistical analysis:

Data entry and analysis were all done with I.B.M. compatible computer using software called SPSS for windows version 19. Graphics were done by Excel Microsoft office 2010. Quantitative data were presented by mean and standard deviation, while qualitative data were presented by frequency distribution. Chi square test, Fisher's exact and Z (test of proportions) test was used to compare between proportions. Student t-test was used to compare two means.

Results

In our study, males were the most predominant than females by a percentage of 54% of all mechanically ventilated children, the mean of age of all mechanically ventilated children was 25.6 ± 33.9 months, when we come to the indications of mechanical Ventilation, we will find that Non-Respiratory causes represents the majority of causes that leads to mechanical Ventilation in children by a percentage of 54%, the most common non-respiratory causes was apnea after status epilepticus (11.6%) and central apnea (7.6%) causing respiratory failure in 48 (19.1%) infants in our cohort. Pneumonia was the most common respiratory indication for mechanical ventilation causing respiratory failure in 84 (33.5%) infants. The mode that was used mostly was PCV by percentage of 86.1% and the mean duration of mechanical ventilation was 4 ± 2.6 days. We found that there is Significant relation was found between indications of Mechanical Ventilation and age groups (Spearman test, $P < .05$).

Table (1): frequency distribution of studied group according to socio demographic characteristic, indications for ventilation, duration of ventilation and modes of ventilatio.

		Total number 251	
		N	%
Age (months)		1-180	25.6 ± 33.9
Sex	Male	135	53.8
	Female	116	46.2
Educational Level	Pre-School	229	91.2
	1 st Primary	3	1.2
	2 nd Primary	9	3.6
	3 rd Primary	2	0.8
	4 th Primary	2	0.8
	5 th Primary	1	0.4
	6 th Primary	2	0.8
	1 st Preparatory	3	1.2
Indications of Mechanical of Ventilation	Respiratory	91	36.2
	Non respiratory	135	53.7
	Both	25	9.9
DURATION OF MECHANICAL VENTILATION (DAY)		1-17	4.1±2.6
Modes of Mechanical Ventilation	PCV	216 (86.1%)	
	SIMV-PSV	146 (58.2%)	
	VCV	8 (3.2%)	
	CPAP	5 (2%)	

Table (2): Frequency distribution of the studied group according to relapse and complication of ventilation causes of respiratory failure and outcomes.

		Total number 251	
		N	N
Relapse		42	16.7
the number of times of relapse		0-5	0.25±0.68
Complication of mechanical ventilation	VAP	32	12.7
	barotrauma	5	2
	Laryngeal tracheal edema	1	0.4
	Lung atelectasis	2	0.8
	Ventilator Dependence	1	0.4
	Bronchopulmonary Dysplasia	1	0.4
Cause of respiratory failure	Pneumonia	70	27.9
	Apnea after status epilepticus	27	10.8
	Septic shock	20	8
	Metabolic acidosis	18	7.2
	Heart failure	17	6.8
	Encephalopathy	14	5.6
	Status asthmaticus	13	5.2
	Sever laryngeal edema	8	3.2
	Central apnea	12	4.8
	Others	52	20.7
Outcome	discharged to in ward patient	126	50.2
	discharged with morbidity	9	3.6
	died	116	46.2

Table 3: The association between age group and indication and duration of ventilation.

		Total number 251			P value
		Infant N= 131	Preschool N=99	More than 6 years N=21	
Indication of ventilation	Respiratory	40(30.5)	46(46.5)	5(23.8)	0.006
	Non respiratory	81(61.8)	39(39.4)	15(71.4)	
	Both	10(7.6)	14(14.1)	1(8.4)	
Duration of ventilation		4.2±2.7	3.9±2.6	3.8±1.9	0.66

Discussion

Mechanical Ventilation is essential intervention for severely ill pediatric patients, Prolonged ventilation is linked to longer hospital stays, higher medical costs, and adverse events like mortality⁽¹⁾.

A total of 733 infants, admitted to the PICU and 251 infant of them, indicated for mechanical ventilation, were enrolled in our study. The mean age of included infants was 25.6 ± 33.9 months. In all, 135 (53.8%) patients were males, while 116 (46.2%) were females, this in agree with⁽²⁾ that showed that of 83 ventilated critically ill children in our PICU, 44 cases (53%) were male and 39 cases (47%) were female. The mean age of the patients was 29 months (the youngest was 1 month and the oldest was 12 years).

Mechanical ventilation was indicated for respiratory failure secondary to either respiratory causes in 91(36.2%) infants, for non-respiratory causes in 135 (53.7%) infants, or for both respiratory and non-respiratory causes in 25(9.9%) infants. This is with⁽³⁾ as regard MV Utilization, NIV was utilized initially in 172 of 1185(15%) of all patients receiving MV and failed in 67(39%, 95% CI: 32–47). These last patients were subsequently intubated and submitted to invasive MV. The main indication of NIV was ARF (n = 151, 88%), while acute on chronic respiratory failure accounted for 17 (10%), and a neuromuscular disease for four (2%).

Pneumonia was the most common cause of respiratory failure in 70(27.9%) infants. Apnea after Status Epilepticus was responsible for respiratory failure and so on mechanical ventilation in 27 (10.8%) infants, septic shock

in 20(8%) infants, Metabolic Acidosis in 18(7.2%) infants, Heart Failure in 17(6.8%) infants, Encephalopathy in 14(5.6%) infants, Status Athmaticus in 13(5.2%) infants, sever laryngeal edema in 8(3.2%) infants, central apnea in 12(4.8%) and others in 52 (20.7%) infants. Our results against⁽⁴⁾ showed that the indications for mechanical ventilation in PICU were divided into four major categories including acute neurological illness (35.8%), respiratory illness (20.8%), cardiac failure (13%) and miscellaneous group (30.3%) mostly involve safety of airway like postoperative patients and septic shock, etc. But they are in agreement with⁽⁵⁾ study, in which the indications for MV in all the studied patients were acute on top of chronic respiratory failure (77.7%) followed by acute hypoxemic respiratory failure (11.54%), post arrest (10%) and coma (0.77%).

The mean duration for mechanical ventilation was 4.1 ± 2.6 days, ranging from 1 to 17 days. This in agreement with⁽⁴⁾ showed that the duration of mechanical ventilation was 4-6 days in few published reports.

The most commonly used mode of mechanical ventilation was pressure-controlled ventilation (PCV) in 216(86.1%) infants. Synchronized Intermittent Mandatory Ventilation (SIMV) and Pressure Support Ventilation (PSV) were used in 146(58.2%) infants. Less commonly used modes of ventilation were volume-controlled ventilation (VCV) used in 8(3.2%) infants, and continuous positive airway pressure (CPAP) used in 5(2%) infants. This in agreement with⁽³⁾ showed that the ventilatory modes preferred at the beginning of MV were A/C pressure-limited ventilation (47%), A/CV (17%), SIMV (11%), NIV (11%), SIMVPSV (9%), as well as

dual modes (5%). But, this against the study done by ⁽⁶⁾ and ⁽⁷⁾, that showed different modes of mechanical ventilation. In NIMV, the modes were BiPAP (84.9%) followed by CPAP (15.2%).

The overall rate of relapse 16.7% affecting 42 infants. The overall complication rate associated with mechanical ventilation was 13.9%. The most common complication was ventilator-associated pneumonia (VAP), reported in 32(12.7%) infants. Five (2%) infants developed barotrauma causing pneumothorax. Two (0.8%) infants had atelectasis, one (0.4%) had ventilator dependence, one (0.4%) had tracheal edema, one (0.4%) infant developed bronchopulmonary dysplasia. This is against ⁽⁵⁾ study in which the highest recorded complication in group A was renal impairment or failure (11.5%) followed by ventilator associated pneumonia (5.77%) and cardiogenic shock (5.77%). But our study is in agreement with the study done by ⁽⁸⁾ that showed that the recorded complications were pneumonia (29%), airway complications (10%) gastrointestinal hemorrhage (11%), cardiovascular complications (8%), equipment failure (7%), barotrauma (2%), and failure of closure of tracheal stoma (1%).

The overall mortality rate was 46.2%. On the other hand, 126 (50.1%) infants demonstrated clinical improvement and were discharged to the inpatient ward. Nine (3.5%) infants were discharged with residual morbidities. This is against ⁽⁹⁾ study, in which the survival rate of mechanical ventilated cases was (23%) while the mortality rate was (77%). But, in contrary with this study and in agreement with our study ⁽¹⁰⁾, ⁽¹¹⁾, ⁽¹²⁾, ⁽¹³⁾ who reported that the mortality rate was less than that reported in this study and reported to be between (43-67 %).

Significant relation was found between the indication for Mechanical Ventilation and age group with (P value < .05). this in agreement with ⁽⁴⁾ The age was further divided in to three subcategories: <12 month (n=99), 1-5 yr (n=98) and >5 yr (n=110). The indications for mechanical ventilation in PICU were divided into four major categories including acute neurological illness (35.8%), respiratory illness (20.8%), cardiac failure (13%) and miscellaneous group (30.3%) mostly involve safety of

airway like postoperative patients and septic shock, etc.

Conclusion

In a large cohort of mechanically ventilated patients, VAP is more likely to be the most common complication of the Mechanical Ventilation. Demographic data of the patients and associated co-morbidities did not affect the choice of type of MV. So the outcome of mechanically ventilated patients depended mainly on characteristics at the start of MV, as well as on the development of complications and management protocols in the PICU.

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