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Outcome of ChildrenTreated with Mechanical Ventilationin PICU of Zagazig University Pediatric Hospital

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ABSTRACT

Background: Mechanical ventilation is often lifesaving but is associated with serious complications, in part because it is delivered to patients at high risk of lung or cardiac compromise. These complications may be related to the direct mechanical effects of the intrathoracic pressures generated by the ventilator, to alveolar and systemic inflammation, or to neural stimulation. The aim of study to assess the clinical profile and outcome of children treated with invasive mechanical ventilation. Patients and methods: An Observational study conducted on 74 patients in PICU in Pediatric Hospital ,Faculty of Medicine, Zagazig University, all patients are intubated and connected on mechanical ventilators, all patients underwent a thorough medical history examination,(Patients' data) were collected including demographic data as age and sex, diagnosis, length of stay on MV from the time of initiation to the time of liberation, mode of MV used upon its initiation, complication,(outcomes and its relations to cause of ventilation and admission ,comorbidity ,mode of MV, age and duration of weaning and all MV parameters). Result: Outcome of mechanical ventilation among studied group showed14.9% have bad outcome and 85.1% had good outcome, also showed that Pneumonia was significantly associated with bad outcome.Conclusion: The results of the present study show a significant number of preventable adverse events, especially atelectasis and ventilator associated pneumonia. Prolonged duration of ventilation was significantly associated with complications as well as mortality related to mechanical ventilation, also APRV mode has significantly association with bad outcomes.

Keywords: Mechanical Ventilation; Outcome; Weaning; Extubation; pediatric Intensive Care Unit.

INTRODUCTION

Mechanical ventilation (MV) has become one of the major indications for admission to paediatric ICUs and often a lifesaving strategy [1]. Weaning from MV is difficult for 30% of patients, and such patients showed a higher mortality rate. Therefore, previous studies have assessed the relationships between weaning classifications and clinical outcomes[2]. Many of the complications of MV can potentially be avoided or minimized [3]. Endotracheal intubation is a critical procedure in which patients are at risk of respiratory and/or circulatory compromise [4]. Preoxygenation is essential, and different techniques such as noninvasive ventilation (NIV)or high flow delivered via nasal cannula have been proposed for patients with the most severe disease [5].

In the early phase of MV, sedation with or without paralysis is often required, especially for patients with shock or ARDS or for those “fighting the ventilator.”

[6].Each sedative agent has specific effects, and the appropriate choice of the type and dose of sedative drugs may impact outcome [7].Propofolis frequently used because of a relatively short half-life, but there are concerns associated with prolonged infusion [8].Dexmedetomidinehas been proposed as a promising alternative to usual sedation because it reduces the rate of delirium [9]. It is important to carefully monitor the depth of a patient's sedation and to use a sedation protocol, including daily interruption of sedation to avoid a state of deep sedation [10].

Several studies have suggested an independent association between hyperoxemia and hospital mortality in some groups of patients (e.g., those with cardiac arrest or stroke) [11]. Recent preliminary targeting a PaO2 of 70 to 100 mm Hg or a pulse oximetry oxygen saturation (SpO_2) of 94% to 98% results in lower ICU mortality than a conventional, more "liberal" approach with higher PaO_2 and SpO_2 targets [12]. More than 50% of patients experience dysfunction related to an excessive level of assistance (controlled or partial ventilation) or to insufficient assistance [13]. Respiratory muscle dysfunction is at least twice as prevalent as limb muscle weakness at the time of separation from MV and has a strong impact on weaning [14].

Recent guidelines recommend limitation of sedation and shortening the duration of MV in order to minimize the risk of ventilation-acquired pneumonia [15]. Mechanical ventilation can induce or worsen lung injury, referred to as ventilator-induced lung injury (VILI). Ventilator-induced lung injury may impact a large number of patients, most specifically those with or at risk for ARDS [16].

A lower limb Doppler and CT pulmonary angiogram may be necessary in certain cases. Fiber-optic bronchoscopy and biopsy are rarely indicated [17]. Gattinoni et al. [18] hypothesized that ventilator-related etiology of lung injury could be converted into a single variable called mechanical power [18]. The interpretation of the way it varies as a function of time and PEEP could be utilized to evaluate not only the degree and nature of lung injury but also the degree of contributions each from volutrauma, and atelectrauma[19]. Mechanical ventilation of at least one week's duration is associated with important consequences on the long-term physical, cognitive, and mental health of ICU survivors [20]. Survivors of ICU care who have undergone prolonged MV (more than 2 weeks) have an in-hospital mortality of 30% and a 1-year mortality rate as high as 60% [21].

The aim of the present study to assess the clinical profile and outcome of children treated with invasive mechanical ventilation.

PATIENTS AND METHODS

This Cohort prospective study was conducted in PICU in Zagazig Children Hospital, Faculty of Medicine, Zagazig University, on 74 cases during the period from March 2021 to August 2021,which applied on 74 cases .

Ethical considerations:

All participants' parents or relatives signed informed permission forms, and the study was given the green light by the Zagazig University Faculty of Medicine's research ethical committee. The study was conducted in conformity with the World Medical Association's Code of Ethics for Human Research (Declaration of Helsinki).

Inclusion and Exclusion criteria:

Patients in age between 1 month and 18 years and intubation for more than 12 hours. While, patients intubated for less than 12 hours,neonates and post-operative cardiothoracic patients.

All patients underwent a thorough medical history examination were collected including diagnosis, reason for initiation of MV, changes in ventilator settings, and event records including SBT, extubation, and intubation trials were reviewed and collected by intensive care fellows from electronic medical records. Baseline patient characteristics of age, sex, underlying disease, reasons for pediatric ICU admission and illness severity were measured, total length of invasive mechanical ventilation, and use of respiratory support after extubation. We measured clinical outcomes of pediatric ICU its relations to cause of ventilation and admission ,comorbidity,mortality ,mode of MV, age and duration of weaning, all MV parameters and methods of weaning, weaning status at ICU discharge, length of ICU stay, length of stay on MV from the time of initiation to the time of liberation, mode of MV used upon its initiation, complications, and methods of weaning.In the studying pediatric ICU, daily screening for readiness to wean was done for patients with mechanical ventilation for more than 24 h. Screening criteria were (1) hemodynamic stability, (2) adequate mentation with spontaneous inspiratory effort, (3) adequate oxygenation and ventilation (oxygen saturation > 90% on fraction of inspired oxygen ≤ 0.4 and pH > 7.30).

Statistical analysis:

Data collected and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) software for analysis. According to the type of data qualitative represent as number and percentage, quantitative continues group represent by mean ± SD, the following tests were used to test differences for significance; Difference and association of qualitative variable by Chi square test (X2). Differences between quantitative independent groups by t test or Mann Whitney, P value was set at <0.05 for significant results &<0.001 for high significant result.

RESULTS

The mean age of patients in the study was 20.04±18.52 (range 2–84 months), the seventy four children in the study there were 42 males (56.8%) and thirty two females (43.2%) **(Table 1)**. Among 6 patients mechanical ventilated (8.1%) suffering from atelectasis, (4.1 %) ventilator associated pneumonia, nasal perioral tissue damage for each, accidental extubation occurred 2.7%, and one patients had lung collapse. Obstruction of endotracheal tube was happened for 2 patients(2.7%) which staying long period on mechanical ventilator with respiratory distress **(Table 2)**. About 14.9% have bad outcome and 85.1% had good outcome **(Figure 1).** Pneumonia was significantly associated with bad outcome **(Table 3)**. There was no significant association between outcome & cause of ventilation **(Figure 2)**. Bad outcome was significantly associated with cerebral palsy, and trisomy 21 **(Table 4).** Bad outcome was significantly associated with APRV **(Table 5)**. Age was significantly lower among bad outcome cases **(Table 6).** PIP was significantly higher among bad outcome at initial but lower before weaning, FiO2 was significantly lower among bad outcome, rate was sig higher among bad outcome at initial but lower at before weaning, PH was sig lower among bad outcome at before weaning , PaO2 was significantly higher at initial but sig lower at before weaning , and regard Pa CO2 was significantly higher at before weaning among bad outcome **(Table 7).**

Table (1): Demographic characters of studied group (n= 74):

Variables		
Age per months Mean ± SD (range)	20.04±18.52 (2-84)	
Gender	n.	%
Males Females	42 32	56.8 43.2

Table (2): Complications from mechanical ventilation among studied group:

		n.	%
Complications	**None**	**63**	**85.1**
	Atelectasis	6	8.1
	Accidental extubation	2	2.7
	pneumothorax	1	1.4
	ventilator associated pneumonia	3	4.1
	Nasal perioral tissue damage	3	4.1
	Lung collapse	1	1.4
	Obstruction of endotracheal tube	2	2.7

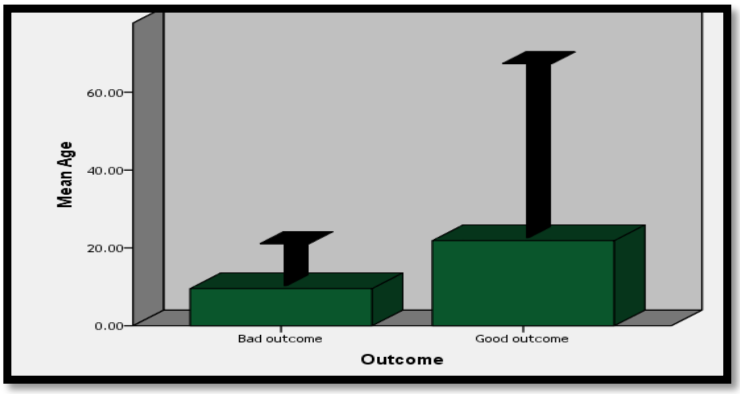

Figure (1): Outcome mechanical ventilation among studied group

Table (3): Relation between outcome & cause of admission:

			Outcome		χ^2	P
			Bad	**Good**		
Cause of admission	**Aspiration pneumonia**	**N**	**0**	**8**		
		%	**0.0%**	**12.7%**		
	Bronchopneumonia	**N**	**4**	**34**		
		%	**36.4%**	**54.0%**		
	CKD	**N**	**0**	**3**	**21.36**	**0.003***
		%	**0.0%**	**4.8%**		
	Convulsion	**N**	**0**	**2**		
		%	**0.0%**	**3.2%**		
	DLC&Convulsion	**N**	**1**	**0**		
		%	**9.1%**	**0.0%**		
	Heart failure	**N**	**1**	**4**		
		%	**9.1%**	**6.3%**		
	Pneumonia	**N**	**5**	**3**		
		%	**45.5%**	**4.8%**		
	Sever dyhydration	**N**	**0**	**2**		
		%	**0.0%**	**3.2%**		
	Status Epilepticus	**N**	**0**	**7**		
		%	**0.0%**	**11.1%**		
Total		**N**	**11**	**63**		
		%	**100.0%**	**100.0%**		

χ^2 Chi square test * p<0.05 significant

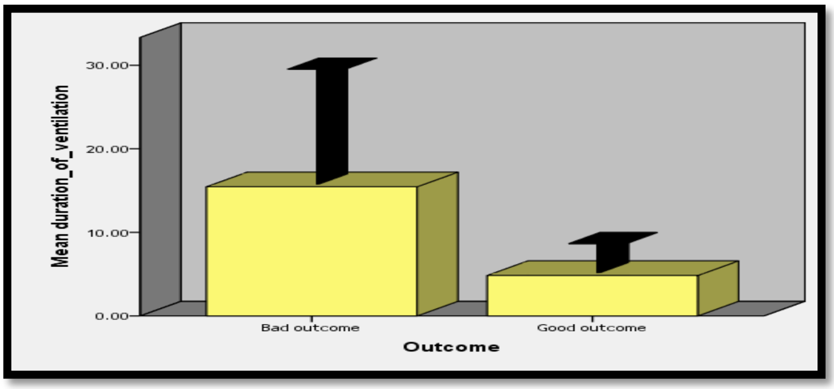

Figure (2): Relation between outcome & Cause of ventilation.

Table (4): Relation between outcome & comorbidity:

			Outcome		χ^2	P
			Bad	Good		
Risk factor	Cerebral palsy	N	3	0		
		%	27.3%	0.0%		
	CHD	N	2	11		
		%	18.2%	17.5%		
	hydrocephalic	N	1	1		
		%	9.1%	1.6%		
	microcephaly	N	1	0		
		%	9.1%	0.0%		
	None	N	1	41	43.04	0.0001*
		%	9.1%	65.1%		
	Renal Failure	N	0	3		
		%	0.0%	4.8%		
	SCID	N	0	2		
		%	0.0%	3.2%		
	SLE	N	0	4		
		%	0.0%	6.3%		
	Trisomy21	N	3	1		
		%	27.3%	1.6%		
Total		N	11	63		
		%	100.0%	100.0%		

χ^2 Chi square test * p<0.05 significant

Table (5): Relation between outcome & mode:

			Outcome		$\chi 2$	P
			Bad	**Good**		
Mode	**AC**	**N**	**1**	**17**		
		%	**9.1%**	**27.0%**		
	APRV	**N**	**8**	**15**	**10.8**	**0.012***
		%	**72.7%**	**23.8%**		
	CPAP	**N**	**0**	**10**		
		%	**0.0%**	**15.9%**		
	PC-SIMV	**N**	**2**	**21**		
		%	**18.2%**	**33.3%**		
Total		**N**	**11**	**63**		
		%	**100.0%**	**100.0%**		

χ^2 Chi square test * p<0.05 significant

Table (6): Relation between outcome & age and duration of weaning:

		Bad outcome	Good outcome	t/ Mann Whitney	P
Age	Median (range)	8 (2-50)	20 (12-84)	u 3.749	0.0001**
Sex	Males	8	34	F 1.3	0.25
		72.7%	54.0%		
	females	3	29		
		27.3%	46.0%		

t student t test u Mann whitnney u F Fisher exact test * * p<0.001 highly significant

Table (7): Relation between outcome & all parameters:

	Bad outcome	Good outcome	t	P
PIP initial	24.18±2.85	22.01±2.42	2.661	0.010*
PIP before weaning	12.90±2.42	14.69±2.76	2.014	0.048*
PEEP initial	7.27±2.69	6.01±1.0	1.919	0.060
PEEP before weaning	3.0±0.63	3.41±0.90	1.441	0.155
FiO2_initial	74.54±23.50	65.07±17.56	1.566	0.122
FiO2_before_weaning	93.36±2.33	95.92±2.75	2.897	0.005*
RATE initial	38.90±5.68	33.47±8.22	2.098	0.039*
RATE before weaning	9.09±1.57	10.55±1.68	2.686	0.009*
Ti initial	0.50±0.089	0.49±0.06	0.293	0.771
Ti before weaning	0.55±0.06	0.57±0.13	0.606	0.546
PH initial	7.28±0.16	7.31±0.11	0.603	0.548
PH before weaning	7.27±0.04	7.37±0.04	6.196	0.0001**
PaO2 initial	91.44±32.63	66.39±21.2	2.249	0.028*
PaO2 before weaning	109.10±20.89	132.45±12.76	5.045	0.0001**
PaCO2 initial	50.32±12.05	45.72±15.63	0.830	0.409
PaCO2 before weaning	37.89±10.44	25.24±4.70	6.613	0.0001**

t student t test * p<0.05 significant * * p<0.001 highly significant

DISCUSSION

Mechanical ventilation (MV) with positive pressure is a technique that has been employed in the PICUs with increasing frequency. The percentage of mechanically ventilated infants and children varies from 30 to 64%. Since its introduction into the modern ICUs, MV has undergone continuous evolution. There has been an explosion of new ventilator modes, many of which have been incorporated into routine clinical practice without evidence of their efficacy their superiority over other modes of ventilation. Indeed, in most cases physicians must rely only on short studies performed on small numbers of patients to help them decide which mode of ventilatory support they should use for their patients with acute respiratory failure[21,22].

Despite its important role, MV is associated with poor outcomes and might lead to complications like shock, ventilator-associated pneumonia (VAP), pulmonary hemorrhage, pneumothorax, atelectasis, and also side effects of medications (e.g., sedatives and analgesia) [23].

Many studies in LRIC have revealed that the mortality rate ranges from 40–60% in mechanically ventilated children. A study in the PICU of Aga Khan University Hospital in Pakistan found that the mortality rate among mechanically ventilated patients was 30.5% and the complication rate was 9.4% [24].A report from Nepal revealed a 34.1% mortality rate [25].

The mean age of patients in the study was 20.04±18.52 (range 2–84 months). Of the seventy-four children in the study there were 42 males (56.8%) and thirty-two females (43.2%).In accordance with our results, study of Martins [26], as they reported that 306 patients were included, with a total ventilation time of 2,155 days. The median age of the group was 24 months (IQR 25–75%: 8–96), with 158 (51.6%) male patients and one with a median weight of 12 kg (IQR 25–75%: 6–23.5).

The present study showed that as regard vital signs; body temperature. mean± SD (37.1±0.57). Heart rate(beat/minute) mean± SD (102.6±6.6). Respiratory rate/minute mean± SD (61.3±4.9). Systolic blood pressure means± SD (92.4±7.8). Diastolic blood pressure means± SD (49.8±8). The main underlying comorbidity of mechanical ventilation children were CHD. The main causes of hospital admission of studied group were bronchopneumonia (51.4%), aspiration pneumonia (10.8%), and pneumonia (10.8%), then status epileptics (9.5%), followed by heart failure (6.8%).

Our results were support by study ofAmanati[27],as they reported that the three most common co-morbidities among patients with VAP (ventilator-associated pneumonia) were bacterial pneumonia, aspiration pneumonia and chronic heart failure (CHF), respectively.

In the study in our hands, as regard complications; among 6 patients mechanical ventilated (8.1%) suffering from atelectasis, (4.1 %) ventilator associated pneumonia, nasal perioral tissue damage for each, accidental extubation occurred 2.7%, and one patient had lung collapse. Obstruction of endotracheal tube was happened for 2 patients (2.7%) which staying long period on mechanical ventilator with respiratory distress.

In the study ofBacha[28],complication occurred in 60 (27.3%) patients that is 30.55 per 1000 ventilation days, categorized as VAP 41(18.6%) (20.9/ 1000 ventilation days), Pneumothorax 15 (6.8%) (7.6 /1000 ventilation days), atelectasis 11(5%) (5.6/1000 ventilation days) and postextubation stridor 1(0.5%) (0.5/1000 ventilation days). More than one complication occurred in 8 (3.6%) patients. About half (57.3%) of the patients developed multiple organ dysfunction Syndrome (MODS).

Our results showed that as regard outcome of mechanical ventilation among studied group; 14.9% have bad outcome and 85.1% had good outcome.

Our results were in line with study of Martins [26]as they reported that patients had a median hospitalization of six days (IQR 25-75%: 3-13), Score Pediatric Index Mortality 3 (PIM 3) at admission of 1.7 (IQR 25-75%: 0.87-6.95) and overall mortality of 18.3% (56/306).

The current study showedbad outcome was significantly associated with APRV. Finally, our results showed that Pneumonia was significantly associated with bad outcome. No significant association between outcome & Cause of ventilation. Bad outcome was significantly associated with cerebral palsy, trisomy 21, APRV and with Not Progressive and Interrupted weaning. Age was significantly lower among bad outcome cases.PIP was significantly higher among bad outcome at initial but lower before weaning, FiO2 was significantly lower among bad outcome, rate was sig higher among bad outcome at initial but lower at before weaning, PH was sig lower among bad outcome at before weaning , PaO2 was significantly higher at initial but sig lower at before weaning, and regard Pa CO2 was significantly higher at before weaning among bad outcome. There was duration of ventilation significantly higher among bad outcome children.

Our results were in agreement with study ofBacha[28], as they reported that prolonged MV more than 3 days were 79 % more likely to die than those of less than 3 days ventilated; (p=0.003). This is similar to the Pakistan study where prolonged mechanicalventilation (>10days) is an important predictor of mortality [24] .Similarly, those who are on MV died more in Italian study than those who are not MV [29],the longer duration of MV is associated with increased mortality. This might be pronged ventilation will expose the patient to MV complications.

CONCLUSION

The results of the present study show a significant number of preventable adverse events, especially atelectasis and ventilator associated pneumonia. The higher frequency of these events is associated with longer hospitalization also APRV mode has significantly association with bad outcomes .Bad outcome was significantly associated with cerebral palsy .There was duration of ventilation significantly higher among bad outcome children.

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