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UPDATE EVALUATION OF MECHANICAL VENTILATION IN PICU OF ZAGAZIG UNIVERSITY CHILDREN HOSPITAL

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ABSTRACT

Background;Mechanical ventilation can be lifesaving, but > 50% of complications in conditions that require intensive care are related to ventilatory support, particularly if it is prolonged. The aim of the present study to assess the pattern of MV in PICU, indication, course, length of stay on MV, mode of weaning, complication and the use of non-invasive after MV. **Patients and methods:** This study is an Observational (Cohort prospective) study, was 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, reason for initiation of MV, 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. **Result:**There was duration of ventilation significantly higher among bad outcome children but there was no significant relation between outcome and inotropes, also a significant number of preventable adverse events, especially atelectasis and ventilator associated pneumonia. **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
Keywords: Weaning; Extubation; Mechanical Ventilation; pediatric intensive care unit.

INTRODUCTION

A mechanical ventilator is a machine that helps a patient breathe (ventilate) when they are having surgery or cannot breathe on their own due to a critical illness. The patient is connected to the ventilator with a hollow tube (artificial airway) that goes in their mouth and down into their main airway or trachea. It is an automatic machine designed to provide all or part of the work the body must produce to move gas into and out of the lungs. The act of moving air into and out of the lungs is called breathing, or, more formally, ventilation [1].

Successful weaning and liberation from invasive mechanical ventilation is important to improve outcomes in critically ill patients. Current international guidelines recommend daily assessment of readiness for extubation with a spontaneous breathing trial, regular breaks in sedation, early mobilisation and protocolised rehabilitation to help with weaning [2].

Mechanical Ventilation (MV) is a life-supporting strategy used at the time of either impending or acute respiratory failure with the aims of improving gas exchange and decreasing work of breathing. Given the high load of respiratory problems being the primary reason for admission to the intensive care unit in low resource countries (LRIC), there is a high need for proper use of MV [3].

Modern ventilation practices for children are more volume control based and with ventilators having much better sensing and triggering. There is the ability for more forms of triggered assisted ventilation. This has had the advantages of allowing less sedation/paralysis to be used and maintaining patient respiratory muscle use. There is however scant evidence that any of these new modes have a great impact on outcome[4].

The aim of the present study to assess the pattern of MV in PICU, indication, course, length of stay on MV, mode of weaning, complication and the use of non-invasive after MV.

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

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was conducted in conformity with the World Medical Association's Code of Ethics for Human Research (Declaration of Helsinki).

Inclusion criteria: Age between 1 month and 18 years and intubation for more than 12 hours..

Exclusion criteria: Patients intubated for less than 12 hours,neonates and post-operative cardiothoracic patients.

Methods

All patients underwent a thorough medical history examination (Patients' data) 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 mortality, 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 coded, entered and analyzed using Microsoft Excel software. Data were then imported into Statistical Package for the Social Sciences (SPSS version 20.0) **(**Statistical Package for the Social Sciences) 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 (X^2). 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). Of the seventy four children in the study there were 42 males (56.8%) and thirty two females (43.2%) **(Table 1)**.Regarding vital signs, body temperature with mean± SD (37.1±0.57) and range from 36 to38.5.Heart rate (beat/minute)mean± SD (102.6±6.6) and range from 88 to 115, .Respiratory rate/minute mean± SD (61.3±4.9) and range from 45 to 75,.Systolic blood pressure mean± SD (92.4±7.8) and range from 70 to 105,.Diastolic blood pressure mean± SD (49.8±8) and range from 30to 60 **(Table 2)**.

The major cause of mechanical ventilation was Hypoxia 25.7% then Hypoxia & cyanosis 18.9%, post arrest 13.5%, cyanosis 9.5% and respiratory failure 9.5% **(Table 3)**. Mode APRV and PC-SIMV represented 31.1% , followed by AC 24.3%, last on was CPAP 13.5% **(Table 4)**.

There was statistically significant higher value of FiO2, Ti , PH, PaO2 before weaning compared to their value at admissions p<0.001. While PIP, PEEP, RATE, PaCO2 were significantly lower before weaning compared to their value at admissions p<0.001.All parameters significantly changed **(Table 5)**.

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 6)**. Bad outcome was significantly associated with APRV**(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	42	56.8
Females	32	43.2

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Table2: Vital signs of mechanical ventilated pediatric patients:

Clinical data	
Temperature **Mean ± SD** **(Range)**	37.1±0.57 36-38.5
Heart rate(beat/minute) **Mean ± SD** **(Range)**	102.6±6.6 88-115
Respiratory rate/minute **Mean ± SD** **(Range)**	61.3±4.9 45-75
Systolic blood pressure **Mean ± SD** **Median (Range)**	92.4±7.8 70-105
Diastolic blood pressure **Mean ± SD** **Median (Range)**	49.8±8 30-60

Table 3: Cause of mechanical ventilation of pediatric patients:

		N	**%**
Cause of mechanical ventilation	**CO2 Retention**	3	4.1
	Cyanosis	7	9.5
	Cyanosis & Hypoxia	14	18.9
	Hypercapnea	4	5.4
	Hypopnea	4	5.4
	Hypoxia	19	25.7
	Post arrest	10	13.5
	Pulmonary Edema	2	2.7
	Respiratory acidosis	2	2.7
	Respiratory failure	7	9.5
	Shocked	2	2.7
	Total	74	100.0

Table 4: Types of ventilation mode for studied group:

		N	**%**
Mode	**AC**	**18**	**24.3**
	APRV	**23**	**31.1**
	CPAP	**10**	**13.5**
	PC-SIMV	**23**	**31.1**

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Table 5: Comparison between initial settings and before weaning parameters among studied group:

	Initial	Before weaning	Paired t	P
PIP	22.33±2.59	14.43±2.77	19.132	0.0001
PEEP	6.23±2.0	3.34±0.87	11.892	0.0001
FiO2	95.54±2.83	66.48±18.68	13.120	0.0001
RATE	34.28±8.10	10.33±1.73	26.012	0.0001
Ti	0.49±0.06	0.57±0.12	6.690	0.0001
PH	7.30±0.12	7.35±0.05	4.056	0.0001
PaO2	70.11±24.36	128.98±16.36	13.520	0.0001
PaCO2	46.40±15.92	27.12±7.36	10.223	0.0001

Paired t= t test of sig(HS) p<0.001 highly significant

Table 6: Complications from mechanical ventilation among studied group:

		n.	%
Complications	**None**	**63**	**85.1**
	Atelectasis	7	9.5
	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

Table 7: Relation between outcome and mode:

			Outcome		χ^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

DISCUSSION

The percentage of children receiving MV in PICUs ranges from 17-64% in developed countries where pediatric intensive care medicine is a well-established discipline of medicine. There is a great scarcity of data from African countries regarding the use of MV in PICUs. The incidence of utilizing MV in children in Egypt was 32.8 % [4].

The study in Nepal showed that out of the 16 pediatric ICUs, 32% had only one functioning mechanical ventilator and another 38% had two ventilators, the other units had 3-6 ventilators [5].

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 et al.** [6] 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

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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 of **Amanati et al. [7]** 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.

The current study showed that as regard mechanical ventilation; the major cause of mechanical ventilation was Hypoxia 25.7% then Hypoxia & cyanosis 18.9%, post arrest 13.5%, cyanosis 9.5% and respiratory failure 9.5%. The mean duration of mechanical ventilation per days is 6.41±2.82 with range (2-25) days for studied group. Mode APRV and PC-SIMV represented 31.1%, followed by AC 24.3%, last on was CPAP 13.5%.

There was statistically significant higher value of FiO2, Ti, PH, PaO2 before weaning compared to their value at admissions p<0.001. While PIP, PEEP, RATE, PaCO2 were significantly lower before weaning compared to their value at admissions p<0 .001. All parameters significantly changed.The median of weaning trials was 2 and range from one to five time, among 54 patients (73%) occurrence Progress of weaning, weaning interrupted in 24 patients (32.4 %), successful weaning counted among 63 patients (85.1%).

In accordance with our results, study of **Bacha et al.[8]** revealed that the most common indication for the initiation of mechanical ventilation was respiratory problems 46 (20.9%). While, the access to airways was through endotracheal tubes in most cases. Regarding the modes used at the initiation of mechanical ventilation, SIMV + PS, SIMV/VSV, AC/PCV, AC/VCV, and BIPAP/CPAP were used in 80%, 8.6%, 4.5%, 3.2 %, and 3.6% of cases respectively. The duration of MV ranged from (1-90) days with a median of 4.4 with IQR (2-10.3). The weaning methods recorded for these patients were CPAP alone 54(24.5%), direct oxygen trial 14(6.4%), PS with CPAP 12(5.5%), and unplanned accidental extubation 3(1.4%).

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 of **Bacha et al.[8]** 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).

The current study showedbad outcome was significantly associated with APRV,
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 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.

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.

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