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Outcomes of Mechanically Ventilated Patients in The Respiratory Intensive Care Unit in Damietta Al-Azhar University Hospital

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ABSTRACT

Background: Mechanical ventilation is frequently provided to cases confessed in intensive care units [ICU] to decrease work of breathing, enhance oxygenation and correct respiratory acidosis. The association of Mechanical ventilation with clinical results was not carefully assessed.

Aim of the work: To evaluate features and findings of ICU cases on mechanical ventilation in Damietta Al-Azhar University Hospital.

Patients and Methods: This prospective interventional research was conducted on consecutive adult cases who received mechanical ventilation between January 2022 and January 2023 at Damietta Al-Azhar Chest Department RICU Unit, after approval from institutional ethical committee. The study included 195 patients in three groups, 78 patients on Intermittent Mandatory Ventilation [IMV], 99 on Non-invasive mechanical Ventilation [NIMV] and 18 underwent NIMV followed by IMV.

Results: Our results showed variation among three groups concerning APACHE II and coma scores, PH, Pao2 and Pcao2, Type I and Type II respiratory failure, Baseline presentations, complications and mortality.

Conclusion: From the findings of our study we can conclude that acute on top of chronic respiratory failure rests common reason for MV.

Keywords: Mechanical ventilation; Respiratory failure; Intensive care units.

INTRODUCTION

Mechanical ventilation is type of life-support system. Mechanical ventilator is a machine that takes over work of breathing when person is unable to do so on their own. There are numerous reasons why case can require ventilator, however common are low oxygen levels and severe shortness of breath produced by infection like pneumonia [1].

Mechanical ventilation is commonly used to reduce work of breathing, improve oxygenation, and correct respiratory acidosis in cases admitted to intensive care units, traditional signs [2].

Mechanical ventilation is a common cause of admission to intensive care unit. Mechanically ventilated cases need complex, well-organized, and theoretically sophisticated level of care [3].

The main risk of mechanical ventilation is infection, which can occur because endotracheal tube allows germs to enter lung. The longer mechanical ventilation is required, the greater risk of infection. Another risk is the lung damage from over-inflation and repeated opening and collapsing of alveoli. Cases who are unable to wean themselves off of the ventilator can require long-term support. Furthermore, the use of non-invasive ventilatory therapy methods has risen [4].

The main aim of the study is to give gauge information to medical specialty patterns, prognostic variables, and results of patients on mechanical ventilation which will facilitate composing of acceptable MV the board programs.

PATIENTS AND METHODS

This prospective interventional research was conducted on consecutive adult studied cases who received mechanical ventilation between January 2022 and January 2023 at Damietta Medical clinic of Al-Azhar University, Chest Department, RICU Unit, after approval from institutional ethical committee.

The study included 195 patients in three groups; 78 patients in Intermittent Mandatory Ventilation [IMV], 99 in Non-invasive mechanical Ventilation [NIMV] and 18 underwent NIMV followed by IMV.

Noninvasive mechanical ventilation was given as Continuous positive airway pressure. In CPAP, constant pressure is preserved during respiratory cycle with no additional inspiratory support**.** Bi-level positive airway pressure. With BiPAP, we set both expiratory positive airway pressure and inspiratory positive airway pressure, with respirations triggered by studied case.

The following data were compared between the studied groups: demographic data, laboratory blood gas analysis, main indication for ventilation, comorbidities and complications.

The primary outcome: mortality and morbidity of the studied cases.

Statistical Analysis

All data were collected, tabulated and analyzed using SPSS 26 for windows. For comparing two continuous variables, the independent t test was used. For comparing three continuous variables, ANOVA test is used, with Post Hoc tests were used for significant results. Chi square test is used to compare categorical variables. For all tests, $P < 0.05$ is significant.

RESULTS

There was no significant difference between three groups concerning age. Regarding APACHE II and Glasgow coma scores, IMV group showed significant higher APACHE II values and significant low Glasgow coma [table 1].

Regarding blood gases, IMV group showed significant affection of PH, Pao2 and Paco2 compared to other groups [Table 2].

There was high variation among three groups concerning acute on top of chronic respiratory failure [Type II], acute hypoxemic respiratory failure [Type I] and Post arrest among the study groups [table 3].

Regarding the main presentation, there was variation among three groups concerning Obesity hypoventilation, AECOPD, Bronchial asthma, interstitial lung disease, bilateral bronchiectasis, severe pneumonia and ARDS. Also, there was no variation among three groups concerning pulmonary edema [table 4].

Comparing mode of mechanical ventilation among groups with NIMV revealed that there was high variation among the studied groups [B and C] concerning CPAP, BiPAP and SIMV [p= <.001] [table 5].

Table [6] shows that there was variation among three groups concerning VAP, cardiogenic shock, delayed intubation and pulmonary embolism. Also, there was no statistical variation among three groups regarding renal failure, hypokalemia, barotrauma, septicemia and nasal bridge. All mortalities were reported among group 1 cases.

Table [1]: Age distribution, APACHE II and Glasgow coma scores among the study groups

	IMV group [n = 78]	NIMV group [n = 99]	NIMV then IMV group [n = 18]	Test	P
Age [years]				F = 1.749	0.177
Mean ± SD	59.58 ± 10.57	58.25 ± 6.63	62 ± 3.9		
Min-Max	25 – 82	43 – 77	55 – 69		
APACHE II score				F = 19.029	**< 0.001**
Mean ± SD	27.74 ± 7.68	20.09 ± 8.79	23.89 ± 6.84		
Min-Max	8 - 45	4 – 45	13 - 34		
	P1 = < 0.001, P2 = 0.048, P3 = 0.045				
Glasgow coma score				F = 62.808	**< 0.001**
Mean ± SD	7.04 ± 3.95	11.41 ± 1.2	11.39 ± 1.2		
Min-Max	3 – 15	8 - 14	9 – 13		
	P1 = <0.001, P2 = 0.935, P3 = <0.001				

P1: group 1 vs. group 2; P2: group 1 vs. group 3; P3: group 2 vs. group 3

Table [2]: Laboratory findings of the studied groups

	IMV group [n = 78]	NIMV group [n = 99]	NIMV then IMV group [n = 18]	Test of Sig.	P
PH				**F = 18.004**	**< 0.001**
Mean ± SD	7.17 ± 0.15	7.28 ± 0.11	7.19 ± 0.12		
Min-Max	7.05 - 7.49	7.03 - 7.54	7.01 - 7.49		
	P1 = < 0.001, P2 = 0.007, P3 = 0.497				
Pao2				**F = 20.703**	**< 0.001**
Mean ± SD	38.73 ± 9.52	47.83 ± 10.03	48.28 ± 9.1		
Min-Max	12 - 64	28 - 74	29 - 61		
	P1 = < 0.001, P2 = 0.851, P3 = < 0.001				
Paco2				**F = 45.728**	**< 0.001**
Mean ± SD.	57.23 ± 16.52	52.81 ± 5.68	68.17 ± 9.47		
Min-Max	40 - 94	48 – 91	50 – 95		
	P1 = 0.045, P2 = 0.001, P3 = 0.002				

P1: group 1 vs. group 2; P2: group 1 vs. group 3; P3: group 2 vs. group 3

Table [3]: Main indication for admission among studied groups

	IMV group [n = 78]		NIMV group [n = 99]		NIMV then IMV group [n = 18]		Test of Sig.	P
	No.	%	No.	%	No.	%		
Acute on top of chronic respiratory failure [Type II]							X2 = 29.82	**< 0.001**
	44	56%	91	92%	17	94%		
	P1 = < 0.001, P2 = < 0.001, P3 = < 0.001							
Acute hypoxemic respiratory failure [Type I]							X2 = 4.026	**0.045**
n [%]	14	18%	8	8%	1	6%		
	P1 = 0.02, P2 = 0.089, **P3 = .043**							
Post arrest							X2 = 28.313	<0.001
n [%]	20	26%	0	0%	0	0%		
	P1 = < 0.001, P2 = < 0.001, P3 = < 0.001							

P1: group 1 vs. group 2; P2: group 1 vs. group 3; P3: group 2 vs. group 3

Table [4]: Baseline Presentation among the study groups

	IMV group [n = 78]		NIMV group [n = 99]		NIMV then IMV group [n = 18]		Test [X^2]	P
	No.	%	No.	%	No.	%		
Obesity hypoventilation	1	1%	30	30%	5	28%	21.42	**< 0.001**
	P1 = < 0.001, P2 = 0.001, P3 = < 0.001							
AECOPD	30	38%	51	52%	14	78%	7.9	**0.005**
	P1 = 0.026, P2 = 0.009, P3 = 0.002							
Pulmonary edema	3	4%	8	8%	0	0%	2.41	0.12
	P1 = 0.079, P2 = 0.079, P3 = 0.129							
Bronchial asthma	10	13%	5	5%	0	0%	4.44	**0.035**
	P1 = 0.023, P2 = 0.067, P3 = 0.027							
Interstitial lung disease	20	26%	6	6%	0	0%	14.49	**< 0.001**
	P1 = < 0.001, P2 = 0.005, P3 = < 0.001							
Bilateral bronchiectasis	3	4%	0	0%	0	0%	3.83	**0.05**
	P1 = 0.018, P2 = 0.097, P3 = 0.056							
Severe pneumonia	5	6%	0	0%	0	0%	6.29	**0.012**
	P1 = 0.004, P2 = 0.048, P3 = 0.019							
ARDS	6	8%	0	0%	0	0%	7.57	**0.006**
	P1 = 0.002, P2 = 0.035, P3 = 0.011							

P1: group 1 vs. group 2; P2: group 1 vs. group 3; P3: group 2 vs. group 3. AECOPD: Acute exacerbation of chronic obstructive pulmonary disease; ARDS: Acute respiratory distress syndrome

Table [5]: Non- invasive & Invasive mode of mechanical ventilation among study groups

	NIMV group [n = 99]		NIMV then IMV group [n = 18]		Test [X^2]	p
	No.	%	No.	%		
CPAP	15	15%	0	0%	3.52	**<0.001**
BiPAP	84	85%	18	100%	5.64	**<0.001**
SIMV	18	23%	0	0%	5.084	**<0.001**

Table [6]: Recorded complications and mortality among the study groups

	IMV group [n = 78]		NIMV group [n = 99]		NIMV then IMV group [n = 18]		Test [X^2]	p
	No.	%	No.	%	No.	%		
VAP	5	6%	0	0%	1	6%	5.27	0.022
	P1 = 0.007, P2 = 0.038, P3 = 0.049							
Renal failure	1	1%	0	0%	0	0%	1.63	0.202
	P1 = < 0.001, P2 = .013, P3 = .002							
Hypokalemia	1	1%	0	0%	0	0%	1.628	0.202
	P1 = < 0.001, P2 = 0.013, P3 = 0.002							
Cardiogenic shock	5	6%	0	0%	0	0%	6.286	0.012
	P1 = 0.004, P2 = 0.048, P3 = 0.019							
Barotrauma	1	1%	0	0%	0	0%	1.628	0.202
	P1 = 0.086, P2 = 0.2, P3 = 0.179							
Delayed extubation	3	4%	0	0%	0	0%	3.83	**0.05**
	P1 = 0.018, P2 = 0.097, P3 = 0.056							
Septicemia	1	1%	0	0%	0	0%	1.628	0.202
	P1 = 0.086, P2 = 0.2, P3 = 0.179							
Delayed intubation	0	0%	0	0%	3	17%	25.27	**<0.001**
	P1 = 0.041, P2 = <0.001, P3 = <0.001							
Nasal bone injury	0	0%	3	3%	0	0%	2.632	0.105
	P1 = 0.043, P2 = 0.102, P3 = 0.133							
Pulmonary embolism	1	1%	0	0%	0	0%	1.628	0.202
	P1 = .086, P2 = .2, P3 = .179							
Morbidity	30	38%	51	52%	14	78%	7.897	**0.005**
	P1 = .026, P2 = .009, P3 = .002							
Mortality	10	13%	0	0%	0	0%	13.98	**0.001**
	P1 = 0.023, P2 = 0.067, P3 = 0.027							

P1: group 1 vs. group 2; P2: group 1 vs. group 3; P3: group 2 vs. group 3

DISCUSSION

Mechanical ventilation is used in intensive care units, and its use is growing in developing world. The aim of ventilation treatment is to decrease work of respiration and pulmonary gas exchange, allowing body to preserve and restore adequate oxygen supply to tissues [5].

Regarding demographic characteristics, the age in IMV group ranged from 25 to 82 with mean of 59.58 ± 10.57, while in NIMV group, the age ranged from 43 to 77 with a mean of 58.25 ± 6.63, while in NIMV then IMV group, the age ranged from 55 to 69 with mean ± SD = 62 ± 3.9, there was no variation [p= 0.177] among three groups.

In accordance with our results, **Zamzam *et al.*** [6] contained 130 MV studied cases who were split into 3 groups based on type of MV: Group A: IMV: 52 cases [40%], Group B: NIMV: 66 cases [50.77%], and Group C: NIMV failure that required IMV: 12 cases [9.23%], with mean age of 58.47 ±8.2 years and 82% percent were men.

The current study showed that APACHE II score was greater in IMV group compared to other groups [p <.001]. This agrees with research done by **Venkatram *et al.*** [7] which proved that NIMV group's mean admission APACHE II score was lower than IMV group. Furthermore, **Celli *et al.*** [8] reported that great APACHE II score was found to indicate NIMV failure and the necessary for IMV. This is due to fact that great APACHE II score indicates more severe acute illness and poor chronic health status in studied cases who require IMV rather than NIMV.

Current research showed that Glasgow coma score was lower in IMV group compared to other groups [p <0.001]. These outcomes were consistent with **Zamzam *et al.*** [6].

In our study, PH was lower in IMV group compared to other groups [<0.001]. Outcomes were in agreement with research of **Zamzam *et al.*** [6] as they observed that PH was lowest in group A, followed by group C, and greatest in group B in terms of admission ABG. This matches researches by **Confalonieri *et al.*** [9] and **Shirakabe *et al.*** [10] that found that lower PH rise risk of IMV and failure of NIMV by > 90%.

In contrast, this disagrees with research performed by **Chu *et al.*** [11] which included cases with severe acidemia [mean pH 7.24] who needed NIMV. Even so, that research contained cases with COPD exacerbations, whereas their cases had other chest diseases, making comparison insufficient.

In the study in our hands, Pao2 was lower in IMV group compared to other groups [p <0.001]. Outcomes were supported by research of **Zamzam *et al.*** [6] as they described that regarding Po2, it was lower in groups A and C compared to group B. This agrees with research by **Confalonieri *et al.*** [9] that found severe hypoxemia was related to risk of IMV and failure of NIMV.

Paco2 in our study was significantly higher in NIMV then IMV group and lowest in NIMV group compared to other groups [p <0.001]. Outcomes were supported by research of **Zamzam *et al.*** [6] as they described that as regard Pco2, it was greater in groups A, C and lower in group B. This is in agreement with researches performed by **Confalonieri *et al.*** [9] and **Plant *et al.*** [12] that found great PaCO2 level is predictive of NIMV failure and essential for IMV.

In present research, we found that acute on top of chronic respiratory failure [Type II] and Post arrest was significantly higher in IMV group [p <0.001] while acute hypoxemic respiratory failure [Type I] was significantly lower in IMV group [p 0.045].

Outcomes were supported by research of **Zamzam *et al.*** [6]. According to their findings, signs for MV in all of cases studied were acute on top of chronic respiratory failure [77.7%], acute hypoxemic respiratory failure [11.54%], post-arrest [10%] and coma [0.77%]. This is in agreement with researches performed by **Demoule *et al.*** [4] and **Kubler *et al.*** [13] which revealed that 60% of mechanically ventilated cases had acute respiratory failure on top of chronic respiratory failure and 40% had post-arrest and coma.

Our outcomes found that there was variation among 3 groups concerning Obesity hypo-ventilation, AECOPD, Bronchial asthma, interstitial lung disease, bilateral bronchiectasis, severe pneumonia and ARDS. Also, there was no statistical variation among three groups regarding pulmonary oedema.

Outcomes were in line with research of **Zamzam *et al.*** [6] as they indicated that prevalent diagnosis in 3 groups [A-C] was COPD [38.5%, 51.5%, 75%] followed by interstitial lung disease [25%], bronchial asthma [13.5%] and lowest was obesity hypoventilation [1.9%] in group A, obesity hypoventilation [30%], pulmonary edema [7.6%], interstitial lung disease [6.1%], bronchial asthma [4.6%] in group B and obesity hypoventilation [twenty five percent] in group C. Likewise, **Kubler *et al.*** [13]**,** COPD was found to be most common cause of respiratory failure resulting in IMV and NIMV [14% and 44%], followed by ARDS, pneumonia, cardiogenic pulmonary edema, and others in IMV. In NIMV, however, obesity hypoventilation, cardiogenic pulmonary edema, & others come first.

Our outcomes found that there was high variation among 2 studied groups concerning CPAP, BiPAP and SIMV [p= <0.001]. In accordance with results, research of **Elmetwally *et al.*** [14] discovered that 55% of studied cases in IMV group received AC\VC as initial mode whereas 45% received SIMV. Though, **Esteban *et al.*** [15] and **Kubler *et al.*** [13], found varied modes of mechanical ventilation. In NIMV, modes were BiPAP [84.9%] followed by CPAP [15.2%]. This agrees with research performed by **Venkatram *et al.*** [7]. In contrast this varies from research by **Passarini *et al.*** [16]. Variations among researches may be due to variations in studied case features and management protocols.

In research in our hands, there was variation among 3 groups concerning VAP, cardiogenic shock, delayed intubation and pulmonary embolism. Also, there was no statistical variation among three groups concerning renal failure, hypokalemia, barotrauma, septicemia and nasal bridge. Moreover, there was variation among three studied groups concerning Morbidity [p= .005] and Mortality [p= 0.001].

Outcomes were supported by research of **Prakash *et al.*** [17]. Pneumonia [29%], airway complications [10%], GIT hemorrhage [11%], cardiovascular problems [8%], equipment failure [7%], barotrauma [2%], and tracheal stoma closure failure [1%]. In their research, ventilator-associated pneumonia was higher with IMV compared to NIMV, which was consistent with previous research by **Nava *et al.*** [18] and **Hill *et al.*** [19]. In group B greatest related problem was nasal bridge ulceration [3.08%] matching research performed by **Hill *et al.*** [19] and **Holanda *et al.*** [20]. As result of using appropriately sized mask, adjusting head gear, and using foam pads and chin straps to minimize air leaks, nasal bridge injury is common complication with NIMV.

Conclusion: From findings of our research we can conclude that acute on top of chronic respiratory failure remains common reason for MV.

Conflict of Interest and Financial Disclosure: None.

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