Clinical Characteristics and Outcome of Mechanically Ventilated Patients in Intensive Care Unit

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Abstract

Background: Mechanical ventilation is a therapy that sustains respiratory function for patients in intensive care units (ICUs). Identifying the factors that lead to morbidity in patients on mechanical ventilation requires an awareness of the clinical characteristics and outcomes of these patients. **Study aim**: assess the clinical characteristics and outcomes of mechanically ventilated patients in the intensive care unit. **Research design**: cross-sectional descriptive research design. **Setting**: The study was conducted in intensive care units at Sohag University hospitals. **Sample**: all mechanically ventilated patients met inclusion criteria (n = 70). **Tools:** A patient assessment tool and patients' outcome tool were used to collect data. **Results**: The majority of the studied subjects had COPD with SIMV; VAP was the most common complication among them. Also, about one-third of the patients were dead. **Conclusion**: The overall mortality rate among those receiving mechanical ventilation in the intensive care unit is substantially high. **Recommendations**: Regular risk and benefit assessments are performed by critical care nurses for all mechanically ventilated patients.

Key words: clinical characteristics, intensive care unit, mechanically ventilated patient, outcome

Introduction

Mechanical ventilation is an essential therapy for supporting respiratory function in patients in intensive care units (ICUs) who are unable to breathe appropriately on their own. It requires the use of a ventilator, which is a machine that delivers oxygen to the lungs while eliminating carbon dioxide. (**Baker., 2020)**

The main goals of mechanical ventilator are to maintain long-term respiratory support for patients with chronic ventilatory issues, minimizing the patient's effort of breathing by reduce loading on respiratory muscles and restore normal arterial blood gas levels and acid-base imbalance through adequate ventilation and oxygenation. **(Burša et al., 2023)**

The patients on mechanical ventilation face an increased risk for not only ventilator-induced complications, such as ventilator-associated pneumonia (VAP), barotrauma, hemodynamic instability, as well as discomfort and agitation. But also, nosocomial complications like clostridium infection. Long-term MV with problems can cause respiratory muscle atrophy. It is critical for healthcare personnel to closely monitor patients on mechanical breathing and take actions to reduce the risk of problems. **(Zilberberg et al., 2020)**

Mechanical ventilation can be a life-saving method for those with respiratory failure, but it is also associated with a higher probability of death, especially in critically ill patients. Multiple variables influence the relationship between ventilatory support and mortality. Underlying disease, ventilator duration, and patient factors: The mortality risk associated with mechanical breathing can be influenced by the patient's age, comorbidities, and overall health. Frailty, immunosuppression, and pre-existing organ failure can all influence results. **(Cumpstey et al., 2022).**

Critical care nurses are responsible for assuring the safety, comfort, and overall health of those with mechanical ventilation by regularly recording their vital signs, respiratory condition, and response to mechanical ventilation to prevent complications and improve recovery. (**Guilhermino et al., 2018)**

Significance of the study

The mechanical ventilation is most important technique for sustaining organ function in patients receiving treatment in intensive care units (ICUs). About 40% of patients admitted to ICU in Egypt receive MV **(Berhe et al.,2022)**. Identifying characteristics linked with either better or worse outcomes in mechanically ventilated patients can assist in predicting their prognosis and tailoring treatment approaches accordingly.

Operational definitions

Clinical characteristics of mechanically ventilated patients are defined as their mode, clinical diagnosis at admission, length of time on a mechanical ventilator, complications, and length of stay (LOS).

Outcome is interpreted as the patient's state following mechanical ventilation whether survived or not survived.

Aims of the study

To assess the characteristic and outcomes of mechanically ventilated patients in intensive care units.

Research design

A cross-sectional descriptive research design was used to conduct this study. This type of research aims to offer an overview of current conditions and perhaps relationships without modifying variables. **(Anahita., 2023).**

Research questions

1. What is the outcome of mechanically ventilated patients in intensive care units?
2. What is the relation between associated characteristics with the outcome of mechanically ventilated patients among adult ICU?

Setting

The study was conducted at intensive care units at Sohag University Hospitals

Subjects

Purposive sample of 70 adults, males and females patients who recently admitted to intensive care unit

$$n = \frac{N Z^2 \quad ^2}{Z^2 \quad ^2 + N e^2}$$

$$n = \frac{1000 \times (1.96)^2 \times (0.221)^2}{(1.96)^2 \times (0.221)^2 + 1000 \times (0.05)^2} = 70 \text{ patient}.$$

Z=1.96 [standard scores] e =0.05 [error] =0.221 [SD]
N=1000 [population] n =70 [sample]

Inclusion Criteria: mechanically ventilated patient within 24 hrs. Aged more than 18

Exclusion criteria: excluded from the current study the patients had a history of ICU admission or hospitalization in days prior to admission.

Study Tools

Two tools were utilized to collect data pertinent to the study.

Tool (I): A patient assessment tool: The researcher developed this tool after examining related literature **(Cui et al., 2021; Alemayehu et al., 2023; Dinse et al., 2022).** That was divided into five parts.

This tool included three parts:

- **Part 1**: Demographic data consists of patient's code, age, gender, and obesity.
- **Part (2)** Clinical data consists of three items (comorbidities, clinical diagnosis, LOS in intensive care unit).
- **Part (3) Physiological parameters** (heart rate, blood pressure, temperature, respiratory rate, Oxygen saturation sao_2, Glasgow Coma Scale GCS)
- **Part 4**: mechanical ventilator data (initial mode of MV, number of days on mechanical ventilator)
- **Part 5: This part covered short term complication from mechanical ventilation such as: -**Pulmonary edema, gastrointestinal bleeding, abnormal heart rhythms, acute renal failure, pneumothorax, electrolyte disturbance, anemia, pulmonary embolism, weaning failure and Ventilator associated pneumonia

Tool (II): Patients' outcome tool: this tool was developed by researchers after examining related literature **(Sundrani et al., 2023)**; it includes 28-days' mortality.

Methods

1. The study began in October 2023, with a literature review, study idea, and tool construction lasting until March 2024.
2. Content validity was done by three experts from the two nursing staff and one intensive care specialist staff at Sohag University.
3. In the pilot study following tool creation, a pre-test was carried out on 10% of patients, which included 7 patients, to determine the reliability and accuracy of the research materials. Because the study tools did not undergo any substantial changes, patients from the pilot study were enrolled in the main research study.
4. Reliability of these tools was assessed in a pilot study by measuring their internal consistency using Cronbach's alpha coefficient method (0.734).

Ethical considerations

The nursing faculty's ethics committee at Sohag University approved the research proposal. Date (27/8/2023) number (1120240662). The research presented no harm to the study subjects.

The study followed ethical guidelines for clinical research. Patients or guidance provided oral consent

for participation in the study after describing the nature and objective of the research. Confidentiality and anonymity were guaranteed. Study participants had the ability to decline or withdraw from the study without explanation at any time. The privacy of study subjects was prioritized during data gathering.

Field work

An official permission to conduct the study was obtained from the dean of the faculty of medicine at Sohag University after an explanation of the aim and nature of the study. The researcher collected data daily from October 2023 to March 2024, from the time of admission to the time of discharge. All patients in were assessed on admission to determine their eligibility for enrollment in the study. Physiological parameters were taken on admission using tool I part 3. Also, complications were recorded once occurrence finally recorded whether survive or not.

Statistical analysis

All data were recorded in a special chart for every patient. The collected data were coded, analyzed and tabulated. Data entry and analysis were done using SPSS 26.0 statistical software package. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and means and standard deviations for quantitative variables. Comparison between qualitative and quantitative variable utilized the chi-square, and independent T-test. The degree of significance was identified at: P >0.05 non-significant, P<0.05 significant while P<0.01 highly significant

Results

Table (1) illustrates that the highest percentage of the studied population is male (70.0%), with ages over fifty (42.9%) and smokers (57.1%). Moreover, more than half (57.1%) have a BMI in the range of 25 to 29.9.

Table (2) shows that the most common medical histories are hypertension and diabetes mellitus (48.5%) and 34.3%, respectively. Also, COPD, followed by shock and polytrauma, are the most common current medical diagnoses (15.7 and 12.9, respectively).

Table (3) declares physiological parameters among study subjects. There are reduced mean DBP, GCS, and sao2 levels, as well as a slight increase in HR and RR upon admission.

Table (4) illustrates that SIMV was the most commonly used mode of mechanical ventilation among the studied population (38.6%).

Table (5) illustrates that the most common incidence of complications among the studied population was VAP (34.3%), arrhythmia (21.4%), anemia (17.1%), ARDS (11.4%), and electrolytes disturbance **(11.4%).**

Table (6) illustrates that the mean number length of stay in the intensive care unit on is 3.77± 1.81, while the mean number of days on mechanical ventilation is (2.70± 1.57) among the studied population.

Figure (1) shows that the present survival rate among mechanically ventilated patients is 68.6%, while the rate of mortality is 31.4%.

Table (7) reveals that there is a significant relationship between mortality and VAP, ARDS, days of MV, GCS, and RR among study subjects.

Results

Table (1): Percentage distribution of demographic characteristic among studied patients (n=70)

Demographic characteristic	No.	%
Gender		
Female	21	**30.0**
Male	49	70.0
Age		
18 – 30	13	18.6
>30 – 40	7	10.0
>40 – 50	20	28.6
More than 50	30	42.9
Smoking		
No	30	**42.9**
Yes	40	57.1
Obesity (BMI)		
Less than 18.5	3	4.3
18.5 - 24.9	21	30
25 - 29.9	29	41.4
30 - 34.9	11	15.7
35 - 39.9	5	7.1
40 and more	1	1.4

Table (2): Frequencies of comorbidities and clinical diagnosis among studied patients (n=70)

Comorbidities and clinical diagnosis	No.	%
Comorbidities		
• Non	20	28.6
• Hypertension	34	48.6
• Diabetes mellitus	24	34.3
• Chronic obstructive pulmonary disease	20	28.6
• Congestive heart failure	10	14.3
• Pulmonary embolism	3	4.3
• Liver disease	8	11.4
• Chronic kidney disease	11	15.7
• Myocardial infarction	2	2.9
• Stroke	4	5.7
• Surgical history	3	4.3
Current Medical Diagnosis		
• Pulmonary embolism	3	4.3
• Pneumonia	5	7.1
• Chronic obstructive pulmonary disease	20	28.6
• Pulmonary edema	1	1.4
• Stroke	5	7.1
• Traumatic brain injury	4	5.7
• Shock	9	12.9
• Poly trauma	9	12.9
• Acute kidney injury	1	1.4
• Acute liver failure	2	2.9
• Diabetic Ketoacidosis	2	2.9
• Poisoning	3	4.3
• Post-operative	6	8.6

Table (3): Physiological parameters on admission among studied patients (n=70)

Physiological parameters on admission	Mean and SD
Heart rate	102.31± 27.18
Systolic blood pressure	118.71 ±32.87
Diastolic blood pressure	69.43 ±16.67
Mean arterial pressure	85.85 ±21.26
Temperature	37.37 ±0.774
Respiratory rate	25.73 ± 8.87
Oxygen saturation sao_2	87.14 ± 11.87
Glasgow coma scale	11.23 ± 4.18

Table (4): Frequency Initial mode of mechanical ventilation in the studied patients (n=70)

Initial mode of mechanical ventilation	No.	%
Assist control mode (AC)	11	15.7
Synchronize intermittent mandatory ventilation (SIMV)	27	38.6
Pressure support ventilation (PSV)	2	2.9
Bilevel	6	8.6
Continuous positive airway pressure (CPAP)	23	32.9
Pressure control ventilation (PCV)	1	1.4

Table (5): Distribution of studied patients according to complications (n=70)

Complications	No.	%
• Pulmonary edema	2	2.9
• Pulmonary embolism	2	2.9
• Acute respiratory distress syndrome ARDS	8	11.4
• Gastrointestinal bleeding	3	4.3
• Ventilator associated pneumonia	24	34.3
• Arrythmia	15	21.4
• Acute Renal Failure	3	4.3
• Electrolyte disturbance	8	11.4
• Anemia	12	17.1
• Weaning failure	4	5.7

Table (6): Distribution of studied patients according to mean ± SD mechanical ventilator days and LOS (n=70)

Mechanical ventilator days and LOS	Mean ± SD
Length of stay in intensive care unit	3.77± 1.81
Number of days on mechanical ventilation	2.70 ±1.57

Figure (6): Distribution of studied patients according to outcome (n=70)

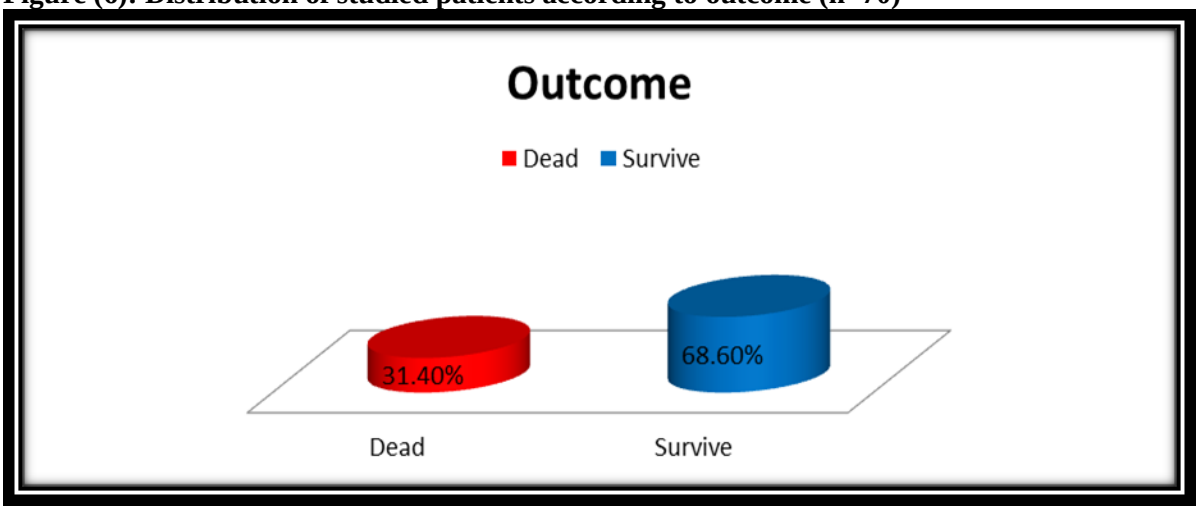

Table (7) Relation between associated characteristics with the outcome of mechanically ventilated patients among adult ICU

Clinical characteristics	Survive (n=48		Dead (n=22)		Test	p-value
	N	%	N	%		
Complications						
Pulmonary edema	0	0.0%	2	100%	X^2 (4.492)	0.096
Pulmonary embolism	0	0.0%	2	100%	X^2 (4.492)	0.096
Acute respiratory distress syndrome	1	12.5	7	87.5	X^2 (13.17)	0.001**
Gastrointestinal bleeding	0	0.0%	3	100%	X^2 (6.839)	0.029*
Ventilator associated pneumonia	3	12.5%	21	87.5	X^2 (0.679)	0.000**
Arrythmia	6	40.0%	9	60.0%	X^2 (7.231)	0.010*
Acute Renal Failure	1	33.3%	2	66.6%	X^2 (1.806)	0.321
Electrolytes disturbance	3	37.5%	5	62.5%	X^2 (0.098)	0.058
Anemia	8	66.7%	4	33.3%	X^2 (0.906)	0.577
Weaning failure	2	50.0%	2	50.0%	X^2 (0.679)	0.585
LOS in intensive care unit	3.90 ±1.76		3.50 ±1.94		T (0.843)	0.402
Days on MV	2.35 ±1.26		3.45 ±1.94		T (-2.434)	0.006**
Physiological parameters						
GCS	13.12 ±3.02		7.09 ±3.27		T (7.540)	0.000**
Heart rate	95.77±3.27		105.31 ±26.17		T (1.372)	0.175
Systolic blood pressure	121.04±28.45		113.64±41.23		T (0.873	0.386
Diastolic blood pressure	71.67±64.55		64.55±17.65		T (1.681)	0.097
Temperature	37.42±0.761		37.28±0.812		T (0.695)	0.490
Respiratory rate	22.68±7.66		27.12±8.96		T (2.011)	0.048*
Sao2	88.42±9.00		84.36±16.43		T (1.333)	0.187

LOS length of stay **MV** mechanical ventilation **sao_2**Oxygen saturation, GCS Glasgow Coma Scale <0.05 statistical significant

Discussion

Mechanical ventilation is essential in the management of severely ill patients in the ICU. It provides critical breathing assistance while letting medical professionals to closely monitor and change the patient's condition. However, the use of mechanical ventilation necessitates appropriate management and tracking in order to reduce potential problems and improve patient's outcome **(Butler, et al., 2023).**

Regarding to age and gender, the current study showed that the majority of studied populations were male with age more than fifty years old. This is identical with **Zilberberg et al., (2022)** which

assessed "Characteristics, hospital course, and outcomes of patients requiring prolonged acute versus short-term mechanical ventilation" found that studied population were male with age of more than fifty years old. Also, **Alemayehu et al., (2022)** on their study "Characteristics and outcomes of mechanically ventilated patients at adult ICU" reported that study population were male while their age was younger than that founded in the current study.

Regarding to BMI, the present study illustrated that near than half of the studied populations had BMI (25 – 29.9), this is not compatible with the finding of **Krause et al., (2021)** in the study about "Characteristics and outcomes of mechanically ventilated patients" that found that the third of studied populations had BMI more than 35 .

In terms of comorbidities, the current study found that more than one-third of the population had a history of hypertension, which was consistent with **Tsegay et al.,'s (2023)** study of "Outcomes of Patients on Mechanical Ventilation among Adult Intensive Care Units " which found that hypertension was the most common comorbidity.

Regarding current medical diagnosis, the current study illustrated that the most clinical diagnosis among the studied population were was COPD, followed which was consistent with **Bacha et al., (2021)** on their study which assessed Outcomes of Patients on Mechanical Ventilation among Adult Intensive Care Units", which found that the respiratory problem. But contradict with , **Alemayehu et al., (2022)** revealed that pneumonia is the most common clinical diagnosis among their study group in their study "Characteristics and outcomes of mechanically ventilated patients at adult ICU". Also, **Berhe et al., (2023)** observed that traumatic brain injury was the most common clinical diagnosis among their research participants.

In terms of physiological parameters, the current study founded reduced mean DBP, GCS, and sao2 levels, as well as a slight increase in HR and RR upon admission. Low GCS levels may be linked to a present medical diagnosis in which low sao2 levels lead to decreased o2 delivery to the brain, resulting in a lower level of GCS. This is consistent with **Alemayehu et al., (2022),** who found that the level of GCS was lower among their study population in their study "Characteristics and outcomes of mechanically ventilated patients at adult ICU". While not in the line with findings of **Yamamoto et al., (2019),** whose study about Association between heart rate on admission and in-hospital mortality"

In terms of the first mode of mechanical ventilation, the current study found that SIMV was the most commonly used among the studied population. The researcher guesses that the initial ventilation approach chosen can vary depending on personal preferences and needs.

This is consistent with **Tobi and Ekwere. (2017),** who found that SIMV was the preferred technique of ventilation (52.3%). However, this is not consistent with the findings of **Ismaeil et al., (2019**), who investigated the "survival of mechanically ventilated patients admitted to intensive care units" and discovered that more than three-quarters had VC as their mechanical ventilation mode. Also, **Nassar et al ., (2018**)whose study on "5-year registry of mechanically ventilated patients comprising epidemiology, initial settings, and clinical outcome" revealed more than half underwent volume-controlled ventilation (VCV) as the initial ventilation method.

Regarding to complications, the present study showed that the most common incidence of complications among studied population were VAP, arrhythmia, anemia, ARDS, and electrolyte disturbance. This is due to presence of many risk factors which contributes to VAP as intubation, many of study subjects last for more than 2 days on MV, in addition of low level of GCS. While anemia related to frequent blood sampling.

This is in the line with **Alemayehu et al., (2022)** on their study titled "Characteristics and outcomes of mechanically ventilated patients at adult ICU of selected public hospitals in Addis Ababa, Ethiopia" Which reported that VAP was the most common complication. While not consistent with **Nassar et al .,(2018)** whose study about "5-year registry of mechanically ventilated patients comprising epidemiology, initial settings, and clinical outcome" founded that lower level of VAP among their study patients.

Regarding to number of days on mechanical ventilation, the present study showed that the mean of days on mechanical ventilation was lower than that in the study of **Alemayehu et al., (2022)**

In the term of mortality, the current study found that death accounts for approximately one-third of the investigated population. This could be attributed to a variety of variables, including low GCS, and an increase in the incidence of problems, older age is a poor predictor of survival and the prevalence of acute respiratory failure raise markedly with age and contributes to one-third of hospital mortality

Which is consistent with **Berhe et al., 2023** in study about "Clinical characteristics and determinants of invasive mechanical ventilation outcome in adult intensive care unit" reported that mortality rate among their study population represented about one third.

Also, **Krause et al., (2021)** on their study, which assessed Characteristics and outcomes of mechanically ventilated patients. That found nearly the quarter of studied population died. while current study's findings are higher than those obtained in **Butler et al., s (2023)** investigation of the outcomes of mechanical ventilation which was less than quarter.

Regarding relation between outcome and associated characteristic, the current study revealed that their significant relation between mortality and VAP, ARDS, days of MV, GCS and RR. Which is in the line with **Berhe et al ., (2018)** who assess the clinical characteristics and outcomes of patients under invasive mechanical ventilation reported that length of stay on mechanical ventilation, and ARDS were significantly associated with mortality.

Conclusion

It is possible to conclude that the clinical characteristics displayed by the participants were the use of SIMV as a common mode. Also, VAP was the most common complications. In addition, around one-third of the patients had died.

Recommendations

1. Critical care nurses must do regular risk and benefit assessments for all patients who require ventilator assistance
2. Implementation of multidisciplinary care teams to provide comprehensive care and support for mechanically ventilated patients.
3. Provide an educational program for critical care nurses to reduce VAP occurrence and subsequently reduce mortality rates.

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