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A Study of the Clinical Characteristics and Outcome Predictors in Cardiac Patients with Preserved Ejection Fraction Requiring Mechanical Ventilation

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Abstract

Acute respiratory failure (ARF) is a common cause of admission to intensive care unit (ICU) that occurs due to several reasons. Among ICU patients, 40-65% patients need mechanical ventilation during their ICU stay. Mechanical ventilation (MV) is cornerstone for management of acute respiratory failure. To determine the clinical profile and predictors of outcome in cardiac patients with preserved ejection fraction requiring mechanical ventilation in a tertiary medical care unit of central India. This was a longitudinal study conducted in Department of Medicine, Sri muthukumaran medical college and hospital, Chennai. A total of 100 patients in medical ICU requiring mechanical ventilation were included in the study. Data was entered and analyzed. 20.83 patients per 100 patients required mechanical support among those admitted in ICU. Mean age was 46.88 ±19.58 years with male (57%) predominance. Association between patient outcome with sepsis (p<0.001), Ventilator associated pneumonia (p<0.001), presence of pneumothorax (p<0.001), extubation trial (p<0.001) and presence of comorbidities (p<0.001) was found to be statistically significant. This study may contribute to better knowledge of risk factors, better ICU environment, proper use of ventilators and the measures to prevent of complications arising during ventilation that can have a bearing on the patient's outcome.

INTRODUCTION

Acute respiratory failure (ARF) is a prevalent reason for admission to the intensive care unit (ICU), arising from several factors such as pulmonary disorders, neuromuscular conditions, shock, and the necessity for airway protection and breathing assistance following significant procedures. Mechanical ventilation (MV) is fundamental for the therapy of acute respiratory failure^[1]. In the ICU, 40-65% of patients require artificial ventilation during their hospitalization. The amount of care required for patients receiving MV is complex, well-organized, and technologically advanced^[2,3]. Nonetheless, despite considerable progress in ventilatory support, it continues to be linked to elevated death rates relative to individuals who do not have such support. Understanding the clinical profiles of patients necessitating mechanical ventilation, including their initial conditions, comorbidities, and characteristics arising over the course of ventilation, may aid clinicians in the decision-making process and optimize resource allocation^[5].

Western research indicates that individuals requiring complex breathing exhibit elevated fatality rates^[4]. The disorders such as acute respiratory distress syndrome (ARDS), multiple organ dysfunction syndrome (MODS), sepsis, and aspiration pneumonia contributes for greater mortality rates^[6]. Minimal data has been disseminated by Indian researchers concerning the origin, progression, complications, and outcomes in patients requiring mechanical ventilation. Thus, this study aimed to identify the clinical profile and determinants of outcome in patients requiring mechanical breathing in a tertiary medical care center of central India.

MATERIALS AND METHODS

A longitudinal observational study was conducted involving 100 participants at the Department of Medicine, Sri Muthukumar Medical College and Hospital, Chennai, from April 2024 to March 2025. The research was carried out on individuals over 18 years old in the medical ICU who needed mechanical ventilation. Following the acquisition of informed consent and a thorough explanation of the study's purpose to the participants, data collection was conducted, and information was documented using a predesigned, pretested, and semi-structured questionnaire.

The survey encompassed data regarding the socio-demographic profile, as well as specifics of clinical and laboratory assessments. Socio-demographic variables encompassed information such as age, gender, contact number, address, and more.

The clinical data encompassed information

regarding the length of in-hospital stay, the period spent in the medical ICU, the duration of mechanical ventilation support, clinical diagnoses, complications and treatments administered, as well as recordings of sensorium, body temperature, pulse rate, blood pressure, respiratory rate, and ventilator settings.

Laboratory data encompasses a complete haemogram, serum biochemistry, blood, urine, and endotracheal aspirate culture and sensitivity reports, chest radiograph, 12-lead electrocardiogram (ECG), along with other special investigations tailored to the specific needs of each patient. The result was noted as either discharge or death. All patients were treated according to the institute's established protocols.

The results obtained from clinical and laboratory examinations were documented and analyzed. Criteria for inclusion: Individuals over the age of 18 in the medical ICU who need mechanical ventilation. Individuals under 18 years old who were intubated during CPR were not included in the study.

A complete haemogram, serum biochemistry, urine analysis, blood urine endotracheal aspirate culture and sensitivity report, chest radiogram, and 12 lead electrocardiogram were conducted, and the data was gathered.

The statistical package for social sciences (SPSS) was utilized for the analysis of the data. Various statistical techniques were employed as suitable. The mean and standard deviation were calculated for quantitative data, while frequency was assessed for categorical variables. The independent t-test was conducted on all continuous variables. The data for normal distribution was verified prior to conducting any t-test. The Chi-Square test was employed to examine differences among groups for categorical variables. In logistic regression models, age was modified to estimate the independent effects of hypertension, ischemic heart disease, and diabetes mellitus. A p-value less than 0.05 was deemed significant.

RESULTS AND DISCUSSIONS

In all, 480 patients were admitted to the intensive care unit. Among these, 100 patients necessitate mechanical ventilation. Consequently, 20.83 patients per 100 required mechanical support among those admitted to the ICU. The distribution of study participants based on the etiology of respiratory failure is illustrated in Figure 1. Among the participants, 22% experienced ARDS, while septic encephalopathy was reported by 21%. Additionally, pulmonary edema occurred in 16% of cases, septic shock in 9%, and status epilepticus in 7%. Fifty-one percent of the patients were admitted to the ICU for a duration ranging from three to six days. A total of 44% of the participants remained in the ICU for a duration ranging

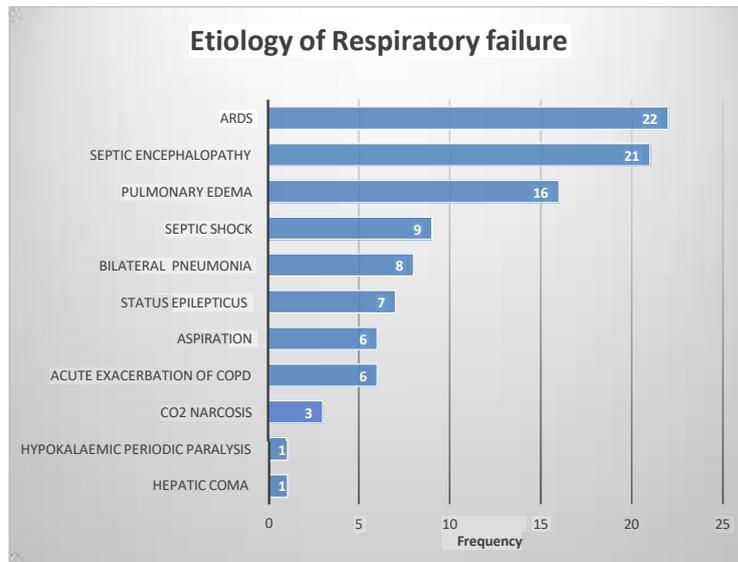


Fig. 1: Distribution of study participants on the basis of etiology of respiratory failure

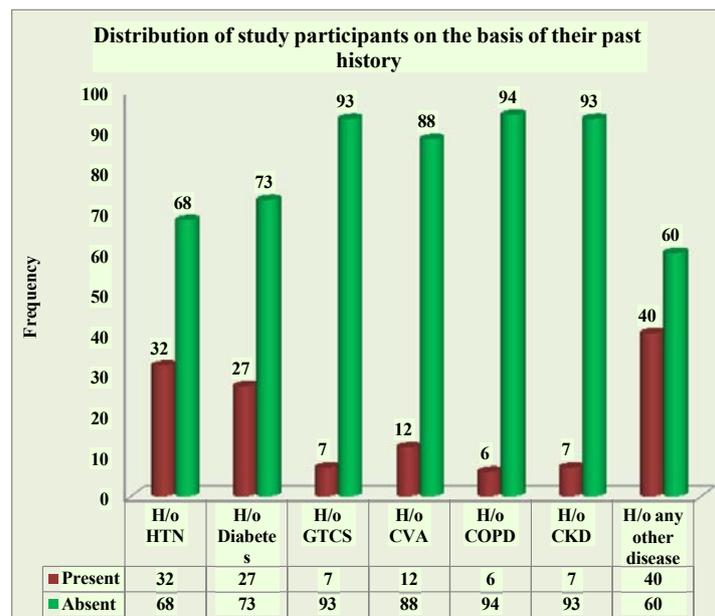


Fig. 2: Distribution of study participants on the basis of their past history

from 0 to 2 days. In a cohort of patients necessitating mechanical ventilation, 66% achieved successful discharge, whereas 34% experienced mortality. 57% of the participants identified as male, whereas 43% identified as female. The average age of the study participants was determined to be 46.88 ± 19.58 years. Approximately 41% of the individuals involved in the study fell within the age range of 41 to 60 years. A mere 10% of participants were aged under 20 years and over 70 years, respectively. Table 1 presents a range of parameters along with their corresponding mean values.

Figure 2 illustrates that 32% of patients indicated the presence of hypertension, 27% were diagnosed with diabetes, 7% reported a prior history of GTCS, and 12% had a previous history of CVA. 6% of the individuals had a history of COPD. A previous history of chronic kidney disease was noted in 7% of patients undergoing mechanical ventilation. It is important to highlight that approximately 40% of patients had a documented history of other diseases, including pulmonary tuberculosis, coronary artery disease, individuals living with HIV/AIDS, and those who underwent double valve replacement.

Table1:Patient characteristics parameters on admission

Sl. No.	Variables	Minimum	Maximum	Mean	Std. Deviation
1	Age (in years)	18	89	46.88	19.584
2	SpO2 on room air (in %)	56	90	58.25	14.408
3	Haemoglobin (in gm/dl)	5.0	14.2	9.222	1.8571
4	TLC (in cells/dl)	5000	115000	14559.11	14778.757
5	Platelets (in cells/ μ l)	40000	320000	141779.00	55583.969
6	ESR (in mm/hr)	14	145	44.19	30.319
7	CRP (in mg/l)	9	320	55.58	54.647
8	FBS (in mg/dl)	71	541	137.49	62.375
9	PPBS (in mg/dl)	120	619	218.77	98.203
10	Urea (IN mg/dl)	18	230	82.38	33.665
11	Creatinine (in mg/dl)	.63	9.00	2.5598	1.65885
12	Sr. Bilirubin (in mg/dl)	.30	7.10	1.5461	1.19949
13	SGOT (in u/l)	19	225	62.40	37.534
14	SGPT (in u/l)	10	301	70.44	45.512
15	Sr. Protein (in gm/dl)	5.0	7.0	5.816	.4359
16	S. Albumin (in gm/dl)	2.0	4.0	2.899	.4162
17	Sodium (in mmol/l)	113	145	128.27	6.745
18	Potassium (in mmol/l)	1.60	6.10	3.7289	.92689

Table 2: Distribution of study participants on the basis of their clinical profile

Sl. No.	Variables	Frequency (n=100)	Percentage (%)	
General Examination	1	Abnormal Pulse <60 &/>100 bpm	64	64.0
	2	SpO2onroomair = 60%	65	65.0
	3	SBP<100 &/>140 (in mmHg)	44	44.0
	4	DBP<60 &/>100 (in mmHg)	9	9.0
	5	Pallor (Present)	39	39.0
	6	Icterus (Present)	22	22.0
	7	Edema (Present)	37	37.0
Laboratory investigations	1	Hblevels (less than normal range)	98	98.0
	2	TLC levels (abnormal levels)	65	65.0
	3	Platelet levels <1.5 lakhs/ul	66	66.0
	4	ESR levels > 22 mm/hr	74	74.0
	5	CRP levels >10 mg/L	95	95.0
	6	FBS > 126 mg/dl	41	41.0
	7	PPBS > 200 mg/dl	65	65.0
	8	Urea levels > 35 mg/dl	100	100.0
	9	Creatinine levels > 1.3 mg/dl	75	75.0
	10	Bilirubin levels >1.2 mg/dl	51	51.0
11	SGOT levels > 45 U/L	57	57.0	
12	SGPT levels > 56 U/L	51	51.0	
13	Sr. Protein levels < 6 gm/dl	49	49.0	
14	Sr. Albumin levels < 3 gm/dl	52	52.0	
15	Sodium levels < 135 mmol/l	82	82.0	
16	Potassium levels < 3.5 mmol/l	55	55.0	

Table 3: Distribution of study participants on the basis culture sensitivity

Sl. No.	Cultures Sensitivity	Frequency(n=100)	Percentage (%)
A Blood culture			
1	Sterile	64	64.0
2	Acinetobacter	2	2.0
3	Escherechia Coli	1	1.0
4	MRSA	6	6.0
5	Pneumococcal	3	3.0
6	Pseudomonas	8	8.0
7	Staphylococcus	10	10.0
8	Streptococcal pneumoniae	6	6.0
B Urine culture			
1	Sterile	79	79.0
2	Candida	9	9.0
3	E. Coli	8	8.0
4	Others	4	4.0
C ET aspirate culture			
1	Sterile	70	70.0
2	Acinetobacter	2	2.0
3	Enterococcus	3	3.0
4	Haemophilus	2	2.0
5	Klebsiella	4	4.0
6	Pneumococcus	3	3.0
7	Pseudomonas	2	2.0
8	Salmonella	4	4.0
9	Staphylococcal	4	4.0
10	Streptococcal	3	3.0
11	Others	3	3.0

The clinical profile distribution of study participants is illustrated in table 2. During the general examination, it was noted that an abnormal pulse was

present in 64% of the patients. Sixty-five percent of patients exhibited SpO2 levels at 60% or lower. A total of 56% of patients indicated that their systolic blood

pressure fell within normal limits, while 91% reported their diastolic blood pressure to be within the normal range. Pallor was observed in 39% of the patients examined. 22% of participants reported icterus, while 37% exhibited edema. At the time of admission, 56% of participants exhibited stupor, while 37% were classified as drowsy.

Normal hemoglobin levels were reported by only 2% of subjects. In 65% of patients, TLC levels exceeded 11,000 cells/dl. Approximately 66% of patients exhibited platelet counts below 1.5 lakhs/ul, 74% of patients showed an ESR greater than 22 mm/hr, and 95% of patients had CRP levels exceeding 10 mg/L. In 41% of the participants, elevated levels of FBS were noted, while 65% exhibited increased PPBS levels. Increased levels of creatinine, Bilirubin, SGOT, and SGPT were noted in 75%, 51%, 57%, and 51% of patients, respectively. Table 2 indicates that merely 51% of patients reported protein levels falling within the normal range of 6 to 8 gm/dl. Nearly half of the patients indicated albumin levels ranging from 3 to 5 gm/dl. A mere 18% of study participants exhibited sodium levels within the normal range of 135 to 145 mmol/l. Fifty-five percent, thirty-one percent, and fourteen percent of the participants indicated potassium levels of less than 3.5 mmol/l, between 3.5 and 5 mmol/l, and greater than 5 mmol/l, respectively. Bilateral hazy infiltrates were observed in 87% of study participants based on Chest X-ray findings.

Table 3 shows the distribution of study participants on the basis of culture sensitivity from blood, urine and endotracheal aspirate. Majority of the study participants reported sterile aspirates from blood (64%), urine (79%) and ET aspirate (70%). Among complications as per our study, 41% of patients reported sepsis, 19% reported Ventilator associated pneumonia, 8% reported bedsores, 17% reported Pneumothorax.

Table 4 depicts association between various predictors and Patient Outcome. $p < 0.001$ depicts that the association of patient outcome with sepsis is statistically significant. Similarly, significant association was observed between patient outcome with Ventilator associated pneumonia, presence of pneumothorax, extubation trial and presence of comorbidities.

During the course of our investigation, a total of 480 patients were admitted to the medical intensive care unit at the hospital. There were one hundred of them that required invasive mechanical ventilation in order to be ventilated. In the medical intensive care unit of Hamidia hospital in Bhopal, ventilation assistance was required for 20.83 percent of the patients who were hospitalized. In an Indian intensive care unit (ICU), Khalid Ismail Khatib *et al.*^[7] (2018) examined the clinical characteristics of 122 patients, or 24 percent, who required mechanical ventilation (MV) out of a total of 500 patients who

were brought to the ICU. They reached similar conclusions. In a study that was conducted in 2015 at the El-Mahala hospital in Egypt, according to Mohamed A. Zamzam *et al.*^[8], 130 patients out of 412 were brought to the intensive care unit and given mechanical ventilation. The patients were either given invasive mechanical ventilation (40%) or noninvasive mechanical ventilation (50.7%). Ninety-two percent of the patients experienced noninvasive failure and needed to be switched to invasive ventilation. In a multicenter prospective cohort study that was carried out in the Brazilian intensive care unit by Luciano CP Azevedo *et al.* (2013), it was found that out of 773 patients who were admitted to the ICU, a total of 622 patients required mechanical ventilation (MV). Department of Medicine at the University of T. D. Sudarsanam *et al.*^[9] claims that 200 of the 400 patients who were admitted to the medical intensive care unit at Christian Medical College in Vellore required invasive mechanical ventilation.

Our research revealed that the hospital mortality rate for patients who required mechanical ventilation (MV) was 34%, whereas the percentage of patients who were successfully discharged from the hospital was 66%. Those that were existing before to the beginning of ventilation as well as those that developed during the course of ventilation were among the factors that were associated with an elevated mortality rate. In patients who were receiving invasive mechanical ventilation, it was discovered that the underlying conditions that necessitated the beginning of MV were the primary contributors to mortality.

It was discovered that the primary reason for the commencement of MV was the underlying disorders, which included acute respiratory distress syndrome (ARDS) (22%), sepsis (21%), pulmonary edema (11%), septic shock (9%) and bilateral pneumonia (8%) respectively. A study that was conducted in 2013 by Luciano CP Azevedo and colleagues^[4] found that the most common reasons for ventilatory support in a Brazilian critical care unit were pneumonia (27%), neurologic disorders (19%), and non-pulmonary sepsis (12%). According to the findings of a retrospective study that was carried out in the northern region of India by Ritesh Agarwal and colleagues^[10] in the year 2006, it was found that out of 180 patients who required MV, 140 patients had ARDS and 40 patients had ALI. Contrary to our findings, a prospective study that was conducted and published in 2014 by Georgene Singh and colleagues^[11] discovered that sepsis was the most common cause, accounting for 34.6% of all cases.

According to the findings of our research, the majority of patients (51%) were admitted to the intensive care unit for a period of time ranging from three to six days. While forty-four percent of the participants remained in the intensive care unit for zero to two days.

Table 4: Association between various predictors with patient outcome

Sl. No.	Variable	Outcome (n = 100)			χ^2 (p- value)
		Death (34)	Discharge (66)	Total	
1	Sepsis (Present)	23	19	42	13.910 (<0.001)
2	VAP (Present)	13	6	19	12.385 (<0.001)
3	Pneumothorax (Present)	16	1	17	32.988 (<0.001)
4	Extubation trial	1	47	48	41.903 (<0.001)
5	Age (>50 years)	27	51	78	0.060 (0.807)
6	Comorbidities (Present)	29	12	41	41.782 (<0.001)

In a study conducted by Michael L *et al*^[12] in the year 2000, it was shown that the mortality rate was higher among patients who required more than 72 hours of mechanical breathing (37% versus 16%; $p < 0.01$). Additionally, the mortality rate was higher among patients who had not experienced any previous episodes of mechanical ventilation (33% versus 11%; $p < 0.01$). However, according to the findings of our research, there is no statistically significant connection between the length of time a patient was hospitalized and the result of their condition (p value = 0.9166).

According to the current study, the death rate in hospitals was 34%, and 66% of patients were successfully discharged. A study conducted by Chih-Cheng Lai and colleagues in 2016 indicated that the in-hospital mortality rate for patients who required MV was 17%. This finding was comparable to the findings of that study. In contrast, a study conducted by Sharlene Ho and colleagues^[14] at Tan Tock Sang Hospital in Singapore in the year 2020 found that 64 percent of patients who required MV had a mortality rate of 180 days or more for their condition. Lea Fialkow and colleagues^[1] conducted a study in 2016 that found that the death rate in patients with MV was 51%. A study conducted by T. D. Sudarsanam and colleagues in 2005 discovered that the death rate of patients who underwent MV was 71.5% (143 out of 200 patients). A number of factors may be responsible for the variation in fatality rates that have been documented for patients who have respiratory failure and require mechanical ventilation. These factors may include differences in the features of the individuals, the severity of the disease, and complications that arise over the course of the illness.

At the time of admission, 56 percent of the participants in our study were classified as stuporous, followed by 37 percent of patients who were classified as drowsy in our study. According to the findings of a study that was published in 2015 by Mohame A. Zamzam and colleagues^[8], the beginning of invasive MV was associated with a low Glasgow coma scale. Similarly to the findings of our own research, a low Glasgow score was also associated with a greater mortality rate.

According to the findings of our research, among the problems, 41% of patients reported having sepsis, 19% reported having pneumonia associated with the ventilator, 8% reported having bedsores, and 17% reported having pneumothorax. Among the complications that were seen in the patients, T. D. Sudarsanam *et al*.^[9] 2005 reported that 19 patients (9.5%) experienced tube block, 53 patients (26.5%)

experienced nosocomial pneumonia, three patients (1.5%) experienced nosocomial sepsis, and four patients (2%) experienced additional complications.

In the current investigation, thirteen out of one hundred patients that were complicated with VAP reported death as the outcome^[13]. There was a statistically significant correlation discovered between the two variables ($p < 0.001$). Similarly, out of one hundred participants, sixteen percent of instances that were complicated with pneumothorax reported death as the conclusion. The statistical significance of the connection between the result and pneumothorax was determined to be $p < 0.001$. We observed that there was a statistically significant association between sepsis and patient outcome, with a p -value of less than 0.001. A study by Lea Fialkow *et al*^[1] in 2016 also found the following variables to be independently associated with mortality - age (hazard ratio:1.01; $p < 0.001$); acute lung injury/acute respiratory distress syndrome (hazard ratio:1.38; $p = 0.009$), sepsis (hazard ratio:1.33; $p = 0.003$), chronic obstructive pulmonary disease (hazard ratio:0.58; $p = 0.042$), and pneumonia (hazard ratio:0.78; $p = 0.013$) as causes of mechanical ventilation.

During the course of this investigation, it was discovered that 41% of the patients had comorbidities. A mortality rate of 29% was found out of 41%. It was discovered that there was a statistically significant association between comorbidities and the subsequent result of the patient. There were 408 occurrences of mortality recorded out of 1311 invasive mechanical ventilated patients who had comorbidities, according to a study that was conducted by Chih-Cheng Lai and colleagues in 2016. The findings of a multivariate analysis conducted by Luciano CP Azevedo *et al*. (2013) demonstrated that age, confidence interval, and comorbidities were independently linked with mortality in patients with MV. There was also the study that was conducted by Michael L. and colleagues in the year 2000. In this study, they used multivariate logistic regression to determine that related comorbidities were an independent predictor of poor outcome in MV patients.

In the course of our research, around 48 percent of the individuals attempted to undergo extubation. For the purpose of determining the association between the attempted extubation trial and the outcome of the patient, it was determined to be highly significant, with a p -value of less than 0.001. A study was conducted by Michael L. and colleagues in the year 2000. The results of the univariate analysis revealed that patients who had attempted extubation but were

unsuccessful had a higher mortality rate (36 percent against seven percent; $p = 0.0001$). In the course of our research, we found that there was no significant correlation between the age of patients who were over the age of 50 and the result of their condition. In contrast to what we discovered, Sharlene Ho and colleagues^[14] discovered in 2020 that age was a good predictor of mortality by 180 days. In their 2016 study, Chih-Cheng Lai and colleagues discovered a statistically significant correlation between patients getting invasive MV and their age exceeding 80 years, with a p-value of less than 0.05. According to the findings of a study that was carried out in the year 2000 by Brun-Buisson *et al*^[15], death was shown to be associated with age (odds ratio=1.2 per 10 year; 95% confidence interval:.05-1.36).

CONCLUSION

Patients requiring mechanical ventilation typically present with more severe conditions, resulting in elevated mortality rates compared to other ICU patients. The growing availability of MV facilities is anticipated to lead to a daily increase in the number of ICUs equipped with respiratory support. This study on patients with MV was conducted to understand the factors that can aid in improving outcomes for MV patients. The outcomes of patients undergoing mechanical ventilation are influenced by multiple factors, which may be present prior to the initiation of mechanical ventilation or may develop subsequently. These factors can include a prior history of hypertension, diabetes mellitus, and coronary artery disease. Our study identified a significant correlation between sepsis and ventilator-associated pneumonia and adverse outcomes. In our study, extubation trials were similarly associated with positive outcomes. This study may, thereby, contribute to better knowledge of risk factor that can have a bearing on the patient's outcome. Things like a better ICU environment for dealing with critical patients in the acute stage, regular training for ICU staff on opt use ventilators and the measures to prevent of complications arising during ventilation, may improve the final outcome of patients.

Limitation: The ICU was at tertiary care hospital that admits patients with more severe illness, so the interpretation of result may not generalize to other ICU patients. Also, this was an observational study with no intervention. A prospective longitudinal investigation may be needed to confirm the relationship between various risk variables.

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