Predicting Mechanical Ventilation For More Than 7 Days In The Emergency Department

Jin Hui Paik
Department of Emergency Medicine
Jung-Soo Kim
Department of Hospital Medicine
Man-Jong Lee
Department of Hospital Medicine
Mi Hwa Park
Devision of Pulmonology, Department of Internal Medicine
Areum Durey
Department of Emergency Medicine
Ah Jin Kim (emjin23@naver.com)
Department of Hospital Medicine https://orcid.org/0000-0001-5689-5227

Research article

Keywords: Mechanical ventilation, Emergency department, Intensive care, Risk factors

Posted Date: September 16th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-404559/v2

Abstract

Background: The duration of mechanical ventilation (MV) required by patients admitted to the emergency department (ED) is difficult to predict. We investigated the duration of MV in ED-admitted patients, as well as their clinical progress.

Methods: We investigated the duration of MV in adult patients (aged ≥18 years) who were attached to ventilators in our ED between January and December 2017. The patients were divided into two groups; MV <7 days and MV ≥7 days. The patients' demographic characteristics, diagnoses, clinical features, and underlying diseases were compared between two groups.

Results: The study comprised 282 patients including 142 in the MV <7 days group and 140 in the MV ≥7 days group. The MV ≥7 days group had more patients diagnosed with metabolic disorder, pneumonia, neurological disease, sepsis, and multiple trauma, and also had a greater proportion of patients with dementia or stroke as the underlying disease. The mean C-reactive protein level in the MV ≥7 days group was 6.4 mg/dL, which was higher than that in the MV <7 days group. The risk factors for requiring ≥7 days of MV were identified as a diagnosis of stroke as well as having the underlying diseases of cancer and stroke or dementia. Among the laboratory test results, pH, HCO_3^-, and albumin <3.5 g/dL were identified as factors influencing the duration of MV.

Conclusions: MV for ≥7 days is predicted to be required for patients admitted for a stroke; those with underlying cancer or stroke; and those with adverse pH, HCO_3^-, and albumin blood test results.

Background

Clinical outcomes in hospital settings are normally judges by survival endpoints or live discharge. Because mechanical ventilation (MV) influences clinical outcomes, mortality rates among patients subjected to MV is important to ascertain [1, 2], as is the duration of MV and its adverse effects [3]. However, because there are no proven guidelines for accurately predicting the duration of MV, the physician depends on the daily assessment of a patient's condition as well as various other factors to decide when to disconnect MV. According to one study, the duration of MV that was estimated by intensivists in the initial stage of treatment was not sufficiently accurate, and became even less accurate as the duration of MV lengthened. In other words, while short-term MV may be relatively easy to predict, long-term prediction is challenging [4].

The failure to discontinue MV, thereby lengthening its duration, is referred to as MV weaning failure. The clinical characteristics of patients who experience such weaning failure include old age, respiratory or heart disease, sepsis at the time of admission [5], reduced cough reflex, malnutrition, sedation, and delirium. There have been previous studies on prediction of prolonged MV (PMV) in single patient groups, such as surgical patients and patients with trauma [6] or sepsis [7]. The predictors of PMV among these

groups varied, as did the accuracy of predictions. Moreover, their initial vital signs and hematologic findings upon admission differed.

Other studies attempted to predict the mortality or disease severity of patients who visited the emergency department (ED) based on their vital signs, states of consciousness, and diagnoses. However, these studies were related to the initial patient classifications at triaging [8]; such classifications focus on the urgency of requiring immediate treatment, whereas prediction of disease severity inherently takes into account the need for intensive care and risk of mortality. Coslovsky et al. attempted to determine the role of early ED presentations as well as other factors of major influence in predicting mortality, and found MV in the ED to be one such predictor [9].

ED physicians often initiate MV in the early stage of intensive care. Predicting the duration of MV in the ED is not as easy as predicting its duration while observing the patient's clinical progress after admission. This is because the patient population in the ED is very diverse, and patients are evaluated only once during their ED visit. Intensive care units (ICUs) are gradually becoming more specialized into cardiovascular, internal medicine, pediatric, neurological, and surgical units; as such, different ICUs have unique resource allocation plans. Moreover, treatments that include respiratory rehabilitation are considered for patients who are expected to be placed on PMV. Taken together, predicting the clinical progress of all patients on MV in the ED is needed to better determine mid- and long-term treatment goals and to devise specific plans to meet these goals.

Although the definition of PMV differs among studies [10], 21 days of MV is generally used as the cut-off [11]. Therefore, we first investigated the duration of MV among our patient population and divide them into two groups of < 7 vs. ≥7 days on MV. We then compared the demographic characteristics, clinical features, and outcomes of patients on MV in the ED, and also investigated the clinical factors that can predict MV for ≥ 7 days.

Methods

Study design

This study was a single-center, retrospective analysis of patients who underwent MV in the ED and were admitted to the ICU while remaining on MV for more than 12 hours between January and December, 2017. Approximately 60,000 patients visit the ED at our institution annually.

Study population

The study population consisted only of adult patients (aged ≥ 18 years), and did not include those who were transferred to our hospital after being placed on MV at another hospital. The exclusion criteria were as follows: Applying MV during cardiopulmonary resuscitation due to cardiac arrest, a previous history of tracheostomy, applying MV during sedation for surgery, patients transferred to another hospital after MV

was applied during hospitalization, patients died within 7 days after admission, and MV was discontinued based on a judgement of brain death.

Data collection and processing

The following data were collected from a review of electronic medical records: age, sex, main diagnosis in the ED, comorbid disease, quality of life (including independence), body mass index (BMI), initial vital signs (systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, O_2 saturation, and body temperature), mental status, modified early warning score (MEWS), results of laboratory tests, vasopressor use, the duration of MV, length of ICU stay, reintubation, tracheostomy, ICU mortality, and 30-day mortality.

Outcomes

The primary outcome of this study was the duration of total MV in patients who were initially attached to ventilators in our ED. Secondary outcomes included the clinical characteristics of the patients with MV durations ≥ 7 days.

Definitions

We defined ventilator weaning as the discontinuation of positive-pressure ventilation; the number of days of hospital stay to that point was defined as the duration of MV. The reapplication of MV within 48 hours after ventilator weaning was defined as reintubation (or weaning failure); in such cases, the duration of MV was calculated using the following formula:

Duration of MV = (final MV weaning date – initial day on MV – ventilator off day)

The total number of days on MV included the date of death for patients who died while on MV. The primary diagnoses were classified according to the APACHE II admission diagnostic categories [12].

Statistical analysis

Continuous variables were tested by independent t-tests or the Mann-Whitney U-test and are expressed as mean (95% confidence interval [CI]) or median (quartiles). Categorical variables were tested using the chi-square or Fisher's exact test. We compared variables between the ≥ 7 day and < 7 day MV groups, and performed binary logistic regression analysis with all variables to identify the predictors of MV for ≥ 7 days as well as the degree of risk. All statistical analyses were performed using the SPSS software 19.0 (SPSS, Inc, Chicago, IL, USA).

Ethics statement

The present study was reviewed and approved by the Institutional Review Board of our hospital (2018-10-009). As a preliminary retrospective study, the requirement for prior consent was waived.

Results

General patients characteristics

A total of 409 patients were placed on MV upon admittance to the ED during the study period. Readmitted patients were not counted separately and their subsequent admissions were excluded. A total 127 patients met at least one of the six aforementioned exclusion criteria; after excluding those patients, data were collected from a total of 282 patients who were included in the study. The mean age of the patients was 64.9 years, and 183 (64.8%) were men. The most common primary diagnoses were respiratory disease followed by stroke, while the most common underlying disease was stroke followed by chronic kidney disease (Table 1). Conditions associated with longer durations of MV were vascular disease (27.5 days) and metabolic disorder (19.0 days) (Fig. 1).

Table 1
Comparison of baseline characteristics and Clinical Diagnosis/Underlying disorder between duration of artifitial ventilation (AV) < 7days and ≥ 7days

	All (n = 282)	Duration of AV < 7days (n = 142)	Duration of AV ≥ 7days (n = 140)	P value
Age, yr (95% CI)	64.9(63.0-66.7)	63.8(61.1–66.4)	66.1(63.5–68.7)	0.212
Male sex, no. (%)	183(64.8)	91(32.2)	92(32.6)	0.804
BMI, kg/m^2(95% CI)	22.9(22.4–23.3)	23.0(22.3–23.6)	22.6(21.8–23.3)	0.488
Main Diagnosis				< 0.001*
Respiratory infection, no(%)	62(22.0)	21(7.4)	41(14.6)	
Stroke/other neurologic disease, no(%)	44(15.6)	11(3.9)	33(11.7)	
CHF, no(%)	28(9.9)	23(8.2)	5(1.7)	
Renal disease, no(%)	22(7.8)	19(6.7)	3(1.1)	
Drug intoxication, no(%)	21(7.4)	14(4.9)	7(2.5)	
Head trauma, no(%)	20(7.1)	9(3.2)	11(3.9)	
Other respiratory disease, no(%)	17(6.0)	8(2.8)	9(3.2)	
Sepsis (GI, UTI), no(%)	16(5.7)	6(2.1)	10(3.6)	
GI bleeding, no(%)	14(5.0)	11(3.9)	3(1.1)	
Other cardiovascular, no(%)	14(5.0)	10(3.6)	4(1.4)	
Multiple trauma, no(%)	11(3.9)	4(1.4)	7(2.5)	
Metabolic disorder, no(%)	6(2.1)	1(0.4)	5(1.7)	
Allergy, no(%)	3(1.1)	3(1.1)	0(0)	
Others, no(%)	4(1.4)	2(0.7)	2(0.7)	

SBP, Systolic blood pressure; MBP, Mean Blood Pressure, DBP, Diastolic blood pressure; PR, Pulse rate; RR, Respiratory Rate; BT, Body Temperature, MEWS, Modified Early Warning Sign

*$p < 0.05$; significant change from baseline values.

	All (n = 282)	Duration of AV < 7days (n = 142)	Duration of AV ≥ 7days (n = 140)	P value
Cormobid disease, no(%)	n = 157	n = 83	n = 74	< 0.001*
Stroke, dementia, no(%)	50(31.8)	19(12.1)	31(19.7)	
Chronic renal disease, no(%)	29(18.5)	22(14.0)	7(4.5)	
Heart disease, no(%)	26(16.6)	17(10.8)	9(5.8)	
Chronic lung disease, no(%)	14(8.9)	11(7.0)	3(1.9)	
Chronic liver disease, no(%)	12(7.6)	8(5.1)	4(2.5)	
Cancer, no(%)	21(13.4)	5(3.2)	16(10.2)	
Others, no(%)	5(3.2)	1(0.7)	4(2.5)	
Laboratroy tests	11.6(10.8–12.4)	11.2(5.1–10.4)	12.5(11.2–13.8)	0.106
Leukocyte count, x10^9cells/mL (n = 282)	12.1(11.7–12.4)	12.3(11.8–12.7)	12.4(12.0-12.9)	0.560
Hemoglobin, g/dL (n = 282)	234.2(222.3–246.0)	232.8(215.9-249.6)	235.6(218.8-252.3)	0.821
Platelet, x103/μl(n = 282)	5.1(3.9–6.2)	3.8(2.4–5.2)	6.4(4.6–8.1)	0.025*
CRP, mg/dL	26.1(23.2–28.9)	28.6(23.7–33.5)	23.6(20.7–26.5)	0.086
Blood urea nitrogen, mg/dL(n = 282)	1.89(1.52–2.25)	2.34(1.68–2.99)	1.44(1.15–1.56)	0.015*
Serum creatinine, mg/dL(n = 282)	0.82(0.68–0.95)	0.80(0.63–0.96)	0.84(0.63–1.17)	0.774
Total bilirubin, mg/dL(n = 282)	63.1(50.5–75.6)	76.4(54.8–98.0)	51.6(39.1–68.9)	0.074
AST, IU/L(n = 282)	43.9(30.9–57.0)	47.0(28.2–65.7)	40.9(22.7-105.9)	0.647
ALT, IU/L(n = 282)	3.79(3.32–4.25)	4.14(3.21–5.06)	3.44(3.31–3.56)	0.145
Albumin, g/dL(n = 282)	199.4(183.1-215.6)	212.0(189.9-234.1)	200.2(177.5–222.0)	0.466
PaO2/FiO2, mmHg(n = 271)		7.30(7.27–7.32)	7.25(7.15–7.36)	0.424
pH(n = 271)			42.9(40.5–45.2)	0.863
pCO_2, mmHg(n = 271)			21.2(19.9–22.5)	0.873
HCO_3^-, mEq/L(n = 271)			5.0(4.2–5.9)	0.521
Lactic acid, mmol/L(n = 258)		46.1(39.1–46.7)	3113(2022–4203)	0.493
NT-proBNP, pg/ml(n = 189)			0.785(0.217–1.353)	0.53

SBP, Systolic blood pressure; MBP, Mean Blood Pressure; DBP, Diastolic blood pressure; PR, Pulse rate; RR, Respiratory Rate; BT, Body Temperature, MEWS, Modified Early Warning Sign

*p < 0.05; significant change from baseline values.

Troponin I, ng/ml (n = 91)	**All**	**Duration of AV**	**Duration of AV**	**P value**
D-dimer, µg/ml(n = 236)	**(n = 282)**	**≤ 7days (n = 142)**	**≥ 7days (n = 140)**	
	7.28(7.22–7.33)	3782(2272–5293)		
	42.7(39.7–45.6)	1.088(0.363–1.813)		
	21.4(19.3–23.4)	3.59(2.54–4.65)		
	4.8(4.2–5.3)			
	3471(2518–4423)			
	0.948(0.479–1.416)			
	3.83(3.10–4.55)			

SBP, Systolic blood pressure; MBP, Mean Blood Pressure, DBP, Diastolic blood pressure; PR, Pulse rate; RR, Respiratory Rate; BT, Body Temperature, MEWS, Modified Early Warning Sign

*p < 0.05; significant change from baseline values.

	All (n = 282)	Duration of AV < 7days (n = 142)	Duration of AV ≥ 7days (n = 140)	P value
Vital signs	143.1(137.9-148.2)	144.6(136.9-152.2)	141.6(134.7-148.4)	0.572
SBP, mmHg	82.6(77.1–88.0)	81.7(77.4–85.9)	83.6(73.5–93.6)	0.727
DBP, mmHg	122.9(118.3-127.4)	123.6(117.2-129.9)	122.2(115.6-128.7)	0.773
MBP, mmHg	103.2(100.1-106.2)	105.4(101.1-109.6)	100.9(96.4-105.3)	0.16
HR, beats/min	26(25.0-26.9)	26.4(24.9–27.8)	25.6(24.3–26.8)	0.396
RR, breaths/min	86.7(84.8–88.5)	86.3(83.8–88.8)	87.1(84.2–89.9)	0.702
O2 saturation	36.6(36.5–36.6)	36.5(35.3–37.6)	36.7(35.6–37.7)	0.777
BT,°C	96(34.0)	54(19.1)	42(14.9)	0.004*
Mentality	78(27.7)	49(17.3)	29(10.3)	0.342
Alert, no (%)	103(36.5)	37(13.1)	66(23.4)	
Verbal response, no(%)	3(1)	1(0.33)	2(0.67)	
Pain response, no(%)	5(4.7–5.2)	5.11(4.77–5.44)	4.89(4.56–5.21)	
Unresponsive, no(%)				
MEWS				
Other outcomes	73(25.8)	29(10.2)	44(15.6)	0.06*
Norpin, no(%)	21(7.4)	4(1.4)	17(6.0)	0.008*
Reintubation, no(%)	39(13.8)	2(0.7)	37(13.1)	< 0.001*
Tracheostomy, no(%)	38(13.4)	5(1.7)	33(11.7)	< 0.001*
ICU mortality, no(%)	37(13.1)	5(1.8)	32(11.3)	< 0.001*
30-days mortality, no(%)				

SBP, Systolic blood pressure; MBP, Mean Blood Pressure, DBP, Diastolic blood pressure; PR, Pulse rate; RR, Respiratory Rate; BT, Body Temperature, MEWS, Modified Early Warning Sign

*p < 0.05; significant change from baseline values.

Comparison of MV durations

Comparison between the MV ≥ 7 day and MV < 7 day groups revealed no differences in age, sex, and BMI. However, there were significant differences in diagnoses, underlying diseases, and states of consciousness between the two groups (all $p < 0.001$). Moreover, there were significant differences in C-reactive protein (CRP) and creatinine levels as determined in the ED between the two groups ($p = 0.025$ and $p = 0.015$, respectively). There were also differences in vasopressor use, reintubation, tracheostomy, and ICU mortality between the two groups ($p = 0.06$, $p = 0.008$, $p < 0.001$, and $p < 0.001$, respectively; Table 1).

Predictors of PMV

The odds ratios derived from our binary logistic regression analysis of the MV ≥ 7 day and MV < 7 day groups revealed that the variables significantly associated with MV ≥ 7 days included stroke as the primary diagnosis; cancer, stroke, or dementia as an underlying disease; and hematologic test results of pH, HCO_3^-, and albumin level < 3.5 g/dL (Table 2).

Table 2
Univariate logistic regression analysis of the risk variables (MV ≥ 7days).

Baseline risk variables	Odds ratio	P value	95% CI
Main Diagnosis, Stroke	11.445	0.009*	1.815–72.186
Underlying disease, Cancer	6.799	0.003*	1.898–24.354
Underlying disease, Stroke or Dementia	2.857	0.023*	1.156–7.060
pH	0.054	0.032*	0.004–0.778
HCO_3^-(mmol/L)	1.054	0.032*	1.004–1.103
Albumin < 3.5 g/dL	2.797	0.049*	1.003–7.802
Albumin < 3.0 g/dL	9.166	< 0.001*	3.003–27.979
Albumin < 2.5 g/dL	4.623	0.048*	1.360-15.716
CI: Confidence Interval, *p < 0.05			

Discussion

The reasons for applying MV in the ED vary, as do the application methods. MV may also affect the clinical course of the patient, while various clinical factors affect the duration of MV and its related outcomes. Therefore, it is challenging to accurately predict the duration of MV. A large-scale study on MV was performed by Esteban et al. in which the clinical features of 5,131 mechanically ventilated patients and MV methods were investigated. Their study also investigated the influencing factors of mortality among mechanically ventilated patients by dividing such factors into three categories: baseline conditions of patients at the time of MV, treatment-related factors, and events that occurred during MV [2]. Additionally, there have been other studies that investigated outcomes and mortality rates among

patients according to their durations of MV and ICU stays; the duration of MV was often used as an outcome indicator for patients who were attached to ventilators [3].

The primary outcome in our present study was the total duration of MV, and we classified our patients into two groups based on a 7-day MV cutoff and compared their characteristics and clinical features. Previous studies have revealed slightly different average MV durations, although a study performed in 2002–2003 found that the average duration of MV is typically 3–4 days [13], and the novel term “prolonged acute MV” was subsequently created to refer to ≥ 96 hours of MV [14]. Because PMV is defined differently among studies, assigning a uniform cut-off is challenging. Our hospital recommends that emergency ICU stays not exceed 7 days, which we judged to be a meaningful cutoff for MV duration as well.

We found that the duration of MV varied according to our patients’ primary diagnosis or underlying disease. The mean duration of MV was ≥ 10 days in patients whose primary diagnosis was metabolic disorder, pneumonia, neurological disease, sepsis, or multiple trauma. Moreover, a high percentage of patients in the MV ≥ 7 days group had previously been diagnosed with stroke or dementia. It has been reported that a variety of factors influence the duration of MV when it is applied for neurological reasons; such factors include the mechanism of neurological abnormality, site of neurological injury, and state of consciousness [15, 16]. It was also reported that MV weaning in patients with neurological injuries requires an alternative means to maintain an open airway when subsequent positive pressure breathing is not required [17]; the numbers of patients in our study who underwent ≥ 7 days of MV due to neurological diagnosis and traumatic injury were 33 and 11, respectively, among whom 10 and 3, respectively, required tracheostomy. These proportions were similar to those of all patients requiring ≥ 7 days of MV who underwent tracheostomy regardless of their underlying conditions. However, unlike tracheostomy for positive pressure breathing owing to a respiratory disease, MV due to neurological reasons may be maintained solely for supporting the airway; thus, other methods such as early tracheostomy may also be required. Patients in our study who had stroke or dementia as an underlying disease required longer MV durations, which is believed to be the result of a higher risk of extubation failure owing to a decrease in cough, vomiting, and deglutition reflexes required for maintaining open airways in patients who are not fully conscious.

The MV < 7 days group included more patients with heart or kidney disease as the primary diagnosis or with chronic kidney disease as the underlying affliction. The patients may have been placed on MV due to respiratory distress caused by acute pulmonary edema arising from their condition, although acute respiratory distress was relieved within a short period after dialysis or diuretic administration.

MEWS is a known indicator of in-hospital outcomes of ED patients, including mortality and ICU admission [18]. In the present study, there was no difference in MEWS between the two MV groups, although the MV ≥ 7 days group comprised a higher proportion of patients who received norepinephrine. Because MEWS better reflects urgency rather than severity, patients in the MV ≥ 7 days group did not

exhibit any initial vital sign abnormalities, but may have been more influenced by hemodynamic effects owing to the administration of sedatives.

Moreover, we found that patients in the MV ≥ 7 days group had higher CRP levels. A previous study found that patients with subacute conditions who had been on MV for approximately 2 weeks and who had low CRP levels had a higher rate of MV weaning than those with high CRP levels, although the difference was not significant [19].

The difference in blood albumin levels between the two groups was not statistically significant in our study; however, albumin was found to increase the risk of requiring MV for ≥ 7 days. Serum albumin level is an indicator of patient prognosis [20], and is associated with CRP levels, lactate levels, and fluid intake requirements. A lower albumin level is associated with an increased frequency of vasopressor use as well as a higher mortality rate. In our study, patients with albumin levels < 3.0 g/dL exhibited a higher risk of requiring MV for ≥ 7 days than those with albumin level < 3.5 g/dL. Xiao et al. reported that hypoalbuminemia increased the duration of MV, as albumin is associated with nutritional state, degree of inflammation, and pulmonary edema [21].

Creatinine levels were actually lower in the MV ≥ 7 days group, which was likely owing to pulmonary edema resolving soon after dialysis in patients in whom kidney disease as the underlying disease or primary diagnosis; this facilitated MV weaning. However, Pan et al. reported that acute kidney injury may be a significant risk factor for PMV when patients who are undergoing regular hemodialysis are excluded [22].

There was no difference in PaO_2/FiO_2 ratio between the two patient groups;

this value was found not to be a risk factor of PMV. Oh et al. reported that the ventilator days in pneumonia was related to PaO_2/FiO_2 ratio [23]. It has been reported that the PaO_2/FiO_2 ratio may differ between patients with acute respiratory distress syndrome who survive versus those who do not, although it does not necessarily serve as an indicator of mortality because of variations in MV settings, the patients' condition, and patient posture. Our patients were placed under MV for various diagnoses and causes; thus, the PaO_2/FiO_2 ratio was not the sole factor considered for MV weaning. However, this ratio may be helpful in predicting the patient's long-term treatment response, rather than serving as an indicator for the early prediction of MV weaning [24].

We found that the rates of reintubation, tracheostomy, ICU mortality, and 30-day mortality were higher among patients in the MV ≥ 7 days group, which is consistent with a previous study that showed that PMV and reintubation are associated with each other [25]. Other studies also found that longer MV durations increase the risk of mortality. Our PMV cutoff of 7 days was shorter than the 21 days defined by the NAMDRC Consensus Conference. However, our findings did not show significant differences in the PMV risk factors that were identified in previous studies.

The patient populations in existing studies are relatively homogenous, and usually comprise those already admitted to the ICU [11]. Our study aimed to predict the duration of MV during the early stage of ED treatment in patients who were placed on MV in the ED. Because we investigated the duration of MV among a diverse range of patients who were admitted to the ED, the study population included patients with a variety of internal diseases, trauma, and central nervous system disorders and were not limited to a certain affliction. As such, we were able to determine the effects of both the acute conditions and underlying diseases governing the duration of MV. Predictions of the duration of MV using hematologic test results and the initial clinical features of ED patients may not be as accurate as those based on patient progress after ICU admission. However, estimating the duration during early treatment stage in the ED or ICU could be helpful in setting early treatment goals and establishing long-term treatment plans based on such goals.

Our study had two major limitations. Because the same protocol for MV weaning was not applied to all patients, those with similar medical conditions may have experienced different durations of MV. This may be attributed to our study being preliminary, and a common MV weaning protocol will be applied to all patients going forward. Second, the patients did not all undergo the same laboratory tests; therefore, certain patient groups may have had no data for specific parameters, thereby resulting in a marked number of missing data points when assessing risk factors for PMV. Future investigations that apply the same protocols and basic tests to all patients ought to determine the risk of PMV more accurately.

Conclusion

Our findings showed that the duration of MV varies depending on the diagnosis and underlying disease. CRP and creatinine levels as measured during the ED visit are associated with the duration of MV, while hypoalbuminemia, low pH, high HCO_3^-, stroke, and prior diagnosis of stroke or cancer can increase the risk of MV for ≥ 7 days.

Abbreviations

MV: mechanical ventilation

ED: emergency department

PMV: prolonged MV

BMI: body mass index

MEWS: modified early warning score

CRP: C-reactive protein

NAMDRC: National Association for Medical Direction of Respiratory Care

Declarations

Ethics approval and consent to participate

The Institutional Review Board of the Inha University Hospital determined the study be exempt from the need to obtain informed consent for retrospective medical record review without using personal information. (IUH IRB 2018-10-009)

Consent for publication

Not applicable

Availability of data and material

Original data remain available and access may be provided upon reasonable request.

Competing interests

None

Funding

This work was supported by an INHA UNIVERSITY HOSPITAL Research Grant.

Authors' contributions

Concept and design: JHP, JSK, AJK Acquisition, analysis or interpretation of data: JHP, JSK, MJL, MHP, AD, AJK Drafting of the manuscript: JHP, AD, AJK Critical revision of the manuscript: JHP, JSK, MJL, MHP, AD Supervision: AJK All authors read and gave final approval for the version to be published.

References

1. Esteban A, Frutos-Vivar F, Muriel A, Ferguson ND, Peñuelas O, Abraira V, et al. Evolution of mortality over time in patients receiving mechanical ventilation. Am J Respir Crit Care Med. 2013;188:220–30.
2. Esteban A, Anzueto A, Frutos F, Alia I, Brochard L, Stewart TE, et al. Characteristics and Outcomes in Adult Patients Receiving Mechanical Ventilation: A 28-day International Study. JAMA. 2002;287:345–55.
3. Blackwood B, Clarke M, McAuley DF, McGuigan PJ, Marshall JC, Rose L. How outcomes are defined in clinical trials of mechanically ventilated adults and children. Am J Respir Crit Care Med 2014:189:886–93.
4. Figueroa-Casas JB, Connery SM, Montoya R, Dwinedi AK, Lee S. Accuracy of early prediction of duration of mechanical ventilation by intensivists. Ann Am Thorac Soc. 2014;11:182–5.

5. Shin HJ, Chang JS, Ahn S, Kim TO, Park CK, Lim JH, Oh IJ, Lim SC, Kim YC, Kwon YS. Clinical factors associated with weaning failure inpatients requiring prolonged mechanical ventilation. J Thorac Dis. 2017;9:143–50.
6. Okabe Y. Risk factors for pronged mechanical ventilation in patients with severe multiple injuries and blunt chest trauma: a single center retrospective case-control study. Acute Med Surg. 2018;5:166–72.
7. Chang YC, Huang KT, Chen TM, Wang CC, Wang YH, Tseng CC, Lin MC, Fang WF. Ventilator dependence risk score for the prediction of prolonged mechanical ventilation in patients who Survive Sepsis/Septic Shock with Respiratory Failure. Sci Resp. 2018;8(1):5650. doi:10.1038/s41598-018-24028-4.
8. Steiner D, Renestseder F, Kutz A, Haubitz S, Faesseler L, Anderson JB, et al. Performance of the Manchester triage system in adult medical emergency patients: A prospective cohort study. J Emerg Med. 2016;50:678–89.
9. Coslovsky M, Takala J, Exadaktylos AK, Martinoli L, Merz TM. A Clinical prediction model to identify patients at high risk of death in the emergency department. Intensive Care Med. 2015;41:1029–36.
10. Rose L, Mawdsley C, McAuley DF, Schultz MJ, Blackwood B. Variation in definition of prolonged mechanical ventilation. Respir Care. 2017;62:1324–32.
11. MacIntyre NR, Epstein SK, Carson S, Scheinhor D, Christopher K, Muldoon S. National Association for Medical Direction of Respiratory Care. Management of patients requiring prolonged mechanical ventilation: report of a NAMDRC consensus conference. Chest 2005;128:3937-54.
12. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. Crit Care Med. 1985;13:818–29.
13. Kahn JM, Goss CH, Heagerty PJ, KramerAA, O'Brien CR, Rubenfeld GD. Hospital volume and the outcomes of mechanical ventilation. N Eng J Med 2006:355;41–50.
14. Zilberberg MD, Luippold Rs, Sulsky S, Shorr AF. Prolonged acute mechanical ventilation, hospital resource utilization, and mortality in the United States. Crit Care Med. 2008;36:724–30.
15. Pelosi P, Ferguson ND, Frutos-Vivar F, Anzueto A, Putensen C, Raymondos K, et al. Management and outcome of mechanically ventilated neurologic patients. Crit Care Med. 2011;39:1482–92.
16. Punj P, Nattanmai P, George P, Newey CR. Abnormal breathing patterns predict extubation failure in neurocritically ill patients. Case Resp Crit Care. 2017;2018:9109054.
17. Godet T, Chabanne R, Marin J, Kauffmann S, Futier E, Pereira B, et al. Extubation failure in brain-injured patients: Risk factors and development of prediction score in a preliminary prospective cohort study. Anesthesiology. 2017:126:104–14.
18. Nannan Panday RS, Minderhoud TC, Alam N, Nanayakkara PWB. Prognostic value of early warning scores in the emergency department (ED) and acute mdical unit(AMU): A narrative review. Eur J Intern Med. 2017;45:20–31.
19. Sierros V, Fleming R, Cascioli M, Brady T. The prognostic value of C-reactive protein in long-term care patients requiring prolonged mechanical ventilation. 2009;6:149–55.

20. Van Beek DEC, Königs MHH, Kuiipers YAM, van der Horst ICC, Scheeren TWL. Predictive value of serum albumin levels on noradrenaline and fluid requirements in the first 24h after admission to the intensive care unit – a prospective observational study. J Crit Care. 2018;47:99–103.
21. Xiao M, Duan J. Weaning attempts, cough strength and albumin are independent risk factors of reintubation in medical patients. Clin Respir J 2018:12:1240–6.
22. Pan SW, Kao HK, Lien TC, Chen YW, Kou YR, Wang JH. Acute kidney injury on ventilator initiation day independently predicts prolonge mechanical ventialtion in intesive care unit patients. J Crit Care. 2011;26:586–92.
23. Yeseul Oh Y, Kang K, Lee. Development of a prognostic scoring system in patients with pneumonia requiting ventilator care for more than 4 dyas: a single-center observational study. Acute Crit Care. 2021;36:46–53.
24. Balzer F, Menk M, Ziegler J, Pille C, Wernecke KD, Spies C, et al. Predictors of survival in critically ill patients with acute respiratory distress syndrome (ARDS): an observational study. BMC Anesthesiol 2016:8;108.
25. Thille AW, Boissier F, Ben Ghezala H, Razazi K, Mekontso-Dessap A, Brun-Buisson C. Risk factors for and prediction by caregivers of extubation failure in ICU patients: a prospective study. Crit Care Med 2015:43;613–20.

Figures

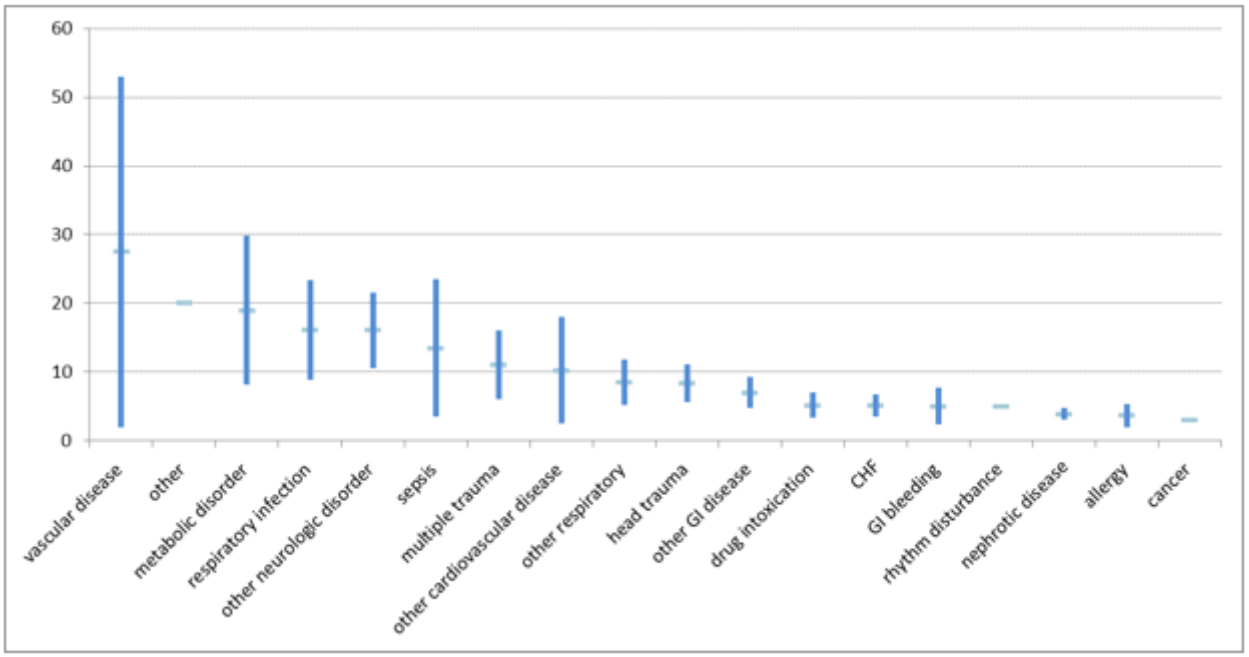

Figure 1

Diagnosis related the duration of artifitial ventilation (mean, 95% CI)