

The Duration of Mechanical Ventilation in Patients with Chronic Obstructive Pulmonary Disease and Acute Respiratory Distress Syndrome admitted to the Intensive Care Unit: Epidemiological Findings from a Tertiary Hospital

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Abstract

Context: Data for examining the duration and risk factors associated with the length of hospital stay with mechanical ventilation (MV) in patients with acute respiratory distress syndrome (ARDS) and chronic obstructive pulmonary disease (COPD) are scarce. **Aims:** The aim of the study was to examine the hospital stay duration with MV in such patients in the intensive care unit (ICU). **Settings and Design:** This cross-sectional study was conducted at King Abdulaziz Medical City in Riyadh between 2016 and 2018. **Subjects and Methods:** Adult patients with ARDS or COPD admitted to the ICU and receiving MV were included in the study. Their medical records were reviewed for information regarding the length of hospital stay, demographic profile, and comorbidity. **Results:** In total, 136 and 95 patients with ARDS and COPD, respectively, were admitted and received MV. The mean (standard deviation) age of patients with ARDS and COPD was 53 (19) and 68 (12) years, respectively. The patients with COPD had a higher obesity rate (61% in the obese category), higher mean Acute Physiology, Age, Chronic Health Evaluation (APACHE) II score (23.5 vs. 22.7), and preexisting chronic respiratory disease than those with ARDS. The median (interquartile range) MV duration in patients with ARDS was 7 (2–13) days, which was higher than that in patients with COPD (4 [1–9] days). **Conclusions:** Age, APACHE II score, and preexisting comorbidity contributed to the increase in the length of hospital stay with MV among patients with ARDS. Clinicians must consider such factors before using MV to improve patient outcomes.

Keywords: Acute respiratory distress syndrome, chronic obstructive pulmonary disease, intensive care unit, mechanical ventilation

INTRODUCTION

Mechanical ventilation (MV) is considered the cornerstone of the management of many patients admitted to the intensive care unit (ICU).^[1-3] Many observational studies have examined the use of MV and its associated outcomes. Thus, studies have shown that the use of MV has been associated with many morbidities and complications that increase the duration of respiratory support, and subsequently, ICU stay. In addition, evidence has linked an increase in mortality rate and associated comorbidity in patients who have been admitted to the ICU and required MV as compared with those who did not require MV.^[2]

Severe exacerbation of chronic obstructive pulmonary disease (COPD) and acute respiratory distress syndrome (ARDS)

are common causes of ICU admission. COPD is a progressive condition characterized by airway obstruction and systematic inflammation. It is considered a major cause of mortality and morbidity worldwide.^[4] Severe exacerbation of COPD requires ICU admission, during which approximately 26%–74% of patients with COPD require MV.^[5] Thus, the aim of using

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Submitted: 15-Oct-2019

Published: 11-Mar-2020

Accepted: 16-Oct-2019

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How to cite this article: Othman FM, Ismaiel YT, Alkhatran SA, Alshamrani AS, Alghamdi MA, Ismaiel T. The duration of mechanical ventilation in patients with chronic obstructive pulmonary disease and acute respiratory distress syndrome admitted to the intensive care unit: Epidemiological findings from a tertiary hospital. *J Nat Sc Biol Med* 2020;11:61-5.

Access this article online

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DOI:
10.4103/jnsbm.JNSBM_188_19

MV is to improve the pulmonary gas exchange and rest the respiratory muscles of patients.^[6] However, many studies have shown that 10% of patients with COPD received MV for >21 days, with a high percentage of weaning failure.^[6] This contributes to an increase in the length of ICU stay and the risk of developing complications.^[5] On the other hand, ARDS is characterized by a life-threatening impairment of the lung gas exchange.^[7] The use of MV remains the cornerstone in the supportive management of such patients to facilitate gas exchange.^[8] The mean length of ICU stay among ARDS patients was estimated to be between 5 and 21 days.^[7,8] Many studies have indicated that infection, mainly pneumonia and sepsis, was the risk factor of ARDS.^[7,8]

Although researchers have investigated patients' length of ICU stay and the associated outcomes, scant data are available on the MV duration for patients with COPD and ARDS on a national scale.^[9-12] Many studies have shown variations in the trend of hospital admission due to COPD exacerbation or ARDS and the associated mortality.^[2,6,8,13] These are attributed to the differences in health-care systems, availability of resources, and characteristics of the study populations. Identifying the MV duration for patients with severe exacerbation of COPD or ARDS would be useful for predicting the length of MV and may assist to plan strategies, improve management plans, and decrease the cost of care in the ICU. Therefore, the present study aimed to evaluate the duration of MV in patients with COPD and ARDS who were admitted to the ICU.

SUBJECTS AND METHODS

Study design and population

A cross-sectional study was conducted in the medical and surgical intensive care department of a tertiary hospital between January 2016 and January 2018.^[14] Adult patients admitted to the ICU who required MV for >24 h were first identified. In this population, we identified patients with the following diagnosis: COPD exacerbation, if the primary or secondary reason for admission, or ARDS as the primary diagnosis for using MV. We excluded patients with trauma accompanied by COPD as the secondary reason for admission. A feasibility count from the hospital showed that 115 patients were admitted to the ICU during the study period. By using the Epi INFO software, we estimated that we needed a minimum of 90 patients with COPD to be included in our study to ensure a 95% confidence level and 5% margin of error. Similarly, for the ARDS, we needed a minimum of 105 patients who met the study inclusion criteria, considering the estimated 142 available patients, to ensure a 95% confidence level and 5% margin of error.

Study variables

The main outcome of this study was the MV duration for patients with ARDS and COPD. We estimated the MV duration for these patients by collecting information on the times and dates of receiving MV, death, and extubation. The following information was collected from each patient's medical

record on the day of ICU admission: demographic variables; body mass index (categorized into underweight, normal, overweight, and obese); reason for ICU admission (medical or surgical); Acute Physiology, Age, Chronic Health Evaluation II (APACHE II) score; and associated diagnosis at ICU admission (mapped to the International Classification of Disease, 10th Revision, codes).

The study was approved by the Research Ethics Committee of King Abdulla International Medical Research Center, under protocol No. SP18/168/R.

Data analysis

Statistical analysis was performed using STATA[®] software, version 15 (StataCorp, College Station, TX, USA). The baseline characteristics of the patients at the time of ICU admission were reported as numbers and percentages for categorical variables and as mean and standard deviation (SD) or median and interquartile range (IQR) for normally and nonnormally distributed continuous variables, respectively. On the basis of the median MV duration, we categorized the MV duration as either short or long. We compared the duration variable and patients' clinical characteristics using the Chi-square test. For comparison, we used the Student's *t*-test, Chi-square test, and Fisher's exact test to obtain the *P* values for the continuous variables, categorical variables, and categorical variables with fewer than five items in each category. The results with *P* < 0.05 were considered statistically significant.

RESULTS

Overall population

In total, 258 patients admitted to the ICU with a diagnosis of either ARDS or COPD who required MV were included in this study. Of the patients, 136 were admitted with an ARDS diagnosis, while 95 were admitted with a COPD diagnosis. The mean age of the patients with ARDS was 53 ± 19 years, while that of the patients with COPD was 68 ± 12 years. Compared with the ARDS group, the COPD group had a higher proportion of patients with obesity (61% in the obese category), a higher mean APACHE II score (23.5 vs. 2.7), and preexisting chronic respiratory disease [Table 1]. The ARDS group had a higher percentage of ICU deaths than the COPD group (27% vs. 20%).

Mechanical ventilation durations for patients with acute respiratory distress syndrome and chronic obstructive pulmonary disease

The mean (SD) MV duration for the patients admitted with ARDS was 10 (11) days, with a median (IQR) of 7 (2–13) days, which was higher than that for the patients admitted with COPD (median [IQR], 4 [1–9] days and mean [SD], 7 [11] days). The independent *t*-test results showed that the ARDS group had significantly longer MV duration than the COPD group (*P* = 0.05). After categorizing the MV duration into two <7 and ≥7 days, 56 patients with ARDS required MV for <7 days. No significant difference in the mean age was found between the two categories. Table 2 presents the

Table 1: Characteristics of the patients who were admitted to intensive care unit with either with acute respiratory distress syndrome and chronic obstructive pulmonary disease diagnosis and required mechanical ventilation

Variables	COPD patients (n=95)	ARDS patients (n=136)
Age (years), mean±SD	68±12	53±19
Length of ventilator dependence, median (IQR)	4 (1-9)	7 (2-13)
Length of hospital stay, median (IQR)	22 (13-59)	31 (14-50)
Gender, n (%)		
Male	42 (44)	84 (61)
Female	53 (55)	52 (38)
BMI, n (%)		
Underweight	8 (8)	3 (2)
Normal	15 (16)	38 (27)
Overweight	14 (15)	40 (29)
Obese	58 (61)	55 (40)
Source of admission, n (%)		
Medical	91 (96)	122 (89)
Surgical/trauma	4 (4)	14 (10)
APACHE II score, mean±SD	23.5±5	22.7±6.88
Associated comorbidity, n (%)		
Chronic respiratory disease	44 (46)	11 (8)
Chronic cardiovascular disease	81 (85)	28 (20)
Death in ICU, n (%)	19 (20)	38 (27)
Hospital death*, n (%)	35 (54)	41 (39)

*The percentage calculated with exclusion of patients who died in ICU. BMI: Body mass index, SD: Standard deviation, ICU: Intensive care unit, COPD: Chronic obstructive pulmonary disease, ARDS: Acute respiratory distress syndrome, APACHE: Acute Physiology, Age, Chronic Health Evaluation, IQR: Interquartile range

Table 2: The factors that associated with length of mechanical ventilation among acute respiratory distress syndrome patients after categorization of length of mechanical ventilation

Variables	MV <7 days (n=56; 41%)	MV ≥7 days (n=80; 58%)	P
Age, mean±SD ^e	54±21	53±18	0.87
APACHE II score, mean±SD ^e	23.6±7.3	22±6.5	0.18
Gender*, n (%)			0.25
Female	20 (35)	32 (40)	
Male	36 (64)	48 (60)	
Source of admission*, n (%)			0.16
Medical	48 (85)	74 (92)	
Surgical/trauma	8 (14)	6 (7)	
Chronic respiratory disease*, n (%)			0.09
No	51 (91)	74 (92)	
Yes	5 (9)	6 (7)	
Chronic cardiovascular disease*, n (%)			0.05
No	45 (80)	17 (21)	
Yes	11 (19)	17 (21)	

^eIndependent *t*-test, *Chi-square test. APACHE: Acute Physiology, Age, Chronic Health Evaluation, SD: Standard deviation, MV: Mechanical ventilation

factors associated with MV duration in the ARDS group. Approximately 80% of the patients in the ARDS group who had no preexisting cardiovascular conditions received MV for <7 days, as compared with the 19% of the patients who had preexisting cardiovascular conditions.

After categorizing the patients with COPD according to the MV duration, 66% required MV for <7 days [Table 3]. The independent *t*-test result showed that the patients with COPD with a high mean APACHE II score had a significantly longer

MV duration (>7 days, *P* < 0.5). Table 3 presents the factors associated with MV duration in patients with COPD. The percentage of the patients with COPD who had preexisting cardiovascular conditions and received MV for >7 days was lower than that of the patients who did not have a preexisting cardiovascular disease.

DISCUSSION

In this study, we examined the MV duration of the patients with

Table 3: The factors that associated with length of mechanical ventilation among chronic obstructive pulmonary disease patients after categorization of length of mechanical ventilation

Variables	MV <7 days (n=63; 66%)	MV ≥7 days (n=32; 33%)	P
Age, mean±SD ^e	67±12	71±11	0.13
APACHE II score, mean±SD ^e	22±4.6	25±5.7	<0.05
Gender*, n (%)			
Female	37 (58)	16 (50)	0.65
Male	26 (41)	16 (50)	
Source of admission**, n (%)			
Medical	60 (95)	31 (96)	0.14
Surgical/trauma	3 (4.7)	1 (3)	
Other chronic respiratory disease**, n (%)			
No	10 (16)	4 (12)	0.19
Yes	53 (85)	28 (87)	
Chronic cardiovascular disease*, n (%)			
No	30 (47)	21 (65)	0.10
Yes	33 (52)	11 (34)	

^eIndependent *t*-test, *Chi-square test, **Fisher's exact test. SD: Standard deviation, MV: Mechanical ventilation, APACHE: Acute Physiology, Age, Chronic Health Evaluation

COPD or ARDS who were admitted to the ICU. The patients with COPD, on average, required a shorter MV duration than those admitted with ARDS, although the former had more comorbidities and preexisting medical conditions. Thus, the comorbidity associated with COPD could be the risk factor of severe exacerbation of COPD that requires the use of MV.

The length of ICU stay with MV has been linked to the duration of ICU stay.^[15] In many observational studies, patients who required MV for >7 days were associated with a high rate of mortality and used >50% of ICU resources.^[16] Many potential risk factors have been identified that are associated with prolonged ICU stays, such as patient age and preexisting comorbidities.^[12,15,17,18] Our findings also demonstrated that elderly patients and those with a preexisting cardiovascular condition had longer MV durations. Therefore, ICU physicians and respiratory therapists who deal with mechanically ventilated patients need to plan management strategies to reduce the occurrence of further complications due to the prolonged MV. Thus, long ICU stay is associated with high hospitalization costs and increased risk of mortality and developing complications such as infection.^[15,19]

In addition, the results of this study demonstrated that 61% of the patients with COPD and 40% of those with ARDS had obesity. Many epidemiological studies have examined the impact of body mass index on many ICU outcomes such as mortality and length of ICU or hospital stay.^[20-23] Most studies have reported an increase in the length of ICU stay in patients with a high BMI as compared with patients with a normal BMI.^[20,24] However, the relationship between BMI and the length of ICU stay is a complex issue, as many confounders such as patient characteristics and cause of ICU admission could affect the direction of such association. Thus, data from a meta-analysis study demonstrated that the association between BMI and the length of ICU stay is dependent on MV duration.^[20] The meta-analysis study showed that patients with

obesity who had a longer MV duration had a shorter overall ICU stay duration than the patients with a normal BMI.^[20] On the other hand, other studies have reported that a higher BMI was associated with reduced risk of ICU mortality, in which the theory of the "obesity paradox" has been referred to in explaining such findings.^[20,25]

In the factors associated with MV duration in patients' COPD, we found significant differences in the APACHE II score in the COPD group, in which the patients who received MV for <7 days had lower APACHE II scores than the patients who received MV for >7 days. This represents a lower hospital mortality among patients who received MV for a shorter period. Thus, the APACHE II score has been widely used as a predictor of the length of ICU stay, and many research studies have reported a strong association between APACHE II and the long-term survival among ICU patients.^[26,27] These findings add valuable support to physicians who manage patients with COPD who require MV to predict their outcome.

The results of the available studies regarding the MV duration for patients admitted to the ICU varied. Thus, most previous studies examined the MV duration for all ICU patients without specifying its initial cause. The available studies examined the survival of patients who required MV and reported a mean MV duration of 7 days. One study in Saudi Arabia showed a mean length of ICU stay of 15 days.^[28] However, the previous study estimated the length of ICU stay, whereas the present study focused on examining MV duration.

The strength of our study is that it specifically examined the MV duration and risk factors associated with any increase in MV duration. However, it has limitations related to its observational nature, such as the inability to measure all confounding factors that could affect the MV duration in the ICU. In addition, the present study presents data from a single institution, which may have limited the generalizability of

our results. However, we do not anticipate that the population will differ enormously from the general population living in Saudi Arabia.

RECOMMENDATIONS AND CONCLUSIONS

The present study provides an in-depth insight into the use of MV for two common groups of patients with respiratory conditions in terms of duration and risk factors associated with an increased length of ICU stay. This could provide insight for physicians and therapists who deal with the study population in planning management strategies to reduce the length of ICU stay with MV or in providing necessary resources if they require more support. Further studies should be planned to examine other respiratory conditions that require MV.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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