Mechanical Ventilation of Patients Hospitalized on General Medical Ward: Outcomes and Prognostic Factors

Phunsup Wongsurakiat MD*,
Narongchai Sangsa MD**, Anupong Tangaroonsanti MD***

** Division of Respiratory Diseases and Tuberculosis, Department of Medicine, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand*
*** Roi Et General Hospital, Roi Et, Thailand*
**** Gastrointestinal Unit, Department of Medicine, Thammasat University Hospital, Pathumthani, Thailand*

Background: *In some hospitals, patients hospitalized on the medical ward are mechanically ventilated due to a shortage of intensive care unit (ICU) beds.*
Objective: *To determine outcomes and prognostic factors of medical patients mechanically ventilated on general medical wards.*
Material and Method: *A prospective observational study was performed in general medical wards of a 2,000-bed tertiary care university hospital.*
Results: *Ninety-three consecutive medical patients who were mechanically ventilated on a general medical ward were included in the study. Overall mortality rate of patients mechanically ventilated on the general medical ward was 68.8%. Average length of stay was 22.9±28.5 days. Average cost per patient was 61,076.64±87,569.10 Thai baht. In univariate analysis, the APACHE II score of the patients who did not survive was significantly higher than the score of the patients who survived (mean APACHE II score 23.3±7.3 vs. 19.8±5.5 respectively, p = 0.02). Multivariate analysis revealed APACHE II score >22 to be the only independent predictor of death (OR 4.3, 95% CI 1.2-15.2, p = 0.02).*
Conclusion: *Medical patients who are mechanically ventilated on general medical wards have high mortality rate. APACHE II score is a good prognostic factor for predicting risk of death in these patients.*

Keywords: *General ward, Mechanical ventilation, Outcome, Prognostic factors*

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Mechanical ventilation is one of the high-priority indications for admission to the intensive care unit (ICU). The number of critically ill patients continues to increase worldwide due to an increasing number of elderly and chronically ill patients and increasing use of new and complicated diagnostic and therapeutic interventions. As a result, the demand for ICUs and ICU beds is increasing[1-3]. It has been estimated that the cost of delivering intensive care is 3.8 times more expensive in an ICU than in a general care unit. In resource-limited countries like Thailand, ICU beds are in short supply. Large numbers of patients are mechanically ventilated in general medical wards, in addition to the ventilatory support given in the ICU. Given the seriousness of illness associated with the need for mechanical ventilation and the level of care needed to support this modality, it would be both logical and reasonable to postulate that mechanical ventilation given on general medical wards would be associated with significant morbidity and mortality. However, few data regarding the outcomes of these patients are available[3,4] and none of the studies conducted thus far were reported from Thailand. As such, the objective of this prospective observational study was to determine the outcomes and prognostic factors of medical patients who required mechanical ventilation while hospitalized on a general medical ward.

Correspondence to:
Wongsurakiat P, Division of Respiratory Diseases and Tuberculosis, Department of Medicine, Faculty of Medicine Siriraj Hospital, MahidolUniversity, Bangkok 10700, Thailand.
Phone: +66-2-4197757, Fax: +66-2-4197760
E-mail: phunsup.won@mahidol.ac.th

Material and Method

This prospective observational study was conducted between August 2008 and February 2009 at Siriraj Hospital, a 2,000 bed tertiary care university hospital located in Bangkok, Thailand. Subjects were hospitalized in 1 of 10 general medical wards affiliated with the Department of Medicine that are located on five different floors of the hospital. Each ward had a 24-patient capacity with a nurse to patient ratio of

approximately 1 to 6. Due to a shortage of ICU bed, patients who required mechanical ventilation were often admitted directly to a general medical ward. In addition, some patients who required mechanical ventilatory support at some point during their hospitalization were also managed in general medical wards. All patients who required mechanical ventilation were included in this study. Exclusion criteria were, as follows, 1) patients having a do not resuscitate (DNR) order, 2) patients with a life expectancy of less than six months, 3) patients initially ventilated on the general medicine ward and subsequently transferred to the ICU, and 4) patients initially ventilated in the ICU and subsequently transferred to the general medicine ward.

Patients mechanically ventilated on the wards were managed by the same type and level of attending physicians that treated non-ventilated patients on the wards. Attending physicians were rotated monthly. Attending physicians were board certified in internal medicine, with minimal critical care training. Pulmonary consultation was not routine and only undertaken upon request from an attending physicians. Nurses on these wards were trained in general medicine and not in critical care nursing. Because we had no respiratory therapists, routine respiratory care for these patients, such as tracheal suctioning and bronchodilator delivery, was performed by nurses. Patients were mechanically ventilated on one of three types of ventilator, as follows: RAPHAEL mechanical ventilator (Hamilton Medical AG, Bonaduz, Switzerland), VELA ventilator (CareFusion Corporation, San Diego, CA, USA), or Bird Mark 7 series ventilator (Viasys Healthcare, Conshohocken, PA, USA). Ventilators were selected randomly depending on ventilator availability.

One of the investigators identified qualifying patients during twice daily rounds (morning and evening) on all of the 10 general medical wards and collected daily related clinical data. Baseline patient characteristics collected included age, gender, primary indication for mechanical ventilation, and Acute Physiologic and Chronic Health Evaluation (APACHE) II score[5] during the first 24 hours of mechanical ventilation. Primary indications for mechanical ventilation were categorized, as follows[6], 1) exacerbation of chronic obstructive pulmonary disease (COPD) or asthma, 2) heart failure, 3) pneumonia, 4) acute lung injury/acute respiratory distress syndrome (ARDS), 5) alteration of consciousness, 6) neuromuscular diseases, and 7) sepsis. Each patient was followed, with the following information being collected, outcome (dead, alive, transferred to ICU, or transferred to another hospital), duration of mechanical ventilation, duration of hospitalization, and cost of hospitalization. If patients were transferred to ICU or another hospital, outcome at discharge (dead or alive) was also recorded.

The protocol for this study was approved by the Siriraj Institutional Review Board, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand. Informed consent was waived because this study did not modify existing diagnostic or therapeutic strategies.

Statistical analysis

All statistical analysis was performed using SPSS Statistics software version 16 (SPSS, Inc., Chicago, IL, USA). Chi-square test and t-test were used to compare discrete and continuous variables, respectively. Logistic regression was used to identify independent factors for predicting in-hospital mortality. All *p*-values were two-sided, with a *p*-value of less than or equal to 0.05 considered statistically significant.

Results

Consecutive patients meeting the study criteria were admitted to general medical wards. Baseline characteristics and clinical outcomes of these patients were presented in Table 1. Primary indications for mechanical ventilation were exacerbation of COPD (8.6%), heart failure (7.5%), pneumonia (31.2%), acute lung injury/ARDS (5.4%), alteration of consciousness (31.2%), sepsis (14%), and post-operation (2.1%). Twenty-nine patients (31.2%) survived to discharge from hospital. There was no difference in mortality rate stratified according to primary indication for mechanical ventilation or location of admission (Table 1). Only high APACHE II score was correlated with higher mortality.

In multivariate analysis, APACHE II score >22 was the only independent predictor of death (OR 4.3, 95% CI 1.2-15.2, $p = 0.02$) after adjusting for primary indication for mechanical ventilation, and location of admission. Mortality of patients mechanically ventilated on general medical wards in this study was higher than the predicted mortality calculated by APACHE II score[5] in all levels of APACHE II score (Table 2). Difference in mortality was more apparent in patients with lower APACHE II score (Table 2). Duration of hospitalization was significantly longer in patients who survived. However, cost of hospitalization was not different between patients who survived and patients who did not survive.

Table 1. Baseline patient characteristics

	Survived (n = 29)	Dead (n = 64)	*p*-value
Age (year), mean ± SD	67.9±14.0	66.0±16.0	0.58
Male, n (%)	19 (65.5)	33 (51.6)	0.20
Primary reason for mechanical ventilation, n (%)			0.43
COPD (n = 8)	5 (62.5)	3 (37.5)	
Heart failure (n = 7)	3 (42.9)	4 (57.1)	
Pneumonia (n = 29)	7 (24.1)	22 (75.9)	
Acute lung injury/ARDS (n = 5)	1 (20.0)	4 (80.0)	
Alteration of consciousness (n = 29)	10 (37.9)	19 (62.1)	
Sepsis (n = 13)	3 (23.1)	10 (76.9)	
Postoperation (n = 2)	0 (0)	2 (100)	
Location of admission, n (%)			0.1
Ward 1 (n = 4)	1 (25.0)	3 (75.0)	
Ward 2 (n = 11)	3 (27.0)	8 (73.0)	
Ward 3 (n = 14)	8 (57.0)	6 (43.0)	
Ward 4 (n = 11)	1 (9.0)	10 (91.0)	
Ward 5 (n = 8)	4 (50.0)	4 (50.0)	
Ward 6 (n = 10)	1 (10.0)	9 (90.0)	
Ward 7 (n = 9)	3 (33.0)	6 (67.0)	
Ward 8 (n = 9)	2 (22.0)	7 (78.0)	
Ward 9 (n = 8)	1 (13.0)	7 (87.0)	
Ward 10 (n = 9)	5 (55.6)	4 (44.4)	
APACHE II score	19.8±5.5	23.3±7.3	0.02*

COPD = chronic obstructive pulmonary disease; ARDS = acute respiratory distress syndrome
* Statistically significant difference

Table 2. Comparison between mortality of patients mechanically ventilated on general medical wards in this study and the predicted mortality calculated by APACHE II score[5]

APACHE II score	n	Observed mortality, n (%)	Predicted mortality (%)
1-10	2	1 (50)	11
11-20	39	24 (62)	26
21-30	42	30 (71)	53
31-40	9	8 (89)	79
41-60	1	1 (100)	98

This can be explained by the significantly higher cost per day of patients who did not survive (Table 3).

Discussion

The number of critically ill patients is increasing worldwide. The shortage of ICU beds is a growing problem in many countries[1,2], especially in resource-limited countries like Thailand. In the hospital where this study was conducted and in other hospitals in Thailand, the need to mechanically ventilate patients on general medical wards due to a shortage of ICU beds has been commonplace for over 20 years. However, the clinical outcomes of patients mechanically ventilated on general medical wards has rarely been studied[3,4], with no such study being reported from Thailand.

In the present study, it was shown that overall mortality of patients mechanically ventilated on general medical wards was high (>60%). This finding is consistent with previous reports. Sprung et al reported that patients triaged for admission to a general ICU, but that were not admitted to ICU had high mortality (46%)[7]. Hersch et al reported mortality of patients mechanically ventilated on general medical wards to be significantly higher than patients who were ventilated in ICU (80% and 62%, respectively)[4]. The high mortality of the patients in this study was found in all subgroups categorized by primary indication for mechanical ventilation. Multivariate analysis revealed APACHE II score to be the only independent predictor of death. APACHE II is a severity score and mortality estimation tool developed from a large sample of ICU patients in the United States[5]. It is currently the world's most widely used severity of illness score[8]. An increasing score is closely correlated with subsequent risk of hospital death. Its role in severity assessment and outcome prediction has been validated in several

Table 3. Duration and cost data of patients mechanically ventilated on general medical wards

	Survived (n = 29)	Dead (n = 64)	*p*-value
Duration of mechanical ventilation (day)	24±36	12±21	0.10
Duration of hospitalization (day)	33±35	18±24	0.02*
Cost of hospitalization (baht)	62,401±69,448	60,476±95,150	0.90
Cost of hospitalization/day (baht)	2,291±1,857	4,113±3,610	0.002*

* Statistically significant difference

ICUs and intermediate care units around the world[8]. However, APACHE II score has never been validated for use in general medical wards. The results of the present study suggest that APACHE II scores might be used to assess severity and predict outcome of critically ill patients admitted to general medical wards.

Furthermore, APACHE II scores may be used to compare performance of intensive care in different hospitals or over time[9]. The authors compared the mortality rate of this cohort with mortality predicted by APACHE II. The comparison revealed that mortality of patients mechanically ventilated on general medical wards in this study was significantly higher than mortality predicted by APACHE II score in all levels of APACHE II score. The difference in mortality was more apparent in patients with lower APACHE II score. This would support the notion or assertion that the quality of critical care in general medical wards is much lower than the quality of care in ICU. Whenever possible, patients who are receiving mechanical ventilatory support should be managed in ICU, regardless of their severity or primary indication for mechanical ventilation. Because of the shortage of ICU beds, alternative patient care strategies should be developed. One possible solution involves development of intermediate care units. Intermediate care units provide more intensive monitoring and patient management with higher nurse to patient ratio than the general medical wards, but less than is offered in the ICU[10]. However, there is relatively little current published evidence to support the benefits of this approach on patient outcomes.

The strength of the present study is the inclusion of patients with various causes of mechanical ventilation and with wide range of severity. In addition, the authors excluded patients having a do not resuscitate (DNR) order, patients with a life expectancy of less than 6 months, patients initially ventilated on the general medicine ward and subsequently transferred to the ICU, and patients initially ventilated in the ICU and subsequently transferred to the general medicine ward.

However, there are some inherent limitations to this study. The authors did not directly compare mortality of patients mechanically ventilated on general medical wards with mortality of patients mechanically ventilated in ICU. Additionally, the authors could not control for factors that may have caused selection bias; specifically, by admitting patients who it was believed would benefit more from ICU care. These factors may have affected the mortality of patients that received mechanical ventilation on general medical wards.

In summary, this prospective observational study demonstrated that medical patients who are mechanically ventilated on general medical wards have high mortality rate, regardless of severity or primary indication for mechanical ventilation. APACHE II score >22 is a good prognostic factor for predicting risk of death in these patients.

What is already known on this topic?

Few data demonstrated that mortality of patients mechanically ventilated on general medical wards was significantly higher than patients who were ventilated in ICU.

What this study adds?

In the present study, it was shown that overall mortality of medical patients mechanically ventilated on general medical wards of a university hospital in Thailand was high regardless of primary indication for mechanical ventilation. APACHE II score is a good prognostic factor for predicting risk of death in these patients.

Potential conflicts of interest

None.

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การศึกษาผลลัพธ์และปัจจัยพยากรณ์โรคของผู้ป่วยที่ใส่เครื่องช่วยหายใจในหอผู้ป่วยสามัญ

พูนทรัพย์ วงศ์สุรเกียรติ์, ณรงค์ชัย สังฆา, อนุพงศ์ ตั้งอรุณสันติ

ภูมิหลัง: *ในบางครั้งผู้ป่วยที่ได้รับการใส่เครื่องช่วยหายใจมีความจำเป็นต้องรับการรักษาที่หอผู้ป่วยสามัญ เนื่องจากการขาดแคลนเตียงในหอผู้ป่วยหนัก (intensive care unit)*

วัตถุประสงค์: *เพื่อทราบผลลัพธ์ของผู้ป่วยที่ได้รับการใส่เครื่องช่วยหายใจที่หอผู้ป่วยสามัญ และหาปัจจัยที่สามารถทำนายถึงโอกาสเสียชีวิตของผู้ป่วยเหล่านี้*

วัสดุและวิธีการ: *Prospective observational study ระยะเวลา 6 เดือน ศึกษาผู้ป่วยที่รับใหม่ไว้ในโรงพยาบาลศิริราช ณ หอผู้ป่วยสามัญ ที่ใช้เครื่องช่วยหายใจเกิน 6 ชั่วโมง จำนวนทั้งหมด 93 ราย*

ผลการศึกษา: *อัตราตายโดยรวมของผู้ป่วยเท่ากับร้อยละ 68.8 ระยะเวลานอนโรงพยาบาลเฉลี่ย 22.9±28.5 วัน ค่าใช้จ่ายเฉลี่ยต่อคนในการนอนโรงพยาบาล 61,076.64±87569.1 บาท การวิเคราะห์แบบ univariate พบว่า ค่าเฉลี่ยAPACHE II score ของผู้ที่เสียชีวิตสูงกว่าผู้ที่รอดชีวิตอย่างมีนัยสำคัญทางสถิติ (23.3±7.3 vs. 19.8±5.5, p = 0.02) การวิเคราะห์แบบ multivariate พบว่า มีเพียง APACHE II score >22 ที่สัมพันธ์กับอัตราการตาย (OR 4.3, 95% CI 1.2-15.2, p = 0.02)*

สรุป: *ผู้ป่วยที่ใส่เครื่องช่วยหายใจในหอผู้ป่วยสามัญมีอัตราตายสูง APACHE II score เป็นปัจจัยพยากรณ์โรคที่ดีในการทำนายโอกาสเสียชีวิตของผู้ป่วยที่ใส่เครื่องช่วยหายใจ*
