Observational Study

Medicine®

OPEN

The outcomes and prognostic factors of the patients with unplanned intensive care unit readmissions

Wei-Ting Lin, MD[a], Wan-Ling Chen, RRT[b], Chien-Ming Chao, MD[c], Chih-Cheng Lai, MD[c,*]

Abstract

This retrospective cohort study investigated the outcomes of patients with unplanned intensive care unit (ICU) readmission.

All of the patients readmitted to ICU within 48 hours between 2010 and 2016 were enrolled.

A total of 99 patients early readmitted to ICU were identified and their mean age of the patients was 68.8 ± 14.8 years. Respiratory failure was the most common cause of ICU readmission (n = 48, 48.5%), followed by acute myocardial ischemia or worsening heart failure (n = 25, 25.3%), sepsis (n = 22, 22.2%), gastrointestinal disease (n = 16, 16.2%), and neurologic disease (n = 11, 11.1%). The median length of stay in the ICU and hospital was 7 (IQR, 4–11.5) and 32 (IQR, 15.5–48.5) days, respectively. A total of 34 patients died during the hospital stay and the rate of in-hospital mortality was 34.3%. Patients with higher APACHE II scores (adjusted odds ratio [OR], 1.17; 95% CI, 1.02–1.33), underlying malignancy (adjusted OR, 4.70; 95% CI, 1.19–18.57), and cardiovascular organ dysfunction (adjusted OR, 5.14; 95% CI, 1.24–21.38) were more likely to die.

The mortality rate of ICU readmission patients was high, especially for those with higher APACHE II score, underlying malignancy and cardiovascular organ dysfunction.

Abbreviations: APACHE II = Acute Physiology and Chronic Health Evaluation II, CI = confidence interval, GCS = Glasgow coma scale, ICU = intensive care unit, IQR = interquartile range, MV = mechanical ventilation, OR = odds ratio, SD = standard deviation.

Keywords: intensive care unit, outcome, prognosis, readmission

1. Introduction

Intensive care unit (ICU) is a place where it can provide the comprehensive life-saving care for the critically ill patients. Once the patients recover from the critical illness, the patients should be discharged from ICU to general ward for further management. However, the timing of patients discharged from the ICU remains a great challenge for intensivists. Although early discharge from the ICU can prevent the patients from further iatrogenic and nosocomial complications during prolonged ICU stay, and facilitate the efficient utilization of ICU and reduce the expansive ICU cost,[1] this decision should take some risks. After leaving ICU, the patients would be put in a lower acuity unit. Therefore, the patients may be at the risk for the possible complication and delayed recognition of clinical deterioration. Finally, it will result in unplanned ICU readmission or even death.

Nowadays, the rate of ICU readmission within 48 hours has been defined as a major performance indicator of the quality of intensive care medicine.[2–4] Moreover, several studies also showed that the patients with ICU readmission have higher mortality and longer hospital stays than the patients without readmission.[5–9] According to the different definitions of ICU readmissions based on previous studies,[5,7,9–15] the rate of ICU readmission ranges from 4.6% to13.4%, and the in-hospital mortality rate of patients with ICU readmission ranges from 13.3% to 41.5%. However, the prognostic factors of patients with ICU readmission remain unclear due to limited investigation. Thus, we conducted this study to assess the outcome of patients with ICU readmission, and find out the risk factors of mortality among these patients.

2. Materials and methods

2.1. Setting and patients

This study was conducted in 5 ICUs at regional teaching hospital that has 63 adult ICU beds. The care in the ICU was covered by intensivists, nurse practitioner, nurses, respiratory therapists, dietitians, physical therapists, and clinical pharmacists. The ICU team made rounds twice daily and patient-to-nursing staff ratios of 2:1. The decision of discharge from ICU was made by the in-charge intensivist. All of the patients with unplanned readmission to the ICU within 48 hours between January 1, 2010 and December 31, 2016 were enrolled in this study. If the patients had several episodes of ICU readmission during the same hospitalization, we only included first episode of ICU readmission for analysis.

The following information, including age, gender, type of previous ICU admission, cause of ICU readmission, Acute

Editor: Bernhard Schaller.

The authors have no funding and no conflicts of interest to disclose.

[a] Departments of Orthopedics and Trauma, [b] Department of Respiratory Therapy, [c] Department of Intensive Care Medicine, Chi Mei Medical Center, Liouying, Tainan, Taiwan.

[*] Correspondence: Chih-Cheng Lai, Department of Intensive Care Medicine, Chi Mei Medical Center, Liouying, Taiwan. No. 201, Taikang, Taikang Vil., Liuying District, Tainan City 736, Taiwan (e-mail: dtmed141@gmail.com).

Medicine (2018) 97:26(e11124)

Received: 25 January 2018 / Accepted: 24 May 2018

http://dx.doi.org/10.1097/MD.0000000000011124

Physiology and Chronic Health Evaluation II (APACHE II) scores, Glasgow coma scale (GCS), underlying comorbidities including dementia, hypertension, chronic obstructive pulmonary disease, congestive heart failure, stroke, chronic kidney disease, liver cirrhosis, and malignancy, use of steroid, mechanical ventilation (MV) and continuous renal replacement therapy, and organ failure in ICU were collected. Additionally, the outcomes including length of ICU and hospital stay, and in-hospital mortality were collected. The data were collected on a routine basis and the analyses were carried out retrospectively. Therefore, no informed consent was required and it was specifically waived by Institutional Review Board. Ethics approval was obtained from Institution Review Board of Chi Mei Medical Center.

2.2. Definitions

As previous studies regarding organ failures,[16–18] respiratory failure was defined as the need for ventilatory assistance of fraction of inspired oxygen of 0.40 or more and positive end-expiratory pressure of 10 cm H_2O or more. Cardiovascular failure was defined as systolic blood pressure of < 90 mm Hg or a mean arterial pressure < 65 mm Hg for at least 1 hour despite adequate fluid resuscitation; or the need for vasoactive agents to maintain systolic blood pressure ≥ 90 mm Hg or mean arterial pressure ≥ 65 mm Hg. Kidney failure was considered as oliguria with an average urine output < 0.5 mL/kg/h for 4 hours despite adequate fluid resuscitation or creatinine > 2 mg/dL. Hepatic failure was defined as markedly increased serum bilirubin level $>$ 4 mg/dL with elevation of glutamate dehydrogenease level > 10 mU/ml or twice normal.

2.3. Statistical analysis

Continuous variables were reported as mean and standard deviation (SD) or median and interquartile range (IQR) depending on the nature and distribution of the variables. Categorical variables were presented as frequency counts with percentages. Continuous variables were compared using the Wilcoxon rank-sum test or Student's independent *t* test, as appropriate. Categorical variables were compared using the chi-square test or Fisher's exact test. Differences in baseline characteristics and clinical variables between the survival and mortality groups were evaluated using Student's t-test or Manny–Whitney *U* rank test for continuous variables and Pearson chi-square tests for categorical variables. A multivariable logistic regression model was constructed from baseline characteristics and clinical variables with *P*-values $<.05$ as candidates. To determine the final prediction model, a stepwise model-selection procedure, in which all candidate variables were inserted until noneffects entered or an effect was removed from the backward elimination, was used to examine the association between predictive variables and the mortality rate and MV dependency using odds ratios (OR) with 95% confidence intervals (95% CI). All statistical analyses were conducted using the statistical package SPSS for Windows (Version 19.0, SPSS, Chicago, IL), and a *P*-value $< .05$ was considered to show statistical significance.

3. Results

3.1. Patient characteristics

During the 6-year period, a total of 99 cases with first ICU readmission were identified. Among them, the mean age of the patients was 68.8 ± 14.8 years (range: 26–93 years). Men comprised most of the patients (n = 67, 67.7%). A total of 43 readmissions were previously discharged from surgical ICU, and each 28 patients were discharged from medical ICU and cardiac ICU, respectively. Respiratory failure was the most common cause of ICU readmission (n = 48, 48.5%), followed by acute myocardial ischemia or worsening heart failure (n = 25, 25.3%), sepsis (n = 22, 22.2%), gastrointestinal disease (n = 16, 16.2%), and neurologic disease (n = 11, 11.1%). Hypertension was the most common underlying disease (n = 51, 51.5%), followed by diabetes mellitus (n = 37, 37.4%), chronic kidney disease (n = 28, 28.3%), malignancy (n = 31, 1.3%), congestive heart failure (n = 13, 13.1%), stroke (n = 10, 10.1%), chronic obstructive pulmonary disease (n = 7, 7.1%), and dementia (n = 4, 14.0%). In addition, 16 patients (16.2%) had a recent history of corticosteroid administration. Respiratory dysfunction was the most common organ dysfunction (n = 86, 86.9%), followed by cardiovascular (n = 57, 57.6%), renal (n = 38, 38.4%), and hepatic failure (n = 12, 12.1%). During the episode of ICU readmission, 71 (71.7%) patients received invasive mechanical ventilation and only 3 patients received intra-aortic balloon pump. Additionally, 16 (16.2%) patients required intermittent hemodialysis and 5 (5.1%) patients needed continuous renal replacement therapy. The median length of stay in the ICU and hospital was 7 (IQR, 4–11.5) and 32 (IQR, 15.5–48.5) days, respectively.

3.2. Outcome analysis

The overall in-hospital rate was 34.3%. Patients with mortality had higher disease severity, lower conscious level, more malignancy, more requiring CRRT, and more organ failure than the patients with survival (Table 1). The patients with neurologic dysfunction as cause of readmission had lower risk of death (Table 1). After using multivariable analysis, only three factors, including APACHE II score (adjusted OR, 1.17; 95% CI, 1.02–1.33; $P = .027$), underlying malignancy (adjusted OR, 4.70; 95% CI, 1.19–18.57; $P = .027$), and cardiovascular organ dysfunction (adjusted OR, 5.14; 95% CI, 1.24–21.38, $P = .024$) were significantly associated with in-hospital mortality (Table 2).

4. Discussion

In this study investigating the outcome of unplanned ICU readmission patients, we have several significant findings. First, the mortality of this population was high, and more than one-third patients had in-hospital mortalities. In addition, these patients had a long LOS in ICU and hospital. The high mortality rate of unplanned ICU readmission in this study was consistent with previous studies.[5,14,15,19] In Lee et al's study[14] the mortality of the early readmitted patients was 27.5%, and these patients spent 18.9 ± 24.2 days (median, 11 days) in the ICU and 46.3 ± 48.4 days (median, 31 days) in the hospital, respectively. Another study[19] showed the similar findings that the mortality of patients readmitted to ICU was 30.8%, and their hospital LOS was 67.3 ± 66.4 days. Even in surgical ICU, the readmitted patients were found to have a long ICU stay (5.68+6.75 days) and high mortality rate of 34%.[20] All of these findings indicate the poor outcome of patients with unplanned ICU readmission. Furthermore, it suggests that we should pay more effort to prevent ICU readmission.

Second, the in-hospital mortality was found to be significantly associated with 4 factors, including APACHE II scores,

Table 1

The comparison of clinical variables between patients with survival and mortality outcomes.

Variables	No. (%) of patients with survival outcomes (n = 65)	No. (%) of patients with mortality outcomes (n = 34)	*P*-value
Age, years	68.4 ± 14.6	69.6 ± 15.3	.70
Gender			.65
Male	45 (69.2)	22 (64.7)	
Female	20 (30.8)	12 (35.3)	
Category of ICU			.11
Medical ICU	15 (23.1)	13 (38.2)	
Surgical ICU	33 (50.8)	10 (29.4)	
Cardiac ICU	17 (26.1)	11 (32.4)	
Glasgow coma scale	14.0 (11.0–15.0)	10.0 (3.5–12.0)	<.001
APACHE II scores	11.0 (8.0–15.0)	22.5 (16.5–30.0)	<.001
Timing of readmission			.78
Day	34 (52.3)	16 (47.1)	
Night	31 (47.7)	18 (52.9)	
Type of readmission			.17
Previous disease complication	18 (27.7)	14 (41.2)	
New disease	47 (72.3)	20 (58.8)	
Cause of ICU readmission			
Respiratory failure	31 (47.7)	17 (50.0)	.83
Sepsis	12 (18.5)	10 (29.4)	.21
Acute myocardial ischemia or heart failure	13 (20.0)	12 (35.3)	.10
Gastrointestinal dysfunction	9 (13.8)	7 (20.6)	.39
Endocrine dysfunction	2 (3.1)	0 (0.0)	.30
Neurologic dysfunction	11 (16.9)	0 (0.0)	.011
Renal failure	3 (4.6)	1 (2.9)	.69
Others	8 (12.3)	1 (2.9)	.12
Comorbidity			
Dementia	1 (1.5)	3 (8.8)	.08
Hypertension	34 (52.3)	17 (50.0)	.83
COPD	4 (6.2)	3 (8.8)	.63
CHF	10 (15.4)	3 (8.8)	.36
Stroke	7 (10.8)	3 (8.8)	.76
Diabetes mellitus	24 (36.9)	13 (38.2)	.90
CKD	19 (29.2)	9 (26.5)	.77
Liver cirrhosis	7 (10.8)	5 (14.7)	.57
Malignancy	16 (24.6)	15 (44.1)	.047
Receiving steroid	11 (16.9)	5 (14.7)	.78
Requiring hemodialysis			
IHD	11 (16.9)	5 (14.7)	.78
CRRT	1 (1.5)	4 (11.8)	.027
Receiving IABP	3 (4.6)	0 (0.0)	.20
Receiving MV	43 (66.2)	28 (82.4)	.09
Organ dysfunction			
Respiratory system	54 (83.1)	32 (94.1)	.12
Cardiovascular system	27 (41.5)	30 (88.2)	<.001
Renal system	20 (30.8)	18 (52.9)	.031
Liver system	7 (10.8)	5 (14.7)	.57
Lengths of ICU stay	7.0 (5.0–11.0)	5.0 (2.0–13.25)	.08
Lengths of hospital stay	34.0 (21.0–52.0)	19.0 (9.0–38.5	.01

Data were shown as number (%) or mean ± SD.

APACHE II = Acute Physical and Chronic Healthy Evaluation II, CHF = congestive heart failure, CKD = chronic kidney disease, COPD = chronic obstructive pulmonary disease, CRRT = continuous renal replacement therapy, ICU = intensive care unit, IHD = intermittent hemodialysis.

Table 2

Risk factor of in-hospital mortality.

Variable	Adjust OR	95% CI	*P* value
APACHE II score	1.17	1.02–1.33	.027
Malignancy	4.70	1.19–18.57	.027
Cardiovascular organ dysfunction	5.14	1.24–21.38	.024

APACHE II = Acute Physiology and Chronic Health Evaluation II, CI = confidence interval, OR = odds ratio.

underlying malignancy, and cardiovascular organ dysfunction. Part of this finding is consistent with previous reports[14] that the high severity of illness, as measured by the APACHE III score, and organ dysfunctions, as measured by the SOFA score, are associated with the mortality of patients with ICU readmission.[14] In contrast, the ICU readmission patients due to neurologic cause had the better outcome, and none of them had in-hospital mortality. The possible explanation is most of these patients readmission due to change of consciousness can be stabilized after securing their airway. After intubation for maintaining airway, and the recovery or stabilization of

consciousness, we can keep these patients alive during hospitalization.

Third, we found that respiratory failure was the most common cause of ICU readmissions. This is consistent with several reports[5,14,21,22] that respiratory problem was the major condition requiring early ICU readmission. Based on these findings, several useful intervention,[23,24] such as a dedicated team of respiratory therapists responsible for caring the post-ICU patients in the floors, and assisted respiratory care, such as suctioning, percussion, and postural drainage, might be applied for reducing the readmission rate.

Our study has several limitations. First, although our ICU had discharge criteria, the decision regarding ICU discharge was finally made by in-charge intensivist. In addition, our findings were based on a single institution and strict admission criteria were applied in our institution. Therefore, it may not be generalized to patients in other hospitals or countries. Second, we did not collect the data regarding do-not-resuscitation, which may affect the outcome analysis in this study. Further detailed analysis should be warranted to clarify this issue. Finally, we only enrolled the patients with early ICU readmission within 48 hours, therefore, we cannot analyze the difference between early and late readmission.

In conclusion, ICU readmission is associated with poor outcomes including high mortality and long hospital stay. The severity of disease, the condition of organ dysfunction, and underlying malignancy are independently associated with the mortality of patients with ICU readmission.

Author contributions

Conceptualization: Wei-Ting Lin, Wan-Ling Chen, Chien-Ming Chao, Chih-Cheng Lai.
Data curation: Wei-Ting Lin, Wan-Ling Chen, Chien-Ming Chao, Chih-Cheng Lai.
Formal analysis: Wan-Ling Chen, Chih-Cheng Lai.
Writing – original draft: Chien-Ming Chao, Chih-Cheng Lai.
Writing – review & editing: Chih-Cheng Lai.

References

[1] Capuzzo M, Moreno RP, Alvisi R. Admission and discharge of critically ill patients. Curr Opin Crit Care 2010;16:499–504.
[2] Timmers TK, Hulstaert PF, Leenen LP. Patient outcomes can be associated with organizational changes: a quality improvement case study. Crit Care Nurs Q 2014;37:125–34.
[3] Angus DC. Grappling with intensive care unit quality—does the readmission rate tell us anything? Crit Care Med 1998;26:1779–80.
[4] Berenholtz SM, Dorman T, Ngo K, et al. Qualitative review of intensive care unit quality indicators. J Crit Care 2002;17:1–2.
[5] Chen LM, Martin CM, Keenan SP, et al. Patients readmitted to the intensive care unit during the same hospitalization: clinical features and outcomes. Crit Care Med 1998;26:1834–41.
[6] Renton J, Pilcher DV, Santamaria JD, et al. Factors associated with increased risk of readmission to intensive care in Australia. Intensive Care Med 2011;37:1800–8.
[7] Kaben A, Correa F, Reinhart K, et al. Readmission to a surgical intensive care unit: incidence, outcome and risk factors. Crit Care 2008;12:R123.
[8] Chan KS, Tan CK, Fang CS, et al. Readmission to the intensive care unit: an indicator that reflects the potential risks of morbidity and mortality of surgical patients in the intensive care unit. Surg Today 2009;39:295–9.
[9] Durbin CGJr, Kopel RF. A case-control study of patients readmitted to the intensive care unit. Crit Care Med 1993;21:1547–53.
[10] Cooper GS, Sirio CA, Rotondi AJ, et al. Are readmissions to the intensive care unit a useful measure of hospital performance? Med Care 1999;37:399–408.
[11] Afessa B, Keegan MT, Hubmayr RD, et al. Evaluating the performance of an institution using an intensive care unit benchmark. Mayo Clin Proc 2005;80:174–80.
[12] Baker DR, Pronovost PJ, Morlock LL, et al. Patient flow variability and unplanned readmissions to an intensive care unit. Crit Care Med 2009;37:2882–7.
[13] Fernandez R, Serrano JM, Umaran I, et al. Ward mortality after ICU discharge: a multicenter validation of the Sabadell score. Intensive Care Med 2010;36:1196–201.
[14] Lee JY, Park SK, Kim HJ, et al. Outcome of early intensive care unit patients readmitted in the same hospitalization. J Crit Care 2009;24:267–72.
[15] Utzolino S, Kaffarnik M, Keck T, et al. Unplanned discharges from a surgical intensive care unit: readmissions and mortality. J Crit Care 2010;25:375–81.
[16] Chen CM, Chan KS, Yu WL, et al. The outcomes of patients with severe dengue admitted to intensive care units. Medicine (Baltimore) 2016;95:e4376.
[17] Lai CC, Shieh JM, Chiang SR, et al. The outcomes and prognostic factors of patients requiring prolonged mechanical ventilation. Sci Rep 2016;6:28034.
[18] Faist E, Baue AE, Dittmer H, et al. Multiple organ failure in polytrauma patients. J Trauma 1983;23:775–87.
[19] Tam OY, Lam SM, Shum HP, et al. Characteristics of patients readmitted to intensive care unit: a nested case-control study. Hong Kong Med J 2014;20:194–204.
[20] Amin NDJ, Agarwal V, Kulkarni AP. Readmissions in a surgical intensive care unit: patient characteristics and outcome. Indian J Crit Care Med 2003;7:14–7.
[21] Ashton CM, Del Junco DJ, Souchek J, et al. The association between the quality of inpatient care and early readmission: a meta-analysis of the evidence. Med Care 1997;35:1044–59.
[22] Baigelman W, Katz R, Geary G. Patient readmission to critical care units during the same hospitalization at a community teaching hospital. Intensive Care Med 1983;9:253–6.
[23] Kirby EGDJC. Establishment of a respiratory assessment team is associated with decreased mortality in patients re-admitted to the ICU. Resp Care 1996;41:903–7.
[24] Rosenberg AL, Watts C. Patients readmitted to ICUs: a systematic review of risk factors and outcomes. Chest 2000;118:492–502.