Original Article

Preventable readmission to intensive care unit in critically ill cancer patients

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BACKGROUND: Readmission to intensive care unit (ICU) after discharge to ward has been reported to be associated with increased hospital mortality and longer length of stay (LOS). The objective of this study was to investigate whether ICU readmission are preventable in critically ill cancer patients.

METHODS: Data of patients who readmitted to intensive care unit (ICU) at National Cancer Center/Cancer Hospital of Chinese Academy of Medical Sciences (CAMS) and Peking Union Medical College (PUMC) between January 2013 and November 2016 were retrospectively collected and reviewed.

RESULTS: A total of 39 patients were included in the final analysis, and the overall readmission rate between 2013 and 2016 was 1.32% (39/2,961). Of 39 patients, 32 (82.1%) patients were judged as unpreventable and 7 (17.9%) patients were preventable. There were no significant differences in duration of mechanical ventilation, ICU LOS, hospital LOS, ICU mortality and in-hospital mortality between patients who were unpreventable and preventable. For 24 early readmission patients, 7 (29.2%) patients were preventable and 17 (70.8%) patients were unpreventable. Patients who were late readmission were all unpreventable. There was a trend that patients who were preventable had longer 1-year survival compared with patients who were unpreventable (100% vs. 66.8%, log rank=1.668, $P=0.196$).

CONCLUSION: Most readmission patients were unpreventable, and all preventable readmissions occurred in early period after discharge to ward. There were no significant differences in short term outcomes and 1-year survival in critically ill cancer patients whose readmissions were preventable or not.

KEY WORDS: Readmission; Cancer; Preventability; Outcomes

World J Emerg Med 2018;9(3):211–215
DOI: 10.5847/wjem.j.1920–8642.2018.03.008

INTRODUCTION

Nishi et al^[1–5] reported that readmission to intensive care unit (ICU) after discharge to ward was associated with longer length of stay (LOS) and increased hospital mortality. As a result, readmission rate was set as a quality indicator of ICU and hospital. Generally, 4% to 6% rate of readmission was acceptable. If readmission rate was lower than 2%, the patients may be kept in ICU too long. On the other hand, if readmission rate was higher than 8%, the ICU may discharge the patients too early.^[6]

Several predictive scores including stability and workload index for transfer score (SWIFT), sequential organ failure assessment score (SOFA) and simplified

therapeutic intervention scoring system (TISS-28) have been derived and validated.^[7] However, only moderate accuracy was demonstrated in these scores in predicting the risk of ICU readmission. Therefore, it is difficult to make precision prediction which patients will be readmitted to ICU.

Recently, studies concerning readmission argued that whether readmission rate was a good quality factor of ICU performance. Brown et al^[8] found that policy change of residency work-hour reform decreased ICU readmission rates, but no change in ICU mortality was found. In a large prospective study, Santamaria et al^[9] found that readmission to ICU was not an independent prognostic factor for hospital mortality. Al-Jaghbeer

et al^[10] found that most early ICU readmissions were unpreventable, and concluded that ICU readmission rates may not become a measure of hospital performance.

There is no study regarding preventability in critically ill cancer patients. Therefore, the objective of this study was to investigate preventability of ICU readmission in critically ill cancer patients in a comprehensive cancer center in China.

METHODS

Data of all consecutive patients who admitted to intensive care unit (ICU) in a tertiary cancer center in China between January 2013 and November 2016 were retrospectively collected and reviewed. The Institutional Review Board of Cancer Hospital approved this study, and therefore the study was performed in line with the ethical Declaration of Helsinki laid down in the 1964 and its later amendments. Owing to the observational nature of this study, patients' consents were waived.

The data included age, gender, presence of comorbidities including history of hypertension, coronary heart disease and diabetic mellitus, sequential organ failure assessment (SOFA) and simplified acute physiology score 3 (SAPS 3) on first ICU admission, diagnosis of sepsis, acute kidney injury (AKI), acute respiratory distress syndrome (ARDS) during ICU, duration of ventilation, ICU LOS, ICU death, hospital LOS and in-hospital death.

Sepsis was defined using the third international consensus definitions for sepsis and septic shock (sepsis-3), which is a dysregulated host response to infection, leading to life-threatening organ dysfunction. And septic shock was defined as particularly profound circulatory, cellular, and metabolic abnormalities.^[11] Acute kidney injury was defined as rise in serum creatinine absolute level ≥ 0.3 mg/dL (≥ 26.4 μ mol/L), or increase in serum creatinine of $\geq 50\%$, or urine output reduction, defined as <0.5 mL/(kg-hour) for more than 6 hours.^[12] ARDS was defined according to the 2012 Berlin definition.^[13] SOFA score was calculated as a sum of six different scores, one each for the respiratory, cardiovascular, hepatic, coagulation, renal and neurological systems, and extent of a patient's organ function was rated as one to four.^[14] SAPS 3 was recorded and calculated within 1 hour of ICU admission.^[15] Overall survival was defined as a period between discharge from ICU and death from any cause.

Patients were classified as unpreventable and preventable groups according to the judgement of two associate professors (YG and XZX). Preventability was

assessed according to the classification of literature.^[10,16] A patient was defined as unpreventable when there was no evidence for management causation. A patient was judged as preventable when there was strong evidence for management causation. For readmitted patients, readmission within 48 hours after discharge to ward was defined as early readmission, and readmission beyond 48 hours was defined as late readmission.

Statistical analyses were performed using SPSS software for Windows, version 16.0 (SPSS Inc., Chicago, IL, USA). Continuous variables are reported as median (interquartile range) and compared respectively using Student's *t*-test. Categorical variables were presented as absolute number (frequency percentages) and analyzed using χ^2 test. The survival was estimated by means of Kaplan-Meier curves, and log-rank test was used for survival comparison. Statistically significant was considered when a two-tailed *P* value < 0.05 .

RESULTS

A total of 39 patients were included in the final analysis, and the overall readmission rate between 2013 and 2016 was 1.32% (39/2,961). The annual readmission rate was between 0.53% and 2.48% (Figure 1).

There were 29 males and 10 females. Median SAPS 3 and median SOFA at first admission was 41 and 2 respectively. Median length of time on ward prior to readmission was 43 hours. Other clinical characteristics of 39 patients were displayed in Table 1.

The most common reason for first admission and readmission was pulmonary (76.9% and 91.8% respectively), followed by cardiovascular (12.8% and 20.5% respectively). Other reasons are displayed in Table 2.

Of 39 patients, 32 (82.1%) patients were judged as unpreventable and 7 (17.9%) patients were preventable. Of 32 patients who were unpreventable, 21 patients were due to an existing problem and 11 patients were due to a new problem. All 7 preventable patients were due to cardiac pulmonary edema which needs mechanical ventilation.

There were no significant differences in duration of mechanical ventilation, ICU LOS, hospital LOS, ICU mortality and in-hospital mortality between patients who were unpreventable and preventable (Table 3).

Regarding the timing of readmission, patients who were late readmission were all unpreventable. For 24 early readmission patients, 7 (29.2%) patients were preventable and 17 (70.8%) patients were unpreventable (Table 4).

As shown in Figure 2, there was a trend that patients who were preventable had longer 1-year survival

Figure 1. Annual readmission rate from 2013 to 2016.

Figure 2. One-year survival between readmission patients who were preventable or not (66.8% vs. 100%, log rank=1.668, $P=0.196$). There was a trend that patients who were preventable had longer 1-year survival. However, no significant difference was reached.

Table 1. Clinical characteristics of 39 readmitted patients

Clinical characteristics	Value (n=39)
Age (years)	60 (54–72)
Male gender, n (%)	29 (74.4)
Comorbidities	
History of hypertension, n (%)	14 (35.9)
History of coronary heart disease, n (%)	5 (12.9)
History of diabetic mellitus, n (%)	7 (17.9)
SAPS 3 at first admission	41 (31–51)
SOFA at first admission	2 (2–4)
Length of time on ward prior to readmission (hours)	43 (24–128)
Mechanical ventilation during ICU, n (%)	36 (92.3)
Presence of ARDS during ICU, n (%)	4 (10.3)
Presence of AKI during ICU, n (%)	7 (17.9)
Presence of sepsis and septic shock during ICU, n (%)	29 (74.4)
Duration of mechanical ventilation (days)	5 (2–14)
ICU length of stay (days)	10 (6–16)
ICU mortality, n (%)	6 (15.4)
Hospital length of stay (days)	28 (21–51)
Hospital mortality, n (%)	6 (15.4)

SOFA: sequential organ failure assessment; SAPS 3: simplified acute physiology score 3; AKI: acute kidney injury; ARDS: acute respiratory distress syndrome; ICU: intensive care unit.

Table 2. Reasons for ICU readmission

Reasons	First admission (n=39)	Readmission (n=39)	P value
Pulmonary	30 (76.9)	28 (71.8)	0.604
Cardiovascular	5 (12.8)	8 (20.5)	0.362
Neurological	2 (5.1)	2 (5.1)	1.000
Endocrine	2 (5.1)	0	0.474
Infectious disease	0	1 (2.6)	0.314

ICU: intensive care unit.

compared with patients who were unpreventable (100% vs. 66.8%, log rank=1.668, $P=0.196$). However, no significant difference was reached.

DISCUSSION

In this study, we found that most readmission patients were unpreventable, and patients who were late readmission were all unpreventable. There were no significant differences in short term outcomes and 1-year survival in patients whose readmissions were preventable or not.

Conflicting results exist regarding the role of readmission rate as a quality indicator. Early study found that 62% of the readmission patients had one or more warning signs which might change the treatment plan of the attending physician, including delaying discharge from ICU, or shifting to a stepdown unit. All these may prevent costly and potentially lethal patient outcomes.^[17] However, the sample of the study was small. In 1999, Cooper et al^[18] found that readmission to ICU was not associated with severity-adjusted mortality or LOS in a study involving 103,984 patients in 28 hospitals and question readmission rate as useful measure of hospital performance. Recently, Santamaria et al^[9] studied 10,210 patients and 674 readmissions and found that age, a medical diagnosis, inotrope use, and treatment limitation order were all independently associated with short term outcome. However, no association was found between readmissions and hospital survival. They concluded that readmission to ICU was not an independent unfavorable factor for mortality. A larger sample study involving 229,375 patients conducted in U.S. demonstrated readmission to ICU was associated with a higher risk of hospital mortality and a longer hospital stay.^[5] Therefore,

Table 3. Comparison between readmitted patients who were preventable or not

Clinical variables	Unpreventable (n=32)	Preventable (n=7)	P value
Duration of mechanical ventilation (days)	6.5 (2.0–13.8)	5.0 (1.0–25.0)	0.599
ICU length of stay (days)	10.0 (5.0–15.5)	14.0 (11.0–31.0)	0.054
ICU mortality (%)	6 (18.8)	0	0.568
Hospital length of stay (days)	27.0 (20.3–41.8)	28.0 (24.0–61.0)	0.882
Hospital mortality (%)	6 (18.8)	0	0.568

ICU: intensive care unit.

Table 4. Relationship between timing and preventability in readmitted patients

Time	Unpreventable (n=32)	Preventable (n=7)	P value
Early readmission	17 (53.1)	7 (100)	0.021
Late readmission	15 (46.9)	0	0.021

readmission to ICU is related to increase in-hospital mortality, which is a good reflection on performance.

In our study, most readmissions were unpreventable. Recently, Al-Jaghbeer et al^[10] studied 136 readmission patients and found 120 (88.2%) patients were nonpreventable. Of 136 readmissions patients, a new clinical problem occurred in 67 patients and an existing clinical problem recurred in 53 patients. And only less than 0.2% (16/9,534) patients were judged as preventable. In our study, only 7 patients were preventable, which accounted for 0.2% (7/2,961) in all patients discharged to ward. Therefore, a minority of readmission patients were preventable. From the point of this view, ICU readmission rate was not a reflection of quality.

Another finding of this study was that 29.2% of early readmission patients were preventable, while all late readmission patients were unpreventable. Nishi et al^[1] reported that 21.8% early readmission was preventable in 97 readmission patients. Therefore, in 48 to 72 hours after patients were discharged from ICU, close communication with attending physicians and intense care of patients might reduce the preventable readmission rate. Further studies are needed to clarify whether close follow-up for 48 to 72 hours of patients who discharged from ICU will reduce readmission rate.

The last finding of our study was that there were no significant differences in short term outcomes and 1-year survival in patients whose readmissions were preventable or not. Al-Jaghbeer et al^[10] found that patients who were preventable had marginal significantly reduced ICU LOS compared with patients who were nonpreventable. The finding of this study implies that targeting preventable readmission may decrease ICU LOS, hence reduce the hospital LOS and cost.

There are some limitations of this study. First, this retrospective study was performed in a single center, and the sample was relatively small. Multicenter prospective studies may overcome this shortcoming. Second, the results of this study are from critically ill cancer patients, which may not be applicable to critically ill patients in other tertiary medical centers. Last, judgement of readmission preventability was made subjectively. However, the judgement was made by two senior intensivists, which made the results credible.

CONCLUSIONS

In conclusion, most readmission patients were unpreventable, and all preventable readmissions occurred in early period after discharge to ward. There were no

significant differences in short term outcomes and 1-year survival in patients whose readmissions were preventable or not.

Funding: None.

Ethical approval: The Institutional Review Board of Cancer Hospital approved this study, and therefore the study was performed in line with the ethical Declaration of Helsinki laid down in the 1964 and its later amendments.

Conflict of interests: All authors declared no conflict of interests.

Contributors: Concepts, design, definition of intellectual content, and Manuscript preparation: HJW and XZX; literature search, data acquisition, data analysis, statistical analysis, manuscript editing: HJW; clinical studies: HJW, XZX, SNQ, CLH, HZ, HW, QHY and YG; manuscript review: all authors.

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Received November 28, 2017

Accepted after revision March 10, 2018