The Association Between ICU Readmission Rate and Patient Outcomes*

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Objective: To examine the association between ICU readmission rates and case-mix–adjusted outcomes.

Design: Retrospective cohort study of ICU admissions from 2002 to 2010.

Setting: One hundred five ICUs at 46 United States hospitals.

Patients: Of 369,129 admissions, 263,082 were first admissions that were alive at ICU discharge and candidates for readmission.

Interventions: None.

Measurements and Main Results: The median unit readmission rate was 5.9% (intraquartile range 5.1%–7.0%). Across all admissions, hospital mortality for patients with and without readmission was 21.3% vs. 3.6%, mean ICU stay 4.9 days vs. 3.4 days, and hospital stay 13.3 days vs. 4.5 days, respectively. We stratified ICUs according to their readmission rate: high (>7%), moderate (5%–7%), and low (<5%) rates. Observed and case-mix–adjusted hospital mortality, ICU and hospital lengths of stay were examined by readmission rate strata. Observed outcomes were much worse in the high readmission rate units. But after adjusting for patient and institutional differences, there was no association between level of unit readmission rate and case-mix–adjusted mortality. The difference between observed and predicted mortality was −0.4%, 0.4%, and −1.1%, for the high, medium, and low readmission rate strata, respectively. Additionally, the difference between observed and expected ICU length of stay was approximately zero for the three strata.

Conclusions: Patients readmitted to ICUs have increased hospital mortality and lengths of stay. After case-mix adjustment, there were no significant differences in standardized mortality or case-mix–adjusted lengths of stay between units with high readmission rates compared to units with moderate or low rates. The use of readmission as a quality measure should only be implemented if patient case-mix is taken into account. (*Crit Care Med* 2013; 41:24–33)

Key Words: ICUs; length of stay; mortality rate; patient readmission; quality assessment; resource utilization

The frequency of ICU readmission appears to have increased over the last 20 yrs. In four large U.S. multi-institutional studies, ICU readmission rate was 4.6% from 1988 to 1989 (1), 5.6% from 1993 to 1996 (2, 3), and 6.4% from 2002 to 2003 (4). These values, however, may underestimate readmission rates because they are based on all admissions rather than only the number of patients discharged alive (3, 5).

ICU readmission rate is of concern because these patients have a higher mortality and longer ICU and hospital lengths of stay (3, 5–8). In addition, studies report that 22% to 42% of readmitted patients may have been prematurely discharged (5, 7, 9, 10). It is intuitive that readmission rate might be an attractive quality indicator because it is easily measured, associated with poor outcomes, and discharge decisions are subjective and to some extent influenced by bed demand (11–14). Two organizations have recommended using the unplanned ICU readmission rate within 48 to 72 hrs as a clinical performance measure (15, 16). Although ICU readmission is associated with adverse outcomes and premature discharge, there is no convincing link between readmission rate and objective measures of quality (3, 8, 17, 18).

There are additional problems with using ICU readmission as a quality measure. First, it is difficult to establish an acceptable readmission rate because rates differ with case mix (5, 6). A recent study examined patient-specific factors that influence readmission (19). This study demonstrated that multiple patient characteristics, most importantly severity of illness at

*See also p. 331.

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ICU admission and discharge, are associated with the risk for readmission. Second, ICUs with a low readmission rate may simply have a length of stay that is longer than necessary. Third, in ICUs with high readmission rates, it is unclear whether a longer ICU stay would prevent deterioration and readmission. Finally, physicians must be able to alter the rate of readmission to make it a viable quality measure. Although methods have been developed to help physicians make safer ICU discharge decisions, these tools have not been externally validated or widely used (20–22).

The objectives of this study are: 1) to describe the frequency of ICU readmission across multiple ICUs; and 2) to determine whether high ICU readmission rates are associated with increased case-mix–adjusted mortality and lengths of stay.

METHODS

Data were obtained from admissions from January 1, 2002, to December 31, 2010, in ICUs that had installed an Acute Physiology and Chronic Health Evaluation (APACHE) system. The APACHE system (Cerner Corporation, Kansas City, MO) provides information for ICU performance benchmarking and quality improvement. Data from each hospital were stripped of patient identifiers in compliance with Health Insurance Portability and Accountability Act requirements. This study was reviewed by the Institutional Review Board at Baystate Medical Center and deemed not to be human subject research requiring Institutional Review Board approval.

Patient Data

Data were generated as a result of patient care and collected on day 1 after admission for consecutive unselected first ICU admissions, first ICU discharges, first ICU readmissions, and at hospital discharge. The institutional, demographic, clinical, and physiological data collected are shown in **Appendix 1**. Details about APACHE data collection and reliability have been described elsewhere (23–25). The characteristics of each hospital and unit were self-reported. We excluded patients with burns, ICU stay lasting <4 hrs, patients aged <16 yrs, ICU nonsurvivors, and ICU survivors who were not candidates for readmission during the same hospitalization. ICU survivors who were not candidates for readmission included patients directly discharged from the ICU to home, another hospital, another ICU, or a postacute care facility.

Outcomes recorded after each patient's first ICU admission included hospital mortality and exact length of stay at ICU and hospital discharge. Lengths of stay were measured in minutes and converted to days and fractions of days. ICU stay was truncated at 30 days and hospital stay at 50 days to limit the influence of extreme outliers (4, 26).

ICU readmission was defined by a patient's return to the same or a different ICU after discharge to an area that provided a lower level of care during the same hospital stay. For each first ICU admission, we compared characteristics and outcomes for patients with and without readmission. Univariate statistical comparisons used Student's *t* test to derive *p* values for continuous variables and the chi-square test for categorical variables.

Analysis of Readmission Rates Across ICUs

We calculated each ICU's readmission rate by dividing the number of readmissions at each ICU by the number of patients who were discharged alive and were candidates for readmission. We eliminated ICUs that collected data for <400 patients to ensure a sufficient number of readmissions for analysis. To examine the impact of ICU type at readmission, we compared rates across medical, surgical, mixed medical–surgical, cardiothoracic surgical, cardiac, and neurological ICUs.

To examine the association of mortality and resource use with ICU readmission, we defined three readmission strata representing low (<5%), moderate (5%–7%), and high (>7%) rates. These ranges were selected as they represent the first quartile, interquartile range, and the last quartile, respectively. Patient factors previously identified as being associated with readmission (3, 5, 7, 19) were compared across ICUs in these three strata. Because an increased risk for ICU readmission has been associated with increased ICU occupancy (11, 13, 14, 27) and with night (11, 28, 29) and weekend discharge (30), we also examined the association of these factors with high, moderate, and low readmission rates. To assess occupancy, we first calculated the daily census for each ICU. We then calculated the following for every patient: difference between the daily census on the day before the patient's ICU discharge and that ICU's mean census during the previous 2 wks. Nighttime discharge was defined as a discharge occurring between 1900 and 0700 hrs. Weekend discharge was a discharge on Saturday or Sunday. The availability of a step-down unit (SDU) was based on whether an ICU discharged at least 10% of patients to an SDU.

The association of the three readmission rate levels with case-mix–adjusted outcomes was examined as follows: predicted hospital mortality, ICU length of stay, and hospital length of stay were calculated using the APACHE IV models (4, 23, 26). These predictions were summed across admissions within each ICU and compared to the observed outcome. We excluded patients admitted from another ICU in this analysis due to inaccuracies in outcome predictions caused by the impact of prior life support on day 1 physiological data (4, 23). Because the APACHE IV models were validated for consecutive unselected ICU admissions, these analyses were performed using day 1 data for all ICU admissions. Observed and expected mortality were compared using the chi-square test, and observed minus expected lengths of stay were compared using the paired *t* test.

RESULTS

There were 369,129 ICU admissions to 130 ICUs at 60 U.S. hospitals from 2002 to 2010. We excluded 26,582 admissions who died before ICU discharge, 2,035 admissions with age <16 yrs, ICU length of stay <4 hrs, or a burn diagnosis and 47,268 ICU survivors who were not candidates for readmission because of discharge to home, another hospital, another ICU, or a postacute care facility. In addition, we excluded 23,067 admissions that were a second or later readmission. These exclusions left 270,177 admissions (73.2% of the database), of which 7,095 (1.9%) were eliminated because they occurred in ICUs that had <400 admis-

sions. Thus, our analyses were carried out on 263,082 admissions (71.3%) in 46 hospitals and 105 ICUs.

Characteristics of the hospitals and ICUs are shown in **Table 1**. The 46 hospitals were well dispersed across bed size, teaching status, and geographic region except the Northeast. The median number of total ICU admissions at each hospital was 3,322 (intraquartile range 1629–8600). The 105 ICUs varied in type and included 13 specialized cardiac (coronary) and nine neurological units. Although only two ICUs were specifically designated as trauma units, another ten units had >25% of their admissions with a trauma diagnosis. Of the 105 ICUs, 83 (79%) had access to a SDU available as evidenced by >10% of their admissions being discharged there. The median number of admissions at each ICU was 1,932 (intraquartile range 937–5138).

TABLE 1. Characteristics of Participating Hospitals ($n = 46$) and ICUs ($n = 105$)

Characteristics	*n* (%)
Region	
Northeast	4 (8.7)
South	12 (26.1)
Midwest	17 (37.0)
West	13 (28.3)
Number of hospital beds	
<300	10 (21.7)
301–399	12 (26.1)
400–524	6 (13.0)
525–799	9 (19.6)
≥800	9 (19.6)
Hospital teaching status	
Council of Teaching Hospital member	16 (34.8)
Teaching, not member of Council of Teaching Hospital	15 (32.6)
Nonteaching	15 (32.6)
Number of participating intensive care units at each hospital	
1	22 (47.8)
2	9 (19.6)
3	6 (13.0)
≥4	9 (19.6)
Type of ICU	
Cardiac (coronary)	13 (12.4)
Cardiothoracic	8 (7.6)
Medical	17 (16.2)
Surgical	19 (18.1)
Mixed medical–surgical	37 (35.2)
Neurological	9 (8.6)
Trauma	2 (1.9)
Step-down unit readily available[a]	83 (79.0)

[a]Defined as having at least 10% of discharges go to step-down units.

Patient Characteristics and Outcomes

Among the 263,082 admissions, 16,481 (6.3%) had one or more ICU readmissions; 11,134 (68%) were to the same ICU that originally discharged the patient. Patient and institutional factors based on whether or not there was an eventual readmission are shown in Appendix 2. Compared to patients who were not readmitted, those with readmission were significantly older, had more comorbidities, nonoperative diagnoses, dialysis, emergency surgery, physiological abnormalities (higher acute physiology score [APS]), longer initial ICU stay, and were more frequently discharged to a SDU at ICU discharge (all $p < 0.001$).

Readmitted patients had a significantly higher postdischarge mortality than patients not readmitted (21.3% vs. 3.6%), longer initial ICU stays (4.9 days vs. 3.4 days), and longer hospital stays (13.3 days vs. 4.5 days). All p values were < 0.001. Among readmissions, 5,631 readmissions (34.2%) were within 48 hrs.

Readmission Rates Across ICUs

Figure 1 shows the distribution of ICU readmission rates for the 105 units. Mean readmission rate was 6.3% (range 1.2% to 14.5%), and the median rate was 5.9% (interquartile range 5.0% to 7.1%). Patient characteristics at units with low, moderate, and high readmission rates are compared in **Table 2**. Patients at ICUs with high readmission rates had a higher APS and longer hospital stay before admission; were more likely to have at least one chronic health condition, admitted to hospitals with a large number of beds, be a medical admission, and discharged at night; and were less likely to be admitted after cardiac surgery. Patients at ICUs with low readmission rates were less likely to have an SDU available, and had the lowest percentage of medical admissions as well as patients requiring mechanical ventilation. An increase in the daily census the day before discharge, marking limited bed availability, was highest in the units with a low readmission rate.

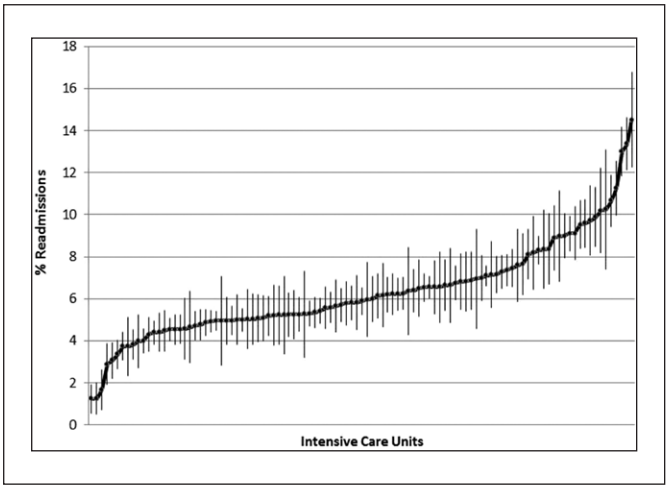

Figure 1. Percentage of patients who were ICU readmissions and 95% confidence interval at 105 ICUs.

TABLE 2. Risk Factors for Potential Readmission, Stratified by Unit Readmission Frequency[a]

Risk Factor	Frequency of ICU Readmission		
	Low (≤5%) *n* = 101,112	Moderate (5.1%–7%) *n* = 145,257	High (>7%) *n* = 102,600
Acute Physiology Score, mean (SE)	40.0 (0.1)	39.9 (0.1)	**44.5 (0.1)**
Age, mean (SE)	**62.7 (0.1)**	61.7 (0.1)	60.2 (0.1)
Hospital stay before intensive care unit admission (hrs), mean (SE)	16.5 (0.1)	19.0 (0.1)	**28.5 (0.1)**
% With ≥1 chronic health item	11.7	11.6	**19.4**
% Mechanical ventilation on day 1	38.2	**41.7**	**41.2**
% Active life-supporting therapy on day 1[b]	23.8	22.3	**25.0**
% Medical admissions	66.2	68.9	**71.7**
% Coronary artery bypass graft and/or valve surgery	9.4	9.6	**1.7**
% Emergency surgery	5.0	4.9	**5.8**
% Unable to have Glasgow Coma Score assessed (sedated)	**7.6**	4.9	5.9
% Dialysis at admission	4.3	4.5	**5.2**
% With step-down unit in the hospital	53.5	**84.1**	77.5
Number of beds in hospital, mean (SE)	544 (0.9)	507 (0.6)	**820 (0.5)**
% Discharged Saturday or Sunday	24.3	24.5	**25.9**
% Discharged from 7:00 PM to 6:59 AM	16.3	22.8	**24.0**
% With increase in daily census[c]	**26.5**	23.7	23.7

[a]Bold numbers indicate highest risk. For % on mechanical ventilation on day 1, the moderate and high readmission groups had similar values, so both of those cells were bold.

[b]Not including mechanical ventilation.

[c]Increase in census the day before discharge vs. 7-day mowving average.

Association of ICU Readmission Rate With Risk-Adjusted Outcomes

Observed and adjusted hospital mortality stratified by readmission frequency is shown in **Figure 2**. There was a substantial increase in mortality across the three readmission strata: 10.0% in the low readmission rate group, 11.6% in the moderate rate group, and 13.3% in the high rate group. After adjustment for patient risk factors, these differences ceased to exist. **Figure 3** shows mean observed and predicted ICU and hospital lengths of stay, stratified by readmission frequency. As with hospital mortality, a trend existed between increasing readmission and increasing ICU length of stay. However, the difference between observed and expected ICU lengths of stay was almost zero (4–5 hrs) within each readmission strata. For hospital length of stay, the observed minus expected values were slightly better for the low (-16 hrs) and moderate (-16 hrs) readmission rate groups than for the high (-5 hrs) rate ICUs. These differences, however, were negated after taking into account the length of hospital stay before ICU admission (Table 2).

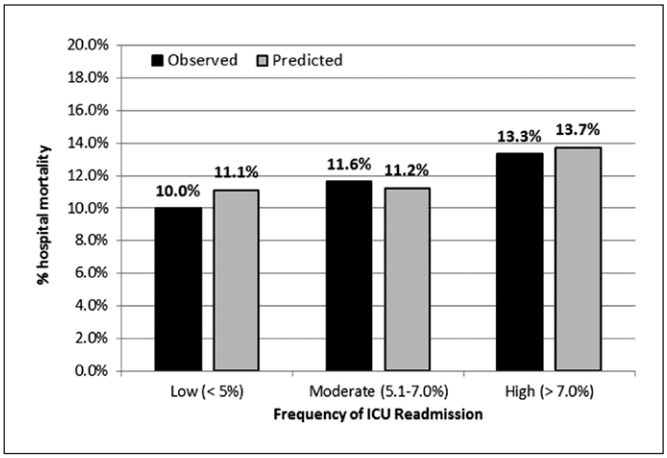

Figure 2. Mean observed and predicted hospital mortality among 105 ICUs stratified by frequency of readmission, high (>7%), moderate (5%–7%), or low (<5%).

DISCUSSION

This study examined the readmission rate for ICU survivors at 105 U.S. units for 263,082 admissions from 2002 through 2010. Compared to patients who were not readmitted, ICU readmis-

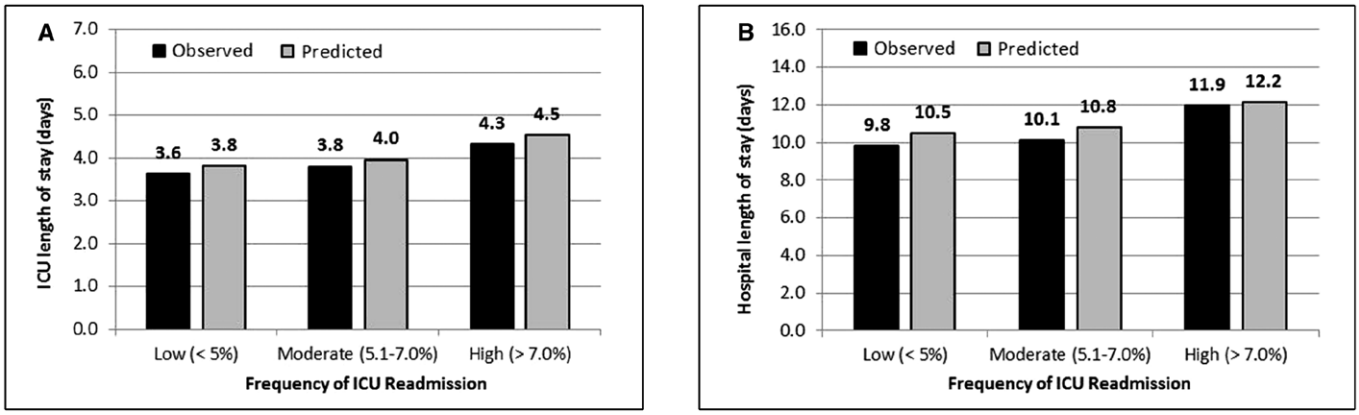

Figure 3. **A**, Mean observed and mean predicted ICU length of stay, stratified by frequency of unit readmission, high (>7%), moderate (5%–7%), or low (<5%). **B**, Mean observed and mean predicted hospital length of stay, stratified by frequency of unit readmission, high (>7%), moderate (5%–7%), or low (<5%).

sions were significantly ($p < 0.001$) older, had more comorbidities and nonoperative diagnoses, greater severity of illness, a higher hospital mortality, and longer ICU and hospital stays. The characteristics, risk factors, and outcomes of these ICU readmissions have been described in greater detail in a recent publication (19), and are similar to those in previous reports (3, 5–7, 10, 18). Institutional factors also influenced the risk for ICU readmission. The univariate relative risk for ICU readmission was higher in cardiac, medical, and surgical ICUs (1.11–1.13); the Northeast (1.54); teaching hospitals (1.13–1.49); and among patients discharged to a SDU (1.19) or at night (1.11). We did not find an increased risk for readmission in patients discharged on weekends or when there was an increased census on the day before discharge.

The 6.3% readmission rate is within the 6.0% to 8.8% range reported for single (20, 31, 32) and multiple U.S. ICUs (33) over the last decade. The 6.7% readmission rate for cardiac (coronary) ICUs may reflect the recently reported increase in complexity and severity of illness among these patients (34, 35). We included cardiac ICUs in our study because their outcomes and performance are of interest to most hospitals. There was considerable variability in readmission rates across ICUs. Units with higher readmission rates had an increased mean hospital mortality, ICU and hospital lengths of stay. These results have been previously reported (3, 5–7), although not in a cohort as large as the one in this study.

Because readmission rate is easily measured and is associated with worse patient outcomes, it is tempting to consider it as a quality measure. However, we found no association between unit readmission rate and quality of care as reflected by aggregate mortality and lengths of stay when adjusted for patient case mix. This lack of a consistent association between ICU readmission rate and case-mix–adjusted measures of ICU performance in our study confirms and extends findings from 38 ICUs at 28 hospitals in Northeast Ohio (18). Furthermore, there were major differences among the low, moderate, and high readmission subgroups in factors that affect outcome apart from quality of care. Patients in ICUs with a high readmission rate had the highest mean APS, were more likely to be a medical admission, and have at least one chronic health condition. Conversely, patients in ICUs with a low readmission rate had the highest percentage of patients initially admitted after cardiac surgery. The above suggests that readmission rate is more of a proxy for patient characteristics, particularly severity of illness, than a quality measure for ICUs.

Our findings have several implications: First, they indicate that high ICU readmission rates are associated with the care of patients with more severe and complex illnesses. This means that tracking readmission rates within or across ICUs without accounting for case mix would penalize ICUs that care for more severely ill patients. Our findings strongly suggest that although ICU readmission rates are easily measured, they are of little value as an indicator of quality of care. ICUs with a high readmission rate might have a higher mortality or length of stay, but this could be attributable to patient risk factors rather than quality of care. Second, future studies of ICU readmission should eliminate from consideration patients who die before ICU discharge (3, 5) as well as patients who are not candidates for readmission. Among 369,129 ICU admissions, our analysis eliminated 26,582 (7.2%) who died before ICU discharge and 42,237 (11.4%) patients who could not be readmitted during the same hospitalization. Failure to eliminate the large number of patients who cannot be readmitted because of discharge to home, another hospital, another ICU, or a postacute care facility results in an artificially low readmission rate. Third, patients are readmitted to ICUs for reasons that are numerous and complex. Multiple patient and institutional factors such as time of discharge and the availability of SDU beds affect risk for readmission. The complexities of these factors indicate that predicting readmission for individual patients would be very difficult. Fourth, our earlier report of an (19) increased risk for ICU readmission among patients discharged to an SDU raised a concern that SDUs "may just act as a revolving door for some patients" (36). The absence of differences in adjusted mortality and resource use among ICUs with high, moderate, and low readmission rates in this analysis suggests an alternative explanation. The availability of a SDU may allow physicians to discharge ICU patients with physiological abnormalities that pose an increased risk for readmission. Because the increased risk for ICU readmission among SDU patients is not associated with an increase in adjusted mortality and resource use,

these patients do not appear to suffer consequences from what in retrospect might have been a premature ICU discharge. In other words, SDUs may be functioning as a "safety zone" for patients at increased risk for readmission after ICU discharge.

Finally, our study has implications for assessing hospital readmission rates. Similar to ICU readmission, patient and institutional characteristics also influence hospital readmission rate (37, 38), and the enumeration and tracking of patients following hospital discharge are also complex (39, 40). These factors should also be accounted for when assessing the relationship between hospital readmission rates and quality of care. The simplicity of measuring hospital readmission rate makes the use of raw data an enticing quality measure, but may do more harm than good.

Our study has several limitations. First, our results may not be representative of all U.S. ICUs because we only studied units that had installed an APACHE system and only 9% of the study hospitals were in the Northeast. In addition, our results may not apply to ICU readmissions in countries with different healthcare systems. Second, we may have overestimated the frequency of unanticipated readmissions because we could not identify planned readmissions, particularly surgical and trauma patients who return to the ICU following staged operative procedures (3, 6, 18), and patients readmitted to an ICU not collecting APACHE data. Third, our data did not include information about do-not-resuscitate orders or treatment limitations. Although these limitations might impact ICU readmission rates, a prior study showed no difference in rates for patients with and without do-not-resuscitate orders (5). Fourth, we acknowledge that adjusted mortality and lengths of stay are not the only measures of ICU performance and quality. Structural and process measures also reflect ICU quality and performance. Fifth, physiologic derangement was assessed using the day 1 APS, rather than the day of discharge APS. Our previous study of patient-level factors showed that the APS taken on day 1 and day of discharge, respectively, were both associated with subsequent readmission risk (19). Although the day of discharge APS was more strongly associated with readmission risk than day 1 APS in our prior study, the predictive equations used in this study were all day 1 equations, thus we utilized the day 1 APS in our prediction of outcomes. Finally, we could not determine if longer ICU stays or the use of objective models to assist discharge decisions might prevent readmission or change outcomes.

CONCLUSIONS

Readmission rates vary considerably across ICUs. Using readmission rate to assess ICU performance might be counterproductive, as ICUs with high readmission rates provide care for patients with more complex and severe illnesses. After adjusting for these factors, high unit readmission rates are not associated with increased hospital mortality, ICU length of stay, or hospital length of stay.

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APPENDIX 1. Data Collected for ICU Admissions and Used to Assess Patients With and Without ICU Readmission

Variable	Measurement
Sex	Male (reference), female
Age	Continuous measure
Acute physiology score variables on ICU day 1	Weight determined by most abnormal value on ICU day 1 and day of discharge, sum of weights equals the acute physiology score, which ranges 0–252. Variables include pulse rate, mean blood pressure, temperature, respiratory rate, P_{AO_2}:F_{IO_2} ratio (or A-aD_{O_2} for intubated patients with F_{IO_2} >0.5), hematocrit, white blood cell count, creatinine, urine output, blood urea nitrogen, sodium, albumin, bilirubin, glucose, acid base abnormalities, and neurological abnormalities based on Glasgow Coma score. Continuous measure
Chronic health items	Acute immunodeficiency syndrome, cirrhosis, hepatic failure, immunosupression, lymphoma, leukemia or myeloma, metastatic tumor. Not used for elective surgery patients. Binary variable created for 0 vs. >0 items
ICU admission diagnosis	116 Acute Physiology and Chronic Health Evaluation IV categories. Listed in references (4, 23)
Location prior to ICU admission	Operating or recovery room, emergency room, acute care floor (reference), step-down unit, transfer from another ICU, other hospital, direct ICU admission from home, and other/unknown
Length of stay before ICU admission	Square root of time from hospital admission to ICU admission (in fractional days)
ICU discharge destination	Acute care floor (reference), step-down unit, other
ICU length of stay, first admission	Continuous measure, truncated at 30.0 days
Hospital length of stay	Continuous measure, truncated at 50.0 days
Patient admitted after emergency surgery	Yes, no
Active therapy on day 1	Patient received one or more of 32 active life-supporting therapies not including mechanical ventilation
Ventilated on day 1	Yes, no
Duration of mechanical ventilation	<4 days (reference), ≥4 days
Diabetes	Yes, no
Dialysis at admission	Yes, no
Unable to assess Glasgow Coma score due to sedation/paralysis on day 1	Yes, no
Glasgow Coma score on day 1	Binned into the following ordinal categories: 3–6, 7–10, and 11–14 and 15

APPENDIX 2. Patient and Institutional Characteristics for ICU Survivors Who Were Candidates for Readmission: Univariate Relative Risk and *p* Value

	No. Admissions	% Readmission	Relative Risk	*p*
Categorical variables of sex				
Female	116,223	6.0	0.92	<0.001
Male	146,711	6.5		
Location prior to first admission				<0.001
Operating room, recovery room	92,300	5.6	0.63	
Emergency room	88,610	5.2	0.58	
Other ICU	8,417	6.3	0.71	
Other hospital	26,249	7.4	0.83	
Direct admission[a]	1,022	4.9	0.55	
Step-down unit	11,196	9.7	1.08	
Telemetry	1,730	7.3	0.83	
Floor	32,046	9.0	Reference	
Discharge destination at ICU discharge				<0.001
Step-down unit	96,208	7.0	1.19	
Telemetry	8,494	5.1	0.87	
General floor/other	158.380	5.9	Reference	
Emergency surgery = yes	14,302	7.5	1.22	<0.001
No	248,779	6.2		
Received active therapy on day 1 (not including mechanical ventilation) = yes	62,862	6.1	0.97	0.06
No	197,442	6.3		
Sedated, unable to assess Glasgow Coma score on day 1 = yes	15,229	7.3	1.18	<0.001
No	247,846	6.2		
≥1 chronic health conditions = yes	33,943	8.6	1.45	<0.001
No	229,139	5.9		
Diabetes = yes	68,133	7.1	1.18	<0.001
No	194,949	6.0		
Dialysis = yes	11,443	9.4	1.54	<0.001
No	254,631	6.1		
Mechanically ventilated on day 1 = yes	97,885	7.4	1.31	<0.001
No	165,192	5.6		
Admission on weekend = yes	55,313	6.7	1.10	<0.001
No	207,769	6.1		
Discharge on weekend = yes	68,089	6.3	0.98	0.37
No	194,993	6.2		

(*Continued*)

APPENDIX 2 Continued.

	No. Admissions	% Readmission	Relative Risk	*p*
Categorical variables				
Discharge at night (7:00 PM–6:59 AM) = yes	66,770	6.8	1.11	<0.001
No	196,312	6.1		
Glasgow Coma score on day 1				<0.001
3–13	72,482	7.5	1.33	
14	37,775	6.5	1.15	
15	152,442	5.6	Reference	
Hospital bed size				<0.001
<300	47,775	5.6	0.80	
301–399	35,618	5.0	0.71	
400–524	27,729	5.9	0.84	
525–799	41,984	6.4	0.90	
>800	109,976	7.0	Reference	
Hospital teaching type				<0.001
Council of Teaching Hospitals	89,219	7.7	1.49	
Non-Council of Teaching Hospitals Teaching	111,885	5.8	1.13	
Nonteaching	61,978	5.1	Reference	
Hospital region				<0.001
Northeast	14,656	8.3	1.54	
South	96,666	6.4	1.19	
Midwest	98,581	6.4	1.19	
West	53,179	5.4	Reference	
ICU type				<0.001
Coronary	36,181	6.7	1.13	
Cardiothoracic	23,600	5.7	0.96	
Medical	41,646	6.6	1.11	
Neuro	21,809	5.9	0.99	
Surgical	45,105	6.6	1.12	
Trauma[b]	3,824	8.3	1.40	
Mixed	90,917	5.9	Reference	
Change in daily census[c] from 7-day moving average				<0.001
Large decrease (≤–5)	5,072	7.4	1.16	
Small decrease (–2, 3, or 4)	32,753	6.4	1.01	
No change (–1, 0, +1)	157,908	6.4	Reference	
Small increase (+2, 3, or 4)	52,534	5.9	0.92	
Large increase (≥5)	12,928	5.8	0.91	

(*Continued*)

APPENDIX 2 Continued

	No. Admissions	% Readmission	Relative Risk	*p*
Continuous variables (mean + SE) % difference				
Age (yrs)	63.5 + 0.1	61.4 + 0.1	3.4	<0.001
ICU length of stay, first admission only (days)	4.91 + 0.04	3.39 + 0.01	44.8	<0.001
Hospital length of stay (days)	13.25 + 0.11	4.49 + 0.02	195	<0.001
Acute physiology score on day 1	44.9 + 0.2	37.1 + 0.1	21.0	<0.001
Hospital stay prior to ICU admission (days)	0.98 + 0.02	0.58 + 0.01	69	<0.001

[a]Direct admission from ambulatory care facility, home, postacute care facility.
[b]Specifically designated trauma unit; other units may have had trauma admissions.
[c]Census on day before discharge.