Relationship Between ICU Length of Stay and Long-term Mortality for Elderly ICU Survivors

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Abstract

Objective—To evaluate the association between length of ICU stay and 1-year mortality for elderly patients who survived to hospital discharge in the United States.

Design and Setting—Retrospective cohort study of a random sample of Medicare beneficiaries who survived to hospital discharge, with 1 and 3-year follow-up, stratified by the number of days of intensive care and with additional stratification based on receipt of mechanical ventilation.

Interventions—None

Patients—The cohort included 34,696 Medicare beneficiaries older than 65 years who received intensive care and survived to hospital discharge in 2005.

Measurements and Main Results—Among 34,696 patients who survived to hospital discharge, the mean ICU length of stay was 3.4 (±4.5) days. 88.9% of patients were in the ICU for 1–6 days, representing 58.6% of ICU bed-days. 1.3% of patients were in the ICU for 21+ days, but these patients used 11.6% of bed-days. The percentage of mechanically ventilated patients increased with increasing length of stay (6.3% for 1–6 days in the ICU and 71.3% for 21+ days). One-year mortality was 26.6%, ranging from 19.4% for patients in the ICU for one day, up to 57.8% for patients in the ICU for 21+ days. For each day beyond seven days in the ICU, there was

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an increased odds of death by 1-year of 1.04 (95% CI 1.03–1.05) irrespective of the need for mechanical ventilation.

Conclusions—Increasing ICU length of stay is associated with higher 1-year mortality for both mechanically ventilated and non-mechanically ventilated patients. No specific cut-off was associated with a clear plateau or sharp increase in long-term risk.

Keywords

Respirator artificial; critical illness; chronic disease; outcomes research; respiratory care units; mechanical ventilation

INTRODUCTION

Due to advancements in medical technology and management of illnesses such as sepsis, an increasing number of intensive care unit (ICU) patients are stabilized during acute illness following prolonged resuscitation and treatment. These patients develop metabolic, neuroendocrine, immunological, and neuromuscular disturbances, become dependent on intensive care therapies, and may require prolonged organ support. These patients are often described as being "chronically critically ill"(1). The development of this new type of patient in the modern era poses novel challenges for care, prognosis, and health care utilization in the ICU and after discharge (2). Yet, studies are hampered by a lack of data identifying the appropriate at-risk groups, and associated long-term outcomes, and often focus on data from single centers (3–8). In particular, definitions of chronic critical illness vary and outcomes differ based on cohort definitions (9). Most studies use a minimum length of stay in the ICU such as 21 days (10), or 28 days to define this illness (3–5, 7, 8). Several studies have investigated patients who specifically received prolonged mechanical ventilation (ranging from 24 hours to 28 days) (5, 6, 9, 11–18), while others have used the need for tracheostomy (2, 13, 17, 19). However, patients who are mechanically ventilated represent a small subgroup of elderly patients who receive intensive care in the United States (20), and the broader population of hospital survivors who received intensive care remains unexplored.

We therefore sought to determine the relationship between ICU length of stay and long-term mortality for elderly Medicare beneficiaries admitted to the ICU and survived to hospital discharge in order to provide data relevant for both future research and prognostication.

METHODS

Design and Data Sources

We conducted a retrospective, cohort study using data from 2004 through 2008 from the 5% Medicare Standard Analytic Files from the Centers for Medicare and Medicaid Services. The data set contains all fee-for-service claims, including hospital inpatient, hospital outpatient, skilled nursing facility, and "carrier" claims (which includes all office visits), for a random, longitudinal 5% sample of beneficiaries.

Cohort

We created a cohort of all Medicare beneficiaries who were 66 years of age or older who received intensive care in 2005 using a random 5% sample. We categorized any person with intensive care room charges as having received intensive care. We excluded anyone who received intermediate intensive care or only coronary care or intermediate coronary care room charges because these patients have lower hospital mortality and constitute a distinct group of patients with cardiac disease. We then excluded anyone who died during the hospitalization, so that the cohort consisted of patients who survived to hospital discharge.

Data Analyses

The exposure of interest was days spent in the ICU. The primary outcome was one year mortality, and secondary outcome was three year mortality. We first calculated summary statistics for demographic and clinical characteristics, including age, sex, race, and comorbidities of patients by using percentages, means ± standard deviations (±sd), and medians with interquartile ranges (IQR) when appropriate. For the purposes of summary statistics, we grouped patients based on the number of days spent in the ICU (1–6 days, 7–13, 14–20, 21+). Due to the small sample size, we grouped all patients who were in the ICU for 21 or more days together. Using information from the index hospitalization, we identified patients who received any mechanical ventilation, defined as ICD-9 procedure code 31.1 (temporary tracheostomy) or 96.7x (mechanical ventilation) or the Diagnosis-Related Group 483 (tracheostomy with mechanical ventilation > 96 hours) (21). We also stratified patients who received mechanical ventilation as less than 96 hours (96.71) and 96 hours or more (96.72). Non-surgical and surgical patients were defined using DRGs, and we grouped patients by age at hospitalization (66 to 74, 75 to 84, and 85 years and above) for the whole cohort and for mechanically ventilated subgroups. We used data from all health care encounters from the 4 quarters prior to the index hospitalization and secondary diagnoses from the index hospitalization to calculate Elixhauser comorbidities by using ICD-9-CM codes (22). We present counts of the total number of Elixhauser comorbidities (see Appendix Table 1).

We then examined the relationship between total ICU length of stay and 1- and 3-year mortality, with 1-year mortality the primary outcome. We first assessed this visually, and then generated logistic regression models to determine whether there was an increased risk of 1-year mortality associated with each additional day spent in the ICU. Due to the fact that (1) the majority of patients spent 1–6 days in the ICU, and we were interested in determining the relative risk for patients with longer lengths of stay in the ICU, we created a model that excluded patients who spent 1–6 days in the ICU, and used patients who were in the ICU for seven days as the baseline group.

Variables included in the model for risk-adjustment included age, sex, race, Elixhauser comorbidities, whether the patients were medical or surgical, and whether or not the patient was mechanically ventilated. Due to an *a priori* hypothesis of different relationships between ICU length of stay and mortality for patients who did or did not require mechanical ventilation, we assessed for a possible interaction between mechanical ventilation and length of stay in the model using the Breslow-Day test and determined that there was no

statistically significant interaction. Because of the concern for immortality bias associated with longer stays in ICU, we did not include factors that would accrue during a stay in ICU (such as dialysis). We did include mechanical ventilation because it typical occurs on day one in the ICU.

Database management and statistical analysis were performed with Excel (Microsoft, Redmond, WA), and SAS version 9.2 (SAS Institute Inc., Cary, NC) software. All hypothesis tests were two-sided and considered statistically significant if   0.05. We also assessed differences for clinical significance because of the large size of the data set. This research involved secondary analyses of de-identified data and was granted a waiver of consent by the Columbia University Medical Center Institutional Review Board.

RESULTS

After exclusions (Figure 1), the cohort included 34,696 Medicare beneficiaries older than 65 years who received intensive care and survived to hospital discharge in 2005.

ICU Length of Stay

The mean ICU length of stay was 3.4 (±4.5) days for intensive care patients who survived to hospital discharge, with a median of 2 day (IQR 1–4) (Table 1). A third of patients (35.9%) spent only 1 day in the ICU and 88.9% of patients were in the ICU for 1–6 days, representing 58.6% of the ICU bed-days in the cohort. Only 1.3% of patients were in the ICU for 21+ days, but these patients took up 11.6% of bed-days (Figure 2).

Cohort Characteristics

Of the cohort, 47.4% were male and 87.6% were non-Hispanic white (Table 1). The mean age of the cohort was 77.3 ±7.1. Most patients (76.7%) had at least one Elixhauser comorbidity (see Appendix Table 1 for full list of comorbidities), and 33.7% had three or more comorbidities. Among survivors to hospital discharge, almost one quarter of patients had organ failure. For patients in the ICU between 7 and 13 days, over 50% of patients had at least one organ that had failed and for patients in the ICU more than 21 days (three weeks), 75% of patients had one or more organs fail. (Table 1) (23). Stratified by ICU length of stay, gender and age distributions were similar. The percentage of patients who were non-surgical decreased as the ICU length of stay increased, such that only 12.8% of patients who stayed 21+ days were non-surgical.

The majority of patients (90.0%) who were admitted to ICU and survived to hospital discharge were not mechanically ventilated. Among patients who stayed only 1–6 days in the ICU, only 6.3% received mechanical ventilation (Figure 3). This increased to 71.3% of patients who were in the ICU for 21+ days.

Discharge Destination

Among all ICU patients who survived to hospital discharge, 45.5% were discharged to home (Table 1). Very few patients who stayed in the ICU for more than 14 days were discharged home (10.7% for patients 14–20 days; 6.7% for 21+ days). As length of stay in the ICU

increased, the percentage discharged to skilled care facilities or rehabilitation increased (83.0% for patients in the ICU 21+ days).

1- and 3-year mortality

The 1-year mortality ranged from 19.4% for patients who stayed one day in the ICU, up to 57.8% for patients staying 21+ days (Figure 4), and 3-year mortality ranged from 35.1% to 70.4% (data not shown). Characteristics of ICU patients stratified by 1-year survival are reported in Appendix Table 2. Overall mortality for patients who were not mechanically ventilated was lower than for mechanically ventilated patients (Figure 5), with a 1-year mortality of 50.4% for non-mechanically ventilated patients (versus 60.8% for those mechanically ventilated) who received intensive care for 21+ days.

After multivariable modeling, for each day beyond seven days in the ICU, there was an increased odds of death by 1-year of 1.04 (95% CI 1.03–1.05), irrespective of the need for mechanical ventilation (Table 2). This estimate was similar for the model using 3-year mortality adjusted OR 1.04 (95% CI 1.02–1.05) (data not shown).

DISCUSSION

Approximately 1.4 million elderly Medicare beneficiaries survive to hospital discharge after receiving intensive care. Elderly patients who are discharged alive and required prolonged critical care services represent a small portion of all ICU patients, yet this population consumes a disproportionate percentage of health care resources (24). In this cohort of elderly US ICU survivors who were discharged from the hospital, 40% of ICU days were used by the 11% of patients who were in the ICU for one week or more. After experiencing one week of intensive care and surviving to hospital discharge, more than a third of patients died within one year of discharge regardless of whether or not they received mechanical ventilation. We found that overall mortality rates continued to increase with increased length of stay, independent of mechanical ventilation.

Definitions of chronic critical illness used in studies do vary, including mechanical ventilation for more than 24 hours (14, 25), 2 days (26), 4 days (12), 14 days (11, 27), 21 days (6, 9, 16, 18), and 28 days (5); tracheostomy (2, 13, 17, 19); or ICU length of stay of more than 7 days (28, 29), 10 days (30, 31), 14 days (32–35), 21 days (10), and 28 days (3–5, 7, 8). After studying the impact of a categorical continuum of ICU length of stay on mortality, we found that although mortality rates increased with increasing length of stay, there does not appear to be a clear length of stay cutoff at which a patient's prognosis significantly changes. Our data suggest that chronic critically ill patients have a mixed trajectory, likely influenced by specific physiological changes and reserve.

Patients with prolonged mechanical ventilation have been identified as a group with a high mortality who consume a significant proportion of health care resources (6, 9, 36). In our cohort of elderly patients, 60% of patients who were in the ICU for more than a week did not receive mechanical ventilation, and the majority were surgical patients (based on DRG). Limiting economic investigations of the chronically critically ill to patients whose lungs are mechanically ventilated for a prolonged period may underestimate the financial impact of

this unique group of patients (24). Poor outcomes, independent of the need for mechanical ventilation, may be attributable to the observed complications of prolonged critical care: nosocomial infections, immunosuppression, protein-wasting malnutrition, suppression of anterior pituitary hormone secretion, myopathy, posttraumatic stress disorder, and brain dysfunction (1).

Inadequate communication between health care providers and patients and their families is problematic (17, 35). The burden on caregivers and the ability to return home may be important when discussing quality of life after hospitalization. Only a small number of patients who were in the ICU for more than two weeks were discharged to home. Surrogate decision makers consider hospital and 1-year mortality "important to know." A published survey reported that 94% of respondents did not receive information on 1-year survival (37). As patients stay longer and longer in the ICU, significant changes accrue in short- and long-term morbidity and mortality, which may be important to consider in medical decision-making. While we found that only 7% of patients in our cohort who were in the ICU for over 21 days were discharged to home, a little over 40% of those patients survived to 1 year. Although the overall prognosis of chronic critical illness is poor, these data also suggest that a significant number of patients actually survive chronic critical illness. While extended time in the ICU may often feel to caregivers like it must be associated with futile care, this simple marker does not provide any satisfactory cut-point.

The use of an administrative data set and the retrospective nature of this study are limitations. In particular, the use of Medicare data means that the analysis includes only those patients who are older than 65 years. However, the majority of US citizens older than 65 years participate in Medicare (19). Another limitation is that we do not have information about delayed or premature discharge from the ICU, both of which may have an impact on ultimate outcomes for patients and could influence our findings regarding the association between ICU length of stay and outcomes. It is also notable that the majority of long-stay ICU patients who survived to hospital discharge were classified as "surgical" based on their DRG. It is impossible to determine whether this is due to the fact that high-risk surgical patients represent a large proportion of this long-stay group, or whether increased length of stay in the ICU is associated with ultimately requiring a surgical procedure that may determine the DRG. This issue warrants further investigation. We do not have detailed data regarding the length of mechanical ventilation in these patients, which has often been used as a marker of chronic critical illness in other studies. We, therefore, cannot correlate the overall ICU length of stay with the exact length of mechanical ventilation for some patients. Finally, our database does not include physiological measurements that may impact management decisions.

CONCLUSIONS

These data provide important epidemiologic and prognostic information regarding the association between ICU length of stay and outcomes in elderly hospital survivors. After systematically, studying the impact of ICU length of stay on mortality in elderly hospital survivors, we found that long-term mortality rates increase with ICU length of stay regardless of whether or not patients experienced surgery or mechanical ventilation.

Outcome studies of the chronically critically ill that limit inclusion criteria to patients who experience prolonged mechanical ventilation, and are only "medical" will exclude a significant number of at-risk patients. We also found that there is no clear ICU length of stay cut-off that identifies a chronically critically ill population at risk for poor long-term outcome.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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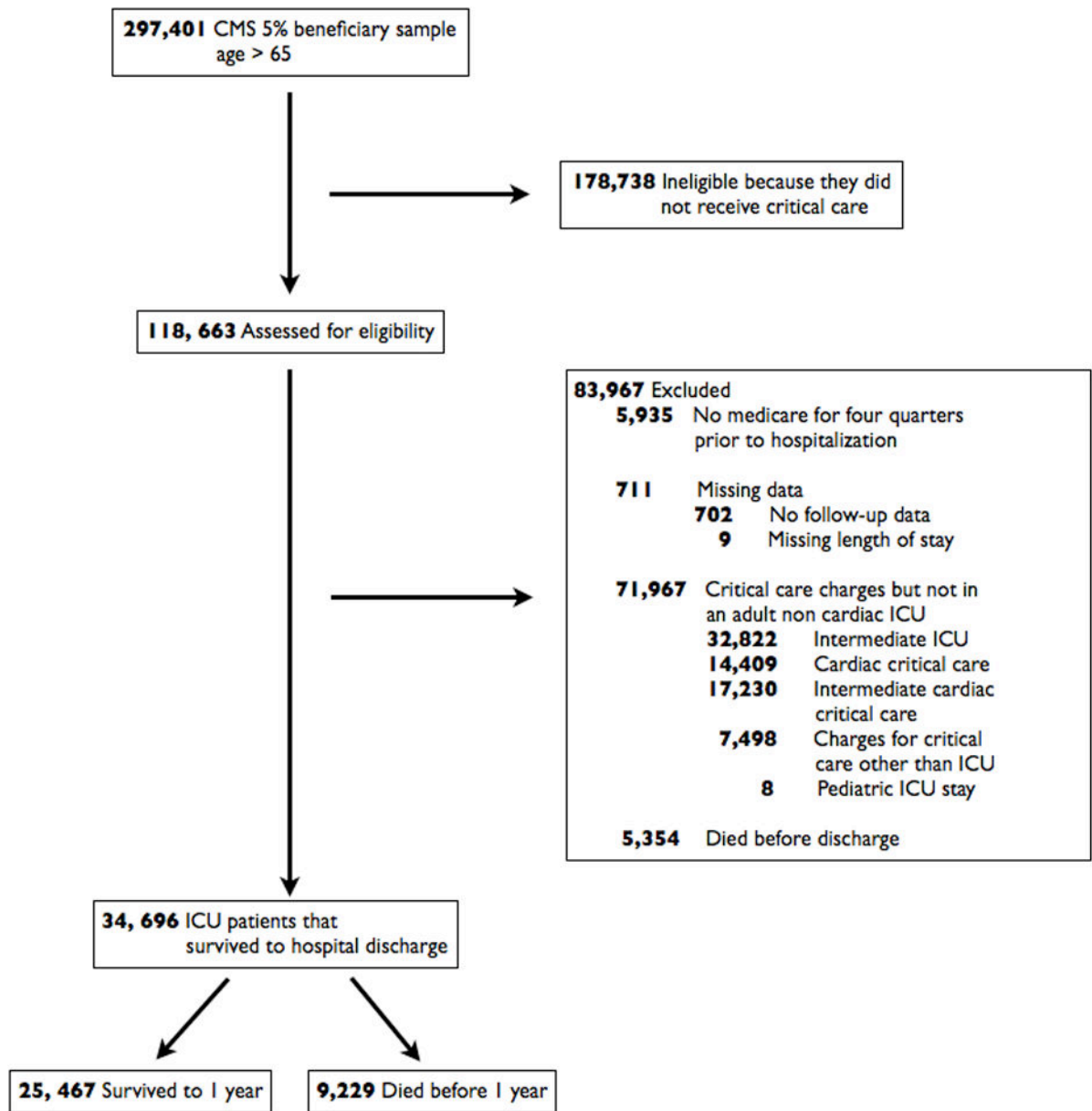
297,401 CMS 5% beneficiary sample age > 65

178,738 Ineligible because they did not receive critical care

118, 663 Assessed for eligibility

83,967 Excluded

    5,935 No medicare for four quarters prior to hospitalization

    711   Missing data
        702 No follow-up data
          9 Missing length of stay

    71,967 Critical care charges but not in an adult non cardiac ICU
        32,822   Intermediate ICU
        14,409   Cardiac critical care
        17,230   Intermediate cardiac critical care
        7,498   Charges for critical care other than ICU
          8   Pediatric ICU stay

    5,354 Died before discharge

34, 696 ICU patients that survived to hospital discharge

25, 467 Survived to 1 year

9,229 Died before 1 year

Figure 1.
Patient flowchart of cohort of ICU survivors

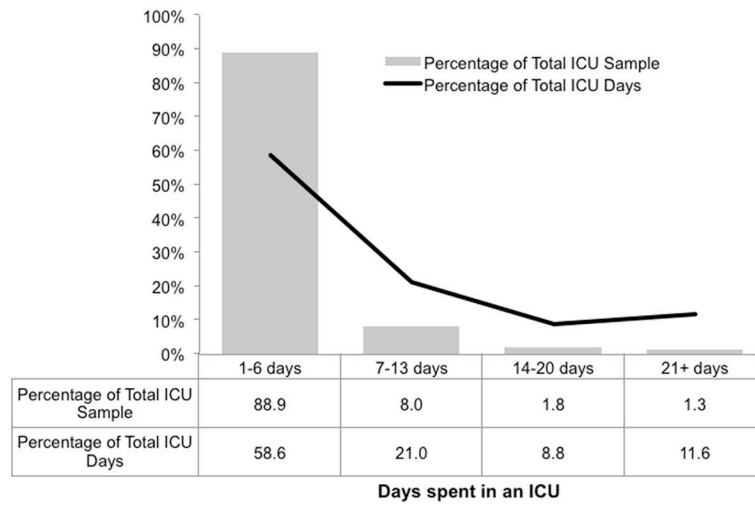|	1-6 days	7-13 days	14-20 days	21+ days
Percentage of Total ICU Sample	88.9	8.0	1.8	1.3
Percentage of Total ICU Days	58.6	21.0	8.8	11.6

Days spent in an ICU

Figure 2.
Distribution of Medicare beneficiaries who survived to hospital discharge, and proportion of total bed days, stratified by length of stay in ICU
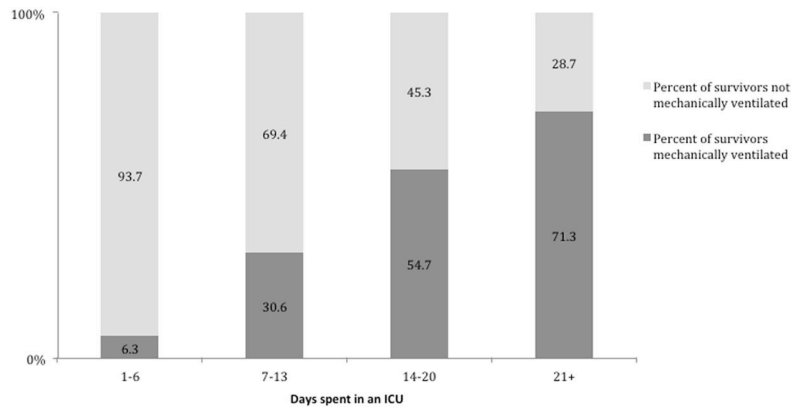
Figure 3.
Percentage of Medicare beneficiaries who survived to hospital discharge who received mechanical ventilation, stratified by length of stay in the ICU
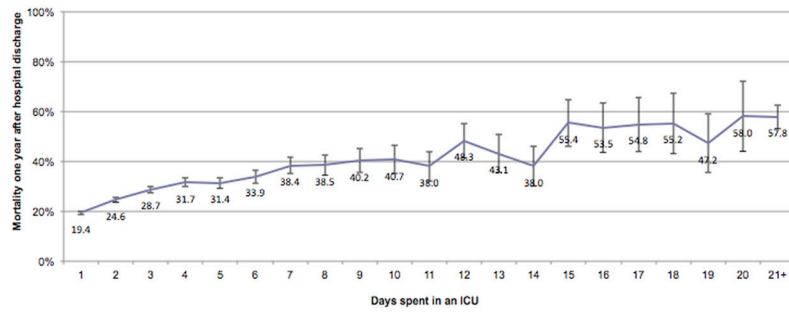
Figure 4.
1-year mortality for Medicare beneficiaries who received intensive care and survived to hospital discharge, by days in the ICU
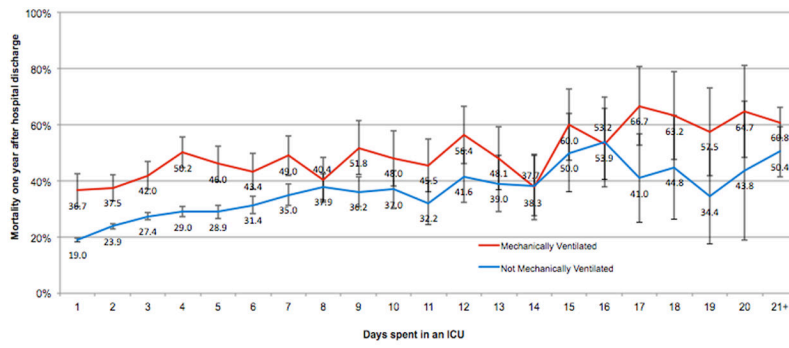
Figure 5.
1-year mortality for Medicare beneficiaries who received intensive care and survived to
hospital discharge, stratified by days in the ICU and whether or not patients received
invasive mechanical ventilation

Table 1

Characteristics of Medicare beneficiaries who received intensive care, stratified by days spent in an ICU

Characteristics	Survived to hospital discharge	Days spent in an ICU (days)			
	(N=34,696)	1–6 (N=30,855)	7–13 (N=2,769)	14–20 (N=636)	21+ (N=436)
Male, n (%)	16,460 (47.4)	14586 (47.3)	1348 (48.7)	318 (50.0)	208 (47.7)
Age, (yrs), median (IQR)	77 (72–82)	77 (72–82)	77 (72–82)	77 (72–81)	75 (70–81)
Age, (yrs) mean (±sd)	77.3 ± 7.1	77.3 ± 7.2	77.5 ± 7.0	76.9 ± 6.5	75.8 ± 6.7
Age, (yrs), n (%)					
66–69	5640 (16.3)	5061 (16.4)	409 (14.8)	82 (12.9)	88 (20.2)
70–74	7875 (22.7)	6979 (22.6)	610 (22.0)	173 (27.2)	113 (25.9)
75–79	8270 (23.8)	7301 (23.7)	699 (25.2)	165 (25.9)	105 (24.1)
80–84	7080 (20.4)	6280 (20.4)	579 (20.9)	135 (21.2)	86 (19.7)
85+	5831 (16.8)	5234 (17.0)	472 (17.1)	81 (12.7)	44 (10.1)
Race, n (%)					
White, non-Hispanic	30375 (87.6)	27124 (87.9)	2362 (85.3)	521 (81.9)	368 (84.4)
Black, non-Hispanic	2964 (8.5)	2535 (8.2)	296 (10.7)	82 (12.9)	51 (11.7)
Hispanic/Other Races	1357 (3.9)	1196 (3.9)	111 (4.0)	33 (5.2)	17 (3.9)
Non-surgical, n (%)	18839 (54.3)	17175 (55.7)	1376 (49.7)	232 (36.5)	56 (12.8)
Co-morbidities[a], n (%)					
0	8098 (23.3)	7401 (24.0)	513 (18.5)	110 (17.3)	74 (17.0)
1	8292 (23.9)	7502 (24.3)	613 (22.1)	99 (15.6)	78 (17.9)
2	6617 (19.1)	5876 (19.0)	509 (18.4)	143 (22.5)	89 (20.4)
3+	11689 (33.7)	10076 (32.7)	1134 (41.0)	284 (44.7)	195 (44.7)
Mechanical Ventilation, n (%)					
None	31235 (90.0)	28899 (93.7)	1923 (69.5)	288 (45.3)	125 (28.7)
<96 hours[b]	2022 (5.8)	1635 (5.3)	321 (11.60)	55 (8.7)	11 (2.5)
96 hours or more[b]	1439 (4.2)	321 (1.0)	525 (19.0)	293 (46.1)	300 (68.8)
Tracheostomy	486 (1.4)	82 (0.3)	84 (3.0)	109 (17.1)	211 (48.4)

Characteristics	Survived to hospital discharge	Days spent in an ICU (days)			
	(N=34,696)	1–6 (N=30,855)	7–13 (N=2,769)	14–20 (N=636)	21+ (N=436)
Organ failure[c]					
None	25675 (74.0)	23995 (77.8)	1370 (49.5)	200 (31.5)	110 (25.2)
1	7110 (20.5)	5699 (18.5)	948 (34.2)	271 (42.6)	192 (44.0)
2+	1911 (5.5)	1161 (3.8)	451 (16.3)	165 (25.9)	134 (30.7)
ICU length of stay, mean (±sd)	3.4 ± 4.5	2.3 ± 1.4	9.0 ± 8.0	16.4 ± 2.0	31.4 ± 12.0
ICU length of stay, median (IQR)	2 (1–4)	2 (1–3)	8 (7–10)	16 (15–18)	28 (23–36)
Non-ICU Hospital length of stay, mean (±sd)	4.6 ± 6.1	4.3 ± 5.4	6.4 ± 7.6	7.8 ± 10.4	9.1 ± 16.3
Total Hospital length of stay[d], mean (±sd)	8.0 ± 8.2	6.6 ± 5.8	15.4 ± 7.9	24.2 ± 10.5	40.5 ± 21.3
Discharge location					
Home	15776 (45.5)	15118 (48.9)	561 (20.3)	68 (10.7)	29 (6.7)
Skilled care/rehab	12866 (37.1)	10455 (33.9)	1595 (57.6)	454 (71.4)	362 (83.0)
Other acute hospital	5101 (14.7)	4530 (14.7)	476 (17.2)	70 (11.0)	25 (5.7)
Hospice	867 (2.5)	670 (2.2)	134 (4.8)	43 (6.8)	20 (4.6)
Other	86 (0.2)	82 (0.3)	NA	NA	NA

Notes:

Abbreviations: ICU, intensive care unit; IQR, interquartile range; sd, standard deviation; NA = not available due to small numbers

[a]Includes only distinct Elixhauser comorbidities that negatively impact mortality; having diabetes with or without complications, and having a tumor with or without metastasis counts as 1 comorbidity each.

[b]Includes patients with tracheostomies

[c]Organ failures defined using the severe sepsis definition from Angus et al. (23)

[d]Hospital length of stay includes both intensive care and hospital days.

Table 2

Multivariable Logistic Regression Analysis of Association between Days Spent in and ICU and Mortality 1 Year after Discharge

Variable	Adjusted OR	(95% CI)	P Value
Spent 7 days in an ICU	*ref*		
Each additional day spent in an ICU	1.04	(1.03–1.05)	<0.0001
White, non-Hispanic	*ref*		
Hispanic/Other Races	0.89	(0.63–1.25)	0.50
Black, non-Hispanic	1.26	(1.01–1.57)	0.04
Female	*ref*		
Male	1.12	(0.98–1.29)	0.10
Age (centered at mean=77 years)	ref		
Age (each 1 year increase)	1.06	(1.05–1.07)	<0.0001
Surgical patient	*ref*		
Medical patient	1.55	(1.34–1.79)	<0.0001
Not Mechanically ventilated	*ref*		
Mechanically ventilated	1.67	(1.44–1.93)	<0.0001
Prior medical history *(ref*=no history of condition)	*ref*		
Congestive heart failure	1.25	(1.07–1.46)	<0.01
Neurological disorders	1.34	(1.10–1.62)	<0.01
Chronic pulmonary disease	1.22	(1.05–1.41)	0.01
Renal Failure	1.36	(1.05–1.76)	0.02
Metastatic Cancer	3.14	(1.93–5.10)	<0.01
Solid tumor w/out metastasis	1.41	(1.13–1.77)	<0.01
Weight loss	1.49	(1.18–1.87)	<0.001
Fluid and electrolyte disorders	1.37	(1.15–1.62)	<0.001
Deficiency Anemias	1.26	(1.08–1.47)	<0.01

Notes:

Abbreviations: OR = odds ratio, CI = confidence intervals, ICU = intensive care unit.

Sample consists of everyone with at least 7 days spent in an ICU n=3,841. Prior medical history is based on Elixhauser conditions defined using ICD-9-CM diagnoses codes from the previous year. Hosmer-Lemeshow goodness -of-fit test, p=0.543