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# Early and Late Unplanned Rehospitalizations for Survivors of Critical Illness*

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## Abstract

**Objectives—**Preventing rehospitalizations for patients with serious chronic illnesses is a focus of national quality initiatives. Although 8 million people are admitted yearly to an ICU, the frequency of rehospitalizations (readmissions to the hospital after discharge) is unknown. We sought to determine the frequency of rehospitalization after an ICU stay, outcomes for rehospitalized patients, and factors associated with rehospitalization.

**Design—**Retrospective cohort study using the New York Statewide Planning and Research Cooperative System, an administrative database of all hospital discharges in New York State.

**Setting—**ICUs in New York State.

**Patients—**ICU patients who survived to hospital discharge in 2008–2010.

**Interventions—**None.

*See also p. 504.



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**Measurements and Main Results—**Primary outcome was the cumulative incidence of first early rehospitalization (within 30 days of discharge), and secondary outcome was the cumulative incidence of late rehospitalization (between 31 and 180 d). Factors associated with rehospitalization within both time periods were identified using competing risk regression models. Of 492,653 ICU patients, 79,960 had a first early rehospitalization (cumulative incidence, 16.2%) and an additional 73,250 late rehospitalizations (cumulative incidence, 18.9%). Over one quarter of all rehospitalizations (28.6% for early; 26.7% for late) involved ICU admission. Overall hospital mortality for rehospitalized patients was 7.6% for early and 4.6% for late rehospitalizations. Longer index hospitalization (adjusted hazard ratio, 1.61; 95% CI, 1.57–1.66 for 7–13 dvs < 3 d), discharge to a skilled nursing facility versus home (adjusted hazard ratio, 1.54; 95% CI, 1.51–1.58), and having metastatic cancer (adjusted hazard ratio, 1.46; 95% CI, 1.41–1.51) were associated with the greatest hazard of early rehospitalization.

**Conclusions—**Approximately 16% of ICU survivors were rehospitalized within 30 days of hospital discharge; rehospitalized patients had high rates of ICU admission and hospital mortality. Few characteristics were strongly associated with rehospitalization, suggesting that identifying high-risk individuals for intervention may require additional predictors beyond what is available in administrative databases.

### Keywords

critical illness; hospital readmission; intensive care; outcomes research; patient readmission; rehospitalizations

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Preventing unplanned rehospitalizations is a target for quality improvement. These rehospitalization events may be indicative of unresolved acute illness, ongoing chronic illness, the development of new medical problems, or gaps in outpatient care (1, 2). Rehospitalizations are costly, with estimates suggesting that 30-day rehospitalizations have an annual cost of $17 billion dollars for Medicare, the largest single insurer in the United States (3). While the Centers for Medicare and Medicaid Services (CMS), the federal agency within the U.S. government responsible for administering national social insurance programs like Medicare, have focused on index conditions such as congestive heart failure, acute myocardial infarction, and pneumonia, one larger group of patients that includes many of the highest risk individuals with these specific diagnoses is the critically ill population. Although the use of intensive care may vary between hospitals (4), ICU admission is a global marker of severity of illness and may provide a manner of identifying sicker patients who may be at highest risk of rehospitalization. Indeed, survivors of critical illness have increased 6-month mortality compared with patients hospitalized without critical illness and have a significant burden of morbidity after an ICU stay (5–8). Although evidence of the sequelae of critical illness accumulates, there is little information about survivors' trajectory of care and their likelihood of seeking or requiring further acute care after their index ICU hospitalization.

With approximately 8 million people a year in the United States admitted to ICUs, critically ill patients represent a very large high-risk population (9). Yet we have minimal information on the frequency of rehospitalizations after critical illness, which patients are at highest risk of rehospitalization, or outcomes associated with rehospitalizations, with prior studies focusing on readmission to the ICU during the same hospitalization (10–12). Thus, the overarching aim of this study was to determine the incidence of rehospitalizations for ICU survivors, with a primary objective of determining the cumulative incidence of early rehospitalization, within 30 days of hospital discharge. We also sought to determine the cumulative incidence of late rehospitalizations, occurring between 31 and 180 days of hospital discharge, to identify patient factors associated with rehospitalization, and to determine the mortality for rehospitalized patients after critical illness.

## METHODS

### Patients and Data Collection

The study protocol was reviewed and approved by the institutional review board of Columbia University Medical Center (IRB-AAAJ2158 New York, NY). Written informed consent was waived. Data for this study came from the New York Statewide Planning and Research Cooperative System (SPARCS) for the years 2008–2010. SPARCS is a comprehensive data reporting system that collects patient-level data, including patient characteristics, diagnoses and treatments, services, and charges for every hospital discharge in New York (NY) State. These data have been used extensively, both on their own and as part of the Nationwide Inpatient Sample, for research purposes (13–15). Within the database, each patient has a unique encrypted identifier, allowing for linkage of hospitalizations over time. Data from SPARCS were also linked to NY State Vital Records and New York City Vital Records to obtain mortality data for all patients.

The cohort consisted of all patients discharged alive after an index acute care hospitalization with admission to an ICU (defined by ICU bed utilization billing codes). Both medical and surgical patients, including cardiac surgery patients, were included in the cohort. Patients with intermediate ICU (step-down unit) care charges, as well as patients with psychiatric ICU charges, were not included. As we did not have data regarding deaths and rehospitalizations occurring outside the state, patients whose primary residence was outside NY were excluded to minimize this loss of information (16). We also excluded patients missing hospital admission or discharge dates or time to death, patients less than 18 years old, and patients with HIV or who had an abortion due to withholding of data on these patients by NY state (Fig. 1). For patients who were transferred to another acute hospital within the SPARCS database, we combined these events into a single acute hospitalization. Any subsequent hospitalization had to have an interval of at least 1 day from the index stay to be counted as a rehospitalization (17). A hospitalization that was planned is operationally defined within the SPARCS database as an admission where the patient’s condition allows time for the admission to be scheduled at least 24 hours prior. Similar to other published estimates, 7.6% of total rehospitalizations in the cohort within 30 days, and 11.4% of within 180 days, were planned (18). As we were interested in examining rehospitalizations that are potentially preventable, planned rehospitalizations were excluded and were not counted as rehospitalization events in this analysis.

### Statistical Analysis

In contrast to prior studies of rehospitalization that used hierarchical logistic regression with the aim of creating risk-adjusted rates by hospital (19–21), we chose to use a competing risk methodology to obtain a better estimate of the true frequency of rehospitalizations. As mortality precludes rehospitalization, use of the Kaplan-Meier method would overestimate the rate of rehospitalizations (22). Consequently, we calculated cumulative incidence, which is the probability of an event (rehospitalization) occurring in a particular time period, modeling death as a competing risk. The primary outcome was the cumulative incidence of first unplanned early rehospitalization (occurring within 30 days of hospital discharge) for the entire cohort, and after stratification by characteristics of the initial hospitalization including 1) receipt of mechanical ventilation, 2) type of patient (surgical vs nonsurgical), 3) age (categorized as age < 60, 60–69, 70–79, and ≥ 80, where groups having similar risk of rehospitalization were combined), 4) use of dialysis during hospitalization, and 5) having a diagnosis of severe sepsis at admission or at any time during hospitalization, using a previously validated claims-based definition that combines the presence of infection with acute organ dysfunction (23). Differences between cumulative incidence functions were assessed using Gray's Test for Equality (24). Secondary outcomes included 1) cumulative incidence of first unplanned late rehospitalization (occurring between 31 and 180 days of hospital discharge) for patients surviving 30 days after discharge without death or rehospitalization, 2) percentage of early and late rehospitalizations necessitating an ICU stay, and 3) percentage of rehospitalizations resulting in death in the hospital. We summarized demographic and clinical characteristics, including admissions diagnoses for patients who experienced early and late rehospitalization. Admission diagnoses were coded using Clinical Classification Software (CCS) diagnostic categories, which are based on the primary diagnosis-related grouping (DRG) for the admission (25). Patients were classified as having the same admission diagnosis if their CCS diagnostic category was the same on rehospitalization. Patients were classified as nonsurgical or surgical based on their primary admission DRG using DRG groupings for year that the hospitalization occurred (available at http://www.cms.gov) (26). We compared differences between groups using chi-square test, *t*-test, and Mann-Whitney *U* test as appropriate.

Risk factors for early and late rehospitalization were examined using a competing risk regression (22, 27). We calculated adjusted hazard ratios (aHRs) and 95% CIs. Covariates that were available and included in the model included age, gender, race (White, Black, Hispanic, Asian, and other), insurance (private, Medicare [a national program that guarantees insurance for Americans over the age of 65, persons with disabilities and end-stage renal disease (ESRD)], Medicaid [a government insurance program for persons of all ages with insufficient income and resources to pay for healthcare], self-pay, other), median household income of the zip code of primary residence, type of patient (nonsurgical, surgical), mechanical ventilation (none, without tracheostomy, with tracheostomy), requiring dialysis during the hospitalization (none, without preexisting ESRD, with preexisting ESRD), severe sepsis, length of stay of the index hospitalization (< 3, 3–6, 7–13, ≥ 14 d), and discharge destination (home, home with services, skilled nursing facility [SNF], inpatient rehabilitation, hospice, other). All individual Elixhauser comorbidities were also included as covariates (Supplemental Table 1, Supplemental Digital Content 1, http://

links.lww.com/CCM/B126) (28). Multicollinearity between covariates was assessed using variance inflation factor and tolerance values (29). We assessed the proportional hazards assumption for the overall model using Schoenfeld-like residual plots. Factors that were both common and associated with the highest risk increase were then combined to form subgroups at highest risk of early rehospitalization that may be potentially targeted. The model was used to generate the predicted cumulative incidence at 30 days of rehospitalization for each subgroup.

### Sensitivity Analysis

As we used a state database, rehospitalizations occurring out of state would not be captured. In order to address this potential problem, we performed a sensitivity analysis excluding all initial hospitalizations for residents of downstate counties of NY (New York City, Richmond, Nassau, Suffolk, Columbia, Dutchess, Orange, Putnam, Rockland, Ulster, and Westchester counties). We chose these counties because southern parts of NY close to New York City are densely populated and are bordered by New Jersey and Connecticut. This area encompasses a large portion of our cohort where some patients may have sought care in a neighboring state after hospital discharge. We assessed cumulative incidence of early and late rehospitalizations, the percentage of patients requiring ICU during rehospitalization, and mortality during rehospitalization to confirm the stability of our primary estimates. Database management and statistical analysis were performed using SAS 9.4 (SAS Institute, Cary, NC) and Stata 13.1 (StataCorp, College Station, TX).

## RESULTS

### Early Rehospitalizations

After exclusions, the cohort included 492,653 ICU patients who survived to hospital discharge (Fig. 1). Seventy-nine thousand nine hundred sixty patients were readmitted to a hospital within 30 days (Supplemental Fig. 1, Supplemental Digital Content 2, http://links.lww.com/CCM/B127), with a cumulative incidence of 16.2%. Patients who had an early rehospitalization were older than patients who were not rehospitalized, had longer index hospitalizations, had a greater number of Elixhauser comorbidities, and were more likely to have been discharged to a SNF or home with health services (Table 1).

The cumulative incidence of early rehospitalizations was higher for patients receiving mechanical ventilation (29.4% for patients with tracheostomy, 20.3% for patients without tracheostomy, and 15.3% for patients not receiving mechanical ventilation; $p < 0.001$) and older patients (21.1% for patients ≥ 80 yr; 18.9% for patients 70–79 yr; 16.2% for patients 60–69 yr; 12.4% for patients < 60 yr; $p < 0.001$). Patients with severe sepsis (25.8% for severe sepsis vs 15.5% for without severe sepsis; $p < 0.001$) and patients who required dialysis (31.3% for patients with preexisting ESRD, 27.9% for patients without preexisting ESRD, and 15.7% for no dialysis; $p < 0.001$) also had a higher cumulative incidence of early rehospitalization. Nonsurgical patients and surgical patients had the same cumulative incidence of rehospitalizations (16.5% for nonsurgical vs 15.9% for surgical; $p = 0.87$) (Supplemental Fig. 1, Supplemental Digital Content 2, http://links.lww.com/CCM/B127).

### Reasons for Early Rehospitalizations

Overall, 16.9% of patients had the same admission diagnosis on early rehospitalization as the index hospitalization. The five most common reasons for early rehospitalization were congestive heart failure, sepsis, “suffering complications from a procedure or medical care,” cardiac arrhythmias, and pneumonia (Supplemental Table 2, Supplemental Digital Content 1, http://links.lww.com/CCM/B126). Nonsurgical patients were twice as likely to be rehospitalized for the same diagnosis as the initial hospitalization compared with surgical patients (22.7% for nonsurgical vs 9.7% for surgical; $p < 0.001$), and reasons for early rehospitalization differed between nonsurgical and surgical patients (Supplemental Table 2, Supplemental Digital Content 1, http://links.lww.com/CCM/B126).

### Resource Use and Outcome During Early Rehospitalizations

Among patients with early rehospitalization, more than a quarter of all rehospitalizations (28.6%) received ICU level care (30.3% of nonsurgical and 26.4% of surgical rehospitalizations). Length of stay for rehospitalizations was 5 days (interquartile range, 3–10 d). Hospital mortality was 7.6% for all rehospitalizations and 15.7% for patients who received ICU care during rehospitalization.

### Patient Characteristics Associated With Early Rehospitalization

The factors with the strongest association with early rehospitalization were having a longer index hospitalization (aHR, 1.91; 95% CI, 1.85–1.97 for hospital length of stay > 14 d; aHR, 1.61; 95% CI, 1.57–1.66 for 7–13 d; $p < 0.001$) or being discharged to a SNF versus discharged home (aHR, 1.54; 95% CI, 1.51–1.58; $p < 0.001$) (Table 2). For mechanically ventilated patients, only those who received a tracheostomy had a clinically significant increase in the risk of rehospitalization versus patients without mechanical ventilation (aHR, 1.27; 95% CI, 1.22–1.33; $p < 0.001$), and patients receiving dialysis were also at increased risk (aHR, 1.33; 95% CI, 1.28–1.38 for patients with preexisting ESRD; aHR, 1.22; 95% CI, 1.15–1.28 for patients without preexisting ESRD; $p < 0.001$) (Table 2). Patients with sepsis also had increased risk of rehospitalization (aHR, 1.14; 95% CI, 1.11−1.17; $p < 0.001$), and of individual Elixhauser comorbidities, metastatic cancer patients had the highest risk of rehospitalization (aHR, 1.46; 95% CI, 1.41–1.51; $p < 0.001$) (Supplemental Table 3, Supplemental Digital Content 1, http://links.lww.com/CCM/B126). Among patients with different types of insurance, those with Medicaid were the most likely to be rehospitalized (aHR, 1.24; 95% CI, 1.20–1.27; $p < 0.001$ vs private insurance). Older age was only weakly associated with an increased risk of rehospitalization (≥ 80 yr vs < 60 yr; aHR, 1.19; 95% CI, 1.16−1.22; $p < 0.001$) (Supplemental Table 3, Supplemental Digital Content 1, http://links.lww.com/CCM/B126). When risk factors were combined to determine subgroups at highest risk, patients with ESRD requiring dialysis who were discharged to a SNF and had a hospital length of stay greater than or equal to 14 days had the highest predicted cumulative incidence of early rehospitalization (38.3%) (Table 3). Each subgroup accounted for a small percentage of overall predicted rehospitalizations (Table 3).

### Late Rehospitalizations

Of 400,689 patients who survived to 30 days without death or rehospitalization, 73,250 patients had a first late rehospitalization (cumulative incidence, 18.9%). Patient characteristics (Table 1), reasons for late rehospitalization (Supplemental Table 2, Supplemental Digital Content 1, http://links.lww.com/CCM/B126), and rates of rehospitalization for the same diagnosis (16.5%) were similar to that of patients with early rehospitalization. In contrast to early rehospitalization, comorbidities were associated with the greatest increases in risk (metastatic cancer: aHR, 1.77; 95% CI, 1.70–1.85; $p < 0.001$) and surgical patients were less likely to be rehospitalized (aHR, 0.73; 95% CI, 0.71–0.74; $p < 0.001$). Risk was further increased for mechanical ventilation with tracheostomy versus no mechanical ventilation (aHR, 1.36; 95% CI, 1.29–1.44; $p < 0.001$) and for patients with ESRD (aHR, 1.54; 95% CI, 1.47−1.60; $p < 0.001$). The strength of association for length of stay decreased (aHR, 1.58; 95% CI, 1.53–1.62 for ≥ 14 d; $p < 0.001$) (Supplemental Table 4, Supplemental Digital Content 1, http://links.lww.com/CCM/B126). Again, over a quarter of all late rehospitalizations (26.7%) were readmitted to an ICU (28.7% of nonsurgical and 23.3% of surgical rehospitalizations), with 4.6% of patients dying during their rehospitalization. In a sensitivity analysis excluding patients living in downstate counties in NY, results for both early and late rehospitalizations were similar (Supplemental Table 5, Supplemental Digital Content 1, http://links.lww.com/CCM/B126).

## DISCUSSION

In a large database of hospital admissions in NY State, we found that the cumulative incidence of first early rehospitalization within 30 days after critical illness was similar to reported rates for other serious conditions that are tracked by CMS (2). The idea of a posthospitalization syndrome has been proposed as an explanatory mechanism for rehospitalizations, where patients have new health concerns, such as loss of strength, nutritional deficits, or cognitive dysfunction, increasing susceptibility to further illness following an acute care hospitalization (2). This syndrome may be more pronounced for patients discharged after an ICU stay, who may experience a "postintensive care syndrome" (30).

We chose to use a cutoff of 30 days for the primary analysis given its wide adoption with respect to policy. As the 30-day time period for rehospitalizations was not derived from clinical evidence (31), we chose to also assess long-term risk of rehospitalization, given that ICU survivors are known to be at higher risk of long-term morbidity and mortality (5). The 30-day period captured half of all first rehospitalizations that occur within a 6-month period, suggesting that the 30-day window is a high risk time period for these patients.

Although many factors were significantly associated with rehospitalization, the magnitude of these associations was weak or moderate. Few patient factors were strongly associated with an increased risk of either early or late rehospitalization, suggesting that it may be difficult to identify high-risk individuals (32). For early rehospitalization, no risk factors conferred more than a doubling of risk for rehospitalization. These results are similar to the models used by CMS to risk adjust rates of 30-day rehospitalization for congestive heart failure, acute myocardial infarction, and pneumonia, where most variables only had weak associations with rehospitalization (19–21). Although several patient factors were related to the acute burden of disease (such as length of hospitalization, mechanical ventilation with tracheostomy, or receiving dialysis during a hospitalization), many factors were associated with a chronic burden of disease, and few are modifiable. Furthermore, consistent with prior studies, we found that the majority of patients were admitted with a different primary diagnosis than their index hospitalization (2, 33). These findings call into question whether rehospitalizations after an ICU stay may be preventable, a concern raised by others related to rehospitalizations in general (34, 35).

Despite these concerns, there may be certain groups of patients at higher risk of rehospitalization who may benefit from intervention. However, when we combined risk factors to identify patients at highest risk of rehospitalization, these subgroups did not account for a large percentage of overall predicted rehospitalizations. This inability to identify large, key subgroups suggests that some of the most significant (and potentially modifiable) risk factors for rehospitalization may not be adequately captured by examining administrative data. Other factors, including clinical factors not captured in administrative data, systems issues particular to individual hospitals, and nonmedical factors such as patients' self-efficacy and patients' support systems, may play an important role in determining whether or not they are rehospitalized. In particular, "nonmedical" factors may be as influential as the medical factors that are commonly examined as interventions focused on increasing patient's capacity for self-care have been found to be more effective at reducing rates of rehospitalization (36).

How to decrease rates of rehospitalization remains elusive, as trials aimed at reducing rehospitalizations that were conducted within the last decade have not been as effective as previous trials (36), and a recent trial of a quality improvement intervention aimed at decreasing the rate of 30-day readmissions did not succeed in decreasing readmissions as a percentage of all hospital admissions (37). Furthermore, our findings regarding risk factors do not provide any clear targets for intervention. ICU clinics and follow-up programs have not yielded significant results with regard to improving long-term outcomes of critical illness (38, 39), but studies of rehospitalization from Canada suggest that access to discharge summaries from the hospitalization may decrease the likelihood of a rehospitalization and that patients who are seen after discharge by physicians who cared for them in the hospital are also at decreased risk (40, 41). Thus, more intensive follow-up with an understanding of the complex events during the hospitalization may be an appropriate approach for this patient population. Furthermore, a meta-analysis of interventions aimed at reducing early rehospitalizations found that interventions that were more complex (involving more components), involved more individuals (such as family members) in plans of care, and focused on increasing patients' capacity for self-care were also more likely to be effective (36). Interventions that combine all of these components together may be necessary to reduce the rate of rehospitalization.

There are several strengths to our study. First, given our data source, we were able to examine rehospitalizations in a large statewide cohort of ICU survivors. Second, we accounted for the competing risk of mortality, which provides more accurate estimates of the frequency of rehospitalization. Most previous studies of rehospitalization have focused largely on the Medicare population; however, patients over 65 years account for only 50% of the ICU population (42). Patients under 60 years had the lowest rates of rehospitalization, and it is important to recognize that these patients have improved outcomes relative to findings in much of the published literature. We were also able to examine the outcomes of patients during rehospitalizations, highlighting the frequent need for admission to ICU, and the relatively high mortality associated with these rehospitalizations in the first 30 days after discharge. Over a quarter of patients rehospitalized required readmission to an ICU, suggesting a high burden of ongoing illness and resource use in this population. Mortality during rehospitalization was 7.6%, which was decreased in comparison to the initial ICU stay (11.0%), but elevated in comparison to nonelective hospital admissions, which have a mortality rate of 2–3% (43). Furthermore, for patients who required ICU care during rehospitalization, mortality was increased beyond that of the index ICU stay.

Our study does have limitations. First, as our data source is a state database, we do not have information regarding transfer of care to hospitals out of state and information about out-of-state deaths. However, we limited our analysis to residents of NY State to minimize the number of missed transfers and deaths. We also performed a sensitivity analysis excluding the downstate areas of NY State, where residents of NY may be more likely to seek care in a neighboring state, and our primary results were largely unchanged. Also, New York is known to be one of the states with a higher rehospitalization rate; as such, our estimates may not be generalizable to other parts of the country (18). Lastly, we were also constrained by the use of administrative data. We relied on revenue codes to identify delivery of critical care services and were limited in terms of information related to actual need for ICU care and what constituted ICU level care. This may have increased the heterogeneity of the cohort with regard to severity of illness as the rate of mechanical ventilation in our cohort was relatively low (14.1%). We also lacked more in-depth clinical data or data regarding social factors that may yield additional risk factors for rehospitalization.

We demonstrate for the first time that the incidence of rehospitalizations after critical illness is comparable to that of other, more homogeneous, serious illnesses, and the cutoff of 30 days captured approximately half of rehospitalizations that occurred within 6 months after hospital discharge. These data further delineate that survivors of critical illness have concerning long-term outcomes, as over 30% of patients were rehospitalized at least once in 6 months following their initial ICU stay, and mortality during rehospitalization was substantially increased in comparison to routine nonelective hospitalizations. Individual risk factors were not strongly associated with an increased risk of rehospitalization, and although high-risk groups could be identified, they accounted for a relatively small percentage of overall rehospitalizations. As we did not identify many factors strongly associated with rehospitalization, this suggests that a large amount of variation in rehospitalization remains unexplained by information captured in administrative data; we may need to better understand trajectories of postdischarge illness and the reasons underlying rehospitalization. It remains debatable whether many rehospitalizations for critically ill patients are preventable. For those that are, it is likely that the most important risk factors, as well as those that are potentially modifiable, have yet to be identified or studied. However, these data provide an additional step toward delineating patients' trajectories after ICU care and confirm that rehospitalizations are common for survivors of critical illness, providing another reason to focus efforts on improving long-term outcomes for these patients.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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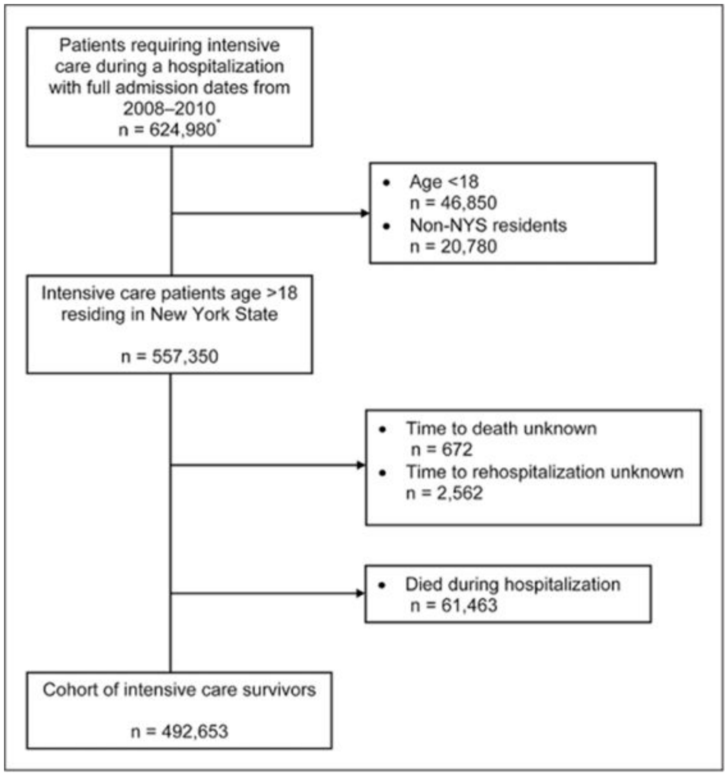


**Figure 1.**

Flowchart for creation of cohort of critically ill patients who survived to hospital discharge. *Hospitalizations for patients who were HIV positive or had an abortion were missing patient identifiers due to New York State (NYS) regulations regarding data and therefore excluded from the analysis.

## TABLE 1

Baseline Characteristics of Cohort of Critically Ill Patients Discharged Alive From Acute Care Hospitals, New York Statewide Planning and Research Cooperative System, 2008–2010

| Patient Characteristics | Early Rehospitalization | | Late Rehospitalization | |
|---|---|---|---|---|
| | None (*n* = 412,693) | One or More (*n* = 79,960) | None (*n* = 327,439) | One or More (*n* = 73,250) |
| Age, mean (sd) | 62.2 (18.2) | 67.1 (16.7) | 60.7 (18.2) | 66.2 (17.2) |
| Female[a], % | 47.1 | 48.7 | 46.4 | 49.8 |
| Race[a], % | | | | |
| White | 63.1 | 62.3 | 62.8 | 62.3 |
| Black | 14.7 | 16.4 | 14.3 | 17.1 |
| Hispanic | 3.4 | 3.6 | 3.5 | 3.6 |
| Asian | 2.8 | 2.6 | 3.0 | 2.4 |
| Other | 16.0 | 15.1 | 16.5 | 14.7 |
| Median household income (IQR) | 54,874 (42,094–75,955) | 54,732 (41,705–75,212) | 55,001 (42,447–76,606) | 53,565 (41,262–74,935) |
| Insurance, % | | | | |
| Medicare | 43.3 | 55.4 | 39.8 | 54.2 |
| Medicaid | 8.8 | 9.5 | 8.7 | 10.1 |
| Private | 40.1 | 30.4 | 43.0 | 30.4 |
| Self-pay | 6.2 | 4.0 | 6.7 | 4.6 |
| Other[b] | 1.6 | 0.9 | 1.8 | 0.8 |
| Nonsurgical, % | 54.0 | 55.1 | 51.8 | 61.1 |
| Mechanical ventilation, % | | | | |
| None | 86.8 | 81.1 | 87.9 | 84.2 |
| Without tracheostomy | 11.3 | 14.9 | 10.6 | 13.2 |
| With tracheostomy | 1.9 | 4.0 | 1.5 | 2.6 |
| Dialysis during hospitalization, % | | | | |
| None | 97.0 | 93.4 | 97.8 | 94.2 |
| No end-stage renal disease at admission | 0.9 | 1.9 | 0.8 | 1.4 |
| End-stage renal disease at admission | 2.0 | 4.8 | 1.4 | 4.4 |
| No. of Elixhauser comorbidities, % | | | | |
| 0 | 12.0 | 6.5 | 13.7 | 6.0 |
| 1–3 | 60.7 | 53.1 | 62.7 | 54.3 |
| ≥ 4 | 27.3 | 40.5 | 23.6 | 39.7 |
| Severe sepsis | 6.4 | 11.5 | 5.4 | 9.1 |

| Patient Characteristics | Early Rehospitalization | | Late Rehospitalization | |
|---|---|---|---|---|
| | **None (*n* = 412,693)** | **One or More (*n* = 79,960)** | **None (*n* = 327,439)** | **One or More (*n* = 73,250)** |
| Median length of index hospital stay (IQR) | 6 (3–12) | 9 (5–17) | 6 (3–11) | 8 (4–15) |
| Discharge destination, % | | | | |
| Home | 51.6 | 34.8 | 55.4 | 41.5 |
| Home with health services | 18.3 | 22.4 | 18.1 | 20.4 |
| Other hospital | 5.2 | 5.5 | 5.1 | 5.5 |
| Skilled nursing facility | 14.9 | 28.5 | 12.3 | 23.3 |
| Inpatient rehabilitation facility | 5.0 | 4.4 | 4.3 | 4.2 |
| Hospice | 1.3 | 0.3 | 0.3 | 0.2 |
| Other | 3.7 | 4.1 | 3.7 | 4.2 |

IQR = interquartile range

[a]Four patients were missing data for gender; 4,415 patients were missing data for race.

[b]Other insurance category includes Civilian Health and Medical Program of the Uniformed Services, the Veterans' Affairs Plan, other federal and nonfederal insurance programs, workers' compensation, and automobile medical claims.

**TABLE 2**

Factors Associated With Increased Risk for Early Rehospitalization,[a] New York Statewide Planning and Research Cooperative System, 2008–2010

| Patient Risk Factors | *n* (492,653) | Hazard Ratio | 95% CI | *p* |
|---|---|---|---|---|
| Mechanical ventilation | | | | |
| None | 432,012 | Reference | Reference | Reference |
| Mechanical ventilation without tracheostomy | 58,726 | 0.97 | 0.95–0.99 | 0.01 |
| Mechanical ventilation with tracheostomy | 10,915 | 1.27 | 1.22–1.33 | < 0.001 |
| Dialysis during hospitalization | | | | |
| None | 475,121 | Reference | Reference | Reference |
| No ESRD | 5,385 | 1.22 | 1.15–1.28 | < 0.001 |
| ESRD | 12,147 | 1.33 | 1.28–1.38 | < 0.001 |
| Severe sepsis | 35,755 | 1.14 | 1.11–1.17 | < 0.001 |
| Discharge destination | | | | |
| Home | 259,780 | Reference | Reference | Reference |
| Skilled nursing facility | 90,610 | 1.54 | 1.51–1.58 | < 0.001 |
| Metastatic cancer | 15,824 | 1.46 | 1.41–1.51 | < 0.001 |
| Length of index hospital stay (d) | | | | |
| <3 | 82,693 | Reference | Reference | Reference |
| 3–6 | 161,932 | 1.30 | 1.26–1.33 | < 0.001 |
| 7–13 | 134,110 | 1.61 | 1.57–1.66 | < 0.001 |
| ≥ 14 | 113,918 | 1.91 | 1.85–1.97 | < 0.001 |

ESRD = end-stage renal disease.

[a]Results of competing risk regression, accounting for death as a competing risk for rehospitalization. The proportional hazards assumption for the overall model did not appear to be violated using a plot of Schoenfeld-like residuals. Selected risk factors are presented here; for full model results, see Supplemental Table 3 Supplemental Digital Content 1, http://links.lww.com/CCM/B126.

## TABLE 3

Predicted Cumulative Incidence of Early Rehospitalization for High-Risk Subgroups

| **Subgroup Characteristics** | ***n*** | **Predicted Cumulative Incidence at 30 Days** | **No. of Predicted Rehospitalizations** | **Percentage of Predicted Early Rehospitalizations[a]** |
|---|---|---|---|---|
| Sepsis, discharge to SNF, and length of stay ≥ 14 d | 12,176 | 33.8 | 4,115 | 5.8 |
| Mechanical ventilation with tracheostomy, discharge to SNF, and length of stay ≥ 14 d | 6,593 | 37.1 | 2,446 | 3.4 |
| Sepsis, mechanical ventilation with tracheostomy and length of stay ≥ 14 d | 6,097 | 30.7 | 1,872 | 2.6 |
| Sepsis, mechanical ventilation with tracheostomy, and discharge to SNF | 4,199 | 27.3 | 1,146 | 1.6 |
| ESRD requiring dialysis, discharge to SNF, and length of stay ≥ 14 d | 2,102 | 38.3 | 805 | 1.1 |
| Sepsis, ESRD requiring dialysis and length of stay ≥ 14 days | 839 | 31.8 | 267 | 0.8 |
| Sepsis, ESRD requiring dialysis, and discharge to SNF | 485 | 28.3 | 137 | 0.4 |
| Mechanical ventilation with tracheostomy, ESRD requiring dialysis, and length of stay ≥ 14 d | 259 | 34.9 | 90 | 0.1 |
| Mechanical ventilation with tracheostomy, discharge to SNF, and ESRD requiring dialysis | 182 | 31.1 | 57 | 0.08 |
| Sepsis, mechanical ventilation with tracheostomy, and ESRD requiring dialysis | 138 | 25.6 | 35 | 0.05 |

SNF = skilled nursing facility, ESRD = end-stage renal disease.

[a]Calculated as the number of predicted hospitalizations for the subgroup over the number of predicted hospitalizations overall (*n* = 71,385)