**Hospital Readmission Rates Among Mechanically Ventilated Patients With Stroke**

Shouri Lahiri, MD; Babak B. Navi, MD, MS; Stephan A. Mayer, MD; Axel Rosengart, MD, PhD; Alexander E. Merkler, MD; Jan Claassen, MD, PhD; Hooman Kamel, MD

**Background and Purpose**—Tracheostomy is frequently performed in patients with severe ischemic stroke, intracerebral hemorrhage, or subarachnoid hemorrhage. Little is known about readmission rates among stroke patients who undergo mechanical ventilation.

**Methods**—We used previously validated *International Classification of Diseases, Ninth Edition-Clinical Modification* codes and data on all discharges from nonfederal acute care hospitals in 3 states. We compared readmission rates among mechanically ventilated patients with stroke who were discharged with or without a tracheostomy.

**Results**—Among 39,881 patients who underwent mechanical ventilation during the index stroke hospitalization and survived to discharge, 10,690 (26.8%; 95% confidence interval, 26.4%–27.2%) underwent tracheostomy. During a mean follow-up period of 3.4 (±2.0) years, the overall incidence rate of readmissions was 4.25 (95% confidence interval, 4.22–4.28) per 100 patients per 30 days. The rate of any readmissions within 30 days was 26.9% among patients with tracheostomy compared with 22.5% among those without a tracheostomy (absolute risk difference, 4.4%; 95% confidence interval, 3.5%–5.4%; \( P<0.001 \)). After adjustment for potentially confounding variables, tracheostomy was associated with a slightly increased readmission rate (incidence rate ratio, 1.07; 95% confidence interval, 1.03–1.11).

**Conclusions**—Approximately one quarter of mechanically ventilated patients with stroke who survive to discharge are readmitted to the hospital within 30 days. Readmission rates are significantly higher in patients with stroke who undergo tracheostomy, but the difference is not clinically meaningful. Thirty-day readmission rates among mechanically ventilated patients with stroke are similar to Medicare beneficiaries hospitalized with major medical diseases such as pneumonia. *(Stroke. 2015;46:00-00. DOI: 10.1161/STROKEAHA.115.010441.)*

**Key Words:** hemorrhage ■ hospital readmission ■ respiration, artificial ■ stroke ■ tracheostomy

**I**schemic stroke, intracerebral hemorrhage, and subarachnoid hemorrhage often cause respiratory failure because of injury to vital structures responsible for respiration, arousal, and airway protection. After initial endotracheal intubation, tracheostomy may be performed for long-term management of respiratory and airway failure. We have shown that 12.5% of all patients with stroke receive mechanical ventilation (MV), and 16.3% of these patients undergo tracheostomy, which is considered a hallmark of chronic critical illness.

Hospital readmissions for patients with chronic critical illness are common and increasingly recognized as a major cause of morbidity and healthcare spending in the United States. Previous studies on readmission rates have been largely limited to medical and surgical intensive care populations. Little is known about readmission rates of patients with stroke who require MV. In this study, we used statewide administrative claims data to examine population-based readmission rates for patients with stroke, who received MV, stratified by whether tracheostomy was performed.
Supplement). We included only patients who underwent MV during the index hospitalization for stroke and were discharged alive. MV was identified using the International Classification of Diseases, 9th Edition, Clinical Modification procedure codes that have been previously validated as 86% sensitive and 98% specific. Once identified, patients with index stroke were followed up throughout the study period for inpatient readmissions and death.

**Measurements**

Our key predictor variable was tracheostomy, identified using the International Classification of Diseases, 9th Edition, Clinical Modification codes that have been previously validated as 100% sensitive and 96% specific to detect incident tracheostomy placement. We adjusted for several covariates that may confound the relationship between tracheostomy status and the risk of readmission (full list of variables is available in the online-only Data Supplement). To explore reasons for readmission, we tabulated the most common primary diagnoses on readmission.

**Statistical Analysis**

Descriptive statistics with exact confidence intervals (CIs) were used to report rates of any readmission within 30 days. The χ² test was used to compare continuous variables. We used survival statistics to report incidence rates of hospital readmission, and Poisson regression analyses with robust SEs to determine the adjusted incidence rate ratio for tracheostomy versus no tracheostomy in relation to readmission. The proportional hazards assumption was confirmed by visual inspection of log–log plots. Because we lacked data on out-of-hospital deaths, we performed sensitivity analyses in which we censored patients at the time of their last hospitalization rather than assuming that they were alive throughout the entire period for which we had data. In subgroup analyses, we compared the association between tracheostomy and readmission rates among individual stroke subtypes.

**Results**

Among 39,881 patients with stroke who received MV during the index hospitalization and survived to discharge, 10,690 (26.8%; 95% CI, 26.4–27.2) received a tracheostomy. Baseline and demographic characteristics are available in Table I in the online-only Data Supplement. Among the 29,191 patients who did not receive a tracheostomy during the index hospitalization, the cumulative rate during follow-up of tracheostomy placement at a subsequent readmission was 0.7% (95% CI, 0.6–0.8). During a mean follow-up period of 3.4 (±2.0) years, the overall incidence rate of readmissions was 4.25 (95% CI, 4.22–4.28) per 100 patients per 30 days. This rate was somewhat higher among those who underwent tracheostomy (4.70; 95% CI, 4.64–4.77) than those without tracheostomy (4.08; 95% CI, 4.05–4.12). The rate of any readmission within 30 days was 26.9% among patients with tracheostomy compared with 22.5% among those without a tracheostomy (absolute risk difference, 4.4%; 95% CI, 3.5–5.4; P<0.001).

After adjustment for potentially confounding variables, such as stroke type, demographic characteristics, vascular risk factors, and Elixhauser comorbidities (Methods in the online-only Data Supplement), tracheostomy was associated with a slightly increased readmission rate throughout follow-up (incidence rate ratio, 1.07; 95% CI, 1.02–1.11). This association was somewhat stronger in a sensitivity analysis limited to the follow-up period during which patients were known with certainty to be alive (incidence rate ratio, 1.17; 95% CI, 1.13–1.21). The most common primary diagnoses at the time of readmission were sepsis (12.7%), pneumonia (4.6%), congestive heart failure (4.1%), and device-related complication (4.0%).

**Discussion**

We found that approximately one quarter of patients with stroke who received MV were readmitted within 30 days of discharge. After adjusting for demographic characteristics, vascular comorbidities, and markers of stroke severity, we found a slight association between tracheostomy and the risk of readmission. This held true in sensitivity analyses accounting for the possibility of unrecorded out-of-hospital deaths.

In this study of patients with severe enough stroke to require MV, readmissions occurred frequently because of sepsis, various infections, and complications directly related to tracheostomy itself. Although we expected a clinically significant increase in readmission with tracheostomy, the rate of any readmission at 30 days was similar to that of Medicare beneficiaries hospitalized for medical illnesses, such as pneumonia, and the readmission rate reported in a study of general intensive care unit patients. Our findings are in contrast to the conventional wisdom, which holds that placing a tracheostomy after stroke consigns patients to a high rate of subsequent readmissions.

Our study has important limitations that should be considered. First, we did not have data on deaths occurring outside of the hospital setting. However, this would not have affected the rate of any readmission within 30 days, which were performed in keeping with the methods of other studies. Furthermore, our results were not substantially changed in sensitivity analyses. Second, because we relied on administrative data, we did not have detailed clinical information on important factors—such as stroke severity, size, location, and mechanism—that may have affected the decision to perform a tracheostomy and readmission rates. Third, we did not have data on federal hospitals although these account for a small minority of hospitals in the states that we studied.

In summary, we found that readmission rates in patients with stroke after tracheostomy are similar to rates in Medicare beneficiaries hospitalized with major medical diseases such as pneumonia. Additional studies are indicated to explore reasons for the continued high mortality among patients with stroke after MV, as well as to elucidate strategies to optimize cost-effectiveness and outcomes after tracheostomy placement in these patients.

**Sources of Funding**

This study was supported by grant K23NS082367 (Kamel) from the National Institutes of Neurological Disorders and Stroke, as well as a grant (Kamel) from the Michael Goldberg Stroke Research Fund.

**Disclosures**

None.

**References**


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Stroke. published online August 13, 2015;
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
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Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/early/2015/08/13/STROKEAHA.115.010441

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