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Nationwide Estimations of Tracheal Stenosis Due to Tracheostomies

Romaine F. Johnson, MD, MPH, FACs; Charles Saadeh, MD

OBJECTIVES: Tracheal stenosis is a recognized complication of tracheostomy. Yet, the incidence and demographics of tracheal stenosis due to tracheostomies have infrequently been studied.

METHODS: We performed a cross-sectional analysis of U.S. emergency department (ED) visits, hospital discharges, and readmissions using the 2013 National Emergency Department Sample, 2013 National Inpatient Sample, and 2013 Nationwide Readmission Database for patients with tracheal stenosis due to tracheostomies. Also, we queried the readmission database for new tracheostomy patients who were readmitted within the same calendar year with tracheal stenosis due to the tracheostomy tube.

RESULTS: There were an estimated 6,156 ED visits; 4,920 hospital discharges; and 2,316 readmissions for tracheal stenosis due to tracheostomies in 2013. These cases represented 28% of all tracheostomy-related complications. Of the 103,484 patients who underwent tracheostomy in 2013, 739 (1.05%) patients were readmitted within the calendar year with tracheal stenosis due to the tracheostomy tube. These stenosis patients’ average age was 55 years old. Forty-five percent of the patients were female and 60% were white. The mortality rate was 7.9%. The demographic risk of stenosis mirrored the risk of tracheostomy: increasing age, male gender, and black ethnicity.

CONCLUSION: Tracheal stenosis due to tracheostomy was uncommon, accounting for 1% of readmissions after tracheostomies, although it represented 28% of tracheostomy-related complications and had a high mortality rate. The risk of stenosis reflected the overall tracheostomy population without apparent age, gender, or racial predilections.

KEY WORDS: Tracheal stenosis, tracheostomy, National Inpatient Sample, Nationwide Readmission Database.

LEVEL OF EVIDENCE: NA

INTRODUCTION

Tracheal stenosis due to tracheostomies is an uncommon but significant condition that can occur among tracheostomy patients. It can be associated with adverse outcomes, including prohibiting the ability to decannulate a patient once the primary indication for the tracheostomy has resolved. Currently, the generalizability of research examining the demographics and the incidence of tracheal stenosis due to tracheostomy are limited because studies are primarily single institutional experiences. A national examination of tracheal stenosis due to tracheostomies, therefore, would be beneficial to clinicians who treat patients with this serious condition.

The Healthcare Cost and Utilization Project (HCUP) was designed to provide a national estimation of U.S. ambulatory, hospital, and emergency department (ED) visits in the United States. These complex surveys can estimate the incidence, demographics, and resource utilization of patients with medical conditions that are assigned International Classification of Diseases, 9th Revision, diagnosis and procedural codes. This is especially well suited to examine diseases that are uncommon among single institutions, such as tracheal stenosis due to tracheostomies. Our primary aim was to determine characteristics of patients with tracheal stenosis due to tracheostomies discharged from emergency rooms as well as inpatient hospitalizations and subsequent readmissions in the United States for a single calendar year. We hypothesized that stenosis due to tracheostomy is rare but more common among older patients and men.

MATERIALS AND METHODS

We examined the 2013 National Inpatient Sample (NIS), National Emergency Department Sample (NED), and Nationwide Readmission Database (NRD) for patients with a diagnosis code of mechanical complication of tracheostomy (ICD9 519.02). This ICD9 code is well accepted to apply to tracheal stenosis after tracheostomy. These databases are parts of the HCUP and can be used to estimate nationwide discharges from EDs and hospital admissions. The NRD can also be used to estimate all cause readmissions within a calendar year. These databases use complex survey designs that statistically weight individual observations, which in turn can be extrapolated to characterize the entire population.

We collected the following information from the databases: diagnosis and procedural codes based on ICD9 coding schemes and HCUP Clinical Classification Software, age, sex, race (NIS only), in-hospital mortality, total charges, and length of stay. We defined the following age groups: 0 to 4 years, 5 to

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RESULTS

There were an estimated 6,156 ED visits; 4,920 hospital discharges; and 2,316 readmissions for tracheal stenosis due to tracheostomies in 2013. Among a sample of 71,446 tracheostomies performed in 2013, 739 (1.05%) were subsequently readmitted with tracheal stenosis after their index admission. See Table I for overview.

The median age of ED patients was 59 years (IQR, 47–70 years). The majority were 46 to 65 years old (42.1%, 95% CI [39.5%–44.9%]). The population was 57.5% male (95% CI, 54.8%–60.2%). The following diagnoses were also present: respiratory failure 43.6% (95% CI, 40.9%–46.3%), pneumonia 18.4% (95% CI, 16.4%–20.7%), and sepsis 13.1% (95% CI, 11.4%–15.1%). Tracheal stenosis due to tracheostomy represented 28.0% (95% CI, 26.8%–29.4%) of all tracheostomy complication-related ED visits. The median ED charges were $1,682 (IQR, $932–$2,920). The majority of patients were admitted to the same hospital: 49.0%, (95% CI, 46.3%–51.7%).

The median length of stay was 8 days (IQR, 4–19 days). The median total charges for the inpatient stay was $66,416 (IQR, $29,770–182,779). The in-hospital mortality was 3.2% (95% CI, 2.4%–4.3%).

The median age of inpatients was 60 years (IQR, 46–70). The majority were 46 to 65 years old (40.5%, 95% CI [37.4%–43.5%]). The population was 54.7% male (95% CI, 51.5%–57.8%). The racial/ethnic breakdown was as follows: white 58.8% (95% CI, 57.2%–60.4%), black or African American 21.5% (95% CI, 20.3%–22.9%), Hispanic 11.7% (95% CI, 10.7%–12.8%), and Asian 3.4% (95% CI 2.8%–4.0%). The following diagnoses were also present: respiratory failure 72.1% (95% CI, 69.2%–75.8%), pneumonia 35.4% (95% CI, 32.4%–38.4%), and sepsis 25.1% (22.5%–27.9%). Tracheal stenosis due to tracheostomy represented 27.8% (95% CI, 26.4%–29.3%) of all tracheostomy complication-related inpatient discharges. The median length of stay was 8 days (IQR, 3–22). The median inpatient charges were $73,313 (IQR, $29,861–$215,853). The in-hospital mortality was 7.9% (95% CI, 6.4%–9.8%).

Twenty-three percent (23%) of patients diagnosed with tracheal stenosis due to tracheostomy had at least one readmission in the same year. The median age of all patients readmitted with a diagnosis of tracheal stenosis due to tracheostomy was 59 years (IQR, 47–70 years). The majority were 46 to 65 years old (41.5%, 95% CI [38.2%–44.9%]). The population was 52.9% male (95% CI, 51.5%–57.8%). The following diagnoses were also present: respiratory failure 70.2% (95% CI, 66.9%–73.2%), pneumonia 32.2% (95% CI, 29.2%–35.4%), and sepsis 23.1% (20.5%–26%). Tracheal stenosis due to tracheostomy

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**TABLE I.** Characteristics of Patients With Tracheal Stenosis Due to Tracheostomy, U.S. Nationwide Estimates in 2013.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>NED N = 6156</th>
<th>NIS N = 4920</th>
<th>NRD N = 2316</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median (IQR)</td>
<td>59 (47–70)</td>
<td>60 (46–70)</td>
<td>59 (47–70)</td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–4 years, N (%)</td>
<td>160 (2.6)</td>
<td>200 (4.1)</td>
<td>86 (3.7)</td>
</tr>
<tr>
<td>5–15 years, N (%)</td>
<td>110 (1.8)</td>
<td>85 (1.7)</td>
<td>55 (2.4)</td>
</tr>
<tr>
<td>16–25 years, N (%)</td>
<td>257 (4.2)</td>
<td>255 (5.2)</td>
<td>108 (4.7)</td>
</tr>
<tr>
<td>26–45 years, N (%)</td>
<td>878 (14.3)</td>
<td>650 (13.2)</td>
<td>277 (11.9)</td>
</tr>
<tr>
<td>46–65 years, N (%)</td>
<td>2593 (42.1)</td>
<td>1990 (40.4)</td>
<td>961 (41.5)</td>
</tr>
<tr>
<td>≥66 years, N (%)</td>
<td>2157 (35.0)</td>
<td>1740 (35.4)</td>
<td>829 (35.8)</td>
</tr>
<tr>
<td>Male, N (%)</td>
<td>3541 (57.5)</td>
<td>2690 (57.7)</td>
<td>1226 (52.9)</td>
</tr>
<tr>
<td>White, N (%)</td>
<td></td>
<td>2805 (59.6)</td>
<td></td>
</tr>
<tr>
<td>Black, N (%)</td>
<td></td>
<td>1060 (22.5)</td>
<td></td>
</tr>
<tr>
<td>Hispanic, N (%)</td>
<td></td>
<td>515 (2.8)</td>
<td></td>
</tr>
<tr>
<td>Asian, N (%)</td>
<td></td>
<td>130 (2.8)</td>
<td></td>
</tr>
<tr>
<td>Length of stay in days, median (IQR)</td>
<td>8 (3–20)</td>
<td>8 (4–19)</td>
<td></td>
</tr>
<tr>
<td>Total charges $, median (IQR)</td>
<td>1682 (832–2805)</td>
<td>70 346 (30 616–193 003)</td>
<td>70 370 (30 409–184 627)</td>
</tr>
<tr>
<td>Respiratory failure, N (%)</td>
<td>2685 (56.4)</td>
<td>3545 (72.1)</td>
<td>1696 (70.2)</td>
</tr>
<tr>
<td>Pneumonia, N (%)</td>
<td>1135 (18.4)</td>
<td>1740 (35.4)</td>
<td>747 (32.2)</td>
</tr>
<tr>
<td>Sepsis, N (%)</td>
<td>809 (13.1)</td>
<td>1235 (25.1)</td>
<td>535 (23.1)</td>
</tr>
<tr>
<td>Mortality, N (%)</td>
<td>0 (0)</td>
<td>390 (7.9)</td>
<td>86 (3.7)</td>
</tr>
</tbody>
</table>

IQR = interquartile range; NED = Nationwide Emergency Department Database; NIS = National Inpatient Sample; NRD = Nationwide Readmission Database.
represented 27.0% (95% CI, 25.4%–28.6%) of all tracheostomy complication-related inpatient readmissions. The median length of stay for readmissions was 8 days (IQR, 4–19). The median inpatient charges were $70,370 (IQR, $30,409–$184,627). The in-hospital mortality was 3.7% (95% CI, 2.7%–5.1%).

Among the new tracheostomy patients who were subsequently readmitted with tracheal stenosis, the median age was 61 years (IQR, 50–70). The population was 62.3% male (95% CI, 55.7%–68.5%). The majority were 46 to 65 years old (44.4%, 95% CI [37.9%–51.0%]). The following diagnosis were also present: respiratory failure 94.0% (95% CI, 90.3%–96.3%), pneumonia 48.4% (95% CI, 41.8%–55.0%), and sepsis 45.2% (38.8%–51.9%). Tracheal stenosis due to tracheostomy represented 22.3% (95% CI, 19.0%–25.9%) of all tracheostomy complication-related inpatient readmissions. The median length of stay for readmissions was 36 days (IQR, 23–66). The median inpatient charges were $390,187 (IQR, $239,943–$659,784). The in-hospital mortality was 22.8% (95% CI, 18.0%–28.6%).

DISCUSSION

This nationwide cross-sectional study of tracheal stenosis due to tracheostomy included observations from ED visits, inpatient hospitalizations, and inpatient readmissions in the United States. The data from 2013 showed few cases of tracheal stenosis due to tracheostomy relative to overall admissions or the number of tracheostomies performed. Roughly 1% of new tracheostomy patients were readmitted with tracheal stenosis within the same calendar year. Despite the low prevalence of tracheal stenosis due to tracheostomy, the disorder is associated with significant morbidity and mortality.

Tracheal stenosis due to tracheostomy is a significant complication of tracheostomy placement. Although cases can be asymptomatic, many others cause airway restriction that limits the ability to decannulate the patient. The pathogenesis of stenosis is varied, but the principle culprits include location within the trachea, surgical technique, and presence of infection.2,16–20 For example, high tracheostomies near the cricoid are believed to increase the risk of stenosis. Additionally, there is observational evidence that percutaneous tracheostomy increases the risk of the stenosis. Our study could not differentiate the type of tracheostomy technique, but the rareness of the disorder compared to the number of tracheostomies performed suggests that the technique's role in stenosis may be less of a factor than suggested.

These patients were older and predominately male, as expected in our hypothesis and as corroborated in the literature. Two-thirds of the patients were greater than 45 years old, and one-third were greater than 65 years old. The ethnicity largely mirrored the tracheostomy population with a larger proportion of African Americans (22%) than would be anticipated compared to the overall U.S. proportion of African Americans (13%). The results of previous studies are consistent with ours.21–26 These findings suggest that age and gender are not associated with elevated risk of stenosis outside of the population of patients who frequently undergo tracheostomy. The one exception as mentioned is African Americans. The risk of airway stenosis appears to be higher among African Americans even after controlling for other variables.27 This data adds more weight to that evidence and deserves further study.

The adverse outcomes associated with this population are significant. Patients who present to the ED are likely to be admitted and diagnosed with respiratory failure, pneumonia, or sepsis. Hospitalized patients tend to have lengthy hospitalizations and high total charges. The chance of being readmitted within the same calendar year is 23%, and the mortality rate is as high as 7.9%. These findings are broadly consistent with previous studies.22,24,26,28 That is, this population as a subset of the tracheostomy population is sicker and therefore has higher resource utilization and adverse events compared to other similar patients without tracheostomies.

Approximately 1% of patients with newly placed tracheostomies were readmitted with tracheal stenosis due to tracheostomy. A limitation of this study is that patients who were not readmitted or who presented in the next calendar year were not captured, which can underestimate the incidence. However, this data is consistent with previous studies that showed the incidence of tracheal stenosis after tracheostomy is low (1%–6%).1 The risk factors associated with this group are a continued source of debate. This study was not designed to answer these questions; however, when comparing the 1% of patients who were identified as developing tracheal stenosis after tracheostomy to other tracheostomy patients, there were no differences in age, gender, pneumonia, sepsis, or length of stay during their index admissions.

Further limitations include that hospital discharge data is built for billing purposes and not research; therefore, misclassifications can occur. Some patients with stenosis will not be identified, and others who are identified as having stenosis will not have it. The analysis was not designed to determine risk factors for the development of stenosis; consequently, any interpretation of stenosis risk factors should be guarded. This population reflects those who visited the ED or were admitted to the hospital and excludes patients with observation status. The characteristics of outpatient and patients admitted under observation status with tracheal stenosis after tracheostomy may be different from this one. Lastly, the study period lasted 1 year; thus, patients who were readmitted after 2013 would be excluded from analysis. Still, many prior studies that have examined the risk of stenosis after tracheostomy have follow-up less than 1 year.19–22,24,26,28–31

CONCLUSION

Among U.S. ED and hospitalized inpatients, tracheal stenosis due to tracheostomy is a rare disorder for which demographics reflect the overall tracheostomy population. The morbidity and mortality among these patients appear to be significant. Continued study of the risk associated with the development of this disorder is prudent.