A propensity-matched comparison of cost and outcomes after esophageal stent placement or primary surgical repair for iatrogenic esophageal perforation

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Objectives: Esophageal stent placement has been shown to be a safe and effective treatment for acute esophageal perforation in selected patients. However, a comparison between surgical repair and stent placement has not been reported. This investigation compares the outcomes and costs of the 2 treatment modalities.

Methods: The Premiere database for a single health system's hospitals was used to identify patients undergoing treatment for an acute intrathoracic esophageal perforation over a 4-year period. Patient cohorts for stent placement or surgical repair were formed using propensity matching. The 2 cohorts were compared for length of stay, morbidity, mortality, and costs.

Results: Between 2009 and 2012, 60 patients undergoing esophageal stent placement or surgical repair were propensity matched. Mean patient age and Charlson comorbidity scores did not differ significantly ($P = .4$ and $P = .4$, respectively). Significant differences in morbidity (4% vs 43%; $P = .02$), mean length of stay (6 vs 11 days; $P = .0007$), time to oral intake (3 vs 8 days; $P = .0004$), and cost ($91,000 vs $142,000; $P < .0001$) were identified in the esophageal stent cohort when compared with patients receiving surgical repair. Operative mortality did not differ significantly.

Conclusions: Esophageal stent placement for the treatment of an acute esophageal perforation seems to be as effective as surgical repair when compared between propensity-matched patients. However, stent placement resulted in a shorter length of stay, lower rates of morbidity, and lower costs when compared with traditional surgical repair. (J Thorac Cardiovasc Surg 2015;149:1550-5)

See related commentary pages 1556-7.

Over the last decade, esophageal stent placement for the treatment of esophageal perforation, fistula, and anastomotic leak has been found to be beneficial in selected patients. Specifically, a hybrid approach to patients with esophageal perforation using esophageal stent placement, enteral nutrition, and minimally invasive surgery, when required, has been described by several groups.[1-3] However, because of the relative rarity of esophageal perforation, the significant diversity of the patient population and the concern by some investigators that equipoise no longer exists between the 2 treatment strategies, a randomized comparison of patients treated with surgical repair or esophageal stent placement has not been published. The objective of this study was to compare the patient outcomes and costs of treatment between propensity-matched patients undergoing transthoracic operative repair (OR) or esophageal stent repair (SR) for the treatment of an intrathoracic iatrogenic esophageal perforation.

MATERIAL AND METHODS

The study institution's institutional review board approved this protocol, including the "off-label" use of esophageal stenting, and waived individual patient consent for this investigation with the condition of patient anonymity outside the initial data gathering phase of the study. Patients undergoing surgical repair or esophageal stent placement (Current Procedural Terminology code 43415, 43256) for an iatrogenic, intrathoracic esophageal perforation (diagnosis codes 530.4, 862.22; International Classification of Diseases, Ninth Revision) during the calendar years 2009 to 2012 within the Ascension Health system by a cardiothoracic surgeon were identified using the Premier inpatient database (Premier Inc, Charlotte, NC) (Figure 2). Although the study population was derived only from Ascension Health facilities so that cost data could be analyzed, the Premier Perspective database covers 20% of the US hospital discharges. Among other things, it is the largest inpatient drug use database in the United States. The database contains complete billing and coding history on more than 45 million hospital inpatient discharges and more than 210 million hospital outpatient visits "from acute care facilities, ambulatory surgery centers and clinics across the nation." Also calculated

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Abbreviations and Acronyms
OR = operative repair
SR = stent repair

were Charlson Comorbidity scores for each patient, based on secondary International Classification of Diseases, Ninth Revision disease codes.[4,5]

Excluded from further analysis were patients with a cervical or intra-abdominal esophageal perforation, patients with an esophageal malignancy, and patients with an esophageal perforation resulting from other causes. Also excluded were patients undergoing procedures other than primary surgical repair with or without buttressing of the repair or those treated with a self-expanding metallic stent. This included patients undergoing esophageal diversion or exclusion and patients undergoing esophagectomy or reoperative repair as an initial procedure. Eligibility also included the availability of 6-month follow-up for a patient after the treatment of their esophageal perforation.

The propensity score method was used to populate 2 patient cohorts from the patients identified: those undergoing OR and those undergoing SR.[6,7] Propensity scores were computed after multivariable regression analysis assessing a set of preoperative risk factors that included year of treatment, location of treatment, age, gender, Charlson comorbidity score, and time from perforation to treatment. Patients who underwent SR were matched nearest neighbor in a 1:1 fashion to those who had OR on the basis of the propensity score so that only patients with similar scores were compared.

Patient demographic data, intensive care unit and total length of hospital stay, readmission, operative morbidities, and mortality were abstracted for each patient from the Premier database. Postoperative morbidities were attributed in a binary fashion by patient so that a patient having more than 1 event was counted only once. However, the tabulation of specific categories of complications includes every occurrence.

Sepsis was defined by the presence of a fever, leukocytosis, arterial hypotension, and organ dysfunction. Operative mortality was defined as patient death after surgery before discharge from the hospital or within 30 days of surgery. All health care provided after discharge from the index admission related to the esophageal perforation for a period of 6 months was reviewed. A readmission was defined as any unplanned admission to any hospital within 30 days of the date of discharge from the initial admission. Dysphagia after esophageal perforation repair was defined as significant if it required endoscopic treatment.

Costs

Costs for individual patients were obtained from the Premier database. Inpatient and outpatients costs attributable to the esophageal perforation are reported. This included facility costs after discharge for inpatient and outpatient care, as well as any outpatient procedures, imaging, or readmissions to the hospital related to the esophageal perforation. For patients undergoing SR, the costs attributed to stent removal were included in the costs of their treatment. Not included in total costs are any approximations of provider costs.

Inpatient costs are broken down into traditional categories, including surgery, room and board, supplies and equipment, intensive care unit, respiratory therapy, laboratory, pharmacy, imaging, physiotherapy/occupational therapy/speech, and other. Costs were reported as averages, and all categories include direct and indirect costs to the hospital because indirect costs could not be separated retrospectively by facility. Cost parity was assumed because each hospital was in the same health care system with a common supply chain and vendor list.

Bivariate analysis of data was performed using GraphPad Prism software 4.02 (GraphPad Software Inc, San Diego, Calif) for Windows (Microsoft Corp, Redmond, Wash). Differences between categoric variables were evaluated by the Fisher exact test. Differences between continuous variables were measured by the 2-tailed Student *t* test or the Mann–Whitney test for non-normally distributed data. Multivariate analysis and propensity matching were performed using Stata version 11 (StataCorp, LP, College Station, Tex).

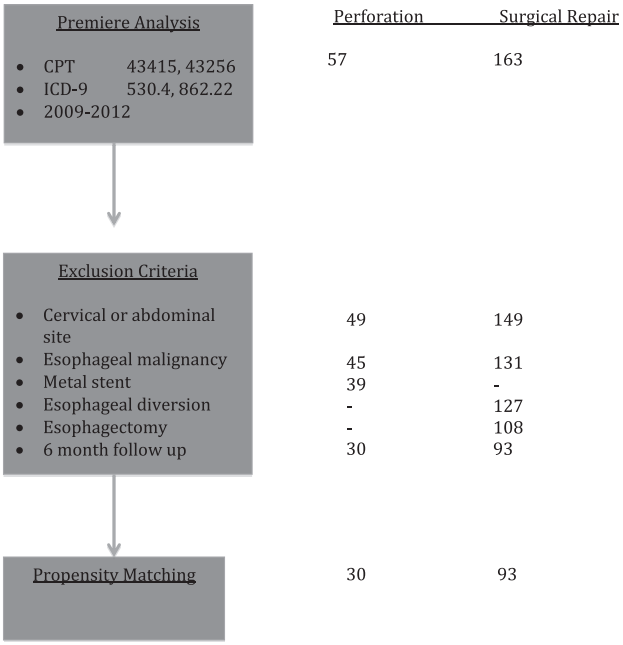

FIGURE 1. Consort table of propensity matching. *CPT*, Current Procedural Terminology; *ICD-9*, International Classification of Diseases, Ninth Revision.

RESULTS

During the 4-year study period, 30 patients were identified who met the previous outlined criteria for SR and were propensity matched to 30 of the 93 patients who underwent OR during the same time period. Patients undergoing SR came from 3 institutions, and patients undergoing OR were matched from 6 different facilities. Figure 1 displays the propensity matching process used to form the SR and OR treatment cohorts. Table 1 compares their demographic data, which implies they are comparable on the basis of the results of the matching process. The cause of perforation is also listed. Comparable number of patients from each cohort who met the clinical criteria for a diagnosis of sepsis on admissions.

Table 2 shows the summary measures of the OR and SR treatment strategies, such as muscle buttressing in the OR group or associated procedures in the SR group. The majority of patients in each treatment group had enteral feeding access established. This was with jejunostomy most commonly in the OR group and percutaneous endoscopic gastrostomy in the SR group. Nineteen patients in the SR group underwent a video-assisted thoracoscopic procedure to drain the mediastinum or pleural space at the time of stent placement, whereas 3 patients in the OR group