



## Comparison of open gastrostomy tube to percutaneous endoscopic gastrostomy tube in lung transplant patients



Sharven Taghavi<sup>a,\*</sup>, Vishnu Ambur<sup>b</sup>, Senthil Jayarajan<sup>c</sup>, John Gaughan<sup>d</sup>, Yoshiya Toyoda<sup>e</sup>, Elizabeth Dauer<sup>b</sup>, Lars Ola Sjöholm<sup>b</sup>, Abhijit Pathak<sup>b</sup>, Thomas Santora<sup>b</sup>, Amy J. Goldberg<sup>b</sup>

<sup>a</sup> Washington University in St. Louis, Division of Cardiothoracic Surgery, St Louis, MO 63110, USA

<sup>b</sup> Temple University School of Medicine, Department of Surgery, Philadelphia, PA 19140, USA

<sup>c</sup> Washington University in St. Louis, Section of Vascular Surgery, St. Louis, MO 63108, USA

<sup>d</sup> Temple University School of Medicine, Biostatistics Consulting Center, Philadelphia, PA 19140, USA

<sup>e</sup> Temple University School of Medicine, Department of Cardiac Surgery, Philadelphia, PA 19140, USA

### HIGHLIGHTS

- In lung transplant patients, open gastrostomy tube may result in less mortality than a percutaneous gastrostomy tube.
- In-hospital complications are less when lung transplant recipients receive open gastrostomy as compared to PEG.
- PEG in lung transplant recipients does not result in decreased length of stay when compared to open gastrostomy.

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### ABSTRACT

**Introduction:** Lung transplant patients require a high degree of immunosuppression, which can impair wound healing when surgical procedures are required. We hypothesized that because of impaired healing, lung transplant patients requiring gastrostomy tubes would have better outcomes with open gastrostomy tube (OGT) as compared to percutaneous endoscopic gastrostomy tube (PEG).

**Methods:** The National Inpatient Sample (NIS) Database (2005–2010) was queried for all lung transplant recipients requiring OGT or PEG.

**Results:** There were 215 patients requiring gastrostomy tube, with 44 OGT and 171 PEG. The two groups were not different with respect to age (52.0 vs. 56.9 years,  $p = 0.40$ ) and Charlson Comorbidity Index (3.3 vs. 3.5,  $p = 0.75$ ). Incidence of acute renal failure was higher in the PEG group (35.2 vs. 11.8%,  $p = 0.003$ ). Post-operative pneumonia, myocardial infarction, surgical site infection, DVT/PE, and urinary tract infection were not different. Post-operative mortality was higher in the PEG group (11.2 vs. 0.0%,  $p = 0.02$ ). Using multiple variable analysis, PEG tube was independently associated with mortality (HR: 1.94, 95%CI: 1.45–2.58). Variables associated with survival included age, female gender, white race, and larger hospital bed capacity.

**Discussion:** OGT may be the preferred method of gastric access for lung transplant recipients.

**Conclusions:** In lung transplant recipients, OGT results in decreased morbidity and mortality when compared to PEG.

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## 1. Introduction

Lung transplantation remains an effective treatment option for

select patients with end-stage lung disease [1–5]. Some lung transplant patients may go on to require enteral access due to being physically incapable of eating or otherwise not able to meet their nutritional requirements [6]. Percutaneous gastrostomy tube (PEG) has become the method of choice for long term enteral access, given its cost effectiveness and lower complication rate compared to open surgical gastrostomy (OGT) [7,8]. However, lung transplant patients present a unique challenge, as they require high doses of

\* Corresponding author. Washington University in St. Louis, 660 S Euclid Ave, Campus Box 8234, St. Louis, MO 63110, USA.

E-mail address: [taghavis@wudosis.wustl.edu](mailto:taghavis@wudosis.wustl.edu) (S. Taghavi).

immunosuppression to prevent rejection. These same medications have been proven to impair wound healing via various mechanisms [9]. Open gastrostomy tube allows for suturing of the stomach to the anterior abdominal wall, which may decrease the risk of intraperitoneal leak as compared to PEG tube. To our knowledge, there have been no studies comparing outcomes between PEG and OGT in lung transplant patients. The goal of this study is to compare postoperative morbidity and mortality between open surgical gastrostomy and percutaneous endoscopic gastrostomy in lung transplant recipients. We hypothesize that because of impaired wound healing, lung transplant patients undergoing OGT would have better outcomes as compared to PEG.

## 2. Materials and methods

### 2.1. Database

After approval from local institutional review board (IRB), the National Inpatient Sample (NIS) Database, developed by the Healthcare Cost and Utilization Project (HCUP), was utilized for this study. This database contains data from approximately 7 million hospital stays each year and is obtained from a stratified sample of 20% of non-federal United States hospitals. The NIS is the largest publicly available, all payer, inpatient health care database in the United States [10]. A self-weighting design reduces the margin of error for estimates and delivers population based estimates. All of our statistical analysis was based on this weighting design as established in previous studies [11]. The NIS is a publically available deidentified database and was therefore granted exempt status from our IRB committee.

### 2.2. Study population

Adult lung transplant patients who underwent OGT or PEG tube placement between 2005 and 2010 were initially identified by the International Classification of Disease, Ninth Revision (ICD-9) diagnosis and Current Procedural Terminology (CPT) procedure code. Patients were initially selected based on diagnosis code for lung transplant (V42.6) and then separated into groups based on the procedure code for open gastrostomy tube (43.19) and percutaneous gastrostomy tube (43.11).

### 2.3. Data and statistical analysis

The primary outcome was inpatient mortality after gastrostomy tube placement. Secondary outcomes included in-hospital complications, length of stay, and cost. Individual postoperative complications were identified by ICD-9 codes as established in previous studies [11]. Continuous and categorical variables were compared with student's t-test and chi square analysis. All continuous variables are presented as mean  $\pm$  standard deviation. Weighted frequencies and weighted multiple variable logistic regression analysis using clinically relevant variables were used to examine post-operative complications and mortality. Covariates included in the model were age, female sex, race, hospital bed size, Charlson comorbidity index, and PEG tube placement. Odds ratio (OR) with 95% confidence intervals were presented for each covariate. A p-value less than 0.05 was considered statistically significant. Data was analyzed using SAS 9.2 software (SAS Institute, Cary, NC).

## 3. Theory

We hypothesize that because of impaired wound healing from chronic immunosuppression, lung transplant patients undergoing OGT would have better outcomes as compared to PEG. Because of

impaired wound healing, there is delayed formation of a fibrotic tract after placement of a PEG tube, which increases the risk of intraabdominal tube dislodgement and intraabdominal leak. Placement of an OGT allows for direct pexying of the anterior gastric wall, which minimizes the risk of intraperitoneal leak and results in better outcomes.

## 4. Results

### 4.1. Baseline characteristics

A total of 215 lung transplant patients underwent gastric enteral access during the study period. Of these, 171 (79.5%) received a PEG tube and 44 (20.5%) had an OGT. As seen in Table 1, the patients in these two groups were not significantly different with respect to age (52.0 vs. 56.9 years,  $p = 0.40$ ), Charlson Comorbidity Index (3.3 vs. 3.5,  $p = 0.75$ ), and private payer status (37.5 vs. 32.9%,  $p = 0.05$ ). Patients undergoing OGT were more likely to have a history of peripheral vascular disease (4.7 vs. 11.9%,  $p = 0.01$ ). There was no significant difference in history of myocardial infarction (0.0 vs. 0.0%,  $p = 0.99$ ), congestive heart failure (14.6 vs. 11.9%,  $p = 0.63$ ), cerebrovascular disease (0.0 vs. 11.9%,  $p = 0.23$ ), diabetes (33.3 vs. 22.7%,  $p = 0.16$ ), and chronic renal disease (36.8 vs. 22.7%,  $p = 0.08$ ) when comparing the two groups. The PEG cohort was more likely to be male (66.3 vs. 45.3%,  $p = 0.01$ ) or Caucasian (94.3 vs. 88.1%,  $p < 0.001$ ) and less likely to be Hispanic (0.0 vs. 5.3%,  $p < 0.001$ ).

### 4.2. Post-operative outcomes

As seen in Table 2, the PEG cohort had higher incidence of acute renal failure when compared to the OGT group (35.2% vs. 11.8%,  $p = 0.003$ ). Post-operative pneumonia, myocardial infarction, surgical site infection, deep vein thrombosis (DVT), and pulmonary embolus (PE) were not different when comparing the two groups. As seen in Fig. 1, length of stay (33.0 vs. 27.1 days,  $p = 0.63$ ) and total hospital charges (\$203,023 vs. 294,679,  $p = 0.45$ ) were also similar.

### 4.3. Survival

Inpatient mortality was significantly higher in the PEG group compared to the OGT cohort (11.2% vs. 0%,  $p = 0.02$ ). As shown in Table 3, using multiple variable analysis, placement of PEG tube (OR: 1.94, 95%CI: 1.45–2.58,  $p < 0.001$ ) and increasing Charlson Comorbidity Index (OR: 1.42, 95%CI: 1.34–1.51,  $p < 0.001$ ) were significantly associated with mortality. Variables associated with survival included female sex (OR: 0.76, 95%CI: 0.65–0.88,  $p < 0.001$ ), white race (OR: 0.75, 95%CI: 0.64–0.87,  $p < 0.001$ ), and

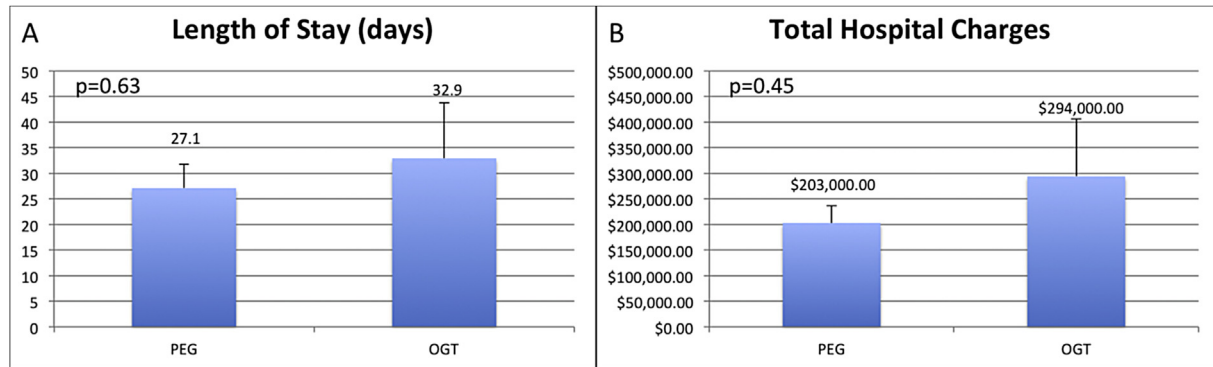
**Table 1**  
Baseline characteristics of patients undergoing gastrostomy tube placement.

|  | PEG (n = 171)   | OGT (n = 44)    | p value |
|--|-----------------|-----------------|---------|
| Age                                    | 56.9 $\pm$ 29.8 | 52.0 $\pm$ 46.5 | 0.40    |
| Charlson Comorbidity Index             | 3.50 $\pm$ 4.19 | 3.27 $\pm$ 4.24 | 0.75    |
| History of myocardial infarction       | 0 (0.0)         | 0 (0.0)         | 0.99    |
| History of congestive heart failure    | 25 (14.6)       | 5 (11.9)        | 0.63    |
| History of peripheral vascular disease | 4 (4.7)         | 5 (11.9)        | 0.01    |
| History of cerebrovascular disease     | 0 (0.0)         | 5 (11.9)        | 0.23    |
| History of diabetes                    | 57 (33.3)       | 10 (22.7)       | 0.16    |
| History of chronic renal disease       | 63 (36.8)       | 10 (22.7)       | 0.08    |
| Male (%)                               | 114 (66.3)      | 20 (45.3)       | <0.01   |
| Caucasian (%)                          | 162 (94.3)      | 39 (88.1)       | <0.001  |
| Hispanic (%)                           | 0 (0.0)         | 5 (11.9)        | <0.001  |
| Other Race (%)                         | 10 (5.7)        | 0 (0)           | <0.001  |
| Private insurance (%)                  | 64 (37.5)       | 14 (32.9)       | 0.055   |
| Medicare (%)                           | 78 (45.3)       | 15 (33.7)       | 0.055   |
| Medicaid (%)                           | 30 (17.2)       | 15 (33.4)       | 0.055   |

**Table 2**  
Outcomes of patients undergoing gastrostomy tube placement.

|                             | PEG (n = 171) | OGT (n = 44) | p value |
|-----------------------------|---------------|--------------|---------|
| Mortality (%)               | 19 (11.2%)    | 0 (0%)       | 0.019   |
| Acute kidney failure (%)    | 60 (35.2%)    | 5 (11.7)     | 0.002   |
| Myocardial infarction (%)   | 0 (0%)        | 0 (0%)       | 0.99    |
| Pneumonia (%)               | 0 (0%)        | 0 (0%)       | 0.99    |
| DVT (%)                     | 10 (5.6%)     | 0 (0%)       | 0.107   |
| Pulmonary embolism (%)      | 9 (5.2%)      | 0 (0%)       | 0.123   |
| Surgical site infection (%) | 11 (6.3%)     | 0 (0%)       | 0.087   |
| UTI (%)                     | 0 (0%)        | 0 (0%)       | 0.99    |

variables, including age and comorbidities, placement of a PEG tube was independently associated with mortality. The reason for increased mortality in the patients receiving PEG tube is not known. Prior studies have shown conflicting results when comparing mortality from PEG to OGT, with some showing no difference [21,22] and others showing better survival with PEG [23]. However, these studies did not examine outcomes of PEG and OGT in chronically immunosuppressed patients. Placement of a PEG tube relies on the formation of a fibrotic tract over the PEG tube. This tract prevents leakage of contents into the peritoneal cavity as



**Fig. 1.** Comparison of (A) length of stay and (B) total hospital charges.

**Table 3**  
Logistic regression examining variables associated with mortality.

| Covariate                    | Odds ratio | 95% confidence interval | p value |
|------------------------------|------------|-------------------------|---------|
| PEG                          | 1.94       | 1.45–2.58               | <0.001  |
| Female gender                | 0.76       | 0.65–0.88               | <0.001  |
| White race                   | 0.75       | 0.64–0.87               | <0.001  |
| Age                          | 0.98       | 0.97–0.99               | <0.001  |
| Larger hospital bed capacity | 0.74       | 0.66–0.82               | <0.001  |
| Charlson Comorbidity Index   | 1.42       | 1.34–1.51               | <0.001  |

admission to a hospital with larger patient capacity (more licensed beds) (OR: 0.74, 95%CI: 0.66–0.82,  $p < 0.001$ ), and younger age (OR: 0.98, 95%CI: 0.97–0.99,  $p < 0.001$ ).

## 5. Discussion

A feeding gastrostomy tube remains an effective way to obtain enteral access in patients that are unable to eat or who cannot meet their nutritional demands by intake volition. PEG has become the method of choice for long term enteral access in the majority of patients given its cost effectiveness and lower complication rate compared to OGT [7,8,12]. However, lung transplant patients pose a unique challenge, as they require high doses of immunosuppression, which have the unwanted side effect of impairing wound healing. This impaired wound healing may lead to increased risk of intraperitoneal leakage with a PEG tube, while OGT allows for suture fixation of the stomach to the anterior abdominal wall, minimizing this risk of intraabdominal leak. While many studies have focused on improving outcomes and increasing donors for lung transplant recipients [13–20], the best method of enteral access in these patients has not been defined.

This study demonstrates that placement of a PEG tube may result in increased mortality in the lung transplant population. While there were no deaths in the OGT group, inpatient mortality was 11.2% in the PEG group. In addition, when controlling for other

well as keeps the anterior portion of the stomach adherent to the anterior abdominal wall. The high doses of immunosuppressive medications required by lung transplant recipients may hinder this process and increase the risk of tube dislodgement and intraperitoneal leak, which may lead to worse survival. Placement of an open gastrostomy tube allows for direct surgical fixation of the stomach to the abdominal wall. This may help a tract form and minimize the risk of intraperitoneal leak. Unfortunately, the incidence of tube dislodgement and intraperitoneal leakage could not be determined from the NIS database. Further studies are needed to determine why lung transplant patients receiving OGT have better survival.

Charlson Comorbidity Index was found to be associated with increased mortality on multivariate analysis. This is not surprising as comorbidities have clearly been shown to affect surgical outcomes [24,25]. In addition, female gender and white ethnicity was found to be associated with survival in lung transplant recipients. This finding is consistent with previous studies [17,19]. While larger hospital size as measured by number of beds has not been shown to be associated with survival in previous studies, high volume transplant centers are known to have better outcomes with transplant recipients [26]. Large number of hospital beds may be a marker of a high volume lung transplant center.

Previous studies have shown increased complications with OGT as compared to PEG [8,21,22]; however, these studies did not examine immunosuppressed patients and in the present study, lung transplant recipients receiving PEG tube had greater incidence of renal injury that those receiving OGT. This is the first study to date to make this finding. Further work is needed to determine the reason for increased kidney injury in lung transplant recipients receiving PEG. One possibility is that immunosuppressive protocols were different between the two groups. Acute renal failure is a known complication of immunosuppressive medications used for lung transplant recipients. Unfortunately, immunosuppressive protocols are not available in the NIS database. Future studies that

take into account immunosuppressive regimens are needed. While tube dislodgement and intraperitoneal leak can ultimately lead to renal injury, the limitations of the database does not allow us to determine the reason for the observed renal injury.

Interestingly, previous studies have shown increased wound infections in patients receiving OGT [21,22]. However, we found no difference in surgical site infection when comparing PEG to OGT. Other documented complications of OGT include internal leakage, dehiscence, peritonitis, fistula, and dislodgement [8]. Unfortunately the incidence of these complications could not be determined using the NIS database. Other in-hospital comorbidities examined in this study included myocardial infarction, DVT, PE, and urinary tract infection and were not found to be different when comparing the PEG and OGT cohorts. These complications have not been examined in previous studies investigating PEG and OGT.

One potential advantage of PEG is that it is a more cost-effective procedure than OGT, as demonstrated in the trauma population [8]. In our study, there was no difference in total hospital charges when comparing the PEG and OGT cohorts. While the procedural cost of a PEG may be lower than that of an OGT [8], it is possible that the increased complications observed in the PEG cohort leads to increased total cost that offsets the more economical procedure. However, the long-term cost-effectiveness of PEG as compared to OGT has yet to be studied.

This study was not without limitation, including those inherent to a retrospective analysis. These databases are confined to in-hospital events and may underestimate the true incidence of mortality and other complications as they may occur after the index hospitalization. Long-term survival, morbidity, and cause of death are not available in the database. In addition, it is not possible to determine the number of intraabdominal complications or tube dislodgements with the NIS database. This analysis is also dependent on accurate coding of diagnoses, complications, and procedures and is therefore inherently subject to a reporting bias.

## 6. Conclusions

In conclusion, for lung transplant recipients, the placement of a PEG tube results in increased morbidity and mortality. In addition, placement of OGT in lung transplant recipients does not result in increased length of stay or increased hospital charges. OGT may be a better method of gastric access in lung transplant patients.

## Ethical approval

Temple University Institutional Review Board.

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None.

## Author contribution

ST – Concept/design, data analysis/interpretation, drafting article, critical revision, approval of article.

VA – Data analysis/interpretation, drafting article, critical revision, approval of article.

SJ – Data analysis/interpretation, critical revision, approval of article, statistics.

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YT – Data analysis/interpretation, critical revision, approval of article.

ED – Data analysis/interpretation, critical revision, approval of article.

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AP – Data analysis/interpretation, critical revision, approval of article.

TS – Data analysis/interpretation, critical revision, approval of article.

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## Conflicts of interest

None.

## Guarantor

Sharven Taghavi.

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