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Risk factors associated with missing post-esophagectomy hospital milestones

Steve R. Siegal MD [a], James P. Dolan, MD, MCR [a, *], Elizabeth N. Dewey MS [a], Abhisek D. Parmar, MD, MS [b], Aura Petcu NP [a], Brandon H. Tieu MD [c], Paul H. Schipper MD [c], John G. Hunter MD [a]

[a] Oregon Health & Science University, Department of Surgery, Division of General Surgery, 3181 SW Sam Jackson Park RD Mail Code: L223A, Portland, OR 97239, USA
[b] University of Alabama at Birmingham, Division of General Surgery, 1808 7th Ave S., Birmingham, AL 35233, USA
[c] Oregon Health & Science University, Department of Surgery, Division of Thoracic Surgery, 3181 SW Sam Jackson Park RD Mail Code: L353, Portland, OR 97239, USA

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ABSTRACT

Background: Our institution utilizes an esophagectomy pathway to guide postoperative management. Our aim was to identify risk factors associated with missing pathway goals.
Methods: Retrospective review of esophagectomies from 2010 to 2015. Multivariate logistic regression models identified risk factors for missing postoperative milestones prior to discharge. Odds ratios of variables affecting goals were calculated.
Results: Of the195 esophagectomies, the most common risk factor for missing milestones was BMI, followed by operating room time, clinical stage, tobacco pack-years, and open surgical approach. Missing any milestone on the expected postoperative day significantly increase the odds of missing a future milestone, regardless of other risk factors.
Conclusions: We have identified specific patient and operative factors that increase the risk of missing post-esophagectomy goals on time. Early identification of at-risk patients allows for pathway modification to avoid adverse outcomes and prolonged hospitalization. Analysis of meeting milestones early may allow for creation of accelerated pathways.

1. Introduction

The incidence of esophageal cancer is increasing worldwide and continues to be a challenging disease to treat. Traditionally, for all patients, the overall five-year survival rate was estimated to be only 15%.[1] In addition, the mortality after surgical resection can range from 1% to 9%, with a reported morbidity as high as 80%.[1–5] Fortunately, advances in the treatment of this aggressive malignancy over the past decade, particularly in the application of minimally invasive surgical techniques and improvement in chemoradiotherapy regimens, have resulted in improved outcomes and survival.[6,7]

Clinical care pathways, timeline protocols for medical decision-making, have been developed for various types of surgeries in order to reduce health care expenditures and streamline patient care.[8] These pathways guide the perioperative care of complex operations with the goal of reducing complications by standardizing evidence-based decision-making. Studies have shown care pathways to improve quality of care, increase satisfaction of patient caregivers, and reduce hospital costs, especially in high volume centers.[9] The implementation of clinical care pathways in the management of esophageal cancer patients undergoing esophagectomy has shown favorable outcomes including reduced length of stay (LOS), morbidity, and pulmonary complications.[10,11]

In 2010, our institution established an esophagectomy care pathway with daily clinical milestones that has been refined over the years as an ongoing process to improve and streamline care. The aim of this study is to identify the specific risk factors that may be associated with missing each postoperative milestone. We

* Corresponding author.
E-mail addresses: siegal@ohsu.edu (S.R. Siegal MD), dolanj@ohsu.edu (J.P. Dolan), deweye@ohsu.edu (E.N. Dewey MS), abhishekpar@gmail.com (A.D. Parmar), petcu@ohsu.edu (A. Petcu NP), tieub@ohsu.edu (B.H. Tieu MD), schippep@ohsu.edu (P.H. Schipper MD), hunter@ohsu.edu (J.G. Hunter MD).

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hypothesize that certain patient, operative, or cancer-related characteristics may be associated with delayed achievement of clinical milestones thus leading to increased LOS.

2. Materials and methods

2.1. Patient selection

We performed a retrospective review of a prospectively maintained esophageal disease registry from a single National Cancer Institute-designated center. Patients undergoing an esophagectomy from January 2010 to December 2015 for high-grade dysplasia or cancer were included in the study. Available demographic, laboratory, and staging data were collected through chart review. Preoperative medical comorbidities were tracked and recorded and age-adjusted Charlson Comorbidity Index (CCI) was calculated.[12] All surgical procedures were performed by a team of three institutional foregut specialists. There were no exclusions based on type or approach of esophagectomy. Patients were excluded if their clinical data were incomplete.

2.2. Clinical care pathway

Our esophageal cancer clinical care pathway includes predefined clinical decisions starting in the preoperative period, guiding anesthetic and operative steps, and continuing on each postoperative day with a goal discharge by postoperative day eight. The full pathway includes numerous steps, many of which are not robust changes in clinical management. Examples include postoperative day (POD) 1 decrease of maintenance intravenous fluids (IVF) by 25% and POD 5 addition of laxatives if the patient has not experienced a bowel movement.

As such, for this study, we included milestones that were important advances in the postoperative course with clinical relevance. These 12 milestones are displayed in Table 1 and are detailed as follows: immediately after esophagectomy, patients remain intubated overnight in the intensive care unit. On POD 1, the patient is extubated and deep vein thrombosis (DVT) prophylaxis is initiated. On POD 2, enteral tube feedings are begun at 10 mL/h (trickle tube feeds), and then slowly advanced to goal rate, and patients transferred to the ward after removal of the bladder catheter. The next day (POD 3), we remove the nasogastric tube and the neck drain. On POD 5, the enteral feeds should be at the patient's goal rate so that on POD 6 the enteral feeds undergo nocturnal cycling. Patients receive an esophagram on POD 7 to check for anastomotic leakage. If this study shows an intact anastomosis, the patient's diet is advanced to full liquids on POD 8. They are then discharged on POD 8 if able to appropriately take in the full liquid diet and are clinically stable.

2.3. Statistical analysis

Milestones achieved on the expected postoperative day were translated into a binary statistical outcome. For each milestone, two multivariate logistic regression models were constructed, using Bursac's purposeful-selection procedure to identify important risk factors for missing a postoperative milestone on the expected day.[13] For the first model, variable reduction methods were used to fit the most parsimonious model. The second model was constructed with the same significant factors as the first model, as well as a continuous variable for how many of the previous milestones were missed. Odds ratios of independent variables affecting a missed milestone were calculated as primary outcomes. Significance was set at a $p \leq 0.05$.

3. Results

3.1. Study cohort

The study cohort included 195 esophagectomies performed between 2010 and 2015. Clinical data was complete for all consecutive patients. The study population was 84% male (n = 163), with an average age of 66 years (range: 38–83) (Table 2). The majority of the cohort (96%) was Caucasian. The average body mass index (BMI) within the cohort was 26.8 kg/m^2 (range: 16–46). A history or active use of tobacco was reported in 73% (n = 142) of the population. The mean Charlson Comorbidity Index (CCI) was 4.97, with hypertension (HTN) being the most common comorbidity (56%), followed by heart disease (36%), pulmonary disease (22%), and diabetes (21%).

Adenocarcinoma was the most common esophageal condition, being diagnosed in 85% (n = 166) of the population. Twenty-three (12%) had squamous cell carcinoma, while six (3%) had high-grade dysplasia (Table 2). There was an increasing prevalence of

Table 1
Oregon Health & Science University Pathway for Minimally Invasive Esophagectomy - Postoperative clinical decision pathway listed by post-operative day (POD). Bold and italicized items were clinical milestones studied in the analysis. *NGT – Nasogastric tube, IVF – Intravenous fluids, J Tube – Jejunostomy tube, ICU – Intensive care unit, O2 – Oxygen, LMWH – Low Molecular Weight Heparin, TF – Tube feeds.*

Intervention	POD 0	POD 1	POD 2	POD 3	POD 4	POD 5	POD 6	POD 7	POD 8
Airway/ Imaging	Intubated	***Extubated*** Supplemental O2 as needed	Supplemental O2 as needed	Supplemental O2 as needed	Supplemental O2 as needed	Supplemental O2 as needed	Supplemental O2 as needed	Supplemental O2 as needed	Supplemental O2 as needed
Imaging			Chest X Ray	Chest X Ray	Chest X Ray	Chest X Ray	Chest X Ray	***Esophagram***	
Lines/Tubes	1. NGT 2. Neck drain 3. Chest Tube 4. Central Venous 5. J Tube 6. Foley	1. NGT 2. Neck drain 3. Chest Tube 4. Central Venous 5. J Tube 6. Foley	1. NGT 2. Neck drain 3. Chest Tube 4. Remove Central Venous 5. J Tube ***6. Remove Foley***	***1. Remove NGT*** ***2. Remove JP*** 3. Chest Tube 4. J Tube	1. Chest Tube 2. J Tube	1. Remove Chest Tube 2. J Tube	1. J Tube	1. J Tube	1. J Tube
Nutrition	IVF	IVF	***TF@10ml/hr***	TF increasing	TF increasing	***TF @ goal rate***	***TF @ nocturnal cycle***	Clear Liquids TF @ nocturnal cycle	***Full Liquids*** TF @ nocturnal cycle
Mobilization	None	Ambulate ***LMWH***	Ambulate LMWH	Ambulate LMWH	Ambulate LMWH	Ambulate LMWH	Ambulate LMWH	Ambulate LMWH	Ambulate LMWH
Disposition	ICU	ICU	***Transfer to ward***	Ward	Ward	Ward	Ward	Ward	***Discharge***