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Thirty-Day Unplanned Postoperative Inpatient and Emergency Department Visits Following Thoracotomy

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Abstract

Background—Unplanned visits to the emergency department (ED) and inpatient setting are expensive and associated with poor outcomes in thoracic surgery. We assessed 30-day postoperative ED visits and inpatient readmissions following thoracotomy, a high morbidity procedure.

Maternal & Methods—We retrospectively analyzed inpatient and ED administrative data from California, Florida and New York, 2010–2011. “Return to care” was defined as readmission to inpatient facility or emergency department within 30 days of discharge. Factors associated with return to care were analyzed via multivariable logistic regressions with a fixed effect for hospital variability.

Results—Of 30,154 thoracotomies, 6.3% were admitted to the ED and 10.2% to the inpatient setting within 30 days of discharge. Increased risk of inpatient readmission was associated with Medicare (OR 1.30; $p < 0.001$) and Medicaid (OR 1.31; $p < 0.0001$) insurance status compared to private insurance as well as Black race (OR 1.18; $p = 0.02$). compared to white race while Lung cancer diagnosis (OR 0.83; $p < 0.001$) and higher median income (OR 0.89; $p = 0.04$) were associated with decreased odds of inpatient readmission. Post-operative ED visits were associated

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with Medicare (OR 1.24; $p<0.001$) and Medicaid insurance status (OR 1.59; $p<0.001$) compared to private insurance as well as Hispanic race (OR 1.19, $p=0.04$) compared to white race.

Conclusions—Following thoracotomy, postoperative ED visits and inpatient readmissions are common. Patients with public insurance were at high risk for readmission, while patients with underlying lung cancer diagnosis had lower readmission risk. Emphasizing post-operative management in at-risk populations could improve health outcomes and reduce unplanned returns to care.

Keywords

Readmissions; thoracotomy; lung cancer

Introduction

Hospital readmissions are expensive, associated with poor patient outcomes, and frequently attributed to decreased quality of care [1,2]. As such, national initiatives from the Center for Medicare & Medicaid Services have targeted unplanned readmissions as a surrogate marker for healthcare quality [3,4]. Under the Hospital Readmissions Reduction Program (HRRP), hospitals are penalized if their 30-day readmissions performance is in excess of the national average for applicable medical diagnoses or surgical procedures. HRRP recently expanded applicable surgeries to include cardiothoracic surgery, beginning with coronary artery bypass graft surgery in fiscal year 2017 [5].

Thoracotomy is associated with significant potential morbidity including higher rates of infection, pneumothorax, and post-operative pain leading to poor respiratory effort [6,7,8] compared to other surgical approaches including other minimally invasive thoracic surgical techniques. Most studies of post-surgical outcomes after thoracotomy have so far been limited to single-procedure (e.g. lobectomy), single-hospital, or focused on particular patient population, for example lung cancer patients.

This descriptive study aims to answer several questions. First, we sought to define what proportion of patients undergoing open thoracotomy return to the emergency department or are readmitted to the inpatient setting within 30-days discharge. Next, we sought to determine which diagnoses are associated with a post-operative ED visit or inpatient readmission (ie what is the reason for the return to care). Lastly, how do patient factors – in particular, underlying lung cancer diagnosis – influence risks of returns to care following thoracotomy? A better understanding of patient factors and diagnoses associated with readmissions may help improve resource allocation to those more likely to have an unplanned return to care.

Materials & Methods

Dataset

Data for this retrospective cohort study utilized two databases of the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality: the State Inpatient Database (SID), and the State Emergency Department Database (SEDD). Index

discharges were identified from the SID; the SID encompasses approximately 97% of all U.S. community hospital discharges in participating states [9]. These datasets allow the linkage of patients across healthcare encounters within a state. Discharge records were obtained for patients in California, Florida, and New York between 2010 and 2011. Our institution determined this study was exempted from IRB review.

Index Cohort

We extracted 37,048 records for patients discharged with an ICD-9-CM primary procedure code of open thoracotomy (32.29, 32.30, 32.39, 32.41, 32.49, 32.59, 32.9, 33.28, 34.09, 34.51). We included patients over 18 years of age with unique patient identifiers. We excluded 188 patients over 90 years of age.

We excluded 1317 patients who died during index visit and 760 patients who were admitted in the last quarter of 2011 and thus were not at-risk for a 30-day readmission. We further excluded 4,629 patients discharged to a short-term hospital, skilled nursing facilities or intermediate care facility due to the lack of information on their care or release from the facility. Our final analytic cohort consisted of 30,154 patients.

Outcome Measures

Our primary outcome measure was “return to care.” This was defined as readmission to an inpatient facility “inpatient readmission” or a postoperative emergency department (ED) visit “ED visit” within 30 days of discharge. Readmitted patients were identified using unique person-level identifiers which track sequential visits within a state and across hospital settings. Visits to the ED that did not result in hospitalization were captured by the SEDD, while patients who returned to the ED and were subsequently hospitalized were captured by the SID database as inpatient readmissions. For patients who may have been readmitted multiple times, only the first readmission was included.

Data were stratified by patient factors including payer and race. Primary expected payer categories “no charge,” “self-pay,” and “Other” were grouped together as “Other.” Race categories “Asian,” “Native American,” and “Other” were grouped together as “Other.” Further analysis metrics included comorbid conditions defined by Elixhauser et al., patient location defined by an HCUP four category urban-rural designation (Metropolitan >1M, metropolitan <1M, micropolitan >10K and <50K, and rural residual), and patient median income defined by a HCUP quartile classification variable [10]. Index surgical procedures were grouped into “Segmental Resection” (ICD-9 32.30, 32.39), “Lobectomy” (ICD-9 32.41, 32.49), “Pneumonectomy” (ICD-9 23.59), “Decortication (ICD-9 34.51), and Other (ICD-9 32.29, 32.29, 32.9, 33.28, 34.09).

Index lung cancer diagnosis was identified by the diagnosis categorization detailed in the HCUP Clinical Classification Software (CCS) with multi-level diagnostic code “2.3: cancer of bronchus; lung”[11]. Pre-existing COPD diagnosis was identified by the HCUP CCS single-level diagnosis code “127: Chronic Obstructive Pulmonary Disease and Bronchiectasis” in any of the twenty-five patient diagnosis fields. Readmission and ED visit primary diagnoses were categorized according to the HCUP Clinical Classification Software single-level diagnosis codes and the first level of multi-level diagnostic codes.

Data Analysis

We described baseline characteristics of the index cohort, 30-day inpatient readmission cohort and emergency department visit cohort using descriptive analysis, chi-squared analysis for categorical variables and a Kruskal-Wallis test for continuous variables. We used a risk-adjusted, population-averaged multivariable logistic regression model to measure the association of risk factors on return to care status, with a fixed hospital effect to control for heterogeneity over time due to hospital site variability. Collinearity between risk factors in the multivariate analysis was assessed using a variance inflation factor <10 and a tolerance >0.1 . Statistical analysis tests were run utilizing Stata analysis software version 14.0 (Statacorp, College Station, TX).

Results

Characteristics of Index Cohort

Our study included 30,154 patients who underwent thoracic surgery with an open approach (Table 1). The thoracic surgeries captured included 51% lobectomy, 13% other local lung resection, 11% other incision of pleura, 10% decortication, 9% segmental or other resection, 4% open biopsy of lung, and 2% pneumonectomy. The average patient age was 62 years and the average index of comorbidities was 2.3. The majority of patients was of white race (73.4%) and had Medicare as their primary payer (51.7%). The average length of stay (LOS) of the index hospitalization was 7.6 days (range 0–229 days). Patients in the wealthiest median income had a significantly shorter average length of stay (mean -1.4 days, $p<0.001$) compared to patients in the poorest median income quartile. Over half (59.5%) of the patients had a primary underlying diagnosis of lung cancer; the next most common primary diagnoses were pleurisy, pneumothorax, and pulmonary collapse (9.9%), secondary malignancy (6.0%), other lower respiratory disease (5.7%), internal injury (3.7%) and pneumonia (3.6%).

Discharge Status

Of the 30,154 index records, 9,835 (32.6%) were discharged to home with home health services in anticipation of covered skilled care. Our analysis excluded 4,629 patients discharged to an intermediate or skilled care facility. Compared to patients that were discharged elsewhere, patients discharged to a care facility were older, had more chronic comorbidities, and were more likely to have Medicare (see supplementary data). Of these excluded patients, 499 (10.7%) were discharged to an inpatient rehabilitation facility and 1,799 (38.9%) were discharged to a Skilled Nursing Facility in anticipation of skilled care including rehabilitation.

Characteristics of Returns to Care

The overall 30-day return to care rate was 16.5% with 10.2% inpatient readmissions and 6.3% ED visits (Table 2). The mean interval from index discharge to revisit was 15 days (SD = 7.6) for ED revisits and 17 days (SD = 7.3) for inpatient readmissions. The mean LOS of an inpatient readmission was 6.6 days (SD=10) with 12% (N=226) of inpatient readmissions

lasting only one day. Patients returning within 7 days of discharge comprised 17% of returns to the ED and 12% of inpatient readmissions (Figure 1).

Those patients with an unplanned return to care had more comorbidities ($p<0.001$) and were less likely to have a lung cancer diagnosis ($p=0.01$) (Table 3). COPD diagnosis at index visit was associated with an increased risk of inpatient readmission ($p<0.001$) but was not significantly associated with returns to the ED. Medicaid patients had higher rates of return to the ED at 9.3% compared to patients with Medicare (5.9%) and private insurance (5.5%).

1.5% of patients had an index LOS greater than 30 days (max 229 days). No patient with index visit LOS greater than 30 days was readmitted. In patients with index LOS < 30 days, patients readmitted as inpatients had a significantly longer index LOS than non-readmitted patients (LOS 7.4 days vs 7.0 days, $p<0.001$). The lowest mean readmission rate occurred at index LOS of 3 days (8.3% readmitted) while the highest mean readmission rate was associated with index LOS of 16 days (16.4% readmitted). Index visit length of stay was not associated with risk of return to the ED.

The most common primary diagnoses for inpatient readmissions (18.4%) was “complications of surgical procedure” while “pleurisy, pneumothorax, or pulmonary collapse” was documented for 12.6% of readmissions (Supplementary Table 1). The most common primary diagnoses for patients visiting the ED were “other lower respiratory disease” (14.9%), “nonspecific chest pain” (8.8%) and “complications of surgical procedures” (8.1%) (Supplementary Table 2).

Multivariate Analysis

Analyses of risk factors associated with higher odds of inpatient readmission or ED visit within 30 days of discharge are presented in Table 4. Increased odds of inpatient readmission were associated with a higher comorbidity index (OR 1.08; $p<0.001$), an index surgery of pneumonectomy (OR 1.94; $p<0.001$), Medicare payer (OR 1.30; $p<0.001$), Medicaid payer (OR 1.31; $p<0.001$) and black race (OR 1.18; $p=0.02$). Decreased odds of inpatient readmission were associated with: a primary diagnosis of lung cancer (OR 0.83; $p<0.001$) or median income in the wealthiest quartile (OR 0.89; $p=0.04$).

Increased odds of ED visit were associated with: higher comorbidity index (OR 1.02; $p=0.03$), Medicare payer (OR 1.24; $p<0.001$), Medicaid payer (OR 1.59; $p<0.001$) or other payer (OR 1.53; $p<0.001$), or Hispanic race (OR 1.19; $p=0.04$).

Discussion

This retrospective study of open thoracotomy patients in three large US states found that 16% of patients had an unplanned return to care within 30 days of discharge, with a 10% inpatient readmission rate and 6% ED visit rate. A greater proportion of patients returning to care following thoracotomy were non-white, publically insured, and with a greater number of comorbidities compared to patients with no return to care. In this cohort, 30-day returns to care occurred in both the ED and inpatient settings, highlighting the importance of

accounting for ED utilization when assessing returns to care following major surgical procedures, such as thoracotomy.

In this study, the rates of inpatient readmissions following thoracotomy are consistent with the literature concerning inpatient readmissions following major surgeries [1] as well as following open lobectomy or resection [12–15]. However, few studies include ED visits within 30-days of discharge in their analyses. One report including postoperative ED visits following major joint replacement surgery found similar postoperative ED rates, which were commonly for pain-related diagnoses [16]. While pain was an important primary diagnoses that brought patients to the ED and inpatient care setting following thoracotomy, a more common diagnosis was complications of surgical procedures and medical care. These common diagnoses for returns to care following thoracotomy could represent an area for focused quality improvement efforts, particularly pain management. Furthermore, as many of these complications may develop post-discharge and 59% of the unplanned care events occurred after 14 days post-discharge, a clinical follow-up in the first 8–12 days could significantly impact these events.

Like many other studies examining patient factors associated with returns to care following an acute care episode, we found public payer status, whether Medicaid or Medicare, was associated with a higher risk of both inpatient readmissions and postoperative ED visits [6,12,17]. Similarly, other studies show low socioeconomic status is associated with increased readmissions and poor survival in non-small cell lung cancer [18,19]. Our results are concordant with this past work. In this study, as median household income increased, the risk of readmission or postoperative ED visit decreased; patients living in the highest median household quartile had significantly lower odds of a readmission. These results suggest that patients with public payers and those with lower household incomes may have barriers to access additional care once discharged from the index admission. Ensuring that all patients have clear discharge information on alternative avenues to seek care if complications or acute pain crises arise could improve the quality of care for all, especially for patients with low resources or vulnerable populations.

Our model estimates also suggest increased LOS was associated with risk of inpatient readmission. These finding are in agreement with current literature associating LOS and readmission [12,20]. However, in a retrospective study, it is difficult to determine with any certainty that a longer length of stay is associated with higher readmission rates or rather that patients who are sicker have longer lengths of stay and therefore higher rates of readmissions. It is likely not the longer LOS that causes higher readmission, but rather underlying disease factors that we are unable to account for in our study. Furthermore, we found that patients with a 3-day LOS had the lowest rates of return to care visits, suggesting that the 72-hour postoperative period warrants inpatient care and suggests a tipping point exists for LOS and hospital readmission.

Patients undergoing pneumonectomy in their index visit were also more likely to be readmitted. This is in alignment with prior work by Handy et al., who found that pneumonectomy was the single predisposing factor for readmission in a cohort of pulmonary resections [21].

Interestingly, we found that patient with a lung cancer diagnosis were less likely to return to the ED within 30-days discharge and less likely to have an inpatient readmission. Cancer patients are more likely to be treated within a multi-disciplinary oncologic team, which may increase coordination of medical and surgical care. This could provide increased resources for patients once they return home and facilitate access to follow up care, and hence reduce unplanned visits following open thoracotomy. In addition, there is widespread public support and focus on cancer survivorship, which may translate to better community support once discharged from the hospital [22, 23]. Therefore, patients with a lung cancer diagnosis likely have strong care support and unplanned visits may be less common among this population.

It is important to note that our analysis considered patients undergoing thoracotomy, an invasive and open surgical approach as opposed to its minimally invasive counterpart, video-assisted thoracoscopic surgery (VATS). The morbidity profile of an open thoracotomy is significantly higher than that of a VATS procedure. Studies have documented open lobectomies carry greater risk of inpatient readmission compared to VATS [14]. Yet, others suggest that although open thoracotomy has a higher perioperative complication rate compared to VATS, readmissions do not differ significantly [13]. Our inpatient readmission rate of 10% following open thoracotomy is well aligned with these published reports. While VATS procedures are being done much more commonly, still the majority of all lung resections in the US are thoracotomies, underscoring the continued need to study this population.

This study has several limitations. The use of administrative data has inherent limitations, including coding errors and omissions. These data lack pertinent clinical information including perioperative pain management regimens or pre-operative tumor stage in lung cancer patients, which limits the interpretation of our results. Furthermore, these data only provide within, state analyses. Therefore, if patients' readmission or ED visit occurred in a different state than their index discharge, their return to care would not be captured. In addition, secondary discharge diagnoses are not reliably coded in these datasets, which limits risk-adjustment and the categorization of readmitted patients beyond primary diagnoses. Another limitation is that we excluded patients discharged from their index visit to a skilled nursing facility or other intermediate care facility, as we do not have information on their care or release date from these facilities. This exclusion could skew our results as patients discharged to a skilled facility may have greater complications and thus may be at greater risk for readmissions. Finally, our study only includes data from Florida, New York and California and results may not be generalizable to the entire US population. Despite these limitations, our study included a large, diverse population of open thoracotomy patients. Our results are consistent with current literature and advance our knowledge reasons for 30-day returns to care following open thoracotomy as well as factors associated with these unplanned care events.

Conclusions

In this large, population-based study, 16.5% of patients had an unplanned return to care after open thoracotomy, with over 35% occurring in the ED. Factors associated with unplanned care visits included public payer, lower median household income—and Black race. The

majority of these visits occurred after 14 days discharge and commonly had a primary diagnosis of surgical complication or pain. Integrating this evidence into clinical care could improve health outcomes throughout the entire episode of care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Glossary of Abbreviations:

ED	Emergency Department
HRPP	Hospital Readmissions Reduction Program
HCUP	Healthcare Cost and Utilization Project
SID	State Inpatient Database
SEDD	State Emergency Department Database
LOS	Length of Stay

References

1. Tsai TC, Joynt KE, Orav EJ, Gawande AA, Jha AK. Variation in surgical-readmission rates and quality of hospital care. *New England Journal of Medicine*. 2013 9 19;369(12):1134–42. [PubMed: 24047062]
2. Jencks SF, Williams MV, Coleman EA. Rehospitalizations among patients in the Medicare fee-for-service program. *New England Journal of Medicine*. 2009 4 2;360(14):1418–28. [PubMed: 19339721]
3. Boozary AS, Manchin J, Wicker RF. The Medicare hospital readmissions reduction program: time for reform. *JAMA*. 2015 7 28;314(4):347–8. [PubMed: 26219049]
4. Press MJ, Rajkumar R, Conway PH. Medicare's new bundled payments: design, strategy, and evolution. *JAMA*. 2016 1 12;315(2):131–2. [PubMed: 26720889]
5. Centers for Medicare and Medicaid Services. Readmissions Reduction Program. Retrieved from: <https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/AcuteInpatientPPS/Readmissions-Reduction-Program.html>. Accessed September, 2016.
6. Paul S, Altorki NK, Sheng S, Lee PC, Harpole DH, Onaitis MW, et al. Thoracoscopic lobectomy is associated with lower morbidity than open lobectomy: a propensity-matched analysis from the STS database. *The Journal of Thoracic and Cardiovascular Surgery*. 2010 2 28;139(2):366–78. [PubMed: 20106398]
7. Laursen LØ, Petersen RH, Hansen HJ, Jensen TK, Ravn J, Konge L. Video-assisted thoracoscopic surgery lobectomy for lung cancer is associated with a lower 30-day morbidity compared with lobectomy by thoracotomy. *European Journal of Cardio-Thoracic Surgery*. 2015 6 18;ezv205.
8. Hu Y, McMurphy TL, Isbell JM, Stukenborg GJ, Kozower BD. Readmission after lung cancer resection is associated with a 6-fold increase in 90-day postoperative mortality. *The Journal of thoracic and cardiovascular surgery*. 2014 11 30;148(5):2261–7. [PubMed: 24823283]

9. HCUP Databases. Healthcare Cost and Utilization Project (HCUP). 2010–2011. Agency for Healthcare Research and Quality, Rockville MD www.hcup-us-ahrq.gov/databases.jsp.
10. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Medical care*. 1998 1 1;36(1):8–27. [PubMed: 9431328]
11. Healthcare Cost and Utilization Project. Clinical Classification Software (CCS) for ICD-9-CM. Agency for Healthcare Research and Quality Retrieved from <https://www.hcup-us.ahrq.gov/toolssoftware/ccs/ccs.jsp>. 9 2016.
12. Stiles BM, Poon A, Giambrone GP, Gaber-Baylis LK, Wu X, Lee PC, Port JL, et al. Incidence and Factors Associated With Hospital Readmission After Pulmonary Lobectomy. *The Annals of thoracic surgery*. 2016 2 29;101(2):434–43. [PubMed: 26718860]
13. Assi R, Wong DJ, Boffa DJ, Detterbeck FC, Wang Z, Chupp GL, Kim AW. Hospital readmission after pulmonary lobectomy is not affected by surgical approach. *The Annals of thoracic surgery*. 2015 2 28;99(2):393–8. [PubMed: 25497070]
14. Rajaram R, Ju MH, Bilimoria KY, Ko CY, DeCamp MM. National evaluation of hospital readmission after pulmonary resection. *The Journal of thoracic and cardiovascular surgery*. 2015 12 31;150(6):1508–14. [PubMed: 26092506]
15. Goodney PP, Stukel TA, Lucas FL, Finlayson EV, Birkmeyer JD. Hospital volume, length of stay, and readmission rates in high-risk surgery. *Annals of surgery*. 2003 8 1;238(2):161–7. [PubMed: 12894006]
16. Finnegan MA, Shaffer R, Remington A, Kwong J, Curtin C, Hernandez-Boussard T. Emergency Department Visits Following Elective Total Hip and Knee Replacement Surgery: Identifying Gaps in Continuity of Care. *JBJS*. 2017 6 21;99(12):1005–12.
17. Maniar HS, Bell JM, Moon MR, Meyers BF, Marsala J, Lawton JS, Damiano RJ. Prospective evaluation of patients readmitted after cardiac surgery: analysis of outcomes and identification of risk factors. *The Journal of thoracic and cardiovascular surgery*. 2014 3 31;147(3):1013–20. [PubMed: 24365269]
18. Tsai TC, Orav EJ, Joynt KE. Disparities in surgical 30-day readmission rates for Medicare beneficiaries by race and site of care. *Annals of surgery*. 2014 6;259(6):1086. [PubMed: 24441810]
19. Erhunmwunsee L, Joshi MB, Conlon DH, Harpole DH. Neighborhood-level socioeconomic determinants impact outcomes in nonsmall cell lung cancer patients in the Southeastern United States. *Cancer*. 2012 10 15;118(20):5117–23. [PubMed: 22392287]
20. Freeman RK, Dilts JR, Ascoti AJ, Dake M, Mahidhara RS. A comparison of length of stay, readmission rate, and facility reimbursement after lobectomy of the lung. *The Annals of thoracic surgery*. 2013 11 30;96(5):1740–6. [PubMed: 23987895]
21. Handy JR, Child AI, Grunkemeier GL, Fowler P, Asaph JW, Douville EC, Tsen AC, Ott GY. Hospital readmission after pulmonary resection: prevalence, patterns, and predisposing characteristics. *The Annals of thoracic surgery*. 2001 12 31;72(6):1855–60. [PubMed: 11789760]
22. McCabe MS, Bhatia S, Oeffinger KC, Reaman GH, Tyne C, Wollins DS, Hudson MM. American Society of Clinical Oncology statement: achieving high-quality cancer survivorship care. *Journal of Clinical Oncology*. 2013 2 10;31(5):631–40. [PubMed: 23295805]
23. Raz DJ, Sun V, Kim JY, Williams AC, Koczywas M, Cristea M, et al. Long-Term Effect of an Interdisciplinary Supportive Care Intervention for Lung Cancer Survivors After Surgical Procedures. *The Annals of thoracic surgery*. 2016 2 29;101(2):495–503. [PubMed: 26443881]

Figure 1.

Days from the index discharge to a return to the ED or inpatient setting, in 7-day intervals. The fewest numbers of patients returned in less than 7 days; the largest number returned to the ED between 8–14 days and to inpatient settings between 22–30 days.

Figure 2.

Percent of patients returning to care, grouped by index length of stay. The lowest percent of inpatient readmissions occurred at LOS of 3 days after which the risk of inpatient readmission increased until LOS of 16 days. Returns to the ED were not significantly associated with length of stay.

Table 1.

Patient Demographics of Index Cohort

Demographic	Index Cohort
N (%)	30,154
Age, mean years (SD)	62.8 (14.2)
Elixhauser Comorbidities (SD)	2.3 (1.9)
Length of Stay, mean days (SD)	7.6 (7.1)
<u>Gender, %</u>	
Female, %	14,434 (48.0%)
Male, %	15,649 (52.0%)
<u>Race, %</u>	
White	22,140 (73.4%)
Black	2,279 (7.6%)
Hispanic	2,936 (9.7%)
Other	2,799 (9.3%)
<u>Payer, %</u>	
Medicare	15,580 (51.7%)
Medicaid	2,798 (9.3%)
Private	9,654 (32.0 %)
Other	2,122 (7.0%)
<u>Diagnosis, %</u>	
Lung Cancer	17,946 (59.5%)
COPD	10,475 (34.7%)

Table 2.

Thirty-Day Postoperative Visit Rate, According to Setting

Setting	Rate	N
Emergency Department	6.3%	1,896
Inpatient	10.2%	3,060
Emergency Department and Inpatient	16.5%	4,956

Table 3.

Patient Demographics: Non-Readmitted, ED Visit, and Inpatient Readmission

Demographic	No Return to Care	ED Visit	P Value ^I	Inpatient Readmission	P Value ^I
N (%)	25,198 (83.6%)	1,896 (6.3%)		3,060 (10.1%)	
Age, mean yrs (SD)	62.8 (14.1)	60.5 (15.9)	<0.001	63.7 (14.4)	0.9
Elixhauser Comorbidities (SD)	2.5 (1.8)	2.8 (1.8)	<0.001	3.0 (2.1)	<0.001
<u>Gender, %</u>					
Female, %	12,118 (83.9%)	917 (6.4%)	0.7	1,399 (9.7%)	0.004
Male, %	13,017 (83.2%)	972 (6.2%)		1,660 (10.6%)	
<u>Race, %</u>					
			0.8		0.01
White	18,567 (83.9%)	1,322 (5.9%)		2,251 (10.2%)	
Black	1,828 (80.2%)	180 (7.9%)		271 (11.9%)	
Hispanic	2,415 (82.3%)	226 (7.7%)		295 (10.0 %)	
Other	2,388 (85.3%)	168 (6.0%)		243 (8.7%)	
<u>Payer, %</u>					
			0.8		<0.001
Medicare	12,928 (82.9%)	913 (5.9%)		1,739 (11.2%)	
Medicaid	2,221 (79.4%)	261 (9.3%)		316 (11.3%)	
Private	8,318 (86.2%)	531 (5.5%)		806 (8.3%)	
Other	1,731 (81.6%)	191 (9.0%)		200 (9.4%)	
<u>Diagnosis, %</u>					
Lung Cancer	15,112 (84.2%)	1,072 (6.0%)	0.003	1,762 (9.8%)	0.01
COPD	8,662 (82.7%)	645 (6.2%)	0.5	1,168 (11.1%)	<0.001

^I. Compared to No Readmission cohort

Table 4.

Risk-Adjusted Model of Factors Associated with Inpatient Readmission and/or ED Visit

Risk Factor	Inpatient Readmission			ED Revisit		
	OR	P Value	95% CI	OR	P Value	95% CI
Female	0.94	0.1	0.87, 1.02	1.06	0.2	0.96, 1.17
Age	0.99	0.2	0.99, 1.00	0.99	<0.001	0.98, 0.99
Elix-Hauser Index	1.09	<0.001	1.07, 1.10	1.02	0.03	1.01, 1.04
<u>Diagnosis (ref: other)</u>						
Lung cancer	0.89	<0.001	0.79, 0.94	0.99	0.9	0.88, 1.13
<u>Surgical Procedure (ref: segmental resection)</u>						
Lobectomy	1.07	0.4	0.92, 1.25	1.10	0.3	0.93, 1.30
Pneumonectomy	1.94	<0.001	1.55, 2.45	1.03	0.17	0.75, 1.40
Decortication	0.84	0.07	0.69, 1.02	0.86	0.18	0.69, 1.07
Other	1.23	0.01	1.04, 1.46	1.10	0.3	0.91, 1.32
<u>Payer (ref: private)</u>						
Medicare	1.31	<0.001	1.16, 1.47	1.24	<0.001	1.10, 1.39
Medicaid	1.32	<0.001	1.14, 1.52	1.60	<0.001	1.36, 1.89
Other	1.13	0.2	0.95, 1.35	1.56	<0.001	1.29, 1.88
<u>Race (ref: white)</u>						
Black	1.18	0.03	1.02, 1.36	1.11	0.2	0.93, 1.33
Hispanic	0.95	0.5	0.83, 1.08	1.19	0.04	1.01, 1.40
Other	0.92	0.2	0.79, 1.06	0.96	0.6	0.80, 1.15
<u>Median Income (ref: 1st Quartile)</u>						
2nd Quartile	1.02	0.7	0.91, 1.15	0.99	0.9	0.87, 1.14
3rd Quartile	0.91	0.2	0.82, 1.03	0.98	0.8	0.85, 1.13
4th Quartile	0.89	0.04	0.79, 0.99	1.01	0.9	0.88, 1.16
<u>Urban-Rural (ref: Metropolitan >1M)</u>						
Small metropolitan	0.95	0.3	0.85, 1.06	1.10	0.1	0.96, 1.25
Micropolitan	0.93	0.5	0.76, 1.15	1.15	0.2	0.92, 1.44
Non metro/micro-politan	0.85	0.4	0.58, 1.23	1.06	0.8	0.75, 1.49