

Unexpected readmission after lung cancer surgery: A benign event?

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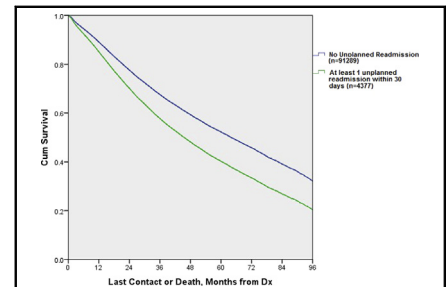
ABSTRACT

Objective: The study objective was to study the incidence, predictors, and implications of unanticipated early postoperative readmission after lung resection for non–small cell lung cancer.

Methods: Patients undergoing surgery for clinical stage I to III non–small cell lung cancer were abstracted from the National Cancer Database. Regression models were fitted to identify predictors of 30-day readmission and to study the association of unplanned readmission with 30-day and long-term survival.

Results: Between 1998 and 2010, 129,893 patients underwent resection for stage I to III non–small cell lung cancer. Of these, 5624 (4.3%) were unexpectedly readmitted within 30 days. In a multivariate regression model, increasing age, male gender, preoperative radiation, and pneumonectomy (odds ratio, 1.77; 95% confidence interval, 1.56–2.00) were associated with unexpected readmissions. Longer index hospitalization and higher Charlson comorbidity score were also predictive of readmission. The 30-day mortality for readmitted patients was higher (3.9% vs 2.8%), as was the 90-day mortality (7.0% vs 3.3%, both $P < .001$). In a multivariate Cox proportional hazards model of long-term survival, increasing age, higher Charlson comorbidity score, and higher pathologic stage (hazard ratio, for stage III 1.81; 95% confidence interval, 1.42–2.29) were associated with greater risk of mortality. Unplanned readmission was independently associated with a higher risk of long-term mortality (hazard ratio, 1.40; 95% confidence interval, 1.34–1.47). The median survival for readmitted patients was significantly shorter (38.7 vs 58.5 months, $P < .001$).

Conclusions: Unplanned readmissions are not rare after resection for non–small cell lung cancer. Such events are associated with a greater risk of short- and long-term mortality. With the renewed national focus on readmissions and potential financial disincentives, greater resource allocation is needed to identify patients at risk and develop measures to avoid the associated adverse outcomes. (*J Thorac Cardiovasc Surg* 2015;150:1496–505)



Kaplan–Meier survival of patients undergoing NSCLC surgery with unexpected readmission versus no readmission.

Central Message

Unexpected readmissions after lung resection are difficult to predict and associated with diminished overall long-term survival.

Perspective

This large database analysis of risk factors and consequences of unexpected postoperative readmission after lung resection for lung cancer identifies increasing age, lower income, higher comorbidity score, and treatment at nonacademic centers as risk factors for readmission. We note shorter overall survival in readmitted patients after accounting for cancer stage and early postoperative mortality.

See Editorial Commentary page 1506.

Supplemental material is available online.

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Hospital readmission is a sentinel event after lung cancer surgery and is seen in at least 5% to 15% of patients.^{1–5} Readmissions may be planned, for instance, to place intravenous access devices for chemotherapy or for medical care unrelated to the lung resection, or they may be unplanned and a direct consequence of the lung operation. Unexpected postoperative readmissions are a major financial burden to the healthcare system, and as part of Section 3025 of the Affordable Care Act, a Hospital Readmissions Reduction Program has been

Abbreviations and Acronyms

AJCC	= American Joint Committee on Cancer
CI	= confidence interval
HR	= hazard ratio
NCDB	= National Cancer Database
NSCLC	= non-small cell lung cancer

created, mandating public reporting of readmission rates with potential monetary penalties for institutions with excessive readmissions. Thus, understanding and ameliorating unexpected postoperative readmissions after lung resection are medical and financial necessities for thoracic surgery programs.

Several patient- and treatment-related factors have been found to be associated with a higher risk of readmission. These include increasing age, male gender, lower socioeconomic status, and higher levels of comorbidity.⁴ More complex operations, such as pneumonectomy and chest wall resection, are also risk factors.² Major postoperative complications and lack of social support also predict a greater likelihood of unplanned readmission. Recent publications also have shown a greater risk of 90-day mortality related to early readmission after lung surgery.² Despite several known risk factors, predictive models for readmission have modest discriminating power. In addition, although the short-term medical and economic implications of readmission have been well described, their impact on long-term survival, especially in lung cancer, remains inadequately understood.

The National Cancer Database (NCDB) is a joint program of the Commission on Cancer as established by the American College of Surgeons and the American Cancer Society. This program collects information on approximately 70% of all new patients with cancer diagnosed in the United States and Puerto Rico. By using this database, we aimed to study the incidence and predictors of unanticipated early postoperative readmission after lung resection for non-small cell lung cancer (NSCLC). In addition, we hypothesized that unexpected readmission would be associated with a greater risk of short- and long-term mortality.

MATERIALS AND METHODS

An NCDB participant user file was obtained from the American College of Surgeons. By using the de-identified database, information was abstracted on patients receiving pulmonary resection for NSCLC between 1998 and 2010 at any of the participating centers. Patients who did not receive pulmonary resection and were treated with only chemotherapy or radiation therapy were excluded. The study was exempted by the institutional review board.

Information on patient- and tumor-related variables, operation type, readmission rates, 30-day mortality, and survival was obtained from the repository. By using information on race and income, we formed dichotomized groups in which a patient was Caucasian or not Caucasian, and had an annual income less than or greater than \$35,000. On the basis of the population size of the area where a patient presented, rural (regional population <250,000

and urban locations were defined. The NCDB uses the Charlson–Deyo score as a measure of comorbidity and categorizes scores into 0 (no comorbidities), 1, and 2 or greater. Because few patients have a Charlson–Deyo score greater than 2, these patients are combined into 1 category by the database. Postoperative readmissions were distinctly coded as planned or unplanned (unexpected) in the database. For this study, treatment center type was dichotomized into nonacademic (including community cancer programs and comprehensive community cancer centers) or academic/research cancer treatment centers. Last known vital status and the time between diagnosis and last known follow-up date were used to determine survival.

Statistical Analysis

Statistical analysis was performed using SPSS Statistics for Windows, Version 21.0 (IBM Corporation, Armonk, NY). Descriptive statistics were expressed as mean \pm standard deviation unless otherwise specified. Independent-sample *t* tests and 1-way analysis of variance were used to compare continuous variables. Chi-square tests were used to compare categorical data. After an initial univariate comparison between patients who experienced unexpected readmission after surgery versus those who did not, a multivariable logistic regression model was fitted to study associations of unexpected 30-day readmission after surgery. Patients who died during their index admission were not included in this model because they were not exposed to the risk of readmission. In addition, a multivariable model was fitted to study associations of 30-day postoperative mortality. Next, a Cox proportional hazards model was fitted to identify associations of long-term survival. Overall survival was estimated by the Kaplan–Meier method. Finally, patients in the readmitted group were then matched to those in the nonreadmitted group using a propensity score–based technique. The propensity score was the probability of readmission, estimated using a logistic regression model including age, gender, race, income, rural versus urban status, Charlson–Deyo score, tumor size, type of operation, type of facility where treatment was administered, American Joint Committee on Cancer (AJCC) clinical stage, and AJCC pathologic stage. Patients for whom the propensity scores matched to the third decimal place were matched in 1:1 fashion. The 2 propensity-matched groups were confirmed to be well balanced using pairwise comparison (paired *t* test and McNemar’s test). Automated matching was performed using the Fuzzy extension command in SPSS (SPSS 21.0 for Windows, SPSS Inc, Chicago, Ill).⁶ The Cox proportional hazards model for long-term survival was again fitted to this propensity-matched population.

For the multivariable models, patients with missing data for variables being considered were excluded from the specific model. For regression model development, all variables deemed clinically meaningful and those that had a *P* value .1 or less on univariate analysis were included in the model. Backward stepwise approach was used for all logistic regression models.

RESULTS

Between 1998 and 2010, 129,893 patients underwent resection for stage I to III NSCLC. Of these, 5624 (4.3%) were unexpectedly readmitted within 30 days of surgery (Table 1). In univariate analysis, readmitted patients were slightly older, were more likely male, had lower annual income, and had higher Charlson comorbidity score. Readmitted patients were also more likely to be from rural areas, to be treated at nonacademic institutions, and to have a longer index hospitalization after surgery (7.3 vs 9.0 days, *P* < .001).

Risk of Readmission

In a multivariate logistic regression model, increasing age, male gender, preoperative radiation, and pneumonectomy were associated with unexpected readmissions

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