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Prognostic Value of National Comprehensive Cancer Network Lung Cancer Resection Quality Criteria

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Background. The National Comprehensive Cancer Network (NCCN) surgical resection guidelines for non-small cell lung cancer recommend anatomic resection, negative margins, examination of hilar/intrapulmonary lymph nodes, and examination of three or more mediastinal nodal stations. We examined the survival impact of these criteria.

Methods. A population-based observational study was done using patient-level data from all curative-intent, non-small cell lung cancer resections from 2004 to 2013 at 11 institutions in four contiguous Dartmouth Hospital referral regions in three US states. We used an adjusted Cox proportional hazards model to assess the overall survival impact of attaining NCCN guidelines.

Results. Of 2,429 eligible resections, 91% were anatomic, 94% had negative margins, 51% sampled hilar nodes, and 26% examined three or more mediastinal nodal stations. Only 17% of resections met all four

criteria; however, there was a significant increasing trend from 2% in 2004 to 39% in 2013 ($p < 0.001$). Compared with patients whose surgery missed one or more criteria, the hazard ratio for patients whose surgery met all four criteria was 0.71 (95% confidence interval: 0.59 to 0.86, $p < 0.001$). Margin status and the nodal staging criteria were most strongly linked with survival.

Conclusions. Attainment of NCCN surgical quality guidelines was low, but improving, over the past decade in this cohort from a high lung cancer mortality region of the United States. The NCCN quality criteria, especially the nodal examination criteria, were strongly associated with survival. The quality of nodal examination should be a focus of quality improvement in non-small cell lung cancer care.

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Provider- and institutional-level disparities in patient survival after curative-intent lung cancer surgery suggest the existence of potentially correctable gaps in the quality of surgical care [1–6]. Such gaps affect short-term outcomes, such as postoperative mortality and hospital readmission rates [7, 8]. Gaps in the oncologic quality of resection may be more difficult to measure because of their delayed manifestation [9]. Such gaps exist in the quality of pathologic nodal staging and rates of resection with positive margins [10–13].

Quality improvement requires validated, survival-impactful benchmarks. The National Comprehensive Cancer Network (NCCN) has established principles of surgical therapy that can be condensed into a composite benchmark consisting of a recommendation for anatomic resection, negative margins, hilar and intrapulmonary lymph node examination, and examination of three or more mediastinal lymph node stations [14].

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Table 1. Patient Characteristics

Characteristics	Values
Total	2,429 (100)
Period	
2004-2008	892 (36.7)
2009-2013	1,537 (63.3)
Mean age, years (SD)	66.9 (9.7)
Age group, years	
<65	881 (36.3)
65-74	1,000 (41.2)
75-84	516 (21.2)
≥85	32 (1.3)
Sex	
Male	1,266 (52.1)
Female	1,163 (47.9)
Race	
White	1,912 (78.7)
Black	497 (20.5)
Other	20 (0.8)
Insurance	
Medicare only	1,207 (49.7)
Medicaid	293 (12.1)
Commercial insurance/supplement	835 (34.4)
Self-pay/no insurance	94 (3.9)
Chest CT ^a	
Yes	1,419 (92.3)
No/missing	118 (7.7)
PET-CT ^a	
Yes	1,223 (79.6)
No	314 (20.4)
Invasive staging examination ^a	
Yes	231 (15.0)
No	1,306 (85.0)
Pathologic T classification	
T1	1,122 (46.2)
T2	949 (39.1)
T3	256 (10.5)
T4	88 (3.6)
Tx	14 (0.6)
Pathologic N classification	
N0	1,687 (69.5)
N1	316 (13.0)
N2	199 (8.2)
NX	227 (9.3)
Pathologic stage	
I	1,581 (65.1)
II	480 (19.8)
III	316 (13)
IV	39 (1.6)
Unknown	13 (0.5)
Total LN examined preop and postop	6 (3-11)
Mediastinal LN examined	2 (0-5)
Mediastinal LN stations sampled	1 (0-2)
Histology	
Adenocarcinoma	1,285 (52.9)

(Continued)

Table 1. Continued

Characteristics	Values
Squamous cell	842 (34.7)
Adenosquamous	68 (2.8)
Large cell	111 (4.6)
Other	123 (5.1)
Grade	
Well differentiated	259 (10.7)
Moderately differentiated	1,037 (42.7)
Poorly differentiated	732 (30.1)
Undifferentiated	52 (2.1)
Not reported	349 (14.4)
Extent of resection	
Pneumonectomy	192 (7.9)
Bilobectomy	152 (6.3)
Lobectomy	1,782 (73.4)
Segmentectomy	72 (3.0)
Wedge	231 (9.5)
Surgical technique	
Open	1,861 (76.7)
Robotically assisted	226 (9.3)
Video assisted	340 (14)
Surgical kit use, 2011-2013	
Yes	233 (25.4)
No	684 (74.6)
Postoperative chemotherapy ^a	
Yes	235 (15.3)
No	1,297 (84.7)
Number of comorbidities ^a	
0	319 (20.8)
1	603 (39.2)
2	376 (24.5)
3	155 (10.1)
4+	84 (5.5)
Mortality rates	
30 days	109 (4.5)
60 days	163 (6.7)
90 days	203 (8.4)

^a Recent era, 2009 to 2013.

Values are n (%) or median (interquartile range).

CT = computed tomography; LN = lymph node; PET = positron emission tomography; postop = postoperative; preop = preoperative.

We examined the rate of attainment, and the survival impact, of these quality guidelines in a diverse population-based cohort.

Patients and Methods

Study Design and Participants

THE MID-SOUTH QUALITY OF SURGICAL RESECTION DATABASE. With the approval of the Institutional Review Boards of all participating hospitals, we conducted a population-based observational study of all curative-intent non-small cell lung cancer (NSCLC) resections in 11 hospitals within four

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