Healthcare Workforce and Regionalization of Services: Lung Cancer Resections

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AHRQ 9/10/08
Disclosures
Are Surgical Outcomes for Lung Cancer Resections Improved at Teaching Hospitals?

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**Thoracic Surgery Directors Association (TSDA) Resident Research Award.**

*Background.* Defining centers of excellence for complex surgical procedures, including pulmonary resection, reveals lower mortality at high-volume centers. We postulate that short-term outcome after lung cancer resection is better at teaching hospitals (TH) compared with non-teaching hospitals (non-TH), independent of volume.

*Methods.* Lung cancer resections in the Nationwide Inpatient Sample (NIS) dataset from 1998 to 2004 were stratified by resection type (segmentectomy, lobectomy, and pneumonectomy). The TH identified in the NIS include those with Accreditation Council for Graduate Medical Education-approved general surgery (GSTH) and thoracic surgery (TSTH) residency programs. The association of hospital teaching status with in-hospital mortality was assessed by multivariate logistic regression, adjusting for patient demographics and comorbidities.

*Results.* Of 46,951 lung resections (5,651 segmentectomies, 37,027 lobectomies, 4,273 pneumonectomies), 56% were performed at TH. Overall mortality was significantly lower at TH versus non-TH (3.2% vs 4.0%; \( p < 0.001 \)). Subgroup analysis for GSTH and TSTH confirmed this decrease. On multivariate regression, overall odds of death was independently reduced by 17% at TH versus non-TH (95% confidence interval: 0.73 to 0.93; \( p = 0.002 \)). At TH, odds of death for pneumonectomy and lobectomy were significantly reduced independent of surgical volume, except for the latter at the highest hospital volume strata.

*Conclusions.* In-hospital mortality is reduced for patients undergoing lung cancer resections at teaching hospitals, with results prominent at all but the highest volume institutions. Lower mortality rates persisted at GSTH and TSTH. Understanding and disseminating the processes of care associated with these settings may improve quality of care for lung cancer patients, and decrease patient bias against teaching hospitals.

Overview

- Incidence of lung cancer
- Study background/methods
- Result:
  - Teaching vs non-teaching
  - General surgery residency
  - Thoracic surgery residency
- AHRQ Implications
It Looks Just As Stupid When You Do It

Minnesota Department of Health
# The High Incidence of Lung Cancer

*Jemal et al, CA 2006*

## Estimated New Cases*

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lung and Bronchus</strong></td>
<td>92,700 (13%)</td>
<td></td>
</tr>
<tr>
<td>Prostate</td>
<td>234,460 (33%)</td>
<td></td>
</tr>
<tr>
<td>Colon and Rectum</td>
<td>72,800 (10%)</td>
<td></td>
</tr>
<tr>
<td>Urinary Bladder</td>
<td>44,690 (6%)</td>
<td></td>
</tr>
<tr>
<td>Melanoma of the Skin</td>
<td>34,260 (5%)</td>
<td></td>
</tr>
<tr>
<td>Non-Hodgkin Lymphoma</td>
<td>30,680 (4%)</td>
<td></td>
</tr>
<tr>
<td>Kidney and Renal Pelvis</td>
<td>24,650 (3%)</td>
<td></td>
</tr>
<tr>
<td>Oral Cavity and Pharynx</td>
<td>20,180 (3%)</td>
<td></td>
</tr>
<tr>
<td>Leukemia</td>
<td>20,000 (3%)</td>
<td></td>
</tr>
<tr>
<td>Pancreas</td>
<td>17,150 (2%)</td>
<td></td>
</tr>
<tr>
<td><strong>All Sites</strong></td>
<td>720,280 (100%)</td>
<td></td>
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</tbody>
</table>

## Estimated Deaths

<table>
<thead>
<tr>
<th></th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lung and Bronchus</strong></td>
<td>90,330 (31%)</td>
<td></td>
</tr>
<tr>
<td>Colon and Rectum</td>
<td>27,870 (10%)</td>
<td></td>
</tr>
<tr>
<td>Prostate</td>
<td>27,350 (9%)</td>
<td></td>
</tr>
<tr>
<td>Pancreas</td>
<td>16,090 (6%)</td>
<td></td>
</tr>
<tr>
<td>Leukemia</td>
<td>12,470 (4%)</td>
<td></td>
</tr>
<tr>
<td>Liver and Intrahepatic Bile Duct</td>
<td>10,840 (4%)</td>
<td></td>
</tr>
<tr>
<td>Esophagus</td>
<td>10,730 (4%)</td>
<td></td>
</tr>
<tr>
<td>Non-Hodgkin Lymphoma</td>
<td>10,000 (3%)</td>
<td></td>
</tr>
<tr>
<td>Urinary Bladder</td>
<td>8,990 (3%)</td>
<td></td>
</tr>
<tr>
<td>Kidney and Renal Pelvis</td>
<td>8,130 (3%)</td>
<td></td>
</tr>
<tr>
<td><strong>All Sites</strong></td>
<td>291,270 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

* Jemal et al, CA 2006
Prior Studies Examining Surgical Outcomes

- Surgeon volume
- Hospital volume
  - Pulmonary resection
  - Esophageal resection
  - Coronary artery bypass
  - Carotid endarterectomy
  - Other complex cancer surgery
- Hospital characteristics associated with improved outcomes poorly defined
Origin of the Study

"Try not to worry Mr Thomas. It's just a minor operation."
Teaching Hospitals

- Teaching hospitals
  - Fellows, residents, medical and nursing students
  - Surrogate of higher levels of tertiary care and services
  - Public perception: “dangerous”

- Published studies:
  - Benefit of teaching hospitals is due to increased volume
Thoracic vs. General Surgeons

- Lung resections traditionally performed by general surgeons as well as specialty-trained thoracic surgeons.
- Debate persists over whether thoracic surgeons should preferentially perform lung (and esophageal) resections.
- Few large, nationwide studies have examined this issue.
Benefit of Teaching Hospitals

- Unclear whether perioperative outcomes are improved at teaching hospitals due to volume or environment

- Hypothesis:

  “In-hospital mortality after lung cancer resection at teaching hospitals is low and improved at thoracic teaching programs, while independent of hospital procedure volume.”
Methods - 1

- **Study Design:** Retrospective analysis using Nationwide Inpatient Sample (HCUP/AHRQ)
  - 1998-2003
  - Combined with ACGME to identify general and thoracic surgery residency programs
  - Primary lung cancer
  - Segmentectomy, lobectomy, pneumonectomy
Definitions: *Lung Cancer Operations*

- **Wedge resection** removes a small portion of a lobe.
- **Segment resection** removes a larger portion of a lobe.
- **Lobectomy** removes an entire lobe.
- **Pneumonectomy** removes the entire lung.
Methods - 2

- Variables:
  - Age, gender, race
  - Charlson Index of comorbidities
  - Annual hospital procedure volumes
  - Teaching hospital status
Definitions

**Teaching Hospitals (NIS):**

- At least 1 residency program (not necessarily surgery)
- Member of Council of Teaching Hospitals
- Maximum 4:1 beds:residents

**Academic Hospitals:**

- University affiliation
- Faculty: university-based, engage in research
Outcome Analysis

- **Outcome:**
  - In-hospital death from any cause as end result based on discharge summary (not usual 30-day mortality)

- **Analyzed Statistics:**
  - Multivariate logistic regression analysis
### Surgical and Hospital Demographics

**Overall Resections**
- Pneum.: 4,901 (9.7%)
- Seg.: 8,143 (16.1%)
- Lobectomy: 37,882 (74.9%) - Total: 50,576

**Overall Hospital Status**
- Teaching: 28,101 (55.2%)
- Non-Teaching: 22,780 (44.8%) - Total: 3215
## Resection Demographics

<table>
<thead>
<tr>
<th></th>
<th>Teaching</th>
<th>Non-Teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hospitals</strong></td>
<td>1095 (34.1%)</td>
<td>2115 (65.9%)</td>
</tr>
<tr>
<td><strong>Total Resections</strong></td>
<td>28,101</td>
<td>22,780</td>
</tr>
<tr>
<td><strong>Segmentectomy</strong></td>
<td>4,383 (15.7%)</td>
<td>3,753 (16.5%)</td>
</tr>
<tr>
<td><strong>Lobectomy</strong></td>
<td>20,740 (73.8%)</td>
<td>17,110 (75.1%)</td>
</tr>
<tr>
<td><strong>Pneumonectomy</strong></td>
<td>2,978 (10.6%)</td>
<td>1,917 (8.4%)</td>
</tr>
</tbody>
</table>
### Patient Demographics

<table>
<thead>
<tr>
<th></th>
<th>Teaching</th>
<th>Non-Teaching</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Median Age</strong></td>
<td>66 years</td>
<td>67 years</td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td>46.8%</td>
<td>45.6%</td>
</tr>
<tr>
<td><strong>Median Charlson Index</strong></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>Median Hospital Stay</strong></td>
<td>7</td>
<td>7</td>
</tr>
</tbody>
</table>
Unadjusted Mortality: Teaching vs. Non-Teaching Hospitals

- Overall: p=0.016
- Seg.: p<0.05
- Lobe: p<0.001
- Pneum.: p<0.05
# Multivariate Analysis of Lobectomies at Teaching vs. Non-Teaching

<table>
<thead>
<tr>
<th>Sub-Groups:</th>
<th>Odds Ratio*</th>
<th>95% CI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>0.81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume ≤ 5</td>
<td>0.83</td>
<td>0.70 - 0.97</td>
<td>0.023</td>
</tr>
<tr>
<td>Volume ≤ 10</td>
<td>0.83</td>
<td>0.70 - 0.98</td>
<td>0.026</td>
</tr>
<tr>
<td>Volume ≥ 10</td>
<td>0.83</td>
<td>0.70 - 0.98</td>
<td>0.026</td>
</tr>
<tr>
<td>Volume ≥ 20</td>
<td>0.84</td>
<td>0.71 - 0.98</td>
<td>0.031</td>
</tr>
</tbody>
</table>

* Adjusted for Age, Gender, Race, Comorbidities, Volume

19% Reduction in Mortality
Unadjusted Overall Mortality: Teaching vs. Non-Teaching Hospitals

- Teaching: 20.2%
- Non-Teaching: 27.3%
- Non-Teaching: 27.5%

In-Hospital Mortality Rate

- Teaching: 3%
- Non-Teaching: 4%
- Gen Surg: 3%
- Non-Gen Surg: 4%
- Thor Surg: 3%
- Non-Thor Surg: 4%
Summary

Statistically significant difference in mortality rate for lobectomies at teaching vs. non-teaching hospitals (2.94% vs. 3.62%)

19% improvement in post-operative survival for lobectomy at teaching hospital (95% CI: 0.69 - 0.96)

These findings are independent of hospital volume
Teaching Hospitals: *Process of Care*

Subspecialty trained surgeons
- Thoracic vs. General surgeons
In-house resident / fellow care
Dedicated SICU directed by intensive care specialists
Thoracic anesthesiology
Physical / Respiratory therapists
Interdisciplinary team management of lung cancer patients
Pathway protocols for post-operative care
Study Limitations

- Retrospective database design
- Definition of teaching hospital in NIS
- Inability to account for differences in surgical specialty training
- Unable to examine other post-op outcomes
- Inability to further delineate what differences exist between teaching & non-teaching hospitals
Conclusions

- These data suggest that post-operative mortality is improved for patients undergoing lobectomy at teaching hospitals.

- More research is needed to define the influence of hospital status and the process of care on post-operative outcomes for high-risk operations.
Conclusions

- Our data refute the fears of patients seeking surgical care at teaching hospitals.

- Information regarding these processes of care could be disseminated to improve patient care and outcomes nationally.

- Critical steps in the process of care should be identified for the benefit of patients undergoing resection for lung cancer independent of hospital volume and teaching status.
Application of NIS/HCUP/AHRQ

- Limitations: patient level data (staging, specific complications, etc)

- Applicability of NIS increased by combining with other datasets (ACGME in this study)

- Specialty Datasets: Society of Thoracic Surgeons database in adult cardiac, general thoracic and pediatric cardiac surgery
Policy Implications

- If data is taken at face value, AHRQ could propose national clinical practice guidelines (i.e. beta-blockers for MI) to have complex procedures performed at teaching hospitals.

- If conclusions are extrapolated, and the “processes of care” are felt to be essential for improved outcomes, policy makers could make these mandatory services for these procedures.
Thank You

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Benjamin S. Brooke, MD
David Chang, PhD, MPH, MBA
J. Timothy Sherwood, MD
Malcolm V. Brock, MD
Adjusted Odds Ratio of In-Hospital Death after Lung Resection

Teaching vs Non-Teaching
Gen Surg vs Non-Gen Surg
Thor Surg vs Non-Thor Surg

Odds of In-Hospital Death

Overall  Seg.  Lobe.  Pneumon.
Overall  Seg.  Lobe.  Pneumon.
Overall  Seg.  Lobe.  Pneumon.

Odds of In-Hospital Death

0  0.5  1.0  1.5  2.0  2.5
Hypotheses:

- **Post-Operative mortality after lung resection is reduced at teaching hospitals**
- **This reduction is independent of volume**
- **Mortality outcomes for Thoracic Surgeons are improved over General Surgeons**
Unadjusted Mortality: General Surgery Teaching vs. Non-Gen Surg Teaching Hospitals

In Hospital Mortality Rate

- Gen Surg Teaching
- Non-Gen Surg Teaching

Overall In Hospital Mortality Rate:
- General Surgery Teaching: 4%
- Non-Gen Surg Teaching: 8%

P < 0.05

Seg.:
- General Surgery Teaching: 2%
- Non-Gen Surg Teaching: 4%

P < 0.05

Lobe.:
- General Surgery Teaching: 2%
- Non-Gen Surg Teaching: 4%

P < 0.05

Pneumon.:
- General Surgery Teaching: 8%
- Non-Gen Surg Teaching: 12%

P < 0.05
**Unadjusted Mortality:**
Thoracic Surgery Teaching vs. Non-Thor Surg Teaching Hospitals

![Bar chart showing in-hospital mortality rate for different lung segments and conditions, comparing Thor Surg Teaching and Non-Thor Surg Teaching hospitals.](image)

- Overall: Thor Surg Teaching vs. Non-Thor Surg Teaching, p<0.05
- Seg.: Thor Surg Teaching vs. Non-Thor Surg Teaching
- Lobe.: Thor Surg Teaching vs. Non-Thor Surg Teaching, p<0.05
- Pneumon.: Thor Surg Teaching vs. Non-Thor Surg Teaching