New Surgical Options for Elderly Lung Cancer Patients*

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To understand the size of the aging population in the United States, the imminent need to include the elderly in clinical studies on lung cancer, and the safe potential of video-assisted thoracic surgery, and to change awareness of the elderly’s need for and ability to undergo treatment for lung cancer, clinical studies of video-assisted thoracic surgery in patients ≥ 70 years of age are presented. The elderly are a fast-growing part of the American population who are at high risk for lung cancer and should be included in clinical studies. Age alone should not be a contradiction to thoracic surgical interventions when video thoracoscopy is performed as treatment. *(CHEST 1999; 116:480S–485S)*

**Abbreviations:** LOS = length of stay; VATS = video-assisted thoroscopic surgery

The population of the United States is aging, with Americans > 65 years of age comprising the largest growing subgroup of the population. This demographic phenomenon is expected to continue into the next century as the children of the 1946 to 1964 baby boom begin to approach retirement age in 2011.1 Furthermore, the average life expectancy in this country has dramatically increased from 47 years in 1900 to 75.6 years by 2000.2 Half of all Americans currently alive can expect to reach the ninth decade of life. This combination of an aging baby boomer generation and increased life expectancy may double the size of the elderly population during the next 30 years.1

Cancer is generally a disease of the elderly.3 Half of all cancer incidence occurs in patients > 65 years old. In 1987, 12% of the U.S. population was ≥ 65 years of age and 8 million of this segment had cancer. It is estimated that in 2030, 20% of the population will be ≥ 65 years of age and 12 million will have cancer.4 Americans > 65 years of age have 10 times the risk of developing cancer as younger members of society.4

Lung cancer remains the most common malignancy in the United States. The American Cancer Society estimates that 171,600 new cases will be diagnosed and 158,900 lung cancer–related deaths will occur in 1999.5 This prevalence is expected to further increase to 91,000 cases in women and 193,500 cases in men ≥ 65 years of age by 2030.1 Currently, the peak incidence of this disease occurs in patients between 60 to 70 years of age (Fig 1).6 Forty-five thousand people ≥ 75 years of age will die next year of lung cancer. Lung cancer is so prevalent among elderly Americans that a 2-cm asymptomatic solitary pulmonary nodule in a 70-year-old male smoker has a ≥ 70% chance of being an occult lung cancer.7

**Increased Operative Risk**

Unfortunately, advanced age is a risk factor for death after thoracotomy. Multiple single-institution studies and one excellent multi-institutional study have substantiated this observation. The studies established a link between increased mortality after thoracotomy and patient age of ≥ 65 years.

One hundred patients ≥ 70 years of age underwent thoracotomy for lung cancer between 1959 and 1968 in the North Middlesex Hospital study.8 Operative mortality was 14% after lung resection in these elderly patients. Mortality was related to the extent of pulmonary resection, with a 26% mortality after pneumonectomy, 14% after lobectomy, but no deaths after segmental resections.

The outcomes of 114 patients of all ages undergoing lung resection at Worthing General Hospital, England, were reported in 1973 by Evans.9 The author found a relationship between increasing patient age and increasing operative mortality: 10% operative mortality for patients < 65 years of age, 16% for those aged 65 to 69, and 27% for patients aged 70 to 83.

The 1976 University of Michigan study comprised 55 patients ≥ 70 years of age.10 The operative mortality for pulmonary resection in this carefully selected elderly group was 14%, which includes a 17% mortality after pneumonectomy and 14% mortality after lobectomy.

Eighty-one patients ≥ 70 years of age treated surgically for lung cancer were reported by the Queen’s Medical Center, Hawaii, in 1977.11 Overall, operative mortality was 16%. Interestingly, this group reported a very high 10% mortality for exploration alone in elderly patients and an 18% mortality in elderly patients undergoing pulmonary resection.

These findings were corroborated by the multi-institutional effort of the Lung Cancer Study Group of North America in 1983.12 Reviewing 2,200 cases of lung resections for cancer, Ginsberg et al12 clearly established the association between increasing risk of death after open thoracotomy and increasing patient age, with a modern 30-day operative mortality of 7 to 8% for patients > 69 years of age (Table 1).12

More recent reports have not identified a difference in expected operative mortality after thoracotomy if lung-sparing operations were performed.13–15 Reported operative mortality for elderly patients undergoing thoracotomy in the past decade has ranged from 3 to 5% in carefully selected patients. Further refinement in the selection process and postoperative care is still needed in this growing subgroup of the population.

More than 1 million Americans who are ≥ 65 years of age will need major thoracic surgery during the next year.1 The elderly cohort, as the most vulnerable to lung cancer and other thoracic malignancies, should be the most...
targeted for study and intervention. However, thus far, the elderly cohort has been underrepresented in clinical studies. There is an urgent need to understand and address the unique needs of elderly cancer patients.

**MECHANISM OF DISEASE**

These observations lead to the fundamental question, “What is aging?” Aging is a change in both structure and function that occurs within all known living organisms. These changes collectively produce a decrease in physiologic capacity and reserve. This loss of reserve manifests clinically as an increasing vulnerability to disease.

There are numerous theories as to why cancer is more prevalent in the aging host. Perhaps there is more accumulated damage to the genome after living within a hostile environment for decades that leads to an increased rate of carcinogenesis. There may be a decay in the ability of the DNA repair enzymes to recognize and repair breaks in the chromosomes. Aging has been associated with an alteration in the ability to control cell growth. There may be an inherent susceptibility to carcinogens in the older cells.

Finally, biological clocks may play a role in the decreased proliferation of cellular immune components that recognize and destroy neoplastic cells.

The clinical presentation of lung cancer may be different in elderly compared with younger patients. Some epidemiologists have claimed that elderly patients frequently present with more localized disease and with more squamous cell cancer, a favorable histology. This more favorable presentation is not typical of all cancers, however, and some cancers in an elderly host have been associated with a more advanced stage and aggressive clinical course. Animal data suggest that there is a spectrum of seed and soil interactions in the elderly host.

Survival rates of elderly patients with lung and esophageal cancer are not as favorable as those of younger patients (Fig 2). Five-year survival rates drop as a function of age. A lung cancer 5-year survival of 21.5% among

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**Table 1—Lung Cancer Study Group Age-Adjusted Mortality Rates by Decades**

<table>
<thead>
<tr>
<th>Age, yr</th>
<th>No. Resections</th>
<th>Deaths</th>
<th>30-Day Mortality, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50</td>
<td>230</td>
<td>3</td>
<td>1.3</td>
</tr>
<tr>
<td>50–59</td>
<td>617</td>
<td>8</td>
<td>1.3</td>
</tr>
<tr>
<td>60–69</td>
<td>920</td>
<td>37</td>
<td>4.1</td>
</tr>
<tr>
<td>70–79</td>
<td>416</td>
<td>29</td>
<td>7.0</td>
</tr>
<tr>
<td>&gt; 80</td>
<td>37</td>
<td>3</td>
<td>8.1</td>
</tr>
</tbody>
</table>

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**Figure 1.** Incidence of lung cancer as a function of age for men and women. Data abstracted from SEER Cancer Statistics database.
patients < 45 years of age drops to a rate of 12.6% for patients between ages 65 and 74, and still further to 8.5% in patients ≥ 75 years of age. This decrease in 5-year survival for elderly lung cancer patients may be caused by comorbid disease, more aggressive biological behavior of cancer in the elderly, or decreased immune function on the part of the elderly host. On the other hand, some investigators report that cancer may behave more indolently in the elderly host, and decreased survival may not be related to the cancer. There is research evidence to support both theories.

Specific organ system decay frequently accompanies aging. Within the respiratory system, aging is accompanied by a decrease in lung elasticity, decrease in respiratory muscle strength, and a decrease in maximal oxygen consumption. This produces the clinical observation of decreased vital capacity and increased residual volume. Furthermore, there is an increase in the baseline ventilation/perfusion mismatch. For this reason, predictions of pulmonary function tests are based on the height, weight, sex, and age of the patient. Aging is accompanied by respiratory muscle atrophy, reduction in the force-generating capacity of the residual muscle, and changed mechanics of breathing. These changes in the muscular architecture of the chest wall may be profoundly affected by a posterolateral thoracotomy incision.

Within the coronary system, there is an increase in occult native coronary artery disease. There is an increase in the baseline and stimulated level of norepinephrine in the blood, which may correlate with the increased incidence of atrial fibrillation within the elderly population. There is certainly an increase in the cardiotoxicity of chemotherapy within this group.

Other organ systems suffer from a lack of physiologic reserve. The kidneys have a decrease in plasma flow and subsequently a reduced glomerular filtration rate. The endocrine system secretes and utilizes less insulin. The nervous system is prone to postoperative confusion and peripheral neuropathy after chemotherapy.

Advanced age may affect treatment. Furthermore, recovery is slower when each organ system is somewhat impaired. For these reasons, caregivers and family members frequently advocate the least morbid treatment option, irrespective of the likelihood of success. Yet, this perception of frailty is poorly quantified. It is not infrequent that an 80-year-old patient who appears robust to some is perceived to be infirm by others. Finally, the expectation of the remaining years of life of very elderly patients frequently influences treatment decisions.

The average years of life remaining have been calculated by insurance companies (Table 2). In general, a patient who has reached the ninth decade of life can be expected to live for at least an additional 5 to 7 years. Patients with untreated or palliated early stage lung cancer only have 1.5 years of average life remaining.

### Multi-Interventional Plan To Reduce Operative Risk

We have developed a multi-interventional plan to reduce operative risk in the elderly. It includes preoperative optimization, changes in operative management and postoperative recovery, and efforts to improve the long-term convalescence from surgery.

Preoperative optimization includes accurate staging of the cancer, control of preoperative infections, pulmonary rehabilitation before lung resection, and comorbid disease assessment and treatment. Intraoperative management is heavily based on thoracoscopic and video-assisted thoracic surgery (VATS) techniques. These include limited incisions of 2 to 8 cm without spreading of ribs. They preserve respiratory muscle function and avoid rib fractures. Most patients receive epidural catheters to minimize pain and maximize normal lung function. In-hospital postoperative recovery begins with early ambulation using weight-bearing carts that carry oxygen tanks and chest tube drainage systems. We minimize psychoactive medications, including antinausea and sleep agents. We make every effort to minimize hospital stay to return the elderly patients to their familiar home environment as soon as possible. Long-term convalescence begins with postoperative pulmonary rehabilitation. Additional key ingredients include visiting home nursing care and altered expectations of recovery time.

At the Brigham and Women’s Hospital in Boston, we believe VATS offers a potential solution to the dilemma of increasing incidence of early stage lung cancer in the elderly patient on the one hand and increasing operative risk with advanced patient age on the other. We hypothesize that the elderly patients at high risk with conventional surgery may benefit most from minimally invasive surgery. Specifically, by minimizing the trauma to the chest wall, VATS offers the elderly patient less pain, less respiratory failure, stronger cough, and shorter recovery time.

To examine this hypothesis, we reviewed our experience from our initial VATS procedures from July 1991 to June 1994. We performed 895 videoscopic procedures in patients aged 65 to 89 years. The procedures were generally evenly split between men and women. Between 40 to 60 thoracoscopic procedures were performed each month, representing 50% of the major thoracic surgery caseload during that time.

The demographic, perioperative, and pathologic data on our patients were collected prospectively. By definition, a closed thoracoscope uses only 2-cm incisions. Ninety

### Table 2—Sex-Specific Expectations of Remaining Life at ≥70 Years of Age*

<table>
<thead>
<tr>
<th>Current Age, yr</th>
<th>Remaining Years</th>
<th>Current Age, yr</th>
<th>Remaining Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>70</td>
<td>11.3</td>
<td>70</td>
<td>15.4</td>
</tr>
<tr>
<td>74</td>
<td>9.2</td>
<td>74</td>
<td>12.6</td>
</tr>
<tr>
<td>78</td>
<td>7.4</td>
<td>78</td>
<td>10.3</td>
</tr>
<tr>
<td>82</td>
<td>6.0</td>
<td>82</td>
<td>8.3</td>
</tr>
<tr>
<td>86</td>
<td>5.0</td>
<td>86</td>
<td>6.8</td>
</tr>
<tr>
<td>90</td>
<td>4.2</td>
<td>90</td>
<td>5.9</td>
</tr>
</tbody>
</table>

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percent of our cases were thoracoscopic in type. A VATS procedure includes thoracoscopic ports and a utility incision of 8 cm or less. Thirty-two cases, or 10% of our experience, were VATS procedures. End points included postoperative length of stay (LOS), final pathology, morbidity, and mortality. Postdischarge follow-up was conducted in our thoracic surgery clinic at 1 and 6 weeks, and continued every 4 months for 3 years for patients with neoplasms.

Table 3 summarizes pulmonary function, type of video-assisted operative procedure, and LOS as a function of age for the study group. The entire elderly population studied has been split into four cohorts by age for comparison. One hundred nine procedures were performed on patients 65 to 69 years old, 110 on patients 70 to 74 years, 55 on patients 75 to 79 years, and 33 on patients 80 to 89 years. The range of FEV₁ reveals our willingness to perform VATS on elderly patients with severely impaired lung function. There was a trend toward lower FEV₁ in the older groups, but this was not statistically significant. One hundred eighty-eight operations involved the lung (61%), including 32 lobectomies or formal segmentectomies; 78 (25%) were for pleural disease, 27 (9%) for mediastinal disease, and 14 (5%) for pericardial windows. Median LOS was 4 days for patients aged 65 to 79 years and 5 days for patients aged 80 to 89 years.

There were three deaths in the entire group, all between ages 70 and 74 years, for an overall mortality of <1%. One death occurred in a 70-year-old man with a malignant pleural effusion who died of his primary disease on the eighth postoperative day. A 73-year-old woman died after experiencing acute renal failure 19 days after thoracoscopic drainage of an empyema. The third death occurred in a 73-year-old man who died of pulmonary fibrosis 24 days after thoracoscopic lung biopsy. There were four conversions (1%). Two conversions were for inadequate thoracoscopic decortication of empyema, a mediastinal node biopsy was abandoned because of inadequateatelectasis of the lung, and an 84-year-old man had a conversion during VATS lobectomy because of intrathoracic bleeding. Overall morbidity (prolonged hospital stay) was 15%. There was no relationship between morbidity and age. The most common major morbidity was prolonged air leak. The most common minor morbidity was dysrhythmia. Only 2.7% of our patients experienced postoperative confusion.

Why do elderly patients seem to benefit from VATS? The answer may be provided by the pioneering efforts of Landreneau and colleagues. They showed that patients treated with VATS used less narcotics and had reduced pain, improved shoulder motion, and less pulmonary dysfunction compared with patients treated with open thoracotomy. The VATS incisions seem to preserve muscle function in the elderly. The incisions are limited to 2 to 8 cm, minimize intercostal muscle damage and rib fracture, and preserve respiratory muscle function.

Operative mortality is improved with VATS. We have had no thoracoscopic pneumonectomies but can compare thoracoscopic lobectomies to the data of the Lung Cancer Study Group (Table 4). In that report, there were 27 patient deaths of 368 lobectomies or lesser pulmonary resections in patients ≥70 years of age, and three deaths of 37 lobectomies or lesser resections (8.1%) (Table 1) in patients ≥80 years of age. At the Brigham and Women’s Hospital, VATS lobectomy or segmentectomy produced no deaths in 32 procedures and only one death in 156 other thoracic surgical procedures.

Median LOS after open thoracotomy was 12.4 days among all Boston hospitals during this same period. In our experience, LOS is 4 days for thoracoscopic and VATS procedures in patients aged 65 to 79 years and 5 days for patients ≥80 years of age. Our oldest patient, 89 years old, went home 3 days after a thoracoscopic wedge resection for a lung cancer.

Operative morbidity for VATS procedures is comparable to open thoracotomy. Two previous groups report an 18% major, 15% minor morbidity and an 11% major, 13% minor morbidity for open thoracotomy in patients ≥70 years of age. This compares well with our rate of 7% major, 9% minor morbidity for thoracoscopic surgery in the elderly. Furthermore, morbidity seems to be independent of age. Hazelrigg and colleagues concisely summarize the self-reporting of the VATS Study Group for all ages and show a 9.3% major and 5.1% minor morbidity rate.

The incidence of postoperative confusion in this elderly population is particularly noteworthy. We know from an ongoing study of >1,300 procedures at the Brigham and Women’s Hospital that there are two independent risk

Table 3—Procedures With Pulmonary Function and LOS by Age

<table>
<thead>
<tr>
<th>Variable</th>
<th>65–69 yr</th>
<th>70–74 yr</th>
<th>75–79 yr</th>
<th>80–80 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median FEV₁ (L)</td>
<td>2.02</td>
<td>1.76</td>
<td>1.68</td>
<td>1.61</td>
</tr>
<tr>
<td>Range (L)</td>
<td>0.73–4.2</td>
<td>0.38–3.66</td>
<td>0.84–2.66</td>
<td>0.7–2.95</td>
</tr>
<tr>
<td>Lung resection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobe or segment</td>
<td>15</td>
<td>8</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Wedge</td>
<td>45</td>
<td>43</td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td>Lung biopsy</td>
<td>7</td>
<td>9</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Bullectomy</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Pericardial window</td>
<td>5</td>
<td>3</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Mediastinal dissection</td>
<td>11</td>
<td>10</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Pleuroscopy</td>
<td>23</td>
<td>35</td>
<td>14</td>
<td>6</td>
</tr>
<tr>
<td>Total (307 procedures)</td>
<td>109</td>
<td>110</td>
<td>55</td>
<td>33</td>
</tr>
<tr>
<td>Length of stay, d</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Median</td>
<td>1–72</td>
<td>1–37</td>
<td>1–22</td>
<td>1–36</td>
</tr>
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<table>
<thead>
<tr>
<th>Variable</th>
<th>65–69 yr</th>
<th>70–74 yr</th>
<th>75–79 yr</th>
<th>80–80 yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonectomy</td>
<td>85</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lobectomy</td>
<td>368</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>453</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Table 4—Lung Cancer Study Group Mortality Rates for Patients ≥70 Years of Age

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. Resections</th>
<th>No. Deaths (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumonectomy</td>
<td>85</td>
<td>5 (5.9)</td>
</tr>
<tr>
<td>Lobectomy</td>
<td>368</td>
<td>27 (7.3)</td>
</tr>
<tr>
<td>Overall</td>
<td>453</td>
<td>32 (7.1)</td>
</tr>
</tbody>
</table>

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factors for postoperative confusion: age ≥ 70 years and noncardiac thoracic surgery. When these two risk factors are combined, the risk of experiencing postoperative confusion is 13 to 19%. In our videoscopic surgery cohort, the incidence was only 2.7%. Postoperative confusion can be a major source of morbidity and mortality in the elderly patient. It is associated with a 13-fold increase in mortality, a 7-fold increase in major complications, and a 3-fold increase in the rate of hospital discharge to a long-term care facility.

Why should videoscope-assisted procedures produce less postoperative confusion in the elderly patient? Possible mechanisms include less physiologic stress, less narcotics, and especially a quicker return to the home environment.

**Conclusions**

A multi-interventional plan to minimize operative risk in elderly patients may provide new surgical options for the treatment of elderly patients with lung cancer. Thoracosopic and VATS procedures can be performed safely on selected elderly patients, with an expected operative mortality of < 1%. Furthermore, they are accompanied by an acceptable morbidity and short LOS. Age alone should not be a contradiction to thoracic surgical interventions when video thoracoscopy is thoughtfully applied.

Many puzzles remain concerning the elderly host and lung cancer. These provide fertile ground for new research. Basic science research is needed to explore tumor-host interactions that produce the increased risk of neoplasia with advanced age. Further understanding in this area may lead to new screening and treatment algorithms.

Clinical science research is needed to explore current treatment choices for elderly patients with lung cancer and to judge the efficacy of these options. Does the workup of the elderly patient with a lung nodule differ from the workup of lung nodules in younger patients seen by the same physicians? What factors influence these decisions? Which groups affect the workup: doctors, patients, extended families? Is there a role for screening within a subgroup of the elderly cohort of patients who are at particularly high risk? Is there age bias in the current treatment of lung cancer? Finally, if the elderly are treated differently, are there differences in outcomes?

The study of the interaction of age and cancer is an exciting and promising new field. We currently have such a paucity of information that it is difficult to advise an 86-year-old patient with a solitary pulmonary nodule about the risks and benefits of workup and treatment options. The knowledge gained within this new field will be of practical benefit to researchers, clinicians, patients, families, and anyone who grows old.

**References**

30. Landreneau RJ, Hazleigg SB, Mack MJ, et al. Postoperative pain-related morbidity: video-assisted thoracic surgery versus...