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Thoracotomy in patients over age seventy years

Ten-year experience

Recent reports have demonstrated satisfactory long-term survival following pulmonary resection in the elderly. However, the high operative risk commonly cited in patients over 70 years of age has led some authors to conclude that advanced age is a contraindication to pulmonary resection. During 1969 to 1978, 218 thoracotomies were performed in patients over the age of 70 years. Operations performed include 175 pulmonary resections and 43 miscellaneous thoracic surgical procedures. Primary or metastatic cancer was the indication for 174 operations (pulmonary resection, 150 cases; exploration and biopsy, 16 cases; pleurectomy, eight cases). One hundred thirty-seven patients (63%) had a benign course, whereas 74 patients experienced a total of 83 complications. Minor complications of atrial fibrillation, air leak persisting for 7 to 14 days, and successfully managed retention of secretions were seen in 34 patients (16%). Nonfatal major complications were predominantly cardiac and respiratory in nature and occurred in 40 patients (18%). The overall hospital mortality was 3% (seven patients). Lung-sparing procedures were utilized whenever possible among the 150 patients undergoing pulmonary resection for carcinoma (sleeve lobectomy, 13 cases; segmental resection, 52 cases; wedge resection, 12 cases). The hospital mortality of 4% among these 150 patients was significantly lower ($p < 0.001$) than the 17% mortality among 308 elderly patients compiled from five series reported by other centers between 1973 and 1978. Long-term follow-up was obtained in 129 of the 139 (93%) available patients surviving pulmonary resection for cancer. The overall 5 year survival rate is 27%, ranging from 13% for patients having pneumonectomy to 42% for those having segmental resection.

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There are presently almost fifteen million people in the United States over the age of 70 years.[1] The average life expectancy at age 70 is 13.1 years, and that at age 80 is still 8.2 years.[2] As more and more of the general population attains the age of 70, the thoracic surgeon is increasingly asked to consider operative treatment on this elderly group of patients.

Unresected carcinoma of the lung in the elderly is associated with a 1 year survival rate of only 7%.[3] As longevity increases, surgical therapy for carcinoma assumes the same importance for elderly patients as for patients in the younger age groups. Recent reports[4, 5] have demonstrated encouraging long-term survival following resection for lung cancer in elderly patients, but the associated mortality has been high (14% to 20%).[3-6] As these mortality rates were at variance with our clinical impression, we reviewed a 10 year experience with thoracotomy in patients over the age of 70. This study includes patients requiring surgical therapy for benign conditions in addition to patients operated upon for primary and secondary carcinoma of the lung.

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Patients

During the years 1969 to 1978, 218 thoracotomies were done in 213 patients over the age of 70 years at Rush-Presbyterian-St. Luke's Medical Center. The

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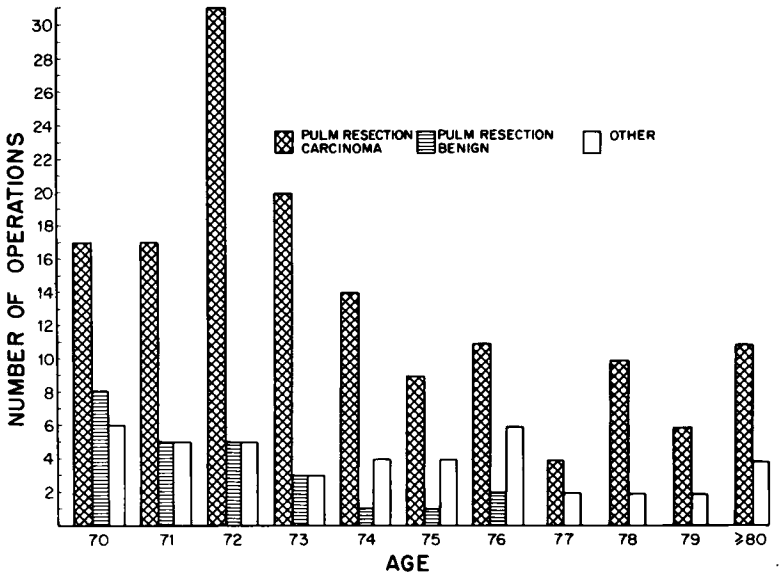

Fig. 1. Distribution by age of 218 thoracotomies performed in 213 patients over the age of 70 years (1969 to 1978). The *cross-hatched bars* indicate pulmonary resection for carcinoma; the *horizontal striped bars*, pulmonary resection for benign disease; and the *unshaded bars*, miscellaneous thoracotomies without pulmonary resection.

group included 149 men and 64 women aged 70 to 93 years (Fig. 1). Primary or metastatic cancer was the indication for 174 operations, and the remaining 44 procedures were for benign pulmonary or esophageal disease. The operative procedures are listed in Table I. Resection was accomplished in 150 of 166 patients with primary lung carcinoma, a resectability rate of 90%. Lung-sparing procedures were utilized whenever possible, and these included 13 sleeve lobectomies and 52 segmental resections for lung cancer (Fig. 2).

Pulmonary function tests and arterial blood gases were obtained preoperatively in patients in whom clinical evaluation indicated marginal pulmonary function and the possible need for pneumonectomy. Data are not available on the number of patients considered inoperable because of poor results on pulmonary function tests, but this number is small.

Results

An uneventful hospital course occurred in 137 patients (63%), whereas there were 83 nonfatal complications in 74 patients (34%) and seven hospital deaths (3%). Complications were classified as major or minor. Major complications included air leak for more than 14 days, respiratory insufficiency necessitating prolonged ventilator support, atelectasis and/or retained secretions necessitating multiple aspiration bronchoscopies, ventricular arrhythmias, congestive heart failure, and myocardial infarction. Complications classified as minor were air leak persisting for 7 to 14 days, atrial fibrillation responsive to treatment with digitalis, and retained secretions and/or atelectasis successfully managed with one aspiration bronchoscopy.

There were 34 patients that experienced minor complications among the entire group of 218 patients (15%). The incidence of minor complications was significantly higher among patients undergoing pulmonary resection than among patients undergoing other thoracic procedures (Table II). Major complications occurred in 40 of the 218 patients (18%). There was no significant difference in the incidence of major complications occurring in patients undergoing pulmonary resection versus patients undergoing other miscellaneous thoracic procedures (Table II).

Eight nonfatal major complications occurred in seven of the 43 patients (17%) undergoing thoracotomy for purposes other than pulmonary resection. Pulmonary complications predominated, with prolonged air leak in two patients, the need for ventilator support in three patients, and atelectasis and retained secretions in one patient. Congestive heart failure and arrhythmias were seen in one patient each.

Detailed analysis of nonfatal major postoperative complications in patients undergoing pulmonary resection is presented in Table III. Complications related to the lungs were the most common and included, in order of descending frequency, retained secretions and/or atelectasis necessitating multiple bronchoscopies, re-

Table I. *Thoracotomy in patients over age 70 years*

Procedure	*For cancer*	*For benign disease*
Pleurectomy	8	6
Esophageal	—	5
Bullous disease	—	5
Mediastinal	—	3
Exploration and biopsy	16	—
Pulmonary resection	150	25
Totals	174	44

Table II. *Incidence of complications in elderly patients undergoing pulmonary resection compared with patients undergoing other thoracic surgical procedures**

Type of thoracic surgery	*Complications*			*Total*
	None	*Minor only*	*Major or death*	
		Frequency		
Pulmonary resection	103	33	39	175
Other	34	1	8	43
Total	137	34	47	218
		Percentage		
Pulmonary resection	58.8	18.9	22.3	100.0
Other	79.1	2.3	18.6	100.0
Mean	62.8	15.6	21.6	100.0

*$\chi^2 = 8.510$, df = 2, p = 0.014.

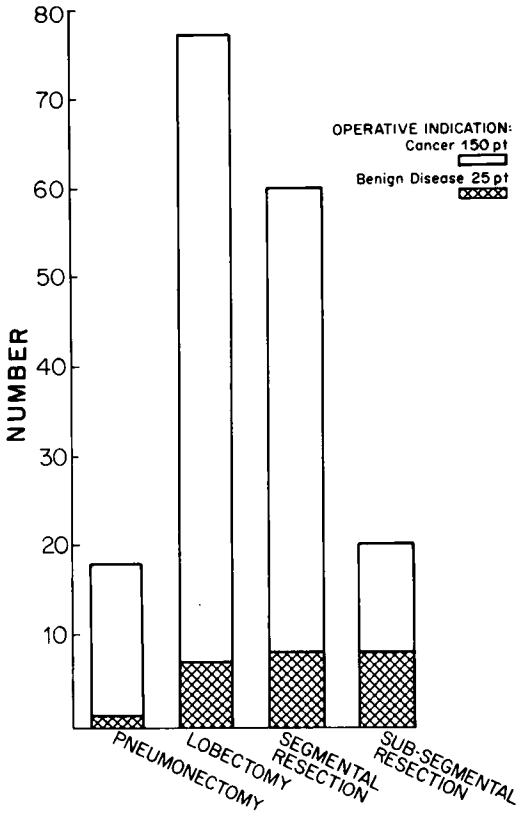

Fig. 2. Distribution by procedure of 175 pulmonary resections in patients over 70 years of age (1969 to 1978). The *cross-hatched bars* indicate resection for benign disease and the *unshaded areas* indicate resection for lung cancer.

spiratory insufficiency necessitating prolonged ventilation, persistent air leak, and pleural space complications. Arrhythmias accounted for eight of 12 major cardiac complications, and myocardial infarction and congestive heart failure were seen in two patients each. Miscellaneous major complications were seen in an additional six patients. The overall incidence of patients having major nonfatal complications was significantly lower among patients undergoing subsegmental or segmental resections than in those undergoing lobectomy or pneumonectomy (Table III).

Seven of 218 patients (3%) died during the hospitalization period after the operation. Operative mortality was similar among patients undergoing pulmonary resection and those undergoing other thoracic procedures. Three deaths were secondary to pulmonary infection, one was a result of aspiration pneumonia, and two were a direct result of respiratory insufficiency. The single death occurring among patients undergoing miscellaneous procedures was secondary to congestive heart failure.

On the basis of data compiled from retrospective chart review and from reported studies at other centers,[6, 7] we identified seven factors which might affect the incidence of major complications and death among the 150 patients undergoing pulmonary resection for lung cancer. Multiple logistic regression analysis was used to determine the independent prognostic value of each of these variables. The results indicate that the amount of lung tissue removed, a history of congestive heart failure, and a history of previous pulmonary resection were all significantly related to an increased risk of major complications or death (Table IV). The odds ratio shown in the far right-hand column of Table IV measures the strength of these associations. Age, sex, and a history of a prior myocardial infarction were not associated with an increased risk of major complications or death.

Patients were classified as having chronic obstructive pulmonary disease if pathognomonic changes were evident on chest x-ray films or if they had been treated for chronic lung disease with bronchodilatations. These

Table III. *Incidence of nonfatal major postoperative complications in elderly patients, according to extent of pulmonary resection*

Extent of resection	No. of patients at risk	Type of complication							
		Pulmonary		Cardiac		Other		Total*	
		No.	%	No.	%	No.	%	No.	%
Subsegmental	20	1	5.0	1	5.0	1	5.0	3	15.0
Segmental	59	6	10.2	2	3.4	1	1.7	8	13.6
Lobectomy	73	14	19.2	7	9.6	2	2.7	17	23.3
Pneumonectomy	17	2	11.8	2	11.8	2	11.8	5	29.4
Totals	169†	23	13.6	12	7.1	6	3.6	33	19.5
Z‡		1.396		1.381		0.958		1.641	
p, 1-tailed		0.081		0.084		0.169		0.050	

*Total: Patients with any complication.

†One hundred sixty-nine patients survived the operation. Six operative deaths were omitted.

‡Z = standard normal deviate to test the hypothesis of no linear trend in incidence of complications against the alternate hypothesis that the incidence of complications increased linearly with amount of tissue resected. (Snedecor GW, Cochran WG: Statistical Methods, ed 6, Ames, Iowa, 1967, Iowa State University Press, p 246.)

patients had a 2.29 times higher incidence of complications than patients without lung disease. However, this difference does not quite achieve significance within our 150 patients ($p = 0.073$).

In order to weigh the risks just detailed versus the benefits of resection in elderly patients, we chose to examine the long-term results in the patients undergoing pulmonary resection for primary cancer of the lung. Follow-up was obtained in 129 of the 139 (93%) available patients surviving pulmonary resection for primary carcinoma of the lung. Standard life-table analysis is shown in Fig. 3 and the overall 5 year actuarial survival rate is 27%. Analysis by procedure shows a 5 year survival rate of 13% for pneumonectomy, 21% for lobectomy, and 42% for patients undergoing segmental resection. The patients undergoing segmental resection had a significantly higher probability of survival than patients undergoing pneumonectomy or lobectomy ($p < 0.05$). Although prospective staging was not accomplished in this group of patients, the great majority of segmental resections were accomplished in patients with Stage I disease without evidence of lymph node spread. The 5 year survival rate among patients undergoing subsegmental or wedge resection for carcinoma was 22%, but this group is too small for a meaningful comparison with the other groups undergoing resection.

Discussion

The majority of previously published reports regarding thoracotomy in elderly patients deal specifically with pulmonary resection for a carcinoma of the lung. Combined review identifies a total of 308 patients reported by five centers during the past decade (Table V).[3-8] The overall operative mortality of 17.2% among these 308 patients is significantly higher ($p < 0.001$) than the 4% operative mortality occurring among our 150 patients having pulmonary resection for cancer.

We believe that the performance of lung-sparing resection was a major factor contributing to a low operative mortality. Over one third of the patients with primary lung cancer (52 patients) presented with Stage I lesions and were treated by segmental resection; operative mortality in this group was only 2%. Ten patients who were judged to have extremely poor pulmonary function underwent subsegmental resection, with no operative deaths. Pneumonectomy was avoided in 13 patients by the use of sleeve lobectomy. However, pneumonectomy was required in 18 patients. The operative mortality for both the pneumonectomy and lobectomy resections was 5% and compares favorably with the reported operative mortality for these procedures in patients of all ages.[9-11]

The 218 consecutive patients in this study comprise an essentially unselected group of elderly patients ranging from 70 to 93 years of age. Patients with previously diagnosed chronic obstructive lung disease or heart disease were not turned down as surgical candidates. Prior pulmonary resection had been accomplished previously in nine patients. Not surprisingly, complications were frequent, occurring in over one third of the patients. The minor complications of atrial fibrillation responding to digitalis, retained secretions treated successfully with one aspiration bronchoscopy, and air leak for 7 to 14 days comprised almost 50% of the total complications in the group. These complications were seen almost exclusively in patients undergoing pulmonary resection and were rare in the non-lung resection group.

Table IV. *Multiple logistic regression of risk of major complication or death following pulmonary resection for lung cancer in 150 elderly patients*

Regressors	*Logistic coefficient*	*t**	*p†*	*Odds ratio*
Prior resection‡	1.7625	2.415	0.008	5.83
Procedure§	1.0305	2.117	0.017	2.80
Congestive heart failure‡	0.9054	1.659	0.049	2.47
Chronic obstructive pulmonary disease‡	0.8301	1.455	0.073	2.29
Prior myocardial infarction‡	0.3631	0.577	0.282	1.44
Sex (0 = F, 1 = M)	0.2897	0.521	0.301	1.34
Age (yr)	0.0569	0.988	0.162	1.06
Constant	−6.8202			

*The statistic t is the ratio of the coefficient to its standard error.

†One-sided probabilities were estimated by referring the value of the t to the normal curve.

‡Prior myocardial infarction, congestive heart failure, prior resection, and chronic obstructive pulmonary disease were coded 0 if absent and 1 if present.

§The operative procedure was coded 0 if a segmental or subsegmental resection was done and was coded 1 if a lobectomy or pneumonectomy was performed.

Table V. *Operative mortality in elderly patients undergoing pulmonary resection for carcinoma, by surgical center**

Surgical center	*No. at risk*	*Died*	
		No.	*%*
Rush–Presbyterian–St. Luke's	150	6	4.0
Others†	308	53	17.2
Totals	458	59	12.9

*χ^2 = 15.680, df = 1, p <0.001.

†Thompson Evans,[3] 1973; Weiss,[6] 1974; Kirsh and associates,[10] 1976; Albano,[8] 1977; and Harviel, McNamara, and Straehley,[5] 1978.

The incidence of atrial fibrillation following pulmonary resection has often been related to age and extent of resection.[12–14] Atrial fibrillation occurred in 13% of our 95 patients undergoing lobectomy or pneumonectomy. Rhythm disturbances including atrial flutter and ventricular arrhythmias were seen in only 5% of 81 patients treated by segmental or subsegmental resection. Arrhythmia occurred in only two of 43 patients undergoing miscellaneous thoracotomy.

Major complications and deaths occurred with equal frequency among patients undergoing pulmonary resection and other miscellaneous procedures. Pulmonary complications were the most common in both groups. This finding is consistent with previous reports that pulmonary complications occurred frequently in elderly patients following nonthoracic procedures.[15, 16] Burnett and McCaffrey[15] reported a 15% incidence of pneumonia following nonthoracic procedures in patients over the age of 70. Our low incidence of pneumonia might be attributed to the uniform employment of chest physiotherapy and also to the liberal use of postoperative aspiration bronchoscopy with the flexible fiberoptic bronchoscope for the management of retained secretions and atelectasis. Thirteen patients underwent postoperative bronchoscopy at the bedside with topical anesthesia. This procedure was required on two or more occasions in seven of these patients.

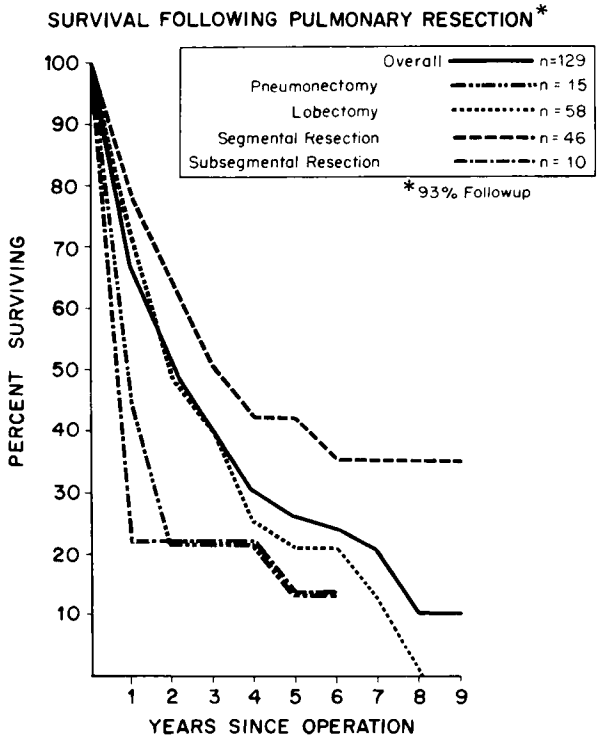

Fig. 3. Survival among 129 patients who underwent pulmonary resection for lung cancer between 1969 and 1978. The *inset* shows the number treated by each type of resection.

Among our patients undergoing pulmonary resection, the overall incidence of major nonfatal complication was related to the extent of pulmonary resection. The decreased incidence of major complications in patients undergoing segmental and subsegmental resection emphasizes the value of lung-sparing procedures in the elderly.

Multiple logistic regression analysis of the mortality and major complications was performed for the 150 patients undergoing resection for cancer. In contrast to Higgens and Beebe's[7] report in 1967, the risk of major complication or operative death could not be related to age. Sex, prior history of myocardial infarction, and a history of chronic obstructive lung disease were not related to major complications or death. However, the extent of resection (pneumonectomy or lobectomy versus segmental or subsegmental resection), prior pulmonary resection, and the history of congestive heart fail-

ure all significantly increased the chance for major complications or death.

Other authors have demonstrated the value of pulmonary function testing in predicting the ability of a patient to withstand lobectomy or pneumonectomy.[4] There were no instances of respiratory insufficiency in patients treated by a segmental or subsegmental resection. Preoperative pulmonary function testing was not done routinely during the years of this study. However, it is our present practice to use preoperative lung function tests in those patients over the age of 70 in whom pneumonectomy may be required.

The low mortality and decreased complication rates associated with aggressive utilization of limited resection were not achieved at the cost of long-term survival. It has been well documented that the major determinant of long-term survival is the stage of disease.[9, 10, 17] We[18] recently reported a 53% 5 year actuarial survival rate following segmental resection for Stage I lung cancer. The 42% 5 year survival rate in patients over the age of 70 undergoing segmental resection is not significantly different from our overall experience. The 5 year survival rate of 27% for our entire group of patients over the age of 70 is similar to the 30% and 34% 5 year survival rates of patients treated by lobectomy and pneumonectomy reported by Thompson Evans[3] and Kirsh and colleagues.[4] Our results added to those of Thompson Evans and Kirsh's group refute the earlier conclusions of Higgens and Beebe[7] and Weiss[6] that long-term survival following pulmonary resection for bronchogenic carcinoma is adversely affected by age.

On the basis of our experience, we conclude that no patient should be denied thoracotomy because of age. Previous pulmonary resection, a history of congestive heart failure, and the extent of pulmonary resection to be accomplished must all be recognized as factors increasing the risk of complication. Operative procedures should be tailored to fit the needs of this age group, with emphasis on the utilization of conservative resections whenever possible.

We wish to thank Richard Shekelle, M.D., Department of Preventive Medicine, Rush Medical College, for his assistance in providing statistical analysis of these data.

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Discussion

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First, let me express the regrets of the coauthors, Dr. Jensik and Dr. Faber, who wrote me saying that they were in

Copenhagen at this time at the International Lung Cancer meeting and regretted that they could not join the prize winner here in Durango.

I also would like to take a moment to tell you about the system for choosing the resident prize manuscript. This method has been adopted by the Council of the Society as the established policy. The first step is for an abstract to be selected for presentation. The residents are immediatley notified that they are finalists and they are asked to submit the complete manuscript by May 1. The manuscripts are reviewed by a panel and rated in order of excellence. The high scorer wins. The prize is awarded not only on the basis of an abstract but after review of the entire manuscript. This method has been the basis of the prize given today.

This paper emphasizes the importance of flexibility in designing operations for carcinoma of the lung. I would like to remind you that last year's prize winner, Dr. Hoffmann, presented a paper which told us pretty much the same thing. He and Dr. Ransdell compared their patients who had lobectomy but could have had a segmental resection or a wedge resection with the patients who actually had a wedge resection, and they found that the latter had a lower operative mortality and just as good overall survival. Their results support the idea that limited resection is very much in order in resection of carcinoma.

The elderly ones of you will remember that the controversy about limited resection is not new. When lobectomy was first proposed instead of pneumonectomy, there was a great deal of skepticism about whether this would be an adequate operation for the treatment of carcinoma. With limited resection in Stage I disease, it is clear that one can get as good a result as with more radical resections.

In this report a number of patients had prior pulmonary resections, presumably for previous carcinoma. I would like to ask Dr. Breyer how many of those prior resections were for previous carcinomas and how many of the patients had a limited resection rather than a lobectomy, if he has that information.

As first lung carcinomas are successfully arrested, the incidence of second carcinomas will increase. Limited resection is not going to burn the bridges for us when we have to do that second resection.

Ten percent of these patients were unresectable at exploration. While this is an acceptable percentage of resections, we must continue to strive for even a lower rate. I would ask Dr. Breyer how many of those patients who were not candidates for resection at the time of exploration were evaluated by mediastinoscopy or some other means to try to ascertain without a thoracotomy that the disease would be unresectable.

Let me express another opinion and ask another question. You report that some patients had postoperative pulmonary insufficiency, and you state that you do not do pulmonary function tests on all patients. Yet you did a chemistry panel and blood count on all of them. I would suggest that a simple spirometry should be no more costly and would be more indicated in such patients than would the blood count and chemistry panel. It will identify more precisely patients with limited function and, equally important, may suggest that you can perform resections in patients considered not candidates on clinical grounds.

I would also suggest that the reason that chronic obstructive airway disease was not a significant predictor of survival may be that you are using roentgenography as a diagnostic method in identifying obstructive disease. This is a notoriously poor way of identifying chronic obstructive airway disease in elderly patients, since they all have increased lung volume.

You point out that congestive failure is an important risk factor. We should expect this. Ventilation-perfusion abnormalities, which are common in the elderly, are magnified with heart disease and low cardiac output. The interaction effect of pulmonary dysfunction and cardiac dysfunction is not just additive—it is more than additive.

These comments should not be interpreted as criticism of the basic theme of the paper. Resection of carcinoma of the lung can be safely done in the elderly by good selection of patients and appropriate operation. The results you present represent a goal for all of us to strive for. I'm sure they reflect the excellent clinical judgment and technical skill of the authors. You have presented the paper in a manner that reflects the excellence of its substance, and we congratulate you and are glad to have you as a resident winner.

DR. BREYER *(Closing)*

Dr. Peters, thank you for your comments. I will try to answer the questions you raise. There were nine patients who had undergone prior pulmonary resection. Of the nine, seven patients had a segmentectomy at one procedure and lobectomy at the other, one patient had a lobectomy and completion pneumonectomy, and the last patient had a pneumonectomy followed by a subsegmental resection.

We have not been performing mediastinoscopy on a routine basis on all patients with carcinoma of the lung. I do not have data to indicate how many patients might have been spared a thoracotomy had they undergone mediastinoscopy. However, I suspect that number would be small.

In regard to the question of respiratory insufficiency and pulmonary function testing, we recognize the limitations of our methods of determining chronic obstructive pulmonary disease. However, this was retrospective chart review and we felt that the combination of the two things that we could derive from the charts was as accurate as possible within the limitations of that kind of a study.

We do perform pulmonary function testing on all patients in whom we suspect that a pneumonectomy will be required and on those patients whose clinical features suggest that even a smaller resection may not be tolerated. Of the two patients who died of respiratory insufficiency, one of the patients undergoing lobectomy did have pulmonary function tests. The forced expiratory volume was 46%, which we consider acceptable for lobectomy. In that one patient, the pulmonary function test did not change our plan.