GENERAL THORACIC SURGERY

POSTOPERATIVE PORTABLE CHEST RADIOGRAPHS: OPTIMUM USE IN THORACIC SURGERY

Ruffin J. Graham, MD^a
Moulay A. Meziane, MD^a
Thomas W. Rice, MD^b
Thirugnanam Agasthian, MD^b
Neil Christie, MD^b
Kathleen Gaebelein, MBA, MSN^a
Nancy A. Obuchowski, PhD^c

Purpose: Daily portable chest radiographs are routinely ordered in many institutions after thoracic surgery. Our purpose was to assess the efficacy and cost of this practice and to determine the optimum use of postoperative x-ray studies. **Methods:** A prospective review of all portable chest x-ray films after 100 consecutive elective thoracotomies (DRG 75) was conducted. Each x-ray study initiated a three-part survey. First, the surgeon listed whether the x-ray study was routine and the anticipated management had it not been available. The radiologist then interpreted and scored the x-ray study as follows: negative, expected findings; A, minor findings necessitating no intervention; B, minor findings necessitating intervention; or C, major findings necessitating intervention. Finally, the x-ray film and the interpretation were returned to the surgeon. Any interventions necessitated by the x-ray study were recorded. **Results:** In 6 months, 99 patients underwent 82 pulmonary resections and 18 other major procedures. In the postoperative period, 769 portable chest x-ray studies were ordered, median five per patient (range 2 to 49). Of these, 731 (95%) were routine and 38 (5%), nonroutine. Severity scores were as follows: negative in 106 (13.8%), A in 558 (72.5%), B in 59 (7.7%), and C in 46 (6.0%). X-ray findings altered management in 43 of 769 studies (5.6%): in 33 routine (4.5%), in 10 nonroutine (26.3%), in 13 A (2.3%), in 22 B (37.3%), and in 8 C (17.4%). **Conclusions:** These results demonstrate that routine daily portable chest x-ray studies have a minimal impact on management. It is, in fact, nonroutine x-ray studies that more often alter management. Had routine portable chest x-ray studies, which cost \$114 each in our institution, been limited to one immediately after the operation, only 133 such studies (100 routine and 33 nonroutine) would have been needed in the care of these patients. Elimination of 636 (82.7%) x-ray studies reduces the cost of care by \$725 per patient (\$286,000 annually). For major thoracic procedures, it is safe, efficacious, and cost effective to eliminate routine postoperative portable chest x-ray studies and order nonroutine portable studies only when clinically indicated. (J Thorac Cardiovasc Surg 1998;115:45-52)

From the Department of Radiology, Section of Thoracic Imaging,^a Department of Thoracic and Cardiovascular Surgery,^b and Department of Biostatistics and Epidemiology,^c The Cleveland Clinic Foundation, Cleveland, Ohio.

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Address for reprints: Thomas W. Rice, MD, The Cleveland Clinic Foundation, 9500 Euclid Ave., Cleveland, OH 44195.

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Portable chest radiographs are an integral part of the postoperative care in thoracic surgery. Their routine use is considered the standard of care. However, this role has not been documented and prospective data concerning the efficacy of routine portable chest x-ray studies in the postoperative period have not been obtained.

Of 146,716 chest x-ray films taken in our institution during 1995, approximately half (69,515) were taken at the bedside. This large number is the result of a variety of factors: a predominantly tertiary care population, a large volume of thoracic surgical procedures, a large teaching services, and the rela-

Table I. Rating of x-ray findings

Rating	Significance
Negative	No or expected radiographic abnormality
A	Minor radiographic abnormality necessitating no treatment
B	Minor radiographic abnormality necessitating treatment or position adjustment
C	Major radiographic abnormality necessitating treatment or intervention

tive ease of obtaining portable chest x-ray films. This volume of portable radiographs requires a large allocation of resources to ensure that these studies are performed and interpreted in a timely manner. This increases the cost of care to both the patient and the hospital.

This study was undertaken to evaluate the clinical utility of portable chest radiographs during the postoperative hospitalization of patients undergoing thoracotomy. Numerous studies have evaluated the need for these examinations in patients in the intensive care unit.¹⁻¹⁰ However, no study has examined the value of portable chest x-ray studies in this patient population during the entire hospitalization.

Patients and methods

The patient population was limited to 100 consecutive patients undergoing open thoracotomy. All procedures were performed by the same thoracic surgeon. All portable chest x-ray studies obtained on these patients between the time of the operation and discharge from the hospital (or death) were included for analysis.

A data collection form included the following information: patient name, hospital number, date of operation, and type of procedure. Date, time, and indication for the portable chest x-ray study were entered. The x-ray study was designated as *routine* if it was performed for no specific indication or *nonroutine* if it was performed to answer a specific clinical question. The surgical team indicated the anticipated management if no information had been available from the portable chest x-ray film. This form was attached to the film by the radiology technician performing the study and brought by the technician to a chest radiologist for interpretation.

The films were interpreted by one of two radiologists to assure consistency of interpretation. On the same form begun by the surgical team, positions of all medical devices (endotracheal tubes, central venous catheters, and thoracostomy tubes) were noted. Malpositioning of these devices was based on standard clinical criteria. The presence of infiltrates and/or atelectasis, pleural effusion, pneumothorax, or other pleuroparenchymal abnormalities (e.g., pulmonary edema) were also recorded. The radiographic severity of each finding was then rated according to the guidelines given in Table I. All x-ray films previously obtained during the patient's postoperative stay were available for comparison at this time.

Table II. Treatment plan and actual treatment: Routine portable chest x-ray films (n = 731)

	No change	Add antibiotics	Adjust chest tube
Preop./postop. chest x-ray films			
No change	698	3	1
New chest tube	6		
Add antibiotics	4		1
Add diuretics	4		
Adjust CVP tube	4		
Adjust ET tube	4		
Thoracentesis	2		
Reoperation	2		
Adjust chest tube	1		
Other	4		

CVP, Central venous pressure; ET, endotracheal.

After interpretation by the radiologist, the film and survey form were returned to the surgical team, who determined whether any change in patient management was required on the basis of the portable radiographic findings. Changes in medication, line adjustment, or procedural intervention (e.g., thoracentesis) were noted. Changes in patient care not initiated as a result of the radiographic findings were not reported. The completed forms were then collected for data analyses.

No distinction was made between films obtained in the intensive care unit and those obtained on nonacute wards. All films were obtained with the patient upright when possible. Bedside anteroposterior radiographs were obtained at a target-to-film distance of 50 inches in maximum deep inspiration. DuPont Cronex 10TL film (DuPont, Wilmington, Del.) was used.

To identify independent factors predictive of a chest x-ray abnormality potentially necessitating treatment (B or C severity), generalized estimating equations¹¹ were used to fit a model that predicted B or C x-ray findings as a function of clinical indication for the film (routine vs nonroutine), postoperative day, and type of operation performed.

Results

Seven hundred sixty-nine portable chest x-ray films in 100 consecutive thoracotomies between September 1995 and March 1996 were evaluated. Of 99 patients (one patient underwent two separate wedge resections), 57 were male and 42 female. Ages at operation ranged from 20 to 81 years; median age was 61 years. Open thoracotomies were performed in 12 patients for pneumonectomy, in 37 for lobectomy, in 33 for wedge resection, and in 18 for other indications (e.g., pleurectomy and decortication, excision of mediastinal masses, exploratory thoracotomies, and repair of tracheoesophageal fistula). Median postoperative hospital stay was 5 days;

Table III. Treatment plan and actual treatment: Nonroutine portable chest x-ray films ($n = 38$)

	No change	Add antibiotics	Add antibiotics
Preop./postop. chest x-ray films			
No change	28	4	1
Add antibiotics	1		
Adjust ET tube	1		
Adjust CVP tube	1		
New chest tube	1		
Add diuretics		1	

ET, Endotracheal; CVP, central venous pressure.

length of stay ranged from 1 to 31 days. Three patients died during the postoperative course.

Of the 769 chest x-ray studies, the surgical team designated 731 as routine. Thirty-eight films were obtained to answer a clinical question and were classified as nonroutine. The 731 routine films consisted of 100 immediate postoperative portable films, 493 early morning routine portable examinations, and 138 routine portable x-ray films after chest tube removal, line placement, or other maneuvers. Median number of portable chest x-ray studies per patient was five (range two to 49). Tables II and III summarize the anticipated management if no chest x-ray film were available and the actual treatment after the chest film interpretation for the routine and nonroutine studies, respectively. These data indicate that portable chest x-ray studies resulted in alteration of the anticipated management in 43 of 769 films (5.6%), in 33 of 731 routine films (4.5%) and in 10 of 38 nonroutine films (26%).

The severity of each abnormal finding determined by the radiologist is summarized in Table IV. If more than one abnormality was seen, the overall grade assigned to the film was based on the most severe radiographic abnormality. Among the 106 portable x-ray films reported without significant abnormality, no changes in treatment were made. In 663 films identified with an abnormality, no change in clinical treatment was ordered in 620 cases (94%). X-ray findings altered management in 13 of 558 A x-ray studies (2%), 22 of 59 B studies (37.3%), and 8 of 46 C studies (17.4%).

Type of operation was found to be the only significant predictor of B or C x-ray results ($p = 0.044$). More specifically, portable chest radiographs obtained after pneumonectomy are more likely to show a significant radiographic abnormality than those obtained after a lobectomy ($p = 0.007$). Similarly, portable chest films after a wedge resec-

Table IV. Severity of radiographic findings: Routine and nonroutine portable chest x-ray films

Severity	Routine ($n = 731$)	Nonroutine ($n = 38$)
Negative	98 (13.4%)	8 (21.1%)
A	533 (72.9%)	25 (65.8%)
B	56 (7.7%)	3 (7.9%)
C	44 (6.0%)	2 (5.3%)
Total	731 (100%)	38 (100%)

tion are more likely to demonstrate a significant abnormality than those obtained after lobectomy ($p = 0.027$). Table V summarizes the radiographic severity of a finding versus the type of operation. Indication (p) and length of stay (p) were not predictive of a B or C x-ray result (Fig. 1).

During this study the cost of a portable chest x-ray study was \$114.00. The total cost for portable chest x-ray films obtained in this study group is \$87,666.00. If a protocol was adopted that limited portable chest x-ray studies to an initial postoperative chest film and all nonroutine chest films, the cost would have been \$15,732.00, for an 82% cost reduction and a savings of \$72,534. If routine portable chest x-ray studies were eliminated, the cost of x-ray films in this study would have decreased to \$4,332.00 or a 95% savings of \$83,334.00.

Discussion

Despite the widespread use of portable chest radiographs, few studies have evaluated the accuracy and efficacy of their use. Fewer have considered the associated financial costs to patients and institutions. With the current trend in health care to streamline all costs relative to procedures, it is an excellent time to examine the use of routine portable chest x-ray studies. In a recent review article, Henschke and coworkers⁶ summarized the findings of most studies done since 1982, which analyze the efficacy and utility of portable chest x-ray films. All of these studies focus on patients in the intensive care unit (medical, surgical, or both), and most target efficacy over accuracy. Reviewing the results of these studies yields mixed conclusions about the efficacy of portable chest radiography. Explanations for these contradictions include the lack of uniformity in the intensive care unit populations (surgical vs medical vs both); variations in the type of chest x-ray study (all intensive care unit portable chest x-ray studies vs routine morning x-ray studies vs those for specific clinical indications); and the lack of uniform criteria for assessing the impact of radiographic findings.⁶

Fig. 1. B and C severity score versus postoperative hospital stay.

In 1993, Silverstein and associates⁹ limited their study of the utility of routine daily portable chest x-ray films to patients in the surgical intensive care unit. Over a 1-month period, 525 routine morning portable chest x-ray films were prospectively evaluated in 256 patients. Radiographic abnormalities were divided into two categories: medical device malposition and cardiopulmonary disease. Examining the placement of 1028 medical devices, 13 devices (1.3%) required immediate repositioning for patient safety. From all films only 89 (12%) new cardiopulmonary findings were identified. Radiographic findings identified two pneumothoraces and one large pleural effusion that necessitated immediate intervention by the surgical team. On the basis of these results it is easy to conclude that routine daily portable chest x-ray studies in patients in the surgical intensive care unit are not warranted. With a cost-base of a portable chest x-ray study of \$105, the total radiographic charge to patients during this 1-month study was \$54,125, a "small but significant percentage of total health care expenditures."⁹

In 1995, Fong and colleagues² prospectively evaluated 1003 portable chest x-ray films in 157 consecutive patients admitted to the surgical intensive care unit. They concluded that routine portable chest x-ray films are not justified because the majority of patients are admitted to the

Table V. Severity of radiographic findings and type of operation

Severity	Pneumonectomy	Lobectomy	Wedge resection	Other
Negative	36 (31.6%)	41 (14.6%)	17 (6.9%)	12 (9.3%)
A	50 (43.9%)	225 (80.4%)	188 (76.4%)	95 (73.6%)
B	15 (13.2%)	13 (4.6%)	27 (11.0%)	4 (3.1%)
C	13 (11.4%)	1 (0.4%)	14 (5.7%)	18 (14.0%)
Total	114 (100%)	280 (100%)	246 (100%)	129 (100%)

surgical intensive care unit for postoperative cardiovascular monitoring. The authors correlated clinically important radiographic findings with the indications for the chest x-ray studies. Clinically important findings were identified in only 17% of films obtained for routine purposes. Twenty-six percent were obtained to verify the position of a medical device and 30% for suspected clinical conditions. According to multivariate analyses, placement of a thermodilution catheter was the only indication justifying the use of routine daily portable chest radiographs. They recommend that portable chest radiographs be obtained only on admission to the intensive care unit and after placement of an invasive device. They estimated that adopting this policy would yield an annual savings of \$99,000 to \$120,000 for their nine-bed intensive care unit. This figure was based on a \$150 cost per chest x-ray film.

In the vast range of health care expenditures, radiologic examinations represent a small percentage of the overall costs of health care in the intensive care unit. In the patient who has had a thoracotomy, the radiology costs, including all computed tomographic scans, nuclear scans, and portable x-ray films, are a minimal percentage of the overall costs. In 1995, radiology accounted for 3.5% of the overall costs in the care of these patients at our institution. Bedside chest x-ray films were an even smaller cost percentage. However, the total figure for portable chest radiographs performed in all patients is monumental. In 1995, 69,515 portable chest x-ray studies were done in our 1000 bed hospital. This is almost half of all chest x-ray films and one quarter of all radiologic examinations performed. With the mean charge of \$114.00 per examination, this generates nearly \$8 million in charges.

The increasing high volume of bedside x-ray studies and their associated cost make it imperative to reevaluate the clinical utility of this procedure. The relatively low cost and risk of a bedside chest

x-ray film coupled with its availability has led to its use and sometimes overuse. Investigations that prospectively study the indications used in the majority of portable chest x-ray studies are overdue.

To our knowledge, studies to evaluate the efficacy of portable chest x-ray films in a patient population undergoing the same surgical procedure have not been undertaken. It is important to examine the practice of portable chest radiography after thoracotomy for three reasons. First, these patients have undergone a major operation and are particularly susceptible to both iatrogenic and nosocomial complications that may be detected by chest radiography. Second, these patients account for a significant percentage of the portable chest x-ray studies obtained at most institutions. Third, the high volume that results from this practice enables us to examine the impact of portable radiography on the overall cost for the patient who has had a thoracotomy.

Our data demonstrate that 95% of the portable chest radiographs ordered were obtained for routine purposes. No change in treatment was anticipated in 726 of these 731 films. This finding was substantiated in 698 of 726 films (96%) that prompted no treatment changes. Five of the remaining 28 films resulted in the addition of new medications, nine in adjustment of existing medical devices, and 14 in procedural intervention. Direct procedural intervention occurred in 1.9% of the patients in whom no change in therapy was anticipated before the portable chest x-ray study. Of the five routine portable chest radiographs in which a treatment change was anticipated, only one (20%) actually resulted in a change in treatment. Data from x-ray studies classified as routine indicate an even lower rate of significant effects on clinical management than that identified by Fong and coworkers.²

Although nonroutine portable chest x-ray studies were fewer in number, the majority of these studies did not alter patient management. Indications for nonroutine films included 17 to exclude a new pneumothorax, three to exclude a new infiltrate, three to exclude pulmonary edema, seven to evaluate endotracheal tube placement, five to evaluate central venous catheter placement, and three to evaluate chest tube placement. No change in clinical management was anticipated in 32 of 38 chest radiographs and was substantiated in 28 of 32 (88%) portable chest radiographs. In four x-ray studies in which no change in treatment was anticipated, one resulted in the addition of antibiotics, two in adjustment of existing life-

support devices, and one in placement of a new thoracostomy tube. Overall, the nonroutine portable chest radiograph altered the preexamination treatment plan in 10 of 38 (26%) studies. This percentage is slightly larger than the 4% alteration affected by routine films; however, caution should be taken when making this comparison because of the difference in sample sizes. Nevertheless, the 26% alteration of the pre-chest radiograph treatment plan for nonroutine films is remarkably similar to the 30% of nonroutine chest radiographs that resulted in a change in clinical management in the study by Fong and associates.²

The data in Table IV demonstrate no significant statistical differences ($p = 0.454$) in the severity of radiographic findings based on the clinical indication for the chest x-ray study (routine vs nonroutine). Sample size may play a role in this finding. The propagation of radiographic abnormalities between routine and nonroutine films may also affect the results. The same or similar radiographic abnormalities that were first detected in a routine examination may be seen or progress in nonroutine chest x-ray studies and cause a change in management only after the nonroutine examination.

Although statistical analyses demonstrate that the type of operation is a significant predictor of a portable chest x-ray film receiving an overall of B or C rating ($p = 0.044$), these conclusions are based on a relatively small study group. The number of patients undergoing pneumonectomy ($n = 12$) is disproportionate to the number of lobectomies ($n = 37$) or segmental and wedge resections ($n = 33$). Among 33 patients undergoing wedge resection, two patients had all 14 of the x-ray films demonstrating a C abnormality. One patient, who died during the study, had 12 films showing a dense alveolar infiltrate. At autopsy, this was shown to be an alveolar hemorrhage. That same patient, who was hospitalized for 2 weeks after the operation, had 12 films demonstrating a B alveolar infiltrate before the C abnormality developed. When that patient is removed from consideration, the percentages of type B and C abnormalities are equal between the lobectomy and segmentectomy and wedge groups. Patients undergoing lesser resections do not require closer monitoring by portable chest x-ray studies than do patients who have undergone lobectomy.

The percentage of routine portable chest x-ray films with a grade B or C abnormality versus the postoperative day is shown in Fig. 1. Although statistical analyses did not identify length of stay as

a significant predictor of a type B or C abnormality ($p = 0.083$), the curve clearly suggests a trend of increased chest x-ray abnormalities as the postoperative stay increases. After the seventh postoperative day there is an increase in abnormal chest x-ray findings. Twenty-three patients were hospitalized for 8 days or longer. No common factors were identified among these 23 patients to account for their complicated postoperative courses. It is not surprising that as complications develop and hospital stay increases there is an increased likelihood of developing an abnormality on the chest radiograph. The group is too small to comment on the utility of portable x-ray films in complicated and prolonged hospitalization.

Although some studies have validated the use of routine portable chest x-ray studies in patients in the intensive care unit,^{1, 3, 5, 7, 10, 12} our data show that routine portable chest x-ray films are of little clinical value after thoracotomy. This has led us to eliminate the majority of routine portable chest x-ray studies in patients who have had a thoracotomy. Although the need for routine immediate postoperative chest x-ray studies has been questioned,¹³ we continue to order one portable chest x-ray film immediately after the operation. This examination verifies line and tube placement and provides a baseline reference of cardiac, pleural, and pulmonary status. All other chest x-ray films are nonroutine and are ordered to answer specific clinical questions. Routine posteroanterior and lateral radiographs of the chest are obtained before the patient's discharge. This protocol is safe and cost effective.

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Discussion

Dr. Claude Deschamps (Rochester, Minn.). The fact that you are presenting this paper and I am discussing it seems at the same time appropriate, ironic, and worrisome: appropriate because we are both Canadians who left our country partly or indirectly because of restrictions on resources; ironic because that system is catching up with us and we are seeing Canadian problems duplicated in the United States, and maybe made worse in the near future; worrisome because you and I were not trained to cut costs but to cut, period. How does one safely decrease cost and not lead one's institution into bankruptcy? That is a distant goal. I am not an accountant, and I will have to do a simple analysis of your presentation.

You have shown that through a simple, innovative, and not so critical pathway that money could be saved by decreasing the number of portable chest x-ray films after DRG 75 types of operations. I was surprised to see so many routine portable chest x-ray studies, because most of the time they could be done in the radiology department, maybe later in the day and probably at a lesser cost.

One issue you did not address is the Medicare patient versus the non-Medicare patient. In my institution the charge to a non-Medicare patient is more than twofold that to the Medicare patient. We are losing money on every chest radiograph we do on a Medicare patient, whatever the type of radiograph, portable or nonportable.

I have three questions. First, throughout your analysis you used the word "cost." I know that the true cost for a large institution like yours is extremely difficult to determine accurately, and I am asking you to specify whether you are talking about estimated cost to your institution or charge to the patient.

Second, you conclude that one chest radiograph in the immediate postoperative period, as a standard, may be appropriate. However, your results do not indicate that that radiograph provided the lion's share of the findings requiring intervention. Inasmuch as you do not really need to know the location of the chest tube that you just placed under direct vision, and most of our

patients do not have any indwelling lines, why not make that first radiograph optional if you pursue your own logic?

More than 75% of the total cost for lobectomy or wedge occurs during the first day in the hospital. Given this, how do you plan to integrate your recommendation into a critical pathway in your own institution, and what do you suggest be done about those first 24 hours?

Dr. Rice. This is our best estimate at the cost of the radiograph. We initially thought we would talk about charges; however, it is best to estimate the cost of the x-ray film; at that time it was \$114.

There is no doubt that x-ray films obtained in the x-ray department, both posteroanterior and lateral, are less costly. It is clinic culture that when chest tubes are present the patients are not transported freely. However, there is no doubt that x-ray films are less costly if obtained in the x-ray department.

The chest x-ray film obtained in the immediate postoperative period is an interesting study. A recent paper from the Toronto group showed that in cardiac surgery it influences treatment only 4.5% of the time, very similar to our results. Such a film probably is not necessary, but we tend to order it in most patients because it provides a baseline. Our critical pathway is now to obtain a chest x-ray film in the immediate postoperative period when the patient arrives in the recovery room and then to order nonroutine x-ray films only as indicated by the clinical course of the patient, if a specific question has to be answered. After the removal of the chest tubes and before discharge home, patients get posteroanterior and lateral chest x-ray films in the x-ray department. Comparing the first 6 months before the study to the 6 months after completion of the study, we were able to reduce the number of portable chest x-ray films in our service by two thirds.

Dr. James B. D. Mark (*Stanford, Calif.*). I am pleased to see that somebody has finally documented what we have done intuitively, and that is limit the number of x-ray studies taken after thoracic surgery. According to our routine, we take a portable chest x-ray film when the patient gets to the intensive care unit. The next and final films (posteroanterior and lateral) are taken in the department after the tubes are removed. We have not hurt patients that way and we have certainly saved a fair amount of money.

I dare say that your expected abnormalities are a little different from the radiologist's expected abnormalities, because you would have probably interpreted a number of those "A" films, at least one per patient, as expected abnormalities. I am pleased to see that your routine now is very similar to ours. At least that reassures us.

Dr. Robert L. Thurer (*Boston, Mass.*). In conjunction with what Dr. Mark just said, do you think that the interpretation by the radiologist had anything to offer. We were all trained to read our own chest x-ray films, and I wonder whether a comparison between the surgeon's reading and the radiologist's reading would show any difference.

Dr. Rice. The radiologist has an important role and we rely on our radiologists quite heavily. There is no doubt

that we interpret a lot of the x-ray films on our own, but I think they provide a very good service.

Dr. Safuh Attar (*Baltimore, Md.*). What are the legal implications of getting fewer x-ray studies? The reason I mention this is that on some occasions a foreign body is left in the chest and is missed on the first x-ray film, and even on the second or third, and picked up later on. Have you had any legal problems related to missed objects not detected because x-ray studies were not obtained but should have been?

Dr. Rice. Fortunately I have no experience with missed objects. We did the study to see how often x-ray findings would affect clinical care. In those 100 patients there were no foreign bodies. Five percent of the time an x-ray study is going to affect the management of a patient. Retention of foreign bodies is rare.

Dr. Thomas R. J. Todd (*Toronto, Ontario, Canada*). My country will be highly interested in what you are doing, but we do not have to worry about the remuneration to the hospital because there is no remuneration. You have raised some interesting points, but I would hasten to point out that it is a longitudinal study. The "n" is small in a population in which the overall mortality is expected to be about 3.2% if pneumonectomies and lobectomies are combined. A large number of patients would be needed before the impact on morbidity could be determined.

Last, behavior is hard to change. You would probably need a larger study, perhaps a controlled study, to be able to determine whether the absence of x-rays affected such things as tube removal time and, therefore, length of stay. If the length of stay increased by 1 day, the savings in chest radiographs would quickly be negated. Your study is very interesting and needs to be pursued, but I certainly would not conclude at this point that postoperative x-ray studies are unnecessary.

Dr. Rice. We did not conclude that we did not need any x-ray studies. It was my teaching that an x-ray film should be obtained every day a chest tube was in place. I wondered whether that was really true. That is why this study came to be. It is a monumental task to monitor 100 patients consecutively, to track every x-ray film, 769 in all. To expand the study to more patients would be very difficult. I will let the study stand.

Dr. Victor F. Trastek (*Rochester, Minn.*). You have ventured into an area that we have all been thinking about, and I give you credit for doing this.

Do you think by reducing the number of postoperative x-ray films you have missed anything that has caused increased cost or complications?

Dr. Rice. In this patient group, no. We have not increased their length of stay, and we have had no increase in readmissions to the intensive care unit or readmissions to the hospital, either ours or others, since we have instituted this program. So far as we can tell, the quality of care has remained the same.

Dr. Trastek. Sometimes when we have done cost reduction maneuvers because there is still indemnity insurance, revenues are also reduced. Have you ever figured out in this study whether you have lost more revenue than the costs that were saved?

Dr. Rice. We didn't look into that. No referral to payor lawsuits came from this 100-patient study group, and we did the study to make sure that we were not adversely affecting clinical care. I think it would be difficult to determine, but we are not aware of increased costs. Typically the radiographic studies were reimbursed at 60% to 65% of our charges. I am told that we just barely break even.

Dr. Douglas J. Mathisen (*Boston, Mass.*). You alluded to there being some patients in this group who did not have pulmonary resections, and you compared pneumo-

nectomies versus lobectomies and lobectomies versus segmentectomies and wedge resections. I realize the number was 18 patients who had nonpulmonary resections, but was there any difference in the analysis of that small group in terms of the chest x-ray studies?

Dr. Rice. It was a very heterogeneous group, pleurectomy/decortication, excision of mediastinal masses, and two tracheoesophageal fistula repairs during that time. This study group was not undergoing esophageal surgery; it was not DRG 150. The group was very mixed, and we could not determine a difference. It was too small to do so.

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