Efficacy of Breathing and Coughing Exercises in the Prevention of Pulmonary Complications After Coronary Artery Surgery*

Kathy Stiller, B.App.Sc.; Joseph Montarello, M.B.B.S.; Malcolm Wallace, M.B.B.S.; Meredith Daff, B.App.Sc.; Ruth Grant, M.App.Sc.; Sue Jenkins, Ph.D.; Bob Hall, M.Sc.; Helen Yates, B.Nurs.

One hundred twenty patients undergoing coronary artery surgery completed a randomized controlled study designed to investigate whether prophylactic chest physiotherapy affected the incidence of postoperative pulmonary complications. Group 1 patients received no preoperative or postoperative chest physiotherapy. Group 2 patients received preoperative education and instruction in breathing and coughing exercises and postoperative supervision and assistance in performing the same. These exercises were supervised by a physiotherapist twice per day on the first 2 postoperative days and once per day on the 3rd and 4th postoperative days. Physiotherapy for group 3 patients was the same as for group 2 patients except that patients were seen by a physiotherapist 4 times per day on the first 2 postoperative days and twice per day on the 3rd and 4th postoperative days. Group 2 and 3 patients were instructed to practice breathing and coughing exercises every hour. Overall, an incidence of clinically significant postoperative pulmonary complications of 7.5 percent was demonstrated. In general, these patients demonstrated lower levels of preoperative pulmonary function and very low early postoperative oxygenation compared with those who did not develop pulmonary complications. There was no indication that the incidence or severity of fever, hypoxemia, chest roentgenologic abnormalities or clinically significant postoperative pulmonary complications was different between groups. These results suggest that the necessity for prophylactic chest physiotherapy after routine coronary artery surgery should be reviewed. ***(Chest 1994; 105:741-47)***

BMI = body mass index; CAS = coronary artery surgery; FIo_2 = fraction of inspired oxygen; IMA = internal mammary artery; LVF = left ventricular failure; RAH = Royal Adelaide Hospital; UAS = upper abdominal surgery

Chest physiotherapy is routinely used after major abdominal and cardiothoracic surgery with the aim of preventing postoperative pulmonary complications. Two studies have shown that, compared with control groups which received no prophylactic chest physiotherapy postoperatively, regular chest physiotherapy significantly decreased the incidence of pulmonary complications after upper abdominal surgery (UAS).[1,2] To date, no studies investigating the efficacy of chest physiotherapy following coronary artery surgery (CAS) have included a true control group.

The present study was undertaken to investigate whether prophylactic chest physiotherapy significantly decreased the incidence of pulmonary complications after CAS.

Materials and Methods

Patients

One hundred twenty-seven consecutive patients undergoing elective CAS who gave informed written consent were included in the study. Patients who were unable to understand written or spoken English were excluded from participation. After obtaining consent, patients were randomly allocated by means of a random numbers table to one of three groups. The study was approved by the Human Ethics Committee of the Royal Adelaide Hospital (RAH).

Group 1: Patients in this group received no chest physiotherapy preoperatively or postoperatively.

Group 2: Treatment for this group consisted of the usual chest physiotherapy for patients undergoing CAS at the RAH. This comprised preoperative education and instruction in deep breathing and coughing exercises by a physiotherapist. Postoperatively, commencing on the morning of the first postoperative day, a physiotherapist supervised and assisted treatment twice a day on the first two postoperative days and once a day on the third and fourth postoperative days. During any one treatment session, the patient performed three to five deep breaths interspersed with periods of quiet breathing followed by two or three coughs or huffs (with wound support). This cycle was repeated until the patient's cough sounded dry. In addition, patients were instructed to perform these breathing and coughing exercises independently every waking hour. The physiotherapist used additional techniques such as positioning and chest wall vibrations if breathing and coughing exercises alone were not effective in clearing excessive or retained pulmonary secretions.

Group 3: Patients in this group were seen by a physiotherapist preoperatively, four times per day on the first two postoperative days and twice daily on the third and fourth postoperative days. Treatment techniques were the same as for group 2. Patients were instructed to perform breathing and coughing exercises every waking hour.

*From Royal Adelaide Hospital, Adelaide, South Australia.
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Qualified physiotherapists carried out all treatments as described. No physiotherapy was given to patients while they remained intubated. Nursing staff were instructed not to perform breathing and coughing exercises with any patients participating in the study.

Whenever possible, patients were mobilized by nursing staff according to the normal protocol used at the RAH, namely sitting out of bed on the second postoperative day, walking from the third postoperative day, and climbing stairs on the seventh postoperative day. Nursing staff were not informed of the groups to which the patients were assigned.

Patients were withdrawn from the study if they required more than 24 h of mechanical ventilation postoperatively or if they developed neurologic or cardiac complications which interfered with their ability to cooperate with treatment.

Measurements

Preoperatively, the patient's age, gender, height and weight were recorded. The body mass index (BMI) was calculated and obesity graded.[3] Information regarding history and symptoms of pulmonary disease, current medication, and other relevant past medical history were obtained. Patients were classified as being ex-smokers if they had ceased smoking more than 6 weeks prior to surgery.[4] With the patient sitting out of bed or on the edge of the bed and wearing a nose clip, three forced vital capacity (FVC) maneuvers were performed using a calibrated portable spirometer (Pony model, Cosmed), and the best of these was recorded.

The following details were noted from the operation records: surgeon, left ventricular function, number of grafts performed and conduits used, presence of pleurotomy, cardiopulmonary bypass time, and duration of anesthesia. Postoperatively, time from completion of anesthesia to extubation, medication administered, and duration of postoperative hospital stay were documented.

Oral temperature was documented preoperatively, and the maximum temperatures on the first and fourth postoperative days were recorded from the nurses' observation charts.

Arterial blood samples were taken by medical staff who were blinded to the patients' treatment groups preoperatively and on the first and fourth postoperative days. From these, the absolute values of the PaO_2, $PaCO_2$, and pH were measured. Fraction of inspired oxygen (FIo_2) was recorded with every measurement and from this the PaO_2/FIo_2 ratio was calculated. Postoperatively, this ratio was expressed as a percentage of the preoperative value.

Chest roentgenograms, taken preoperatively and on the first and fourth postoperative days, were evaluated by a radiologist (M.W.) who was blind to the patients' groups. For each film, the extent of atelectasis, consolidation, or other pulmonary infiltrate was noted and scored as: 0, no abnormality; 3, minimal; 7, moderate; 15, major. Each lung was scored separately, the total score was calculated, and the location and type of abnormality were recorded. Other roentgenologic abnormalities were also documented.

The preceding measurements were taken preoperatively to identify preexisting abnormalities and on the first postoperative day to indicate each patient's status as a result of surgery. Those taken on the fourth postoperative day were used to reflect the effect of the presence or absence of prophylactic chest physiotherapy.

Patients were reviewed by the cardiologist affiliated with the Cardiothoracic Surgical Unit (J.M.) who identified patients with clinically significant pulmonary complications which required that the patient no longer remain in his or her allocated group but receive definitive chest physiotherapy. All medical staff were blind to the patients' groups.

Statistical Analysis

Analyses were completed using the JMP statistical software package on a MacIntosh Powerbook 170 computer. Log-linear modeling was employed for categorical data, analysis of variance techniques were used for continuous scores, and nonparametric tests (Wilcoxon/Kruskal-Wallis tests) were implemented where skewed distributions were encountered. Probability values of less than 0.05 were deemed significant.

Examiner Reliability Study

To investigate the intra-examiner reliability of the radiologist, the radiologist assigned scores to a series of 33 chest roentgenograms obtained from 12 patients who had undergone CAS and repeated this procedure with the same films 4 to 6 weeks later. The radiologist achieved identical scores for 29 films (88 percent) and was within one grade for the other four films (12 percent).

Results

Of the initial 120 patients included in the study, seven were early withdrawals following surgery: two from group 1, three from group 2, and two from group 3. Reasons for withdrawal were mechanical ventilation for more than 24 h (four patients) and neurologic complications (three patients). These seven patients were replaced so that an equal num-

Table 1 — *Preoperative Profiles of the 120 Patients Completing the Study**

	Group		
	1 (No. = 40)	2 (No. = 40)	3 (No. = 40)
Sex, F/M (No.)	7/33	7/33	8/32
Age, yr	62 ± 11	61 ± 9	63 ± 8
Weight, kg	77.7 ± 12.2	77.9 ± 9.9	77.6 ± 10.1
Height, cm	171.8 ± 7.8	171.3 ± 8.0	169.6 ± 7.9
BMI	26.3 ± 3.3	26.7 ± 3.9	27.0 ± 2.9
Obesity grade†			
0 (No.)	13	15	11
1	23	19	24
2	4	6	5
Respiratory history			
Smokers, No.	5	5	8
Ex-smokers	16	21	14
Non-smokers	19	14	18
Pack years	17 ± 21	26 ± 30	16 ± 22
Using bronchodilators (No.)	7	9	4
Pulmonary function tests			
FVC, L	3.55 ± 0.9	3.49 ± 0.8	3.46 ± 0.9
% predicted	92.8 ± 12.3	92.4 ± 17.1	93.8 ± 9.6
FEV_1, L	2.58 ± 0.7	2.50 ± 0.7	2.57 ± 0.7
% predicted	84.8 ± 14.7	83.7 ± 20.9	88.1 ± 12.0
Peak expiratory flow, L/s	6.26 ± 2.1	6.02 ± 2.0	6.42 ± 2.3
% predicted	79.5 ± 22.2	76.7 ± 22.6	82.8 ± 24.6
FEV_1/FVC%	72.0 ± 7.6	71.9 ± 10.8	75.3 ± 6.5
% predicted	90.5 ± 9.0	89.9 ± 13.4	94.6 ± 7.7
FEF25-75%, L/s‡	2.14 ± 1.0	2.22 ± 1.1	2.36 ± 0.9
% predicted	63.2 ± 23.0	66.4 ± 31.7	71.6 ± 21.6

*Values are means ± SD unless otherwise noted.

†Obesity grade: 0, BMI of 20 to 24.9; 1, BMI of 25 to 29.9; 2, BMI of 30 to 40.

‡FEF25-75% = forced expiratory flow between 25 and 75 percent of FVC.

Table 2—*Operative and Postoperative Profiles**

	Group 1 (No. = 40)	Group 2 (No. = 40)	Group 3 (No. = 40)
Surgeon 1/2, No.	26/14	18/22	18/22
Total No. of grafts	2.35 ± 1.0	2.38 ± 1.0	2.48 ± 1.2
Unilateral IMA grafts, No.	28	26	26
Bilateral IMA grafts, No.	2	1	0
Valve replacement, No.	2	2	1
Pleurotomy, No.	2	1	3
Left ventricular function, No.			
Good	21	20	25
Moderate	13	12	10
Poor	4	3	2
Not stated	4	3	2
Return to O.R., No.	1	3	2
Duration of cardiopulmonary bypass, min	39.6 ± 18.0	43.4 ± 21.5	39.2 ± 16.9
Duration of anaesthesia, min	156.8 ± 29.7	155.0 ± 39.5	157.5 ± 31.7
Time to extubation, h	10.2 ± 3.8	9.2 ± 3.8	9.4 ± 3.3
Total dosage omnopon, mg	82.2 ± 53.3	94.6 ± 52.1	94.6 ± 50.9
Additional antibiotics, No.	8	15	8
Bronchodilators, No.	16	18	13
Inotropic, diuretic, antiarrhythmic drugs, No.	11	19	16
Length of postoperative stay, d	9.0 ± 5.7	10.4 ± 6.9	8.5 ± 2.6

*Values are means ± SDs unless otherwise noted.

ber of patients remained in each group.

Descriptive data, including results of pulmonary function testing, for the 120 patients who completed the study are given in Table 1. Of the 120 patients, 98 were male, and the mean age was 62.0 years (range, 39 to 79 years). There were no significant differences between the groups in the patients' preoperative profiles or pulmonary function test results. Similarly, operative and postoperative details were not significantly different between groups

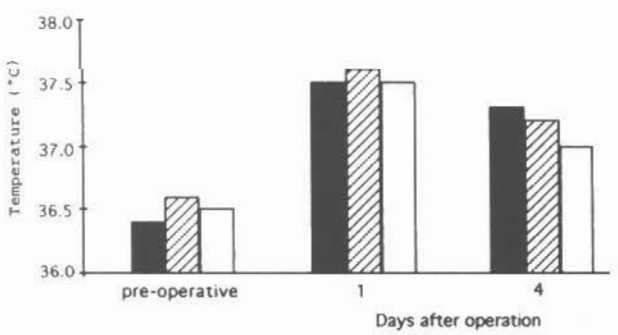

FIGURE 1. Mean oral temperatures. Solid bar, group 1; hatched bar, group 2; open bar, group 3.

Table 3—*Arterial Blood Gas Analyses**

	Group 1	Group 2	Group 3
Preoperative			
PaO_2, mm Hg	83.8 ± 10.5	84.2 ± 9.9	82.9 ± 10.5
$PaCO_2$, mm Hg	39.4 ± 3.4	39.1 ± 3.7	39.9 ± 2.9
pH	7.41 ± 0.02	7.42 ± 0.03	7.41 ± 0.02
Day 1			
PaO_2	125.4 ± 40.1	125.0 ± 46.5	141.2 ± 53.4
$PaCO_2$	46.6 ± 7.3	46.2 ± 4.6	48.3 ± 5.2
pH	7.35 ± 0.05	7.35 ± 0.04	7.33 ± 0.04
PaO_2/FIo_2 % preop†	50.7 ± 18.5	48.0 ± 18.7	54.8 ± 18.2
Day 4			
PaO_2	68.7 ± 14.1	67.7 ± 12.8	69.5 ± 14.7
$PaCO_2$	38.1 ± 6.1	37.2 ± 3.4	37.6 ± 3.9
pH	7.44 ± 0.04	7.45 ± 0.03	7.44 ± 0.04
PaO_2/FIo_2 % preop†	77.0 ± 19.8	74.4 ± 16.1	75.5 ± 20.1

*Values are means ± SDs. The numbers in each group preoperatively and on days 1 and 4 were group 1 — 39, 39, and 39; group 2 — 37, 38, and 38; group 3 — 39, 39, and 39.
†Value is PaO_2/FIo_2 as a percentage of the preoperative value.

(Table 2). Sixty-nine percent of patients had an internal mammary artery (IMA) graft as the sole conduit or in combination with a saphenous vein graft. There were no significant differences between groups in the number of patients receiving IMA grafts. Six patients who were reoperated on for control of hemorrhage were included in the study, since they were extubated within 24 h of completion of the initial anesthetic.

Figure 1 compares the mean oral temperature of patients allocated to groups 1, 2, or 3. There were no significant differences between groups at any stage. Postoperative fever (defined as a temperature of 38°C or higher[5]) on day 1 was detected in 31 patients (12, group 1; 11, group 2; 8, group 3) and in six patients on day 4 (4, group 1; 1, group 2; 1, group 3). The incidence of fever was not significantly different between groups.

The absolute values of the arterial blood gas analyses and the PaO_2/FIo_2 ratio values (expressed as a percentage of the preoperative value) are given in Table 3. On day 1, all patients were receiving additional oxygen, whereas by day 4 the majority of patients were breathing air. In all groups, the PaO_2/FIo_2 ratio was significantly reduced on the first postoperative day compared with preoperative values ($p < 0.001$). By the fourth postoperative day, oxygenation had improved but was still significantly reduced ($p < 0.001$) compared with preoperative values. There were no significant differences between groups in these measurements at any stage.

Chest roentgenogram findings are shown in Figure 2. Preoperatively, all except nine patients had a score of zero. In these nine patients, evidence of minor atelectasis was present. On the first postop-

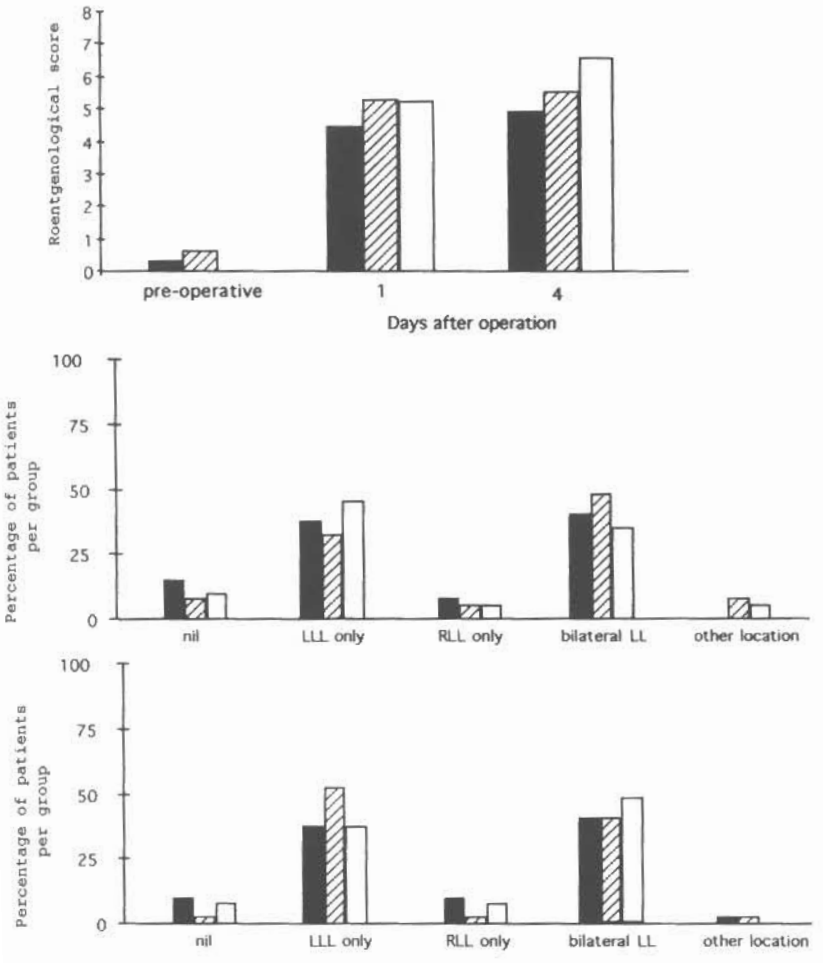

FIGURE 2. Top, Mean roentgenologic scores. Solid bar, group 1; hatched bar, group 2; open bar, group 3. Center, Incidence and location of atelectasis on the first postoperative day. Left lower lobe, LLL; right lower lobe, RLL; lower lobes, LL. Bottom, Incidence and location of atelectasis on the fourth postoperative day.

erative day, minor pulmonary infiltrates were detected in the majority of patients (Fig 2, top). The predominant findings consisted of atelectasis located in the lower lobes, with the left lower lobe most commonly affected (Figure 2, center). Similar findings were detected on the fourth postoperative day (Fig 2, bottom). There were insufficient numbers in some categories to enable detailed statistical analysis. However, since the frequencies differed by only small numbers, even in the more commonly occurring categories, there was clearly no suggestion that significant differences were present between groups in the chest roentgenogram scores, the incidence, or the location of the abnormalities preoperatively or postoperatively. Pleural effusions were noted in 27.5 percent of patients on day 1 and in 80.5 percent of patients on day 4. On day 1, the majority of the effusions were small and located on the left side, whereas by day 4 small bilateral effusions were most common. Neither the incidence nor severity of pleural effusions was obviously different between the groups.

Based on the cardiologist's review, nine patients were classified as having clinically significant pulmonary complications necessitating chest physiotherapy. Data from these nine patients are summarized in Table 4. Of these patients, three developed pulmonary complications within 12 h of completion of surgery before chest physiotherapy was scheduled to commence, indicating that the complications could not be attributed to the presence or absence of prophylactic chest physiotherapy. For the other six patients, a diagnosis of sputum retention or chest infection, or both, was made from late in the afternoon of the first postoperative day to the third postoperative day, a time when it could be expected that the presence or absence of prophylactic chest physiotherapy may have had an effect. The low incidence of complications does not allow detailed statistical analysis; however, there was certainly no indication that the incidence of these complications was different between groups (1, group 1; 4, group 2; 1, group 3). All nine patients, in addition to intensive chest physiotherapy, required medical treatment in excess of the standard care given for routine postoperative CAS patients. The postoperative length of stay of these patients was also significantly prolonged ($p = 0.0002$ [Table 4]).

Five of the nine patients who developed clinically significant pulmonary complications also had left

Table 4 — *Profiles of the Nine Patients With Clinically Significant Pulmonary Complications**

Day of Diagnosis	Group	Initial Diagnostic Signs	Diagnosis	Medical Management	Length of Postoperative Stay, d
0-1	1	Confused, drowsy, appearance, auscultation, increased RR & HR, decreased SaO_2	Acute respiratory failure, sputum retention	IPPV, inotropes, antibiotics, bronchodilators	28
0-1	3	Appearance, auscultation, increased RR & JVP, decreased SaO_2	Acute respiratory failure, LVF	O_2, CPAP, inotropes, diuretics, bronchodilators	8
0-1	3	Confused, auscultation, increased JVP, decreased SaO_2	LVF	O_2, diuretics	9
1	2	Appearance, auscultation, increased RR & HR, decreased SaO_2	Sputum retention, chest infection	IPPV, antibiotics, bronchodilators	15
2	1	Appearance, auscultation, fever, increased RR & HR, decreased SaO_2	Sputum retention, chest infection, LVF	IPPV, antibiotics, bronchodilators, inotropes, diuretics	34
2	2	Appearance, auscultation, fever, increased RR & HR, decreased SaO_2	Sputum retention, chest infection, AF, LVF	O_2, antibiotics, bronchodilators, diuretics, antiarrhythmic agents	10
2	2	Appearance, auscultation, fever, increased RR & HR, decreased SaO_2	Chest infection	O_2, antibiotics, bronchodilators	14
2	3	Appearance, auscultation, fever, increased RR, decreased SaO_2	Chest infection	O_2, antibiotics, bronchodilators	9
3	2	Appearance, auscultation, fever, increased RR & HR, decreased SaO_2	Sputum retention, chest infection, LVF	O_2, antibiotics, bronchodilators, diuretics	9

*RR = respiratory rate; HR = heart rate; SaO_2 = saturation of oxygen; JVP = jugular venous pressure; AF = atrial fibrillation; IPPV = intermittent positive pressure ventilation; CPAP = continuous positive airway pressure.

ventricular failure (LVF). Four of these five patients had evidence of respiratory disease (*ie*, sputum retention and chest infection) and the LVF occurred subsequent to the pulmonary complication. Conversely, while the other patient had severe pulmonary dysfunction, there was no evidence of respiratory disease and it became apparent, with the benefit of retrospection, that the primary problem was one of LVF.

Compared with the patients who did not have clinically significant pulmonary complications, the nine patients with these complications generally had lower values for preoperative pulmonary function and very low early postoperative oxygenation. Indeed, the mean value for these nine patients was significantly lower for forced vital capacity, percent predicted ($p = 0.02$), peak expiratory flow ($p = 0.04$), and peak expiratory flow, percent predicted ($p = 0.009$), and lower for FEV_1, percent predicted ($p = 0.07$). On the first postoperative day, PaO2 was significantly lower ($p = 0.003$) as was the $PaO2/FIo_2$ ratio (expressed as a percentage of the preoperative value) ($p = 0.01$). However, there were patients with low values for these parameters who did not develop pulmonary complications. Results of other pulmonary function tests and preoperative and operative data were not significantly different between patients with and without pulmonary complications.

Discussion

Although routine chest physiotherapy is widely used after CAS with the aim of preventing pulmonary complications, relatively few studies could be found which evaluated the efficacy of this treatment.[6-15] In these studies, different regimens of treatment such as breathing and coughing exercises, incentive spirometry, intermittent positive pressure breathing, and periodic application of continuous positive airway pressure were compared. No treatment regimen was found to be superior to any other in the prevention of pulmonary complications. Dull and Dull[6] and Jenkins et al[13] found that the addition of breathing exercises or incentive spirometry to a regimen of early mobilization and coughing conferred no extra benefit after CAS. However, since no control group was included in either study, it is not certain if any prophylactic chest physiotherapy

was required.

In the past, the clinical importance of the pulmonary complications identified in many studies of postoperative patients has been poorly addressed. In many instances, it is likely that complications were clinically insignificant, self-limiting, and may have resolved spontaneously without specific treatment.[16,17] In the majority of patients in the present study, the abnormalities of temperature, arterial blood gas values, and roentgenologic findings detected on the first and fourth postoperative days were not accompanied by any obvious signs of illness, nor did they require specific medical intervention. On many occasions the severity of the hypoxemia and roentgenologic abnormalities did not appear to correlate with the patient's clinical condition. Conversely, those patients identified by the cardiologist as having clinically important pulmonary complications appeared distressed and demonstrated overt signs of marked pulmonary dysfunction. Furthermore, the extent and type of intervention required in the treatment of these patients and their extended length of postoperative stay, confirm the clinical significance of the pulmonary complications diagnosed in this study.

The present study demonstrated an overall incidence of clinically significant pulmonary complications of 7.5 percent. There was no obvious difference between a control group and treatment groups in the incidence of these complications. Thus, prophylactic chest physiotherapy, at least as performed in this study, did not seem to decrease the incidence and severity of fever, hypoxemia, roentgenologic abnormalities, clinically significant pulmonary complications, or length of postoperative stay. The frequency and extent of these findings were similar to those previously reported.[9,11-15,18,19] In this study, patients who developed clinically significant pulmonary complications had lower preoperative pulmonary function test results and very low early postoperative oxygenation, although it is recognized that not all patients with low values for these parameters will necessarily develop clinically significant pulmonary complications.

The reason for the failure of prophylactic chest physiotherapy to have a beneficial effect on the parameters measured in this study is not certain. The preoperative characteristics of the population studied were typical of patients undergoing CAS, in terms of their age, the predominance of males, degree of obesity, and their positive smoking history. Certainly, no attempts were made to select patients who were considered to be at low risk of developing postoperative pulmonary complications. In addition, there were no significant differences between groups in these preoperative characteristics. Thus, it would seem unlikely that the failure of prophylactic chest physiotherapy to affect the incidence of fever, hypoxemia, roentgenologic abnormalities, and clinically significant pulmonary complications could be attributed to an overall healthier sample of patients with fewer preoperative risk factors, or a control group comprised of the healthier patients. Similarly, since the operative details were comparable between groups this is unlikely to have influenced the results.

It could be argued that different chest physiotherapy techniques may have been more effective. However, given the results of previous studies which found no significant advantage associated with the use of other modalities of treatment, this would seem unlikely. As far as the frequency of treatment is concerned, no significant benefit was identified in the treatment group in this study which received supervised breathing and coughing exercises more frequently. Although patients were instructed to perform independent breathing and coughing exercises every waking hour, their compliance with this was not measured. Thus, it is possible, although perhaps remote, that a greater frequency of supervised chest physiotherapy may have been of benefit.

Since the decrements in pulmonary function which occur after CAS are as severe if not more so than those seen after UAS, it could be anticipated that UAS and CAS patients not receiving prophylactic chest physiotherapy should have a similar incidence of postoperative pulmonary complications. In the two controlled studies of patients after UAS, the incidence of pulmonary complications in the control groups was 88 and 60 percent, whereas it was reduced to approximately 33 and 19 percent, respectively, for those groups which received prophylactic chest physiotherapy regimens.[1,2] Thus, chest physiotherapy in these studies was significantly and dramatically effective. Although direct comparison of results is difficult in view of the different populations studied and the varied methods used to diagnose pulmonary complications, some interesting observations can be made. Because the patients received similar treatment regimens, it is unlikely that variations in treatment influenced the results to a significant degree. It is certain that the overall low incidence of pulmonary complications detected in this study made it difficult to detect differences between groups. Thus, it would seem that factors unique to UAS, such as the incision site and severity of pain, cough suppression, and diaphragmatic inhibition, may predispose these patients to the development of a higher incidence of complications than that seen in the CAS population, and thus they would be more responsive to prophylactic therapy. After CAS, patients appear to be able to cough and

clear pulmonary secretions more effectively than their UAS counterparts, at least in our experience, and thus they may not require assistance with secretion clearance to prevent pulmonary complications.

While prophylactic chest physiotherapy did not prevent pulmonary complications after CAS in this study, it is important to stress that no attempt was made to investigate the effectiveness of chest physiotherapy in the treatment of pulmonary complications once they occurred. Similarly, the role of physiotherapy in rehabilitation following CAS was not examined.

The results of this study suggest that the physiotherapist's role in the management of patients after routine CAS should change. The physiotherapist should continue to assess all patients to detect the presence of clinically significant pulmonary complications and selectively treat only these patients. It is recommended that institutions where patients receive prophylactic chest physiotherapy after CAS should review the necessity for such treatment.

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