

Does removal of deep breathing exercises from a physiotherapy program including pre-operative education and early mobilisation after cardiac surgery alter patient outcomes?

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The aim of this study was to establish whether removal of breathing exercises from a regimen including early mobilisation changes the incidence of post-operative pulmonary complications for patients after cardiac surgery. Two hundred and thirty patients undergoing open heart surgery at Monash Medical Centre, Melbourne, were enrolled in this randomised controlled trial. All patients received physiotherapy treatment pre-operatively and post-operatively for three days. Patients were mobilised as soon as possible after surgery. Breathing group (control) patients performed a set routine of deep breathing exercises at each physiotherapy visit while those in the intervention group did not perform this routine. Other than the breathing exercises, patient management was similar between groups in terms of assessment, positioning and mobility. The incidence of post-operative pulmonary complications, post-operative length of stay, oxyhaemoglobin saturation and pulmonary function were measured pre-operatively and post-operatively. Intention-to-treat analysis was performed for post-operative pulmonary complications and length of stay. Other data were analysed using *t*-tests, chi square and repeated measures analysis of variance. There were no significant differences between the groups in the primary dependent variables. It is concluded that removal of breathing exercises from the routine physiotherapy management of open heart surgery patients does not significantly alter patient outcome. [Brasher PA, McClelland KH, Denehy L and Story I (2003): Does removal of deep breathing exercises from a physiotherapy program including pre-operative education and early mobilisation after cardiac surgery alter patient outcomes? *Australian Journal of Physiotherapy* 49: 165-173]

Key words: Breathing Exercises; Heart Surgery; Patient Education; Postoperative Complications

Introduction

It has been well established that pulmonary function decreases following open heart surgery (Taggart et al 1993, van Belle et al 1992, Vargas et al 1992). General anaesthesia has been shown to reduce functional residual capacity (FRC) by approximately 20%, cardiopulmonary bypass impairs gas exchange, and cardiac surgery patients with mammary arteries harvested have been shown to have a higher risk of pleural effusion and subsequent pulmonary problems (Matthay et al 1989). The incidence of atelectasis increases with each of general anaesthesia, cardiopulmonary bypass and cardiac surgery (Matthay 1989) and atelectasis itself can result in a decrease in FRC, vital capacity and lung compliance (Weiman et al 1993). As a result, patients undergoing cardiac surgery are at risk of developing post-operative pulmonary complications.

Historically, chest physiotherapy has been performed prophylactically with patients undergoing open heart surgery to reduce the risk of post-operative pulmonary complications. Physiotherapy for open heart surgery patients may include a variety of techniques. Those most commonly used in Australia in the initial post-operative

period include deep breathing exercises, early ambulation, positioning, huffing and coughing (Tucker et al 1996). O'Donohue (1992) suggested that refractory post-operative atelectasis may best be prevented or treated by spontaneous deep breathing exercises to improve inspiratory capacity and lung compliance, with an hourly routine of at least five sequential deep breaths, each held for five to six seconds. Deep breathing exercises have been shown to improve both basal ventilation (Tahir et al 1973) and diaphragmatic displacement. Blaney et al (1997) found a significant increase in diaphragmatic displacement when deep breathing exercises were performed with tactile stimulation over the subject's lower costal margin in addition to verbal instruction, compared with instruction alone. In addition, deep breathing exercises are advocated to improve tidal volume (Webber and Pryor 1998) and facilitate secretion removal (Menkes and Britt 1980).

The effectiveness of prophylactic deep breathing exercises in patients undergoing cardiac surgery has been questioned (Dull and Dull 1983, Jenkins et al 1989, Stiller et al 1994) and although the results of these studies are well known, they do not appear to have significantly influenced clinical practice in Australia (Tucker et al 1996).

The physiotherapy management of patients recovering from open heart surgery at Monash Medical Centre and Jessie McPherson Hospital (a private hospital within the Monash Medical Centre building and staffed by physiotherapists from Monash Medical Centre) has traditionally included the use of prophylactic deep breathing exercises. In comparison with the research of Stiller et al (1994), preliminary investigations revealed that Monash Medical Centre's open heart surgery patient population differed notably in terms of operative characteristics, specifically anaesthetic and cardiopulmonary bypass time, and included those undergoing valve surgery as well as coronary artery bypass surgery, while Stiller's population included only the latter. Thus we felt it was warranted to investigate the role of prophylactic deep breathing exercises in the Monash Medical Centre patient population prior to implementing a change of practice based on the results of Stiller et al (1994). If the results of Stiller et al (1994) were supported in the different patient population at Monash Medical Centre, then it was felt that a change in practice could be implemented more confidently.

The aim of this study was therefore to determine whether the removal of a regimen of deep breathing exercises from post-operative physiotherapy management altered the patient's outcomes following elective open heart surgery. Specifically, we sought to determine if the removal of breathing exercises altered the incidence of post-operative pulmonary complications, post-operative length of hospital stay, pulmonary function and oxyhaemoglobin saturation (SpO₂).

Method

Study design The study was a randomised controlled trial. The Human Research and Ethics Committee of the Monash Medical Centre granted approval for the research to proceed.

All patients presenting for elective open heart surgery involving a sternotomy incision, from July 1999 to May 2000 at Monash Medical Centre and Jessie McPherson Private Hospital, were included. Written informed consent was gained from the patients pre-operatively after they were assessed as meeting study inclusion criteria. Subjects were excluded if they were unable to understand instructions in English, or were immobile due to a prior neurological or musculoskeletal condition. After providing consent, subjects were randomly allocated to 'breathing exercise' (control) or 'intervention' groups by manual selection of marked tickets.

Subjects were withdrawn from the study if they:

- required more than 24 hours of assisted ventilation post-operatively;
- spent more than 48 hours in the intensive care unit (ICU);
- returned to theatre after the first 24 hours post-operatively; or

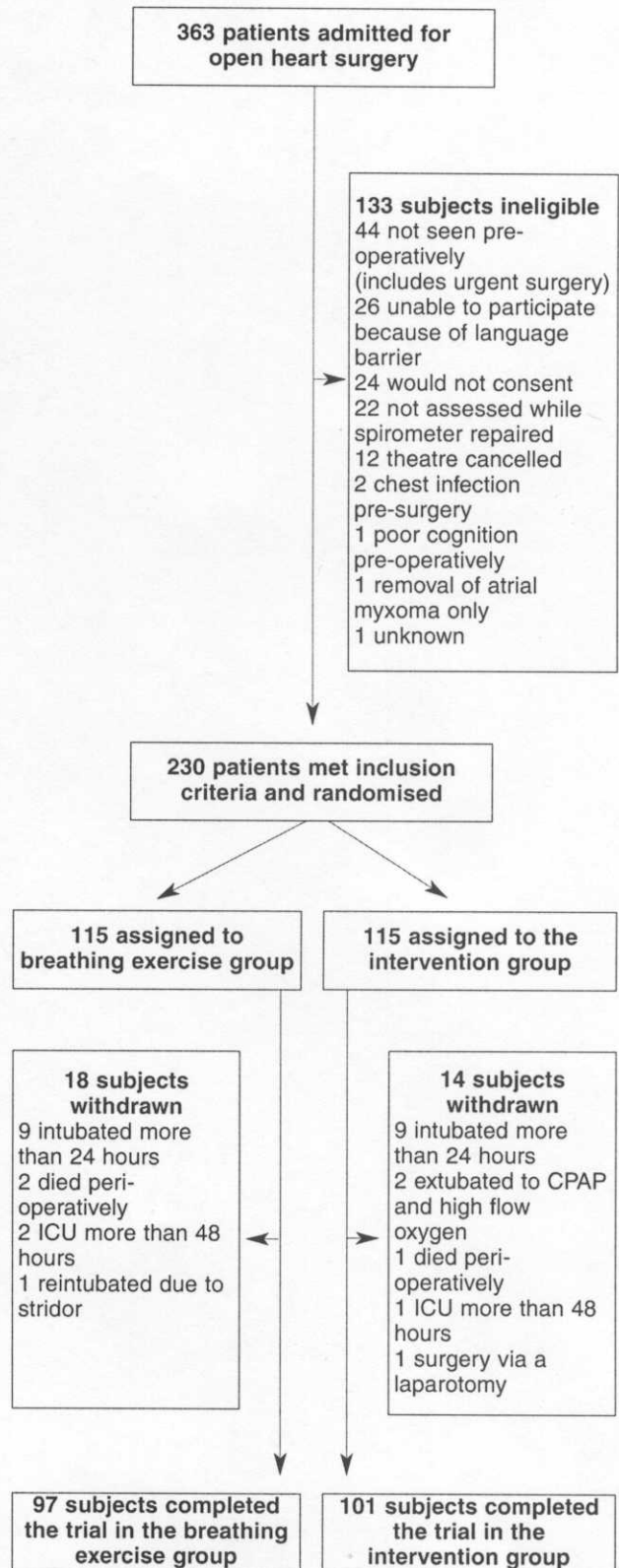


Figure 1. Flow chart showing progression of subjects through trial.

Table 1. Subject demographics. Data are mean and (SD) unless otherwise stated.

	Breathing exercise group n = 97	Intervention group n = 101	Statistic	p
Males:Females	81:16	79:22	$\chi^2 = 0.89$	0.35
Age in years	60.7 (10.9)	63.3 (10.8)	$t = -1.66$	0.10
Median (range)	62 (35-80)	64 (30-83)		
BMI	27.5 (3.9)	27.2 (4.2)	$t = 0.51$	0.61
ASA score frequency				
1	0	0		
2	7	7	$\chi^2 = 0.18$	0.91
3	53	54		
4	32	37		
5	0	0		
Smoking (%)				
Never	30 (31.6)	38 (38.0)	$\chi^2 = 1.94$	0.38
Ex	65 (68.4)	61 (61.0)		
Current	(0.0)	1 (1.0)		
Public:Private (%)	72 (74.2):25 (25.8)	75 (74.3):26 (25.74)	$\chi^2 = 2.43$	1.0

BMI = body mass index, ASA = American Society of Anesthetists score of co-morbidity

- had clinically significant neurological complications post-operatively.

Procedure Each subject was seen pre-operatively by one of a team of four physiotherapists educated in the aims and methodology of the study, and able to perform subject recruitment, treatment and data collection. The subject was given an educational sheet explaining the research. Those randomly assigned to the intervention group were educated about the effects of surgery on lung function, positions to improve lung function and progression of mobility after surgery. They were also taught a supported cough. Subjects assigned to the breathing exercise group were provided with the same education and in addition were taught how to perform deep breathing exercises.

Post-operatively, all subjects were treated by a physiotherapist who was not blinded to allocation. Data was collected twice on Days 1 and 2, and once on the third day after the operation. Where necessary, subjects continued to be reviewed by the physiotherapist beyond the third post-operative day. At each visit, a complete cardiopulmonary assessment was performed. On the first post-operative morning in the ICU, all subjects were re-educated about the positions most likely to improve lung function. Supported cough was reviewed and encouraged by the physiotherapist. Where possible, the subjects were sat out of bed at the afternoon treatment. On the second

post-operative day, subjects were ambulated (defined as a minimum of 10 metres) and sat out of bed and supported cough was encouraged. On the third post-operative day, subjects were ambulated (defined as a minimum of 30 metres) as able. In addition to this protocol, at each physiotherapy treatment those subjects in the breathing exercise group performed a regimen of four sets of five deep breaths from FRC to total lung capacity (TLC). Each breath included a 3 second hold at end inspiration, and was performed with the treating physiotherapist's hands placed on the subject's lateral costal margin. These exercises were interspersed with a supported cough after the second and the final set of breaths and were completed in either upright sitting or flat sidelying. Subjects were requested to perform these breathing exercises independently each waking hour between physiotherapy treatments and maintain a diary of their practice. A prepared tick sheet and pen was provided at the bedside to facilitate adherence. Medical and nursing involvement with the subjects was not changed during the course of the study and medical and nursing staff were blinded to group allocation.

Measurement Pre-operative information The subject's age, gender, weight, height, body mass index, smoking history and past medical history were documented. Pre-operative SpO₂ was measured using a pulse oximeter and finger sensor^(a) with the patient breathing room air in upright sitting. Pulmonary function tests were performed

Table 2. Operative information giving mean and (SD) unless otherwise stated.

	Breathing exercise group n = 97	Intervention group n = 101	Statistic	p
Surgery (frequency)				
CAGS	75	80		
Off pump	3	6		
CAGS/valve	10	8	$\chi^2 = 4.45$	0.35
Valve	9	5		
Other	0	2		
Duration of anaesthesia (h)	5.13 (1.21)	5.28 (1.23)	t = 0.92	0.36
Length of intubation (h)	10.19 (4.4)	10.75 (4.99)	t = 0.84	0.41
CPB time (min)	108.1 (39.2)	107.4 (41.7)	t = 0.13	0.90

CAGS = coronary artery surgery. Off pump = coronary artery surgery without cardiopulmonary bypass. CAGS/valve = cardiac valve and coronary artery surgery. Valve = cardiac valve surgery. CPB = cardiopulmonary bypass.

with the subject in upright sitting using a dry spirometer^(b) according to American Thoracic Society guidelines (American Thoracic Society 1994).

Post-operative information Length of time of anaesthesia, post-operative intubation/ventilation and cardiopulmonary bypass times were recorded. The number of grafts and type of conduit for those undergoing bypass surgery, and valve types used for those undergoing valve replacement surgery, were recorded. The American Society of Anesthesiologists classification of co-morbidity score, as rated by the assessing anaesthetist, was recorded.

A number of measurements were taken for each subject prior to each post-operative physiotherapy treatment during the period of study. With the subject breathing room air and sitting upright, SpO₂ was recorded continuously over a 7 min period. After seven minutes, the most consistent reading over a 30 second period was recorded (Howe et al 1975). Once a reading had been obtained, the subject's previous oxygen therapy was recommenced. If at any time during the assessment the subject's SpO₂ dropped to below 85%, their oxygen was recommenced and "85%" was recorded.

A verbal pain score was obtained using the Monash Medical Centre acute pain service observation sheet. This nominal scale requires the subject to rate his or her pain on different activities as documented below:

- No pain on coughing or movement.
- Pain on coughing or movement but not on deep breathing.
- Pain on deep breathing but not at rest.
- Pain at rest, desires no further analgesia.
- Pain at rest, desires more analgesia.

The subject's maximum oral or tympanic temperature recorded on the observation charts since the prior physiotherapy treatment was documented in addition to the white cell count (WCC). The subject's mobility during the treatment session in relation to the protocol for post-operative mobility (see "Procedure") was recorded and any reasons for not meeting the standard mobility were documented.

A radiologist who was blinded to subject allocation assessed the post-operative chest x-rays (CXR). The post-operative CXR reports, sputum microscopy and culture results and the Day 3 post-operative pulmonary function tests (completed as per pre-operative testing) were documented.

For the purposes of this study, post-operative pulmonary complications were defined as either decreased SpO₂ to below 85% breathing room air or CXR signs of collapse and/or consolidation in addition to two or more of the following:

- Increased oxygen requirements (fraction of inspired oxygen greater than 0.5 for at least 24 hours).
- Temperature greater than 38 degrees C for two or more days.
- Increased WCC to greater than 11x10⁹ per litre.
- Prescription of respiratory antibiotics.
- Isolation of respiratory pathogens on sputum microscopy and culture.

The diagnosis of post-operative pulmonary complications was made by the on-call cardiothoracic surgery registrar, who was blinded to allocation.

At discharge, length of stay was recorded. The subject's

Table 3. Results of intention-to-treat analysis for length of stay. Data are mean and (SD) unless otherwise stated.

Breathing exercise group (n = 115)	Intervention group (n = 115)	Mean difference (95% CI)	z value	p
8.04 (6.36)	8.28 (8.76)	0.24 (-1.77 to 2.25)	-0.24	0.69

Table 4. Results of intention-to-treat analyses for frequency of post-operative pulmonary complications.

Breathing exercise group	Intervention group (n = 115)	Relative risk (n = 115)	Absolute risk reduction (95% CI)	Number needed to treat (95% CI)	p (95% CI)
5 (4.3%)	3 (2.6%)	0.60% (0.15% to 2.45%)	1.7 (-3.7% to 7.4%)	58 (-27 to 13)	0.72

Table 5. Pulmonary function tests – Day 3 figures as % of pre-operative figures giving mean (SD). Data are mean and (SD) unless otherwise stated.

Day 3 as % of pre-op	Breathing exercise group n = 88*	Intervention group n = 88*	Mean difference (95% CI)	t value	p
FEV ₁	50.6% (23.7%)	50.0% (13.1%)	0.6% (5.1 to 6.3)	0.21	0.84
FVC	52.1% (21.5%)	51.4% (12.84%)	0.7 (4.6 to 6.0)	0.26	0.80

FEV₁, forced expiratory volume in one second. FVC, forced vital capacity. *measurements not obtained for many subjects (see Results).

inclusion in the hospital in the home program was also recorded, an initiative which facilitates early discharge from the hospital ward with nursing follow-up over the first two days at home. Readmission within 28 days of discharge was ascertained from the hospital database at 30 days post discharge. The total time spent by the physiotherapist attending each subject was recorded, including time spent on data collection, notewriting and communication with nurses about the patient.

Data management Data were analysed with SPSS 10 for Macintosh[®]. Nominal data were compared using a chi squared test or Fisher's exact test. Between-group comparisons of continuous data (duration of anaesthesia, intubation time, cardiopulmonary bypass time, pulmonary function tests) were performed with independent *t*-tests. Continuous data with repeated measures (SpO₂,

physiotherapy time) were analysed using two-way analysis of variance with one repeated measure. Simple main effects analysis was performed for significant results using one-way ANOVA and the Scheffe *F* test. Verbal pain scores were analysed using non-parametric statistics.

Intention-to-treat analysis was performed for incidence of post-operative pulmonary complications and length of stay (ie all randomised subjects for whom follow-up data were available were analysed in the group to which they were assigned) so that comparability of groups remained adequate. The incidence of post-operative pulmonary complications was analysed using Fishers exact test and length of stay data were analysed using the Mann Whitney U test, since data were not normally distributed. Alpha was set at 0.05 (two-tailed) for all tests. Demographic data were presented using both means (standard deviations) and

median (range). The sample size across analyses varies due to occasional missing data, but is given for all results.

Results

The patients admitted for open heart surgery via a sternotomy during the study period progressed as shown in Figure 1. Their demographic and operative data are presented in Tables 1 and 2. There were no statistical differences between groups on any parameters measured.

Post-operative data Intention-to-treat analysis for length of stay (Table 3) showed there were no significant differences between the breathing exercise and intervention groups ($Z = -0.24, p = 0.69$). Four subjects had a post-operative length of stay greater than 20 days; all of these had surgical complications.

Three subjects in each of the intervention and breathing exercise groups developed post-operative pulmonary complications as defined in the study. Two further subjects who were withdrawn from the study developed a post-operative pulmonary complication (both in breathing exercise group). Intention-to-treat analysis using Fisher's exact test showed there were no significant differences between the groups ($\chi^2 = 0.72, p = 0.72$; Table 4).

Case by case analysis of the eight subjects who developed a post-operative pulmonary complication showed that all had undergone coronary artery bypass grafting alone. No trend is apparent when comparing demographic, pre-operative and operative data for these patients. However, mean post-operative length of stay was 16.76 days with a range from six to 33 days for these subjects, compared with the study mean length of stay of 8.16 days. This result was significant ($Z = -3.70, p < 0.001$).

There were no significant differences between breathing exercise and intervention groups for the verbal pain score ($p = 0.28$). There was a significant decrease in the verbal pain score over time after surgery ($p < 0.001$) where scores peaked on Day 1 post-operatively and were at their lowest on Day 3 post-operatively.

Seventy-seven subjects (79.4%) in the breathing exercise group completed the tick sheets to indicate when they had practised their breathing exercise routine independent of the treating physiotherapist. There was a significant difference between subjects for the number of independent practices ($F_{(76,154)} = 7.49, p < 0.001$) but no significant difference comparing the number of practices across days after surgery ($F_{(2,152)} = 1.29, p = 0.28$) for the group as a whole. Subjects completed a mean of 2.7 (± 3.0) independent sessions of breathing exercises on the first post-operative day, 3.0 (± 4.0) on the second day and a mean of 3.2 (± 4.2) practices on the third day after surgery.

Physiotherapy treatment time was significantly different between groups. Mean total time for Days 1 to 3 post-operatively was 151.61 minutes (30.32 minutes per session) for the breathing exercise and 131.92 minutes (26.38 minutes per session) for the intervention group

($F_{(1,182)} = 36.29, p < 0.001$). The mean daily physiotherapy treatment time reduced significantly with time from surgery for both groups ($F_{(2,364)} = 405.87, p < 0.001$). Upon simple main effects testing, differences were demonstrated between Day 1 and Days 2 and 3, and between Days 2 and 3 for both groups.

Nine (9.3%) subjects from the breathing exercise group were readmitted to hospital within 28 days of discharge compared with 14 (13.9%) in the intervention group. This difference was not significant ($\chi^2 = 0.96, p = 0.45$) and none of the readmissions were for predominantly pulmonary problems.

All patients followed the mobility protocol for the first post-operative day. No significant difference was measured between groups for following the protocol for mobility for the second ($\chi^2 = 1.21, p = 0.37$) or the third post-operative days ($\chi^2 = 0.10, p = 0.75$).

There was no significant difference in mean SpO₂ between groups ($F_{(1,170)} = 1.40, p = 0.32$) and no significant difference in the pattern of SpO₂ changes between groups over the post-operative period of measurement. There was a significant increase in SpO₂ values over time from surgery ($F_{(1,170)} = 195.9, p = 0.001$). Mean SpO₂ levels were lowest on the first post-operative day and improved thereafter, remaining above 90% for both groups throughout the period of measurement.

There were no significant differences between breathing exercise and intervention groups for any pulmonary function parameter measured (Table 5), although many subjects were too sore, too unwell or refused testing on Day 3 post-operatively.

Discussion

This research aimed to determine whether the removal of a regimen of deep breathing exercises from post-operative physiotherapy management including assessment and early mobilisation altered subject outcomes following elective open heart surgery. Given that, in our population, we found no significant difference between breathing exercise and intervention groups in terms of incidence of post-operative pulmonary complications, post-operative length of stay, pulmonary function tests, readmission rate, or post-operative SpO₂, we conclude that the removal of breathing exercises from the subject's post-operative physiotherapy management had no deleterious effect on outcome.

This finding is in agreement with the findings of previous research (Dull and Dull 1983, Jenkins et al 1989, Stiller et al 1994).

In terms of the dependent variables measured, arguably the most clinically important is post-operative pulmonary complications where a post-operative pulmonary complication is defined as "a pulmonary abnormality that produces identifiable disease or dysfunction that is clinically significant and adversely affects the clinical course" (O'Donohue 1992, p. 167). Development of a post-

operative pulmonary complication may slow a patient's recovery and increase post-operative length of stay (Stiller et al 1994). Importantly, the breathing exercises had no impact on incidence of post-operative pulmonary complications, with no significant differences for post-operative pulmonary complications between groups.

This study found a comparatively low incidence of post-operative pulmonary complications for both breathing exercise (4.3%) and intervention groups (2.6%) in relation to those found in previous research of similar populations. Stiller et al (1994) found 7.1% of the study population developed a post-operative pulmonary complication after cardiac surgery, whilst Jenkins et al (1989) found an incidence of 10%, Johnson et al (1989) reported an incidence of 20%, and Dull and Dull (1983) reported 77% of patients were diagnosed with a post-operative pulmonary complication following open heart surgery. These differences may be the result of a number of factors, most notably the differing criteria for definition of post-operative pulmonary complications between studies. Also, differences in demographic or peri-operative variables between studies may influence incidence of post-operative pulmonary complications. However, compared with the other Australian study in the field by Stiller et al (1994), cardiopulmonary bypass time and length of anaesthesia in the current study were noticeably longer and patients underwent either valve and/or coronary bypass surgery compared with coronary bypass alone in the previous research.

It may be expected that an increased cardiopulmonary bypass time, length of anaesthesia and inclusion of valve surgery might increase the incidence of post-operative pulmonary complications in the current study, yet this was not the case. With the studies in this field, the more recently the research was completed the lower the incidence of post-operative pulmonary complications. It may be argued that this decline in the incidence of post-operative pulmonary complications in the cardiac surgery population with time is a result of both improved peri-operative care and the use of both clinical and radiological criteria in an attempt to define only those post-operative pulmonary complications that are clinically relevant.

The mean length of stay (eight days) in the current study was similar to previous research in this patient group and breathing exercises did not significantly affect length of stay. However, as would be expected, the mean length of stay in the eight patients with a post-operative pulmonary complication was greater (mean = 16.8 days, range = 6 to 33 days). Six of the eight subjects had a length of stay greater than eight days. These results reflect the clinical significance of the post-operative pulmonary complications as measured in the current study.

Regression analysis of contributory factors for post-operative pulmonary complications could not be performed in this study due to the low numbers of subjects diagnosed with a post-operative pulmonary complication. Nor was any visible pattern established from the pre-operative,

operative or early post-operative information that would allow prediction of those most likely to develop a post-operative pulmonary complication. This is in contrast with several previous studies that have been able to identify subjects most likely to develop a post-operative pulmonary complication from their pre-operative assessment data (Dull and Dull 1983, Stiller et al 1994, Warner et al 1989).

Of those withdrawn from the research, two subjects were extubated to high FiO_2 and CPAP but did not fulfil any other criteria for a post-operative pulmonary complications, so were not classed as such. The efficacy of breathing exercises in these patients could not be assessed.

With no significant difference found between groups in terms of the primary outcome measures, post-operative pulmonary complications and length of stay, the research also showed no difference for more subtle measures of the efficacy of the breathing exercises, including SpO_2 and pulmonary function tests.

Recording the change in FRC may have been a useful further measure given its relevance in the development of post-operative atelectasis (Nunn 1993) but time and equipment restraints prevented its measurement in this study.

Total physiotherapist treatment time (includes time reading, writing or communicating about the patient) was significantly higher in the breathing exercise group given the breathing exercises they performed. This is a consideration for allocation of physiotherapy resources in the hospital setting. Even though the difference between groups was only four minutes per physiotherapy session, saving that amount of time with several patients in the day may allow time to be spent on research projects or study. Additionally, patients who require more time as a result of a diagnosis of post-operative pulmonary complications or poor mobility may receive more physiotherapy input.

The evidence provided by this and other research (Dull and Dull 1983, Jenkins et al 1989, Stiller et al 1994) suggests change needs to be made to what was considered traditional practice in subjects following open heart surgery. However, change in practice is difficult to implement and research has shown that physiotherapists are reluctant to do this despite supporting research evidence (Tucker et al 1996). Surgeons and nursing staff are also resistant to changes in practice. Research to investigate what is needed to promote physiotherapy practice change is vital. With further evidence providing the need for change, perhaps now would be an ideal time to re-survey the use of breathing exercises for patients following open heart surgery

The number of patients following open heart surgery who would need to be treated (NNT) to prevent one post-operative pulmonary complications is 58. A group of experienced cardiopulmonary physiotherapist working in Australia indicated that prevention of one post-operative pulmonary complication in every 20 treatments was a

clinically worthwhile number (Herbert 2000). This corresponds to a difference in post-operative pulmonary complications between interventions of 5%. In the current study, there was minimal difference in incidence of post-operative pulmonary complications and a large NNT. On this basis, including breathing exercises in the management of patients following cardiac surgery is not clinically worthwhile. Further assessment of perceptions of clinicians regarding the clinical benefits of treatment over non treatment in different patient groups may constitute a vital step toward understanding and documenting reasons for resistance to changing practice in this area of physiotherapy.

A limitation of this study was that the physiotherapists treating the subjects could not be blinded to allocation and nor could subjects be blinded to the aims of the research if they were to give true informed consent. Thus all subjects were made aware of the breathing exercises and the reasoning behind their use. All subjects also viewed an educational pre-operative video which included mention of breathing exercises. Additionally, the medical and nursing staff who were blinded to the subject grouping may have actively encouraged intervention group subjects to complete the breathing exercises because these exercises had previously been routine in post-operative patient management. Each of these factors may have influenced the intervention group subjects to perform breathing exercises. However, considering the low frequency with which the subjects in the breathing exercise group independently performed their breathing exercise routine, despite strong encouragement, it is unlikely that practice by subjects in the intervention group would have an effect on outcome.

Importantly, this research makes no comment on the efficacy or otherwise of cardiopulmonary physiotherapy for those subjects after open heart surgery who have already developed a post-operative pulmonary complication, or for those following any other surgical procedure.

Conclusion

A number of conclusions can be drawn from this research. Firstly, the patients receiving physiotherapy management at Monash Medical Centre and Jessie McPherson Private Hospital have a low incidence of post-operative pulmonary complications following open heart surgery. Secondly, removing the breathing exercises from the post-operative physiotherapy management of this patient group saves therapists' time and therefore may allow a redistribution of resources. Finally, and most importantly, the results of this research add to the body of literature that suggests that the removal of a regimen of routine prophylactic deep breathing exercises from the physiotherapy management of open heart surgery patients has no deleterious effect on patient outcome.

Footnotes ^(a)Criticare Systems Inc 503 SPO2T,

Milwaukee, USA. ^(b)Vitalograph spirometer Model R, Buckingham, England. ^(c)SPSS 10 Norusis/SPSS Inc., Chicago, Ill, USA.

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