Prophylactic respiratory physiotherapy after cardiac surgery: systematic review

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Abstract

Objective To assess whether respiratory physiotherapy prevents pulmonary complications after cardiac surgery.

Data sources Searches through Medline, Embase, CINAHL, and bibliographies, for randomised trials comparing any type of prophylactic respiratory physiotherapy with another type or no intervention after cardiac surgery, with a follow up of at least two days, and reporting on respiratory outcomes.

Review methods Investigators assessed trial validity independently. Information on study design, population, interventions, and end points was abstracted by one investigator and checked by the others.

Results 18 trials (1457 patients) were identified. Most were of low quality. They tested physical therapy (13 trials), incentive spirometry (eight), continuous positive airway pressure (five), and intermittent positive pressure breathing (three). The maximum follow up was six days. Four trials only had a no intervention control; none showed any significant benefit of physiotherapy. Across all trials and interventions, average values postoperatively were: incidence of atelectasis, 15-98%; incidence of pneumonia, 0-20%; partial pressure of arterial oxygen per inspired oxygen fraction, 212-329 mm Hg; vital capacity, 37-72% of preoperative values; and forced expiratory volume in one second, 34-72%. No intervention showed superiority for any end point.

For the most labour intensive intervention, continuous positive airway pressure, the average labour cost for each patient day was €27 (£19; $32).

Conclusions The usefulness of respiratory physiotherapy for the prevention of pulmonary complications after cardiac surgery remains unproved. Large randomised trials are needed with no intervention controls, clinically relevant end points, and reasonable follow up periods.

Introduction

Pulmonary complications after surgery prolong hospital stay and increase healthcare costs.1 We performed a systematic review to determine to what extent respiratory physiotherapy prevents such complications, and the best type of physiotherapy intervention.

We chose the setting of cardiac surgery for three reasons. Firstly, patients are prone to pulmonary complications after surgery; up to 65% of patients may have an atelectasis, and 3% may develop pneumonia.2 Sec-ondly, the prevalence of cardiac surgery is high; around 110 per 100 000 population annually in the Western world.1 Thirdly, the extra costs of pulmonary complications after cardiac surgery exceed €28 000 (£19 500; $35 000) for each patient.3

Methods

We carried out an extensive search through Medline, Embase, CINAHL, and the Cochrane controlled trials register. We checked the bibliographies of retrieved reports and reviews4-6 and contacted the main authors of included studies.

We included full reports of randomised trials of adults or children who had undergone cardiac surgery. Inclusion criteria included any method of prophylactic respiratory physiotherapy compared with no intervention or with another method of respiratory physiotherapy, and an observation period of at least two days.

The trials also had to assess at least one of four end points: atelectasis, pneumonia, oxygenation (partial pressure of arterial oxygen, with the corresponding fractional inspired oxygen), and pulmonary function (vital capacity or forced expiratory volume in one second). We checked for cointerventions that may have influenced the efficacy of the physiotherapy: analgesia, respiratory physical therapy other than the tested intervention, and mobilisation. One investigator (PP) abstracted the data, which were independently cross checked by the others. We independently scored the methodological quality of the included studies.

Data analyses

To establish the relative efficacy of physiotherapy in the absence of a gold standard intervention, we regarded the most valid study design comparisons between an active intervention and a no intervention control. Active (head to head) comparisons were of secondary importance.

We estimated the cost of physiotherapy, assuming that one physiotherapist was treating one patient at a time. The cost of equipment was not considered, but we estimated the cost of labour from reported labour time. If no such data were given, we made three assumptions: incentive spirometry lasted 10 minutes for each patient day; continuous and intermittent positive pressure breathing lasted 25 minutes for each patient day; and for physical therapy, the physiotherapist needed to be present during the entire treatment period except for breathing exercises. The average salary of a physiotherapist in Europe was estimated at €13/h (personal communication, 2003).

Results

Of 107 papers screened, we finally analysed data from 18 trials (1457 patients) published between 1978 and 2001 (table). The average group size was 32 patients (range 12-95 patients). Four trials described an adequate randomisation method, two reported on concealment of treatment allocation, and 14 reported on blinding of observers. Three trials used an intention to treat analysis.

Thirteen trials tested 11 different physical therapy regimens; incentive spirometry (n = 8), continuous
positive airway pressure (n = 5), intermittent positive pressure breathing (n = 3), and blow bottles (n = 2). Cointerventions were used in most trials but adequately described in only four. One trial studied children, one trial studied children and adults, and 16 trials studied adults. Average length of stay in the intensive care unit was 2 to 2.8 days and in the hospital was 7.5 to 13 days.

Four trials had a no intervention control. They tested three physical therapy regimens; deep breathing, deep breathing and cough, and deep breathing and costal expansion exercises. Two also tested incentive spirometry. We found no evidence of superiority of any active intervention for the end points.

The incidence of atelectasis was reported in 14 trials (1266 patients) and was 15-58%. One study (44 children) found a significantly lower incidence when less intensive physical therapy was compared with more intensive physical therapy. Nine trials (942 patients) reported on the incidence of pneumonia (0-20%). No statistically significant differences were evident. Ten trials (752 patients) reported on partial pressure of arterial oxygen per inspired oxygen fraction (212-329 mm Hg). One trial (58 patients) found a significant increase with continuous positive airway pressure compared with physical therapy. Vital capacity was reported in 11 trials (921 patients) and was 37-72% of preoperative values; forced expiratory volume in one second was reported in eight trials (748 patients) and was 34-72% of preoperative values. One trial (96 patients) found a significant increase in both with both continuous positive airway pressure and non-invasive ventilation compared with incentive spirometry.

Adverse effects and cost estimation

Four trials provided data on adverse effects; gastric distension in 2-10% of patients and nausea in 0-12% of patients. Inconvenience of the mask was reported in 45% of patients receiving continuous positive airway pressure. During physical therapy, 4% of patients had a percutaneous capillary oxygen saturation of less than 90%, and 1% of patients had tachycardia. Eleven trials did not mention any adverse effects, and none were observed in two trials.

The median time patients spent receiving physiotherapy was 80 minutes (range 20-120 minutes) for incentive spirometry, 480 minutes (70 to 720 minutes) for continuous positive airway pressure, 80 minutes (80 to 120 minutes) for intermittent positive pressure breathing, and 120 minutes (data from one trial only) for physical therapy. Physiotherapy lasted on average 0.3 to 5 days. The average daily cost of labour for each patient was €6 for incentive spirometry, €10 for physical therapy, and €20 to €27 for continuous positive airway pressure.

Discussion

Evidence is lacking as to whether prophylactic respiratory physiotherapy prevents pulmonary complications after cardiac surgery. Two published systematic reviews examined the relation between respiratory physiotherapy and outcome after different operations, but obtained conflicting results. Our conclusions reflect more uncertainty, showing several limitations in the original trials.

Eighteen trials tested eight regimens of prophylactic respiratory physiotherapy. This variety may be due to the lack of a gold standard method. If ethically acceptable, the best comparator is then a placebo or no intervention control. Four trials only had a no intervention control group, and each tested a different method of physiotherapy.

On average the quality of the trials was low. Only a minority reported on an appropriate method of randomisation or on concealment of allocation. In only a few trials was the follow up of patients
Evidently, on this topic

Prophylactic respiratory physiotherapy after cardiac surgery is widely used.

It is thought to reduce the risk of pulmonary complications such as pneumonia or atelectasis.

What this study adds

Evidence is lacking on benefit from any method of prophylactic respiratory physiotherapy after cardiac surgery.

It is likely that there are adverse effects and costs only.

adequately reported and data analysed according to intention to treat. Over two thirds of the trials attempted to blind the observers.

Practical management of physiotherapy was inconsistent. For example, the reported duration of daily continuous positive airway pressure varied by a factor of 10. Inconsistency suggests that there is uncertainty about each method.

The average incidence of pneumonia was 0.2%. Two reasons may explain this variability. Firstly, there were no uniform definitions of pneumonia; one study used established criteria only. Secondly, most trials were of limited size. Only two studies included groups of more than 50 patients.

The longest observation period was six days; this may be too short to identify all respiratory complications. Nosocomial pneumonia, for instance, occurs on average eight days after cardiac surgery.

In large randomised controlled trials, coinventions are usually balanced between the groups. Sixteen of the 18 trials, however, had less than 50 patients in each group; thus coinventions may have affected the efficacy of physiotherapy. Method intensity and intensity of postoperative analgesia may have an impact on pulmonary function.

Early mobilisation may also have an effect on outcome. Only three trials adequately controlled for concomitant analgesia or mobilisation.

Because there was no evidence of any benefit from respiratory physiotherapy, we were unable to determine the cost incurred to generate one patient who would profit from an intervention compared with doing nothing. If there is no benefit, there are only costs, and these are not negligible in this context.

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Corrections and clarifications

Mortality in young offenders: retrospective cohort study

We failed to spot an error in table 1 of this paper by Carolyn Cofley and colleagues (BMJ 2003;326:1064–6). The total shown for person years of observation for the Victoria population (2 812 387) is in fact for females only. The correct total for males and females should be 6 133 674, giving a crude mortality of 3051 per 6 133 674 (0.5 per 1000). This affects the crude mortality given in the results and discussion but does not affect the standardised mortality ratios from which the paper’s conclusions were drawn.

Minerva

Despite popular myth, Minerva is neither a goddess nor terribly wise, she says. She confesses to making two errors in the text that accompanied the picture on 22 November (p 1286). Firstly, the newborn in question was a 5 day old baby, not a 5 year old child. Secondly, she should have said that the problem had been detected by the baby’s mother, not the community midwife.

Pre-existing risk factor profiles in users and non-users of hormone replacement therapy: prospective cohort study in Gothenburg, Sweden

The authors of this paper, Kerstin Rödström and colleagues, have reported some errors in their article (BMJ 1999;319:890-3). In two places the paper referred to “multivariate” modelling when the authors intended to say “age adjusted.” These instances occur in the second sentence of the results section of the abstract and in the heading of the final column of table 2. In a third place—the “multivariate analysis” section of the results—the final sentence should have said that central obesity (measured as waist to hip ratio and waist circumference) “and the body mass index were no longer significant in the multivariate model” (not “seemed slightly more predictive than body mass index, whereas the reverse had previously been the case in the age adjusted model”).


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