Postoperative pulmonary complications

INTRODUCTION:

Abdominal surgery involves a high risk of the development of postoperative pulmonary complications (PPCs). This is thought to be due to the disruption of normal respiratory muscle activity when a patient is anaesthetised, thereby impairing ventilation, expectoration and forced residual capacity (Auler et al 2002, Warner 2000). This may continue postoperatively leading to atelectasis, pneumonia and respiratory dysfunction (Richardson and Sabanathan 1997). Furthermore, abdominal pain resulting from the surgical incision may limit deep breathing (Dias 2008). Exercises which promote lung inflation may help to counteract the decreased lung volumes which patients tend to present with following surgery (Guimarães 2009).

Incentive spirometry (IS) is commonly used as a prophylactic treatment to prevent pulmonary complications following surgery. An incentive spirometer is a device that uses visual feedback, such as raising a ball to a line, to encourage a maximal, sustained inspiration (Overend 2001). IS is often promoted as a useful tool for rehabilitation of the respiratory muscle function following surgery. It is hypothesised that inspiration to full capacity discourages the development of atelectasis by preventing the collapse of the alveoli, and encourages correct respiratory muscle control and coordination, thereby decreasing the incidence of PPCs (Overend 2001).

Incentive spirometry is a low-cost intervention, and allows the patient to experience regular rehabilitation with minimal therapist hours (Hall 1991). However, recent arguments have claimed that this technique has little more effect than conventional physiotherapy, deep breathing methods or no intervention at all (Dias 2008).

Several recent randomised controlled trials have attempted to determine the effect of incentive spirometry in comparison to other interventions such as deep breathing exercises, or no specific post-operative rehabilitation. The aim of this systematic review was to evaluate recent literature to determine the prophylactic effect of incentive spirometry for the avoidance of pulmonary complications in patients recovering from abdominal surgery.

METHOD:

A wide-ranging search of the literature was carried out, utilizing a series of key words deemed optimal for recruitment of relevant articles (Table 1). Several databases were searched by this method (Appendix 1). These included PubMed, PEDro, CINAHL, Medline via OVID and Cochrane. Reference lists sourced from several of these articles were then hand-searched. Limits were set to locate randomised controlled trials on humans, published in English from 1985 onwards. Articles published prior to 1985 were deemed to be potentially unreliable and irrelevant due to the advances in technology and medical knowledge regarding respiratory physiotherapy since this time.

Articles which fulfilled the inclusion criteria (Table 2) were then assessed for methodological quality using the Physiotherapy Evidence Database (PEDro) Scale.

The PEDro Scale is an 11-item Scale devised to rate the methodological quality of randomised controlled trials relating to physiotherapy (Maher et al 2003). The components of the PEDro Scale are seen in Table 3. The PEDro Scale was selected to consider the value of the methodology used for each RCT because there is a high level of recent, independent evidence to indicate that the scores generated by this Scale are of sufficient reliability to support decision-making in physiotherapy (Maher et al 2003, Mosely et al 2002). The RCTs assessed by the author were all included within the PEDro database, thus had already been rated by persons with specific training in applying the PEDro Score to RCTs. The scores gained from this are therefore regarded to display a high level of accuracy.

Prior to assessment, the exclusion criteria was set as a PEDro Score of less than five out of ten. A PEDro Score of five or greater is evidential of a study of moderate to high quality (Mosely et al 2002).

A summary table (Appendix 2) was constructed to display the information retrieved from the four articles included in the review. This data included: PEDro Score, sample size and follow-up, outcome variables, intervention, limitations, results and clinical implications of the findings.

This systematic review evaluated the benefit of the use of incentive spirometry in comparison to a control group or other intervention. This was achieved by considering the incidence of pulmonary complications (defined by a variety of outcome variables) between the groups involved in each trial.

RESULTS:

Search method and study selection:

The initial search produced 85 non-duplicate articles of which 24 were screened. The criteria for inclusion into the review are documented in Table 2. After reading the abstract of the 24 articles selected, a further 16 records failed to meet one or more of the inclusion criteria. The remaining eight articles were then assessed for eligibility by applying the exclusion criteria

(Table 2). One review article was excluded. Three RCTs were deemed to exhibit low methodological quality having produced a PEDro Score of less than five out of ten, and were excluded. The remaining four RCTs selected for the review are documented in Appendix 2. The complete search process is shown by Figure 1.

Methodological quality:

Table 4 shows the level of methodological quality for each article. All articles rated six or above on the PEDro Scale, and demonstrated competency in the aspects of random allocation, baseline comparison, assessor blinding, and adequate follow up. Those trials by Stock et al (1985) and Schwieger et al (1986) failed to include concealed allocation and intention to treat. Due to the nature of the intervention, none of the trials had subject or therapist blinding.

Intervention and outcome variables:

The four studies selected for the review include the use of IS as an intervention.

Outcome variables were obtained from common methods used to diagnose pulmonary complications, including (but not limited to) blood gas analyses, body temperature, sputum analysis, chest radiography and spirometry. None of the studies documented in Appendix 2 found any significant difference between the intervention of IS and other intervention or control groups in the development of pulmonary complications.

Pulmonary complications:

Hall et al (1991) compared the intervention of IS to a control group of patients receiving conventional chest physiotherapy. Pulmonary complications developed in 15. 8% (95% CI 14. 0-17. 6%) of those patients undergoing regular maximal inspirations with the use of an incentive spirometer, compared to 15. 3% (95% CI 13. 6 – 17. 0%) of patients receiving conventional chest physiotherapy (Hall et al 1991). Similarly, Schwieger et al (1986) found no statistically significant benefit to promote the use of IS. 40% of those patients performing regular IS developed pulmonary complications. The control group, receiving no specialized post operative respiratory care, had a 30% incidence of the development of respiratory complications (Schwieger et al 1985).

Two studies (Hall et al 1996, Stock et al 1985) compared IS against other interventions designed to have a prophylactic effect on the development of pulmonary complications following abdominal surgery. Hall et al (1996) found that IS has different levels of efficacy depending on a patient's risk of developing a PPC. Post operative respiratory complications were found in 8% of low risk patients randomised to receive incentive spirometry, and in 11% of those who undertook deep breathing exercises. PPCs were detected in 19% of high risk patients receiving IS and 13% of patients who received a combination of IS and conventional chest physiotherapy (Hall et al 1996). Stock et al (1985) found no notable difference in the development of PPCs between patients randomised to IS, continuous passive airway pressure and coughing and deep breathing exercises.

Post operative atelectasis

All of the studies considered in this review included the presence of atelectasis detected by radiograph as a specific outcome variable to indicate a PPC. No studies showed a significant difference in the presence of post operative atelectasis between groups. Swieger et al (1986) found atelectasis to affect 30% of the IS group and 25% of the control group. Stock et al (1985) recorded a 24 hour postoperative incidence of atelectasis of 50%, 32% and 41% for patients receiving incentive spirometry, coughing and deep breathing exercises and continuous passive airway pressure, respectively (p <0. 001). The presence of atelectasis was evident in 9% of low risk IS group patients, and 10% of low risk deep breathing exercise group patients in the study by Hall et al (1996). 16% of high risk patients receiving IS, and 12% of high risk patients receiving mixed therapy developed postoperative atelectasis (Hall et al 1996). While Hall et al (1991) also considered atelectasis, the results for this were grouped with collapse/consolidation and pneumonic changes thus no individual value may be given.

FEV/FVC

Two studies (Stock et al 1985, Swieger et al 1986) considered the change in forced expiratory volume and forced vital capacity following abdominal surgery. Stock et al (1985) noted an average decline of forced vital capacity to 49%, 62% and 69% of the preoperative value at 24, 48 and 72 postoperative hours respectively (p <0. 001). This decline is statistically significant, to confirm the decrease of lung volumes observed in patients following abdominal surgery. Swieger et al (1986) found an average decline to 53% of the preoperative FVC on the second postoperative day, and 76% on the fourth postoperative day.

DISCUSSION:

This systematic review provides a comparative analysis of the use of incentive spirometry for a prophylactic effect on the development of pulmonary complications following abdominal surgery. Four RCTs comprised the results analysed in this review. Two of these articles rated 6/10 on the PEDro Scale (Stock et al 1985, Swieger et al 1986) and two articles were awarded a score of 8/10 (Hall et al 1991, Hall et al 1996).

While each study evaluated the use of IS for prevention of PPCs following abdominal surgery, the comparisons within each study varied. Only one trial (Schwieger et al 1986) compared the IS intervention group to a control group which received no specialised post operative respiratory care. Hall et al (1991) instead considered the IS intervention group to patients receiving conventional chest physiotherapy. Two trials, (Hall et al 1996, Stock et al 1985) compared the use of incentive spirometry to other specific respiratory physiotherapy modalities. Hall et al (1996) also investigated the effect of the patient’s putative risk factors on their incidence of development of PPCs. It is difficult to make comparisons between the selected studies, due to the high variance of intra-study comparison.

Participants

Two of the studies had high numbers of participants (Hall et al 1991, Hall et al 1996), allowing for the assumption to be made that the results gained from this are accurate and representative of the sample population. Two studies had comparatively low numbers of participants (Stock et al 1985; n= 64. Swieger et al 1986; n= 40). The studies with low participation rate exhibited high levels of incidence of PPCs compared to the larger studies.

This indicates that the low number of participants may have caused an exaggeration of the incidence of PPCs considered in these studies.

The overall male: female ratio of the studies investigated was 679: 758. The gender imbalance was particularly pronounced in the trials which had low levels of participation (Stock et al 1985, Swieger et al 1986), with females outnumbering males. This makes the results more generalizable to females and decreases external validity (Juni et al 2001). This is particularly important to the analysis of respiratory function due the gender-related differences regarding function, shape and size of the lungs and the chest cavities (Becklake and Kauffman 1999). This can alter the respiratory mechanics and thus create gender biased results (Auler 2002).

Publication bias is also a possible limitation of this review. Studies which obtained undesirable results are less likely to be published, thus the available literature may be biased toward a favourable outcome (Egger 1998).

Intervention and outcomes

The intervention itself may create bias with respect to using the comparability between the studies evaluated in this review. The administration of incentive spirometry varied slightly between trials. For example, in the trial by Schwieger et al (1986), patients were instructed to breathe deeply (with use of IS) for five minutes hourly, twelve times daily for three postoperative days. The participants in the study by Hall et al (1996) required patients to maximally inspire and hold ten times per hour. This means that broad term of ‘ incentive spirometry’ may actually correlate to a slightly different intervention for each study, so the ‘ incentive spirometry’ results evaluated in this review may not be entirely comparable. The comparable intervention of ‘ conventional chest physiotherapy’ is also questionable as this could also involve incentive spirometry, thus give the same results as IS whilst appearing as a separate intervention. There was inconsistency in follow up time between the four trials (see Appendix 2), which makes it difficult to pool results.

Variances of outcome measures across the four studies were also a source of limitation. Outcome variables for each study are summarised in Appendix 2. The definition for ‘ pulmonary complication’ is potentially limiting as this would affect the diagnosis and thus results gained. The professional ability of those assessing the outcome measures (e. g radiologists) needs to be taken into account.

Trial methodology

Due to the nature of incentive spirometry, neither patient nor therapist blinding was carried out. This introduces the possibility of performance bias and detection bias (Juni et al 2001). Concealed allocation was missing from two studies (Stock et al 1985, Schwieger et al 1986). A lack of concealed allocation allows for the possibility that an investigator may change who gets the next assignment, thus making the intervention group less comparable to the control group (Shulz 2000).

Intention to treat analysis is also devoid in two studies (Stock et al 1985, Schwieger et al 1986), therefore clinical effectiveness may be overestimated in these trials (Hollis and Campbell, 1999).

CONCLUSIONS:

This review found that there is currently no evidence to support the hypothesis that incentive spirometry has a prophylactic effect on the incidence of pulmonary complications in patients recovering from abdominal surgery, compared to other physiotherapy modalities such as deep breathing exercises and conventional physiotherapy. Another recent systematic review (Guimarães et al 2009) has obtained similar findings. One study (Schwieger 1986) found that there is no significant difference in the development of PPCs between post abdominal surgery patients receiving incentive spirometry and those who received no specialised post operative respiratory care. This was the only study to compare incentive spirometry against a control group receiving no other form of physiotherapy, so it is difficult to completely rule out the possibility that IS may have some prophylactic effect which has been masked by an equal prophylactic effect of the other therapies. The clinical implications of this is that if incentive spirometry does in fact provide some prophylactic effect on postoperative abdominal surgery patients, this benefit is no greater than that provided by other forms of physiotherapy. IS is less cost effective than deep breathing exercises, but requires less therapist hours than conventional physiotherapy. Therefore, a higher level of adequate and conclusive research needs to be done before incentive spirometry can be promoted as having a prophylactic effect on the incidence of PPCs following abdominal surgery.

Articles used as a template for the review format:

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Articles used in review:

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