Impact of incentive spirometry on mortality and pulmonary complications following upper abdominal surgery; systematic review

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Abstract

Study aim: Examining the effects of incentive spirometry on mortality and pulmonary problems in individuals who have had upper abdomen surgery was the aim of this study.

Method: The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standards were followed in the conduct of this study. Our sample consisted of studies including adults admitted to the hospital for any type of upper abdominal surgery, including laparoscopic procedures. Studies with adult patients with co-morbid conditions as well as those who had any additional issues throughout the recovery period were also included. We planned to look at the following therapies: no intervention, breathing exercises, chest physical therapy techniques, and IS. We looked through the Cochrane Library, PubMed, and Google Scholar electronic databases to find papers that met the inclusion requirements and were published in English up to 2015.

Results and conclusion: A total of 1659 individuals from 5 articles were included in this study. Among the interventions used include IS, IMT, and breathing exercises. The length of hospital stay, pulmonary issues and arterial blood gas tests, were evaluated by Hall et al., 1991. Hall et al. (1996) assessed respiratory issues and staff time spent on preventative respiratory therapy. The respiratory variables, physical capacity, pain score, and discharge date were evaluated by Kulkarni et al. 2010. Absolute and relative changes in all respiratory indicators were the main objectives, with duration of stay, postoperative time in the intensive care unit, and additional pulmonary problems serving as secondary outcomes. The length of hospital stay, arterial blood gas tests, FVC, FEV1, and pulmonary issues were evaluated by O'Connor et al. in 1988. We conclude that, one of the most effective preventative measures against respiratory problems following abdominal surgery, when resource use is considered, is incentive spirometry for high-risk patients and deep breathing exercises for low-risk patients.

Keywords: incentive spirometry, mortality, pulmonary complications, abdominal surgery

Introduction

There is a significant chance of pulmonary complications following upper abdominal surgery. According to two previous studies, they are characterized as pulmonary anomalies that arise during the postoperative phase and result in clinically significant recognizable illness or dysfunction that negatively impacts the patient's clinical course (1,2). Pulmonary complication risk rates in upper abdomen surgery have been reported to vary from 17% to 88% (3).

Atelectasis, pneumonia, respiratory failure, and tracheobronchial infection are examples of pulmonary problems. Although pneumonia is thought to be the primary cause of death, pulmonary atelectasis is the most frequent of these adverse effects (1).
Atelectasis may occur as a result of shallow, repetitive breathing that reduces ventilation to dependent lung areas. Other contributing causes include prolonged bed rest, incisional discomfort, and persistent anesthetic effects. Even while surgical atelectasis often resolves on its own, infection might develop as a secondary event if the collapsed lung areas do not re-inflate (1,4). Patients' outcomes may deteriorate due to the development of additional severe postoperative problems, including intraperitoneal infection, wound infection, and cardiac and hemodynamic issues (5).

Since postoperative pulmonary problems are the most commonly documented cause of morbidity and death during the postoperative period, it is especially critical to identify patients who are at risk for them (6). Risk variables, many of which are detectable during the patient's preoperative examination, are associated with the incidence of pulmonary problems. These include co-morbidities, obesity, smoking status, age, and pre-existing chronic lung illness (1,4). The kind and length of anesthesia, the many medications used for anesthesia, and the management of postoperative pain are all considered anesthetic variables.

The length of the surgical incision, the type of operation, and its duration are all considered surgical considerations (4,7). The goal of physiotherapy is to improve inspiration and raise the unusually low functional residual capacity following surgery (5,7,8). It has been demonstrated that deep breathing exercises, including inspiring to full lung capacity with a focus on the diaphragm, can expand alveoli and restore postoperative hypoxaemia (7).
Mechanical tools called incentive spirometers were created to accomplish this goal. In order to improve lung inflation, the spirometer is made to simulate maximal deep inspirations and urges the patient to take slow, deep breaths (9). The purpose of this research was to examine how incentive spirometry affects mortality and pulmonary complications in patients who have had upper abdominal surgery.

Method

This study was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Adults hospitalized for any kind of upper abdominal surgery, including laparoscopic operations, were included in our sample. Co-morbid adult patients and patients who experienced any further problems during the postoperative phase were included. The therapies that we intended to investigate were IS, breathing exercises, chest physical therapy approaches, and no intervention. We searched the electronic databases (PubMed. Google scholar, and Cochrane library) for articles fill the inclusion criteria and published in English until 2015.

The titles and abstracts of every trial found by the computerized search were evaluated separately by two writers. We acquired physical copies of full-text studies that seemed to meet our selection criteria. In consensus sessions, we settled any disputes by individually evaluating and analyzing the chosen articles.
Data was extracted separately by two writers, who then discussed and resolved any inconsistencies. Initially, we extracted the following data using a standard data extraction form: study features (design, randomization procedures); participants; treatments; and outcomes (types of outcome measures, timing of outcomes, adverse events).

Result and discussion

In this study we included 5 articles with a total of 1659 participants. Interventions utilized include, breathing exercise, IS or IMT. Hall et al., 1991 (8) assessed the length of hospital stay, arterial blood gas tests, and pulmonary problems. Respiratory problems and staff time spent on preventative respiratory treatment were evaluated by Hall et al. 1996 (5). Kulkarni et al. 2010 (10) assessed the respiratory factors, physical ability, pain score, and date of discharge. While length of stay, postoperative time in the ICU, time on a ventilator, respiratory rates, oxygen saturations, confirmed respiratory infections, and other pulmonary complications were secondary outcomes, the primary outcomes were absolute and relative changes in all respiratory variables. O'Connor et al. 1988 (11) assessed the length of hospital stay, arterial blood gas analysis, FVC, FEV1, and pulmonary problems (Table 1).

According to a study by Kulkarni et al. (2010), using a prescription inspiratory muscle trainer for two weeks prior to surgery led to a significant increase in inspiratory muscle strength before major abdominal surgery, which remained significantly better than other groups after the procedure (Table 2). Postoperative lung function and respiratory muscle strength were significantly impaired in patients in all other groups; however, vital capacity seemed to be better preserved in the IMT group. These findings are consistent with earlier randomized investigations of IMT in individuals having thoracic and cardiac procedures (12,13). Furthermore, these results are in line with IMT studies conducted on athletes (14,15), and patients with COPD (16,17), which demonstrated improvements in quality of life, exercise tolerance, and inspiratory muscle strength following training.

Postoperative pulmonary problems are common in individuals after major abdominal surgery (18). This is believed to be caused by alveolar collapse brought on by inspiratory muscle exhaustion. One may hypothesize that an increase in inspiratory muscle strength after training is likely to prevent inspiratory muscle fatigue, which in turn may result in fewer postoperative pulmonary complications and hospital stays, even though this study does not fully reflect the incidence of postoperative pulmonary complications. It's interesting to note that research on young, healthy athletes shows that IMT significantly reduces exercise-induced inspiratory muscle fatigue (14,15).

According to hall et al., 1991 study, in order to prevent infection, post-operative respiratory physical therapy aims to prevent future atelectasis and promote early re-expansion of collapsed alveoli. Prolonged and deep inspiratory attempts improve surfactant replenishment and encourage atelectasis reversal in patients with reduced tidal volumes and functional residual capacity (8). Therefore, encouraging maximal inspiratory effort is the main goal of respiratory physical therapy's best practices (5).

46 papers were selected for examination in a 2001 systematic review (3). Were left for review after ten were discarded because of the inadequate approach. Six of these studies had patients undergoing heart surgery, and seven of them had subject populations under 50. Only two studies involving a larger number of patients were carried out after abdominal surgery, but they both compared IS with positive pressure administration techniques, such as intermittent positive pressure breathing and continuous positive airways pressure (3,19). After major abdominal surgery, these techniques are not frequently employed.

By providing visual feedback, the incentive spirometer encourages patients to use it and promotes this effective inspiration.4 There is clear evidence that maximal inspiratory exercises reduce post-operative atelectasis; in a study of 343 patients undergoing open cholecystectomy, the incidence of atelectasis was 42% in the control group compared to 27% in the physiotherapy group that focused on inspiratory exercises.9 The rate of atelectasis decreased to 12% for patients who had received additional pre-operative instruction. Among the potential benefits of incentive spirometry are the following: patients can use the device independently and whenever they choose after receiving simple instructions; the device is inexpensive and disposable; and effective inspiratory efforts are maximized by patients reaching a visual "target." The idea that IS is better than other post-operative physiotherapy methods or aided lung expansion is not supported by the majority of the research, despite these possible benefits. But generally speaking, this evidence is of poor quality (20).

Table 1: characteristics of the included studies

Citation	Study design	Sample size	Intervention
Kulkarni et al., 2010 (10)	Randomized controlled trial	66	Group 1 consisted of no training, Group 2 consisted of deep breathing exercises, Group 3 was IS, and Group 4 was IMT. Each group contain 20 participants
Westwood et al., 2007 (20)	Prospective observational study	231	IS
Hall et al., 1991 (8)	Randomized controlled trial	876	An Airx incentive spirometer with a one-way valve was given to the patients.
Hall et al., 1996 (5)	Randomized controlled trial	456	Patients were randomly assigned to either deep breathing therapy, which involved one session and ten deep breaths per hour or IS
O'Connor et al., 1988 (11)	Randomized controlled trial	40	One group's postoperative chest physical therapy included the use of an IS, whereas the other group's patients got standard postoperative physical therapy. There are 20 participants in each category.
IS, Spiroball; IMT, inspiratory muscle training			

Table 2: main findings of the included studies

Citation	Main findings
Kulkarni et al., 2010 (10)	MIP did not rise from baseline to pre-operative evaluations in groups 1, 2, and 3. The median MIP in group D rose from 51.5 cmH2O before to training to 68.5 cmH2O following training before surgery. Following surgery, MIP decreased from baseline in groups 1, 2, and 3. In group 4, there was no discernible decrease in postoperative MIP. MIP is enhanced preoperatively and maintained postoperatively by pre-operative tailored IMT. To determine if this is linked to fewer pulmonary problems, more research is needed.
Westwood et al., 2007 (20)	An rigorous post-operative physiotherapy program that included the incentive spirometer reduced the length of stay on the surgical high dependency unit and the incidence of pulmonary problems. When comparing age, sex, smoking history, the necessity for emergency surgery, and post-operative analgesia, the two groups were similar.
Hall et al., 1991 (8)	The incentive spirometry and chest physical therapy groups did not vary substantially in the occurrence of pulmonary problems (68 of 431 and 68 of 445, respectively). The incidence of positive clinical symptoms, pyrexia, abnormal chest radiographs, sputum pathogens, respiratory failure, and length of hospital stay did not differ across the groups. In the overall care of patients having abdominal surgery, prophylactic incentive spirometry and chest physical therapy had comparable clinical effectiveness.
Hall et al., 1996 (5)	Baseline equivalency between the groups was excellent. Patients in the combination treatment group saw a 12% incidence of respiratory problems, whereas those in the incentive spirometry group experienced a 15% incidence. Giving low-risk patients incentive spirometry and deep breathing exercises took about the same amount of staff time. However, the addition of physiotherapy for

	high-risk patients led to an additional 30 minutes of staff time being used for each patient. Deep breathing exercises for low-risk patients and incentive spirometry for high-risk patients are the most effective regimen of prophylactic measures against respiratory problems following abdominal surgery when resource use is considered.
O'Connor et al., 1988 (11)	According to pulmonary function tests, length of hospital stay, and clinical indications of pulmonary problems, there were no advantages to using the incentive spirometer.
MIP, maximum inspiratory pressure	

Conclusion

When resource use is taken into account, deep breathing exercises for low-risk patients and incentive spirometry for high-risk patients is one of the most successful course of preventive interventions against respiratory issues after abdominal surgery. There were no benefits to utilizing the incentive spirometer based on clinical signs of pulmonary issues, length of hospital stay, or pulmonary function testing. Prophylactic incentive spirometry and chest physical therapy were equally beneficial in the overall management of patients undergoing abdominal surgery. The duration of stay on the surgical high dependency unit and the frequency of pulmonary issues were decreased by a strict post-operative physical therapy program that incorporated the incentive spirometer.

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