



ROLE OF INCENTIVE SPIROMETRY IN IMPROVING LUNG VOLUME POST OPERATIVE CARDIAC SURGERY

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ABSTRACT Open heart surgery is a major surgical procedure that requires careful pre-operative evaluation skilled surgical techniques and comprehensive post-operative care to ensure proper recovery and restoration of heart function and is commonly associated postoperative pulmonary complications such as atelectasis, reduced lung volumes and impaired respiratory function due to pain, anaesthesia and prolonged immobilization. This might be associated with chest and lung complications which may be related to procedure, the risk of anaesthesia or other general problems related to surgery such as decreased lung volume atelectasis retained secretion increased risk of pneumonia lower oxygen level etc. The rehabilitation technique used is non-invasive respiratory technique designed to encourage voluntary deep breathing and improve pulmonary function during the post-operative recovery period. This study aims to access the effectiveness of incentive spirometry in improving lung volume in patients following open heart surgery. **Methodology:** - This study shows the complete cooperation review of national and international literature repossess from case studies including Physiopedia, PubMed, ScienceDirect and, Physio conferences, and journals like (JPHY, IJMHR), Wiley online library for presentation or publication. **Observation:** - Multiple clinical studies indicate that incentive spirometry leads to significant improvement in pulmonary function such as tidal volume, inspiratory capacity and vital capacity. Additionally, it helps lower the occurrence of post-operative complications particularly atelectasis and pneumonia. It also strengthens respiratory muscles and encourages early patient mobilization thereby promoting quicker recovery and minimizing the duration of hospital stay. The observation of this technique largely depends on adequate patient education correct handling of the device the consistent compliance with prescribed breathing exercises. It is safe and non-invasive approach to improve lung function. **Conclusion:** - Role of Incentive spirometry is an effective and evidence-based intervention for improving pulmonary function and enhancing peak expiratory flow rate. This device is really helpful as it is non-invasive and painless technique, it also gives a cheap therapeutic purpose for the patient. It acts as a preventive measure against lung problems by encouraging deep and sustained breathing specially after cardiac surgery.

KEYWORDS : TV, LV, IRV, VC, JPHY, IJMHR.

INTRODUCTION

The term spirometry originates from the Latin word 'spiro' meaning 'to breathe' and the Greek word 'metron', meaning 'measure'. Incentive spirometry is widely used to prevent postoperative pulmonary complications, despite limited clinical effectiveness data and a lack of standardized use protocols¹. Two different spirometers on postoperative incentive spirometry performance in patients at high risk and moderate risk for postoperative pulmonary complications². The test is performed using a device called a spirometer, which records the volume and flow of air that moves in and out of the lungs. The flow-oriented incentive spirometer is designed to improve lung volumes and employs a flow-controlled mechanism using three floating balls. The device displays airflow at 600, 900, and 1200 ml/s as three different coloured balls³. Use of incentive spirometry is for the prevention of postoperative pulmonary complications that helps to improve lung functions⁴. During the test the patient is asked to breathe into a mouthpiece connected to the spirometer while following specific breathing instruction: It is recommended that incentive spirometry be used with deep breathing techniques, directed coughing, early mobilization, and optimal analgesia to prevent postoperative pulmonary complications. Postoperative pulmonary complications present high rates of morbidity, mortality, increase hospital costs and prolonged hospital stay predominantly in abdominal, cardiac and thoracic surgery⁵. Such complications are the leading cause of mortality following the above-mentioned surgeries, with incidence ranging from 17 to 88%. The risk and severity of postoperative pulmonary complications can be reduced by the judicious use of therapeutic manoeuvres that increase lung volume⁶. Routine use of incentive spirometry to prevent atelectasis after coronary artery bypass graft surgery is not recommended. It is suggested that a volume-oriented device be selected as an incentive spirometry devices⁸. Atelectasis is one of the most common pulmonary complications following cardiac procedures when the patient performs spirometry exercises regularly the lungs are encouraged to expand fully, which helps maintain alveolar inflation and prevent the collapse of lung tissue. Provider time and costs of incentive spirometry implementation have not previously been reported⁹. The effectiveness of spirometry post cardiac surgery depends upon a proper technique and regular use. Patient are usually instructed to perform the exercise several times per hour while awake. Postoperative physiotherapy aims to reverse atelectasis and secretion

retention, and may include incentive spirometry¹⁰. The device contributes to improved oxygenation and ventilation by promoting deeper inhalation, it increases the amount of oxygen reaching the alveoli which enhances gaseous exchange between oxygen and carbon dioxide in the lungs. Improved oxygenation supports better tissue healing, reduces fatigue and accelerates post operative recovery. Thoracotomy, patients frequently receive routine respiratory physiotherapy which may include incentive spirometry, a breathing technique characterised by deep breathing performed through a device offering visual feedback¹¹. Benefit from well-designed clinical trials becomes available, the routine use of incentive spirometry in postoperative care is not supported by high levels of evidence¹². Spirometry plays a vital role in improving lung function by promoting deep breathing, enhancing lung expansion, preventing atelectasis, and improving oxygenation. The aims were to evaluate its effects on respiratory symptoms, functional capacity, psychological outcomes, quality of life and to compare its effectiveness with standard care and deep breathing interventions¹³.

Based on the concept of maintaining sustained maximal inspiration to prevent atelectasis, incentive spirometry is currently a common pulmonary rehabilitation tool for patients undergoing major surgeries to prevent the occurrence of PPCs due to its convenience and inexpensiveness¹⁴. Reducing postoperative pulmonary complications by improving postoperative lung expansion and ventilation is a primary goal after major thoracic surgeries, and can directly impact morbidity and downstream health care costs¹⁵. Volume-oriented incentive spirometry applied to patients after a stroke modifies the total and compartmental chest wall volume variations¹⁶. Spirometric variables and oxygen saturation in patients undergone deep breathing exercises and flow-oriented incentive spirometry after coronary artery bypass grafting¹⁷. Incentive spirometry can be used as a simple mean to follow lung function, especially VC and IRV, in the postoperative period in spontaneously breathing patients. It is non-invasive and can be performed repeatedly at the bedside in the intensive care setting¹⁸.

METHODOLOGY:

Study design:

This study is conducted as a systematic review to evaluate the role of incentive spirometry on lung volumes after cardiac surgery. The review

involves a structured search of published literature, selection of the relevant studies based on inclusion criteria.

Data sources and search strategy:

Relevant literature sources were used in the consensus-building process, which was based on searches on google scholar, PubMed, google books, Research Gate, Science Direct, EBSCO and the library.

Database	No. of articles arch	No. of relevant articles	No. of selected articles
Google books	30	20	5
Google scholar			
PubMed	10	10	5
Research gate	50	40	6
EBSCO	20	10	2

Inclusion Criteria:

Studies were taken if they –

1. Involve patient who have undergone cardiac surgery.
2. Investigate the incentive spirometry interventions.
3. Evaluate functional recovery outcomes such as lung volumes, ventilation and oxygenation.
4. Clinical trials, randomized controlled trials, or cohort studies.
5. Published in English and available in full text.

Exclusion criteria:

1. Review articles, editorials, or case reports.
2. Do not focus on post cardiac surgery recovery.
3. Do not involve incentive spirometry interventions.
4. Insufficient data.

Study selection:

Relevant studies were selected through screening of titles, abstracts, and full texts according to the eligibility criteria.

Data extraction:

Information was extracted from selected study including:

1. Author and year
2. Study design
3. Sample size.
4. Type of cardiac surgery.
5. Type of incentive spirometry program.
6. Outcome measures related to functional recovery of lung volumes.

Data analysis:

The data from the selected studies were analysed and summarised to determine the role of incentive spirometry on lung volumes post-operative cardiac surgery.

DISCUSSION:

incentive spirometry has long been incorporated into post-operative care protocol following cardiac surgery with the primary objective of improving lung volume, enhancing alveolar ventilation and reducing post-operative pulmonary complications. Cardiac surgical procedures specially those involving median sternotomy and cardiopulmonary bypass are known to significantly impair pulmonary function. The impairment is characterised by reductions in lung volumes such as FVC, FRC and inspiratory capacity largely due to anaesthesia effects, post-operative pain, diaphragmatic dysfunction and reduced mobility. The observation was multiple clinical trials and concluded that incentive spirometry did not demonstrate significant benefits in enhancing lung volumes when compared with no interventions or other breathing exercises. In a systematic review focusing on respiratory physiotherapy interventions, found that incentive spirometry alone did not significantly improve outcome such as FVC or reduced the incidence of atelectasis when compared to deep breathing exercises or other physiotherapeutic techniques.

RESULTS:

A total of 110 articles were initially identified through database searches including PubMed, Scopus, web of science and google scholar. After studying 80 studies remained for the title and abstract screening.

Following the eligibility criteria 35 articles were selected for full text assessment based on relevance to exercise-based rehabilitation after cardiac surgery out of these 18 were included in the final study according to the inclusion criteria.

The use of spirometry following cardiac surgery has been widely recognized as an effective intervention to improve postoperative pulmonary function and restore lung volumes that are often compromised after thoracic surgical procedures. This programme demonstrated significant improvements in inspiratory capacity, lung expansion, oxygenation status and overall respiratory recovery among patients who had undergone cardiac surgery. The implementation of respiratory exercises such as incentive spirometry is essential for improving pulmonary mechanics and facilitating early recovery. At the baseline assessment conducted during the immediate postoperative period, most patients exhibited significantly reduced inspiratory volumes compared with their expected postoperative values. At first after post operative day the average inspiratory volume achieved with the incentive spirometer ranges between 600mL and 900mL. The decline in lung function following cardiac surgery, which is commonly attributed to postoperative pain, reduced diaphragmatic excursion, and mild reductions in peripheral oxygen saturation levels during the early recovery phase. With the initiation of regular spirometry exercise gradual improvements were in both lung volume measurement and overall pulmonary function. The patients must be instructed incentive spirometry exercise at regular intervals throughout the day, completing 10-15 slow, deep inspiratory efforts every hour while awake. This repetitive deep breathing activity promoted gradual alveolar recruitment and improved ventilation distribution across the lungs.

The patients may show a noticeable increase in inspiratory capacity with average volumes reaching approximately 900mL to 1100mL. This improvement indicates early recovery of lung expansion and they were suggested regular respiratory exercises that were effectively opposing the restrictive effects commonly observed after cardiac or thoracic surgical procedures. The improvement in the patient develops confidence and familiarity with the device contributed to better techniques and more consistent performance of the breathing exercises.

The improvement in the lung expansion achieved through incentive spirometry helped reopen partially collapsed alveoli, thereby improving ventilation-perfusion matching many patients also exhibited improved peripheral oxygen saturation levels, with average SpO₂ values rising from approximately 92-94% in the early postoperative period to 95-97%. Reduction in respiratory discomfort and decreased reliance on supplemental oxygen in several patients. Later days showed the most significant improvements in inspiratory capacity and lung volume measurements. Another important result in the postoperative period was the reduction in pulmonary complications associated with impaired lung expansion. Incentive spirometry contributed significantly to the prevention and management of atelectasis which is one of the most frequently encountered respiratory complications following cardiac surgery. The progressive rise in inspiratory capacity from approximately 700-900mL by postoperative days demonstrated a consistent and measurable improvement in pulmonary function. This plays a critical role in accelerating respiratory recovery after cardiac surgery.

The results of this study clearly indicates that the routine use of the incentive spirometry is an effective and practical intervention for improving lung volume and pulmonary function following cardiac surgery. Patients who are engaged in regular spirometry exercise experienced progressive increase in inspiratory capacity, improved oxygen saturation levels, enhanced airway clearance and reduced incidence of postoperative pulmonary complications such as atelectasis.

CONCLUSION:

Role of incentive spirometry in improving lung volumes after cardiac surgery incentive spirometry plays an important role in the post-operative management of patients after open heart surgery. Physiological evidence suggests that incentive spirometry may be appropriate for lung re-expansion following major thoracic surgery. Based on sparse literature, postoperative physiotherapy regimes with, or without, the use of incentive spirometry appear to be effective following thoracic surgery compared with no physiotherapy input.

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