

# **Effects of Incentive Spirometry Exercises on Pulmonary Function and Dyspnea in Patients Undergoing Acute Coronary Artery Bypass Grafting**

**Dr. S. Dilly Prasad<sup>1\*</sup>, Dr. N. Siva Harish<sup>2</sup>**

<sup>1</sup> Assistant Professor MPT, KKC College of Physiotherapy, Puttur, Tirupathi, Andhra Pradesh, India  
sivanarasapuram@gmail.com

<sup>2</sup> Associate Professor MPT, KKC College of Physiotherapy, Puttur, Tirupathi, Andhra Pradesh, India

## **Abstract**

**Background:** CABG (Coronary Artery Bypass Grafting) is a procedure that is frequently performed to treat severe cases of coronary artery disease. Postoperative pulmonary complications such as reduced pulmonary function and dyspnea frequently occur following CABG due to anesthesia, sternotomy, and reduced mobility. Respiratory physiotherapy interventions, including incentive spirometry, are commonly used to improve lung expansion and prevent pulmonary complications during the postoperative period.

**Objective:** To study the effect of incentive spirometry exercises on pulmonary function and dyspnea in patients undergoing Coronary Artery Bypass Grafting.

**Methods:** A randomized study was carried out with 30 patients who underwent CABG surgery, aged between 50 and 60 years. Participants were randomly allocated into two groups, each consisting of 15 participants. The experimental group (GROUP A) received conventional physiotherapy exercises along with incentive spirometry exercises, while the control group (GROUP B) received conventional physiotherapy exercises alone. The intervention was administered five sessions per week for three weeks. Pulmonary function was assessed using spirometry by measuring Forced Expiratory Volume in one second (FEV<sub>1</sub>), and dyspnea was assessed using the Borg Dyspnea Scale before and after the intervention.

**Results:** Experimental group shows statistically significant improvement in patients with acute coronary artery bypass grafting when compared with control group.

**Conclusion:** Incentive spirometry exercises combined with conventional physiotherapy significantly improve pulmonary function and reduce dyspnea in patients undergoing CABG during the postoperative period.

**Keywords:** Coronary artery bypass grafting, incentive spirometry, pulmonary function, dyspnea, physiotherapy rehabilitation.

## **INTRODUCTION**

Coronary artery disease (CAD) remains a primary contributor to global morbidity and mortality. The World Health Organization has indicated that cardiovascular diseases accounted for 31% of all deaths in 2019. Coronary heart disease (CHD) arises from the accumulation of atherosclerotic plaque within the coronary arteries, which leads to progressive narrowing and diminished myocardial blood supply. Severe arterial obstruction may present clinically as angina, dyspnea, or myocardial infarction.

Coronary Artery Bypass Grafting (CABG) is a well-established surgical intervention performed to restore adequate myocardial perfusion in patients with significant coronary artery blockage. The procedure involves grafting a healthy artery or vein—most commonly the internal thoracic artery or the great saphenous vein—to bypass the obstructed coronary segment. This creates an alternative pathway for oxygen-rich blood to reach the myocardium. CABG may be performed using conventional cardiopulmonary bypass with cardiac arrest or through off-pump techniques on a beating heart. The procedure is associated with improved symptom relief, enhanced functional capacity, and better long-term survival in appropriately selected patients <sup>[1, 2,3]</sup>

However, postoperative pulmonary complications remain common after CABG. Factors such as general anesthesia, sternotomy, postoperative pain, and prolonged immobilization contribute to reduced lung volumes, impaired ventilation, respiratory muscle weakness, and atelectasis. These alterations frequently result in decreased pulmonary function and increased perception of dyspnea during the early recovery phase, potentially delaying rehabilitation and prolonging hospital stay. <sup>[4, 5]</sup>

Incentive spirometry is a commonly prescribed respiratory therapy that promotes sustained maximal inspiration through slow, deep breathing exercises with visual feedback. Regular practice facilitates lung expansion, improves ventilation, strengthens the respiratory musculature, and helps prevent atelectasis. Dyspnea, defined as a subjective experience of breathing discomfort, is commonly assessed using tools such as the Modified Borg Scale and plays a significant role in evaluating postoperative recovery. <sup>[5, 6]</sup>

Although incentive spirometry is routinely incorporated into postoperative care following CABG, limited evidence exists regarding its combined effect on objective pulmonary function

parameters and subjective dyspnea levels in acute CABG patients. This gap in evidence necessitates further investigation. [7, 8]

## **NEED OF THE STUDY**

CABG is a standard surgical intervention for patients with severe coronary artery disease; however, postoperative pulmonary complications remain frequent. Reduced lung volumes, impaired ventilation, and respiratory muscle weakness often lead to decreased pulmonary function and increased dyspnea during the acute recovery period. Incentive spirometry is routinely prescribed to prevent these complications and promote lung expansion. Although widely used, limited evidence exists regarding the combined effect of this approach on objective pulmonary function parameters and subjective dyspnea in acute CABG patients. Therefore, systematic evaluation of incentive spirometry in this population is necessary to support evidence-based postoperative rehabilitation practices.

## **AIM OF THE STUDY**

To determine the effects of incentive spirometry exercises on pulmonary function and dyspnea in CABG patients.

## **OBJECTIVES**

1. To examine the impact of incentive spirometry exercises on pulmonary function in patients undergoing CABG.
2. To examine the impact of incentive spirometry exercises on dyspnea in patients undergoing CABG.

## **METHODOLOGY**

**Study Design** - Experimental study.

**Sample Size** – 30

**Study Setting** – SVRRGH Cardiothoracic Inpatient and Outpatient Department. Tirupati.

## **INCLUSION CRITERIA**

- ❖ Patients aged 50-60 years.
- ❖ Both male and female participants.

- ❖ Acute stage Patients (less than 3 months after surgery).
- ❖ Patients with a dyspnea score greater than 7 on the Borg Scale.
- ❖ Patients who willingly agreed to take part in the trial.

### **EXCLUSION CRITERIA**

- ❖ Patients with unstable angina.
- ❖ Patients with severe renal dysfunction.
- ❖ Patients with a history of cardiac surgery greater than 3 months.
- ❖ Patients are unable to perform the required exercises or assessments.

### **OUTCOME MEASURES**

1. **Pulmonary Function (FEV<sub>1</sub>):** Pulmonary function was measured using **spirometry** by recording **Forced Expiratory Volume in one second (FEV<sub>1</sub>)** before and after the intervention.
2. **Dyspnea:** Dyspnea was assessed using the **Borg Dyspnea Grading Scale** before and after the intervention.

### **STUDY PROCEDURE**

Thirty patients from SVRRGGH Hospital who had CABG were chosen at random. Patients between the ages of 50 and 60 of both sexes were included in the study. The selected patients were split into two groups at random: a control and an experimental group, each with 15 patients.

The experimental group received conventional physiotherapy exercises along with incentive spirometry exercises, whereas the control group received conventional physiotherapy exercises alone. Before surgery, all subjects were assessed by a physiotherapist and were educated about the postoperative physiotherapy protocols and interventions. Routine physiotherapy maneuvers were explained and demonstrated to the participants.

Patients were provided with a detailed explanation of the study methodology before the intervention began, and informed consent was obtained. Baseline assessment of vital signs was performed. Pulse rate was measured by palpating the radial pulse using the first three fingers

for 60 seconds. Respiratory rate was assessed immediately after pulse measurement by observing the movement of the abdomen in male patients and the thoracic movement in female patients.

Patients were included in the training only after confirming medical stability and appropriate medical management. Nutritional status and medication adherence were ensured before initiating the intervention. Dyspnea and pulmonary function were assessed both prior to and following the conclusion of the intervention period.

### **Experimental Group Intervention (GROUP-A)**

Patients in the experimental group received conventional physiotherapy exercises combined with incentive spirometry exercises and relaxation techniques. The training program consisted of five sessions per week for three weeks. Each session lasted approximately 20 minutes. Incentive spirometry was performed in two sets of ten deep breaths with a five-minute rest interval between sets.

Patients were told to hold the incentive spirometer upright, exhale normally, and tighten their lips over the mouthpiece while performing the exercise. After that, they were told to take a deep, slow breath to elevate the balls in the chamber to the desired level. They were then asked to hold their breath for around five seconds before exhaling normally.. Incentive spirometry encourages sustained maximal inspiration and provides visual feedback to facilitate lung expansion and prevent atelectasis. The device contains three chambers with colored balls representing airflow rates of approximately 600 ml/sec, 900 ml/sec, and 1200 ml/sec.

Patients in the experimental group were positioned comfortably with the head end of the bed elevated up to forty-five degrees. The exercises were performed on the 1<sup>st</sup> postoperative day and on the 2<sup>nd</sup> and 3<sup>rd</sup> postoperative days while sitting upright with back support.



**Figure 1 & 2: Incentive Spirometry Exercises**

### Control Group Intervention (GROUP-B)

Patients in the control group received conventional physiotherapy exercises, including deep breathing, diaphragmatic breathing, pursed-lip breathing, paced breathing, and segmental breathing exercises. Patients were positioned comfortably in upright sitting or Fowler's position with back support during the exercises. One hand was placed on the chest and the other on the abdomen to facilitate diaphragmatic breathing.

Airway clearance techniques such as coughing and the forced expiratory technique were also taught. In CABG patients, coughing was performed with splinting by applying pressure over the surgical incision using a pillow or belt to reduce pain and support the surgical site.  
DURATION: 20 Minutes for each session, 5 sessions per 3 weeks



**Figure 3: Conventional Physiotherapy Exercises**

### STATISTICAL ANALYSIS

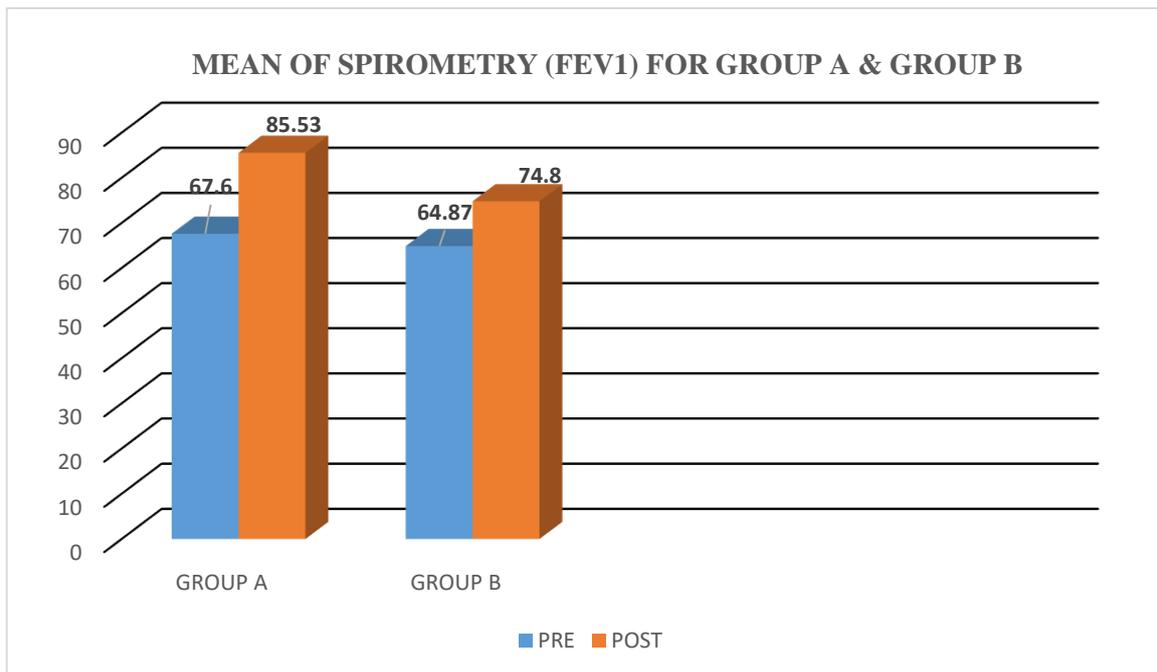
Microsoft Excel 2007 and SPSS were used for the statistical analysis and data interpretation. Each group's changes prior to and during the intervention were compared using a pair of t-tests, whereas changes following the intervention were compared using an unpaired t-test.  $P < 0.0001$  was found to be statistically significant.

**Table 1: Means Of Spirometry (FEV<sub>1</sub>) For Group A & Group B Descriptive statics**

GROUP A	Paired t- test		
	Mean $\pm$ SD	t- value	p- value
Comparison of Spirometry (FEV <sub>1</sub> )			
Pre-Test	67.60 $\pm$ 6.32	11.418	<0.0001
Post-Test	83.53 $\pm$ 4.21		

GROUP B	Paired t- test		
	Comparison of Spirometry (FEV <sub>1</sub> )	Mean ± SD	t- value
Pre-Test	64.87 ± 4.24	14.188	<0.0001
Post-Test	74.80 ± 3.32		

Table 1 represents the outcome measures of Spirometry (FEV<sub>1</sub>) in group A with a mean of 67.6 and SD 6.32. After the intervention post-test, the mean was 83.53, the SD was 4.21, and the t-value was 11.418. Group B had a mean of 64.87 and SD 4.24 after the intervention post-test; the mean was 74.80 and SD 3.32, and the t-value was 14.188. Therefore, the P-value was 0.0001, indicating an extremely statistically significant improvement in pulmonary function.



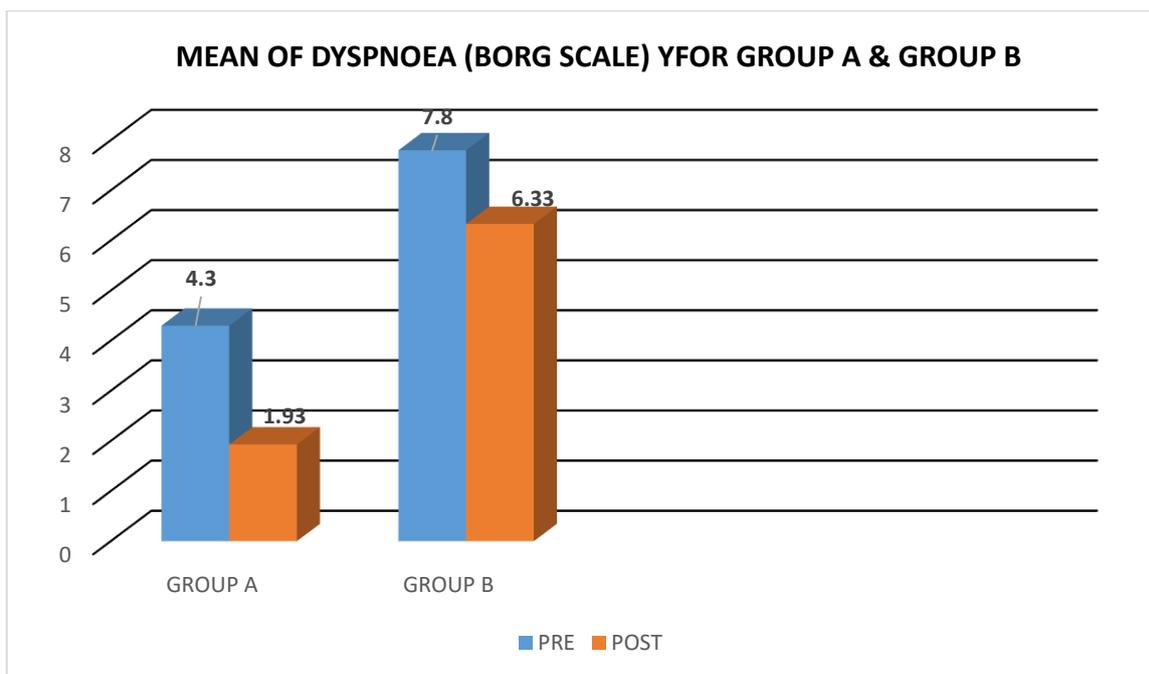
**Figure 4: Mean Of Spirometry (FEV1) For Group A & Group B**

**Table 2: Mean Of Dyspnoea (BORG SCALE) For Group A & Group B**

**Descriptive statics**

<b>GROUP A</b>	<b>Paired t- test</b>		
<b>Comparison Of Dyspnoea (Borg Scale)</b>	<b>Mean ± SD</b>	<b>t- value</b>	<b>p- value</b>
<b>Pre-Test</b>	4.53± 1.13	9.5394	<0.0001
<b>Post-Test</b>	1.93± 0.7		
<b>GROUP B</b>	<b>Paired t- test</b>		
<b>Comparison Of Dyspnoea (Borg Scale)</b>	<b>Mean ± SD</b>	<b>t- value</b>	<b>p- value</b>
<b>Pre-Test</b>	7.8± 1.08	8.8764	<0.0001
<b>Post-Test</b>	6.33± 1.18		

Table 2 represents the outcome measures of Spirometry (FEV<sub>1</sub>) in group A with a mean of 4.53 and SD 1.13. After the intervention post-test, the mean was 1.93, the SD was 0.7, and the t-value was 9.5394. Group B had a mean of 7.8 and SD 1.08 after the intervention post-test; the mean was 6.33 and SD 1.18, and the t-value was 8.8764. Therefore, the P-value was 0.0001, indicating an extremely statistically significant improvement in pulmonary function



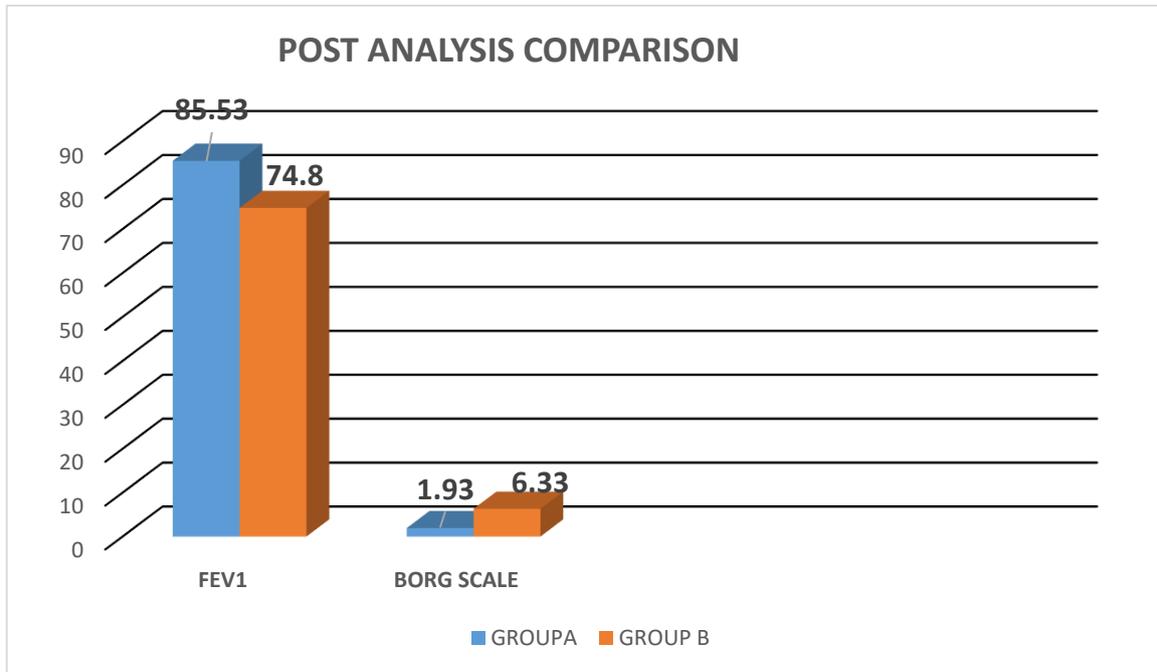
**Figure 5: Post Analysis Comparison Between Group A & Group B**

**Table 3: Post Analysis Comparison Group A & Group B**

**Descriptive statics**

	Unpaired Paired t- test		
Post analysis Comparison Spirometry (FEV <sub>1</sub> )	Mean ± SD	t- value	p- value
GROUP A	85.3± 4.21	6.3111	<0.0001
GROUP B	74.8± 3.32		
	Unpaired Paired t- test		
Post analysis Comparison DYSPNOEA (BORG SCALE)	Mean ± SD	t- value	p- value
GROUP A	1.93± 0.7	12.4411	<0.0001
GROUP B	6.33± 1.18		

Table 3 shows the post-test comparison between the two groups. The mean FEV<sub>1</sub> in Group A was  $85.3 \pm 4.21$ , whereas in Group B it was  $74.8 \pm 3.32$ , with  $P = 0.0001$ , indicating a highly statistically significant difference. Similarly, the mean dyspnea score measured using the Borg Scale was  $1.93 \pm 0.70$  in Group A and  $6.33 \pm 1.18$  in Group B, with  $p < 0.0001$ , showing a highly significant reduction in dyspnea in Group A compared to Group B.



**Figure 6: Post Analysis Comparison Group-A & Group-B**

## DISCUSSION

The current study compared the effects of traditional physiotherapy exercises with incentive spirometry on pulmonary function and dyspnea in patients who had undergone CABG. The study's findings showed that after the therapies, lung function and dyspnea levels significantly improved. Patients who performed incentive spirometry along with physiotherapy exercises showed greater improvement compared to those who performed conventional physiotherapy exercises alone.

A common complication following cardiac surgery is postoperative pulmonary dysfunction. The reduction in pulmonary function observed after surgery may be attributed to several factors, such as postoperative pain, reduced inspiratory effort, fatigue, the development of atelectasis, and decreased coughing efforts. In addition, surgical procedures such as lung retraction during cardiac surgery and increased intra-thoracic fluid volume may also contribute to the reduction in pulmonary function. Similar findings were reported by Barna Babik et al.

(2003), who showed that during thoracic surgery, the respiratory system's mechanical characteristics significantly change.

In the present study, spirometry values ( $FEV_1$ ) showed significant improvement following the intervention period in both groups. However, greater improvement was observed in the group that performed incentive spirometry. This result is in line with research by P. Agostini et al. (2007), which found that incentive spirometry is a useful intervention for enhancing lung function and averting pulmonary problems after thoracic surgery. Similarly, Jean N. Crowe et al. (1997) added that incentive spirometry to postoperative pulmonary physiotherapy would help high-risk patients experience fewer pulmonary problems following CABG surgery.

The current study's results also showed a decrease in dyspnea levels as determined by the Borg scale after the intervention. These results are supported by the work of Elisabeth Westerdahl et al. (2005), who reported that deep breathing exercises after CABG surgery significantly improved pulmonary function and reduced atelectasis. Furthermore, John C. Hall et al. (1996) reported that lung expansion and incentive spirometry are effective in preventing postoperative respiratory complications.

Early postoperative respiratory physiotherapy plays a vital role in preventing pulmonary complications and promoting recovery after cardiac surgery. According to Rochelle Wynne et al. (2004), pulmonary treatments administered over an extended period of time are advantageous in the treatment of pulmonary dysfunction following surgery. Hulya Akdur et al. (2001) reported that intensive postoperative physiotherapy programs improve pulmonary function, reduce pulmonary complications, and shorten the duration of hospital stay.

However, some previous studies have reported conflicting findings regarding the effectiveness of incentive spirometry. For instance, a comprehensive review by Tom J. Overend et al. (2001) found inadequate evidence to justify the routine use of incentive spirometry in reducing pulmonary problems following cardiac or abdominal surgery. Despite these findings, the present study demonstrated significant improvements in pulmonary function and dyspnea scores with the use of incentive spirometry.

Overall, this study's findings indicate that incentive spirometry combined with conventional physiotherapy exercises may be beneficial in improving pulmonary function and reducing dyspnea in postoperative CABG patients. Regular practice of breathing exercises and lung

expansion techniques may help prevent postoperative pulmonary complications and promote faster recovery.

## **CONCLUSION**

The present study demonstrated that both conventional physiotherapy and incentive spirometry exercises contributed to improvements in pulmonary function and reduction of dyspnea in postoperative Coronary Artery Bypass Grafting (CABG) patients. However, patients who received incentive spirometry in addition to conventional physiotherapy showed greater improvement in FEV<sub>1</sub> values and Borg dyspnea scores. These findings suggest that incentive spirometry is an effective adjunct to conventional physiotherapy in enhancing pulmonary function and reducing dyspnea following CABG surgery. Therefore, the incorporation of incentive spirometry in postoperative physiotherapy management may facilitate better respiratory recovery and help minimize postoperative pulmonary complications.

---

## **References**

1. Wynne R, Botti M. Postoperative pulmonary dysfunction in adults after cardiac surgery with cardiopulmonary bypass: clinical implications for practice. 2004;125(4):1269–1277.
2. Akdur H, Yigit Z, Yalcin O. Effects of postoperative physiotherapy on pulmonary function in patients undergoing cardiac surgery. 2001;95(2):123–128.
3. Babik B, Asztalos T, Petak F, Deak ZI, Hantos Z. Changes in respiratory mechanics during cardiac surgery. 2003;97(5):1280–1287.
4. Crowe JM, Bradley CA. The addition of incentive spirometry to postoperative pulmonary physiotherapy in patients following coronary artery bypass graft surgery. 1997;2(3):177–188.
5. Agostini P, Singh S. Incentive spirometry following thoracic surgery: evidence-based practice. 2007;93(2):102–110.
6. Westerdahl E, Lindmark B, Eriksson T, Hedenstierna G, Tenling A. Deep-breathing exercises reduce atelectasis and improve pulmonary function after coronary artery bypass surgery. 2005;128(5):3482–3488.

7. Hall JC, Tarala RA, Hall JL. Prevention of respiratory complications after abdominal surgery: a randomized clinical trial 1996;109(2):312–318.
8. Overend TJ, Anderson CM, Lucy SD, Bhatia C, Jonsson BI, Timmermans C. The effect of incentive spirometry on postoperative pulmonary complications: a systematic review. 2001;120(3):971–978.