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# The Immediate Effects of Breathing Exercises with Acapella and Incentive Spirometer on Preventing Early Pulmonary Complications Following Cabg. - A Comparitive Study

Sachin Chaudhary<sup>1</sup>, Neha Ingale Chaudhary<sup>2</sup>, Babaji Ghewade<sup>3</sup>,  
Gaurav Mahajan<sup>4</sup>

<sup>1</sup>Professor, Department of Cardiorespiratory Sciences, Datta Meghe College of Physiotherapy, Sawangi (Meghe), Wardha-442001, India;

<sup>2</sup>Professor, Department of Neurosciences, Datta Meghe College of Physiotherapy, Sawangi (Meghe), Wardha-442001, India; <sup>3</sup>Professor Department of Respiratory Medicine, Jawaharlal Nehru Medical College and Datta Meghe Institute of Medical Sciences, Sawangi (Meghe), Wardha-442001, India; <sup>4</sup>Junior Resident, Dept. of Medicine, Jawaharlal Nehru Medical College and Datta Meghe Institute of Medical Sciences, Sawangi (Meghe), Wardha-442001, India.

## ABSTRACT

**Background:** The incidence of postoperative pulmonary complications (PPCs) following coronary artery bypass grafting (CABG) is between 30% and 60% and are the most significant contributor to morbidity, mortality, and expenses associated with the hospitalization. Chest physiotherapy is the fundamental component in post-operative physiotherapy. This study will specify the preferable technique for early prevention of postoperative pulmonary complications.

**Objective:** The study aims at comparing the immediate effects of deep breathing with acapella and incentive spirometer in preventing early postoperative pulmonary complications followed by CABG.

**Method:** In this study, 30 subjects fulfilling criteria divided into group A and group B randomly. Group A received breathing exercises with acapella and group B with the incentive spirometer. The outcome was evaluated through SPO2 levels, peak expiratory flow rate (PEFR), and numerical rating scale scores for dyspnea (NRS). The data was analysed and the inference was drawn through paired and unpaired t-tests.

**Results:** The study obtained very discrete findings. Out of 4 days recordings of the outcome, the SPO2 levels were significantly improved in group B than group A on the first day of treatment, while after 4days of treatment there was no significant difference between group A and group B. The PEFR score was significantly higher in group A than group B after four days. There was no significant difference in the lowering of NRS score for perceived shortness of breath among both groups.

**Conclusion:** In this study it is concluded that the breathing exercises through Acapella and Incentive Spirometer are effective in preventing early PPCs followed by CABG by improving PEFR (mostly through acapella), SPO2 levels and reduction of shortness of breath, thus improving quality outcome.

**Key Words:** Acapella, Incentive Spirometer, PPCs, SPO2, PEFR, NRS, Prevention, CABG

## INTRODUCTION

Cardiovascular diseases (CVDs) have now become the leading cause of mortality in India. The Global Burden of Disease study estimate of age-standardized CVD death rate of 272 per 100 000 population in India is higher than the global average of 235 per 100 000 population.<sup>1,2</sup> Coronary artery disease has reached an epidemic proportion in South East Asia especially India in the recent few years<sup>3</sup>. Cardiovas-

cular Outcomes after Acute Coronary Syndrome are unpredictable<sup>4</sup>. Studies have reported the association between Cardiac Dysfunction, Arrhythmias and Chronic Liver Diseases.<sup>5</sup> Rhythm Disturbances in Acute Myocardial Infarction are also highlighted.<sup>6</sup> A Narrative Review Coronary artery bypass grafting (CABG) is remaining a gold standard for the treatment of triple vessel diseases. It is one of the widely used treatments as every year more than 1 million coronary artery bypass surgery procedures are performed around the

### Corresponding Author:

**Dr. Sachin Chaudhary**, Professor, Department of Cardiorespiratory Sciences, Datta Meghe College of physiotherapy, Sawangi (Meghe), Wardha-442001, India; Contact No.: +91 9960898805; Email: [drsachin1982@gmail.com](mailto:drsachin1982@gmail.com)

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world.<sup>7,8</sup> In India, at 2010 the annual number of CABG procedures was about 60,000 according to industry sources.<sup>3</sup>

Cardiac surgeries are associated with an occurrence of postoperative pulmonary complications (PPC), defined as any pulmonary abnormality that occurs during the postoperative period which produces identifiable disease or dysfunction that is clinically significant, and which adversely affects the clinical course.<sup>7</sup> Patients undergoing coronary artery bypass grafting are at increased risk of pulmonary complications.<sup>8,9</sup> The incidence is between 30% and 60%. These complications are the most significant contributor to morbidity, mortality, and expenses associated with the hospitalization.<sup>8</sup>

The commonest complications among PPCs are pneumonia, atelectasis or infiltrates, postoperative fever, respiratory failure and the prolongation of mechanical ventilation, as well as pleural effusions, pneumothorax and pulmonary oedema.<sup>10</sup>

Postoperative atelectasis is common in patients following coronary artery bypass graft surgery<sup>(5)</sup> with the prevalence of 27-95% (the most common early PPC).<sup>11</sup> The cause of atelectasis is complex and may include several factors such as general anaesthesia, diaphragmatic dysfunction, abdominal distension, alterations in the chest wall, pleural effusions and pain<sup>10</sup>. These may land up in impaired ventilator mechanics, decrease lung compliance and increased effort of breathing which are mainly presented during and after surgery. Reduction in lung volume contributes to impaired gas exchange.<sup>12</sup> Various studies have documented arterial hypoxemia and decreased diffusion capacity in the early postoperative period.

The PPCs increase with the increase in age, obesity, smoking and preexisting lung diseases. The other factors that also contribute to are the site of surgery, duration of anaesthesia and post-operative risk factors such as immobilization analgesia, emergency procedures and inadequate preoperative education.<sup>13</sup>

Reductions in lung volumes and oxygenation are common during the initial period after open-heart surgery. The effects of the median sternotomy, hypothermia for myocardial protection, dissection of the internal mammary artery, and the use of cardiopulmonary bypass negatively influence lung function.<sup>14</sup>

Mucociliary clearance is adversely affected after surgery by the effects of general anaesthesia, intubation and analgesia. Expiratory flow rate is directly related to lung volume and therefore when lung volumes are decreased, as, in the postoperative period, coughing will be less effective.<sup>15,16</sup> Insufficient breathing, as well as the absence of a normal sigh mechanism and coughing technique, immobilization and inadequate patient cooperation, may

affect the pulmonary function.<sup>17,18</sup> The absence of sigh has been suggested to lead to alveolar collapse within one hour.<sup>19,20</sup> The pain and postoperative (PO) apprehension associated with lung mechanics changes resulting from the operation affect the performance of periodic deep inspiration and effective cough, allowing the accumulation of secretion, alveolar collapse and changes in gas exchange.<sup>11</sup>

Respiratory physiotherapy plays a vital role in postoperative CABG status. The Interventions such as postoperative breathing exercises, effective coughing techniques, early mobilisation, and inspiratory muscle training are used by physiotherapists to limit lung volume decreases and atelectasis and to increase oxygenation after open-heart surgery.<sup>20</sup> According to recent literature, devices of respiratory physiotherapy are introduced as alternative therapy methods to facilitate and improve the mobilization of mucus from airways, through which better lung ventilation and improved pulmonary function can be achieved.<sup>21</sup> These devices are safe and offer acceptable airway clearance and effective breathing capacity.

Incentive spirometry provides feedback at a preset inspiratory flow of the volume of air. Incentive Spirometry is designed to mimic natural sighing or yawning by encouraging the patient to take slow, deep breaths. Incentive Spirometer is used to provide information about the patient's inspiratory effort by measuring the airflow (FEV<sub>1</sub>) and the air volume (FVC).<sup>21</sup> The use of incentive spirometer has been supported to increase or maintain inhaled lung volume, improve sputum expectoration and to avoid serious lung infection, especially after surgery.<sup>21</sup> Deep inhalations promote the mobilization of secretions and the opening up of lung areas that may have become collapsed. Also, it exercises the lungs, keeping them active, especially during the recovery from surgery, hence is routinely used in post-operative physiotherapy.

The Acapella is a handheld airway clearance device that operates on the principle of a valve interrupting expiratory flow generating oscillating positive expiratory pressure (PEP).<sup>21</sup> PEP is believed to increase pulmonary pressures resulting in an increased functional residual capacity (FRC).<sup>13</sup> Acapella consists of an anti-weight cover and a metal bar connected to a handle and magnet. The oscillation of the airflow is generated by breaking and repairing the magnetic gravity through the plug where the air passing through the unit is interrupted periodically.<sup>22</sup> It can be also used to improve respiratory muscle strength thus preventing its atrophy.

In this study, the immediate effect of breathing through acapella and incentive spirometer on the prevention of early PPCs has been studied for utilization of specific treatment device for improving specific parameters in early postoperative phase for better outcomes.

## NEED FOR STUDY

The benefits of Coronary Artery Bypass Graft (CABG) surgery concerning survival and improved ventricular function is well established, but as in many other cardiac interventions, there is a risk for postoperative pulmonary complications (PPC) such as pneumonia, atelectasis, respiratory failure, pneumothorax or bronchospasm. Although global mortality caused by these complications has decreased in recent years, these are still heavily related to patient morbidity with results in longer lengths of hospitalization, which impacts on patients, families and increased medical expenses.<sup>23</sup>

According to in Charlotte Urell et al, in their study, it was concluded that there were large decreases in lung volumes two days after open-heart surgery.<sup>12</sup> For the improvement in the pulmonary function, no single method is preferred.<sup>24,25</sup> In most of the studies, intensive spirometry and acapella has been widely used, especially in the management of patients in the postoperative period of cardiac surgery for improvement in exchange of gases and oxygenation<sup>9,10,11,13,22</sup>. But the results vary widely. So there is a need for further studies to clarify the effect of these techniques on oxygen saturation, PEFr and to state the specific use of the devices in enhancing parameters to preventing early PPCs.

Further very few studies have focused on the individual perception of the patient for ease from breathlessness after the treatment manoeuvres. This study has included Numerical Rating Scale (NRS) for dyspnea as an outcome measure to analyse the effect of breathing through acapella and incentive spirometer on easing breathlessness encountered as a result of postoperative status, fear and pain.

The number of published reports is limited with the use of acapella device and incentive spirometer in early effects, though more research is needed to define the effectiveness of the devices of respiratory physiotherapy and their place among the current techniques available<sup>(21)</sup>.

This research will provide a base for specific intervention based protocol for a specific parameter and will also establish some facts for improving the overall component of rehabilitation.

## MATERIALS AND METHODOLOGY

A randomized controlled trial comparing the immediate effects of breathing exercises through incentive spirometry with the breathing through Acapella was conducted in the cardiac intensive care unit and recovery wards of Acharya Vinoba Bhave Rural Hospital (Sawangi). The study began after getting approval from the ethical committee of the hospital. Written consent was taken from all 35 patients who were included in the study. Out of them, 5 patients devel-

oped some emergency complications i.e. atrial fibrillations, abdominal distensions so they were excluded from the study. The final population studied was 30 who were having stable vitals following CABG, age between 40 - 75 years, male, female and those not having any existing pulmonary complication.

The postoperative CABG patients were divided into two groups by the first come first basis method. Both group participants received standard physiotherapy. All subjects were treated with basic postoperative respiratory physiotherapy including diaphragmatic breathing exercises, ankle pump exercises, proper huffing and coughing technique with guarding the suture site, bedside mobilization and active range of mobility exercises for upper limb and lower limb. Patients were mobilized as early once the sheath is removed. Patients were also instructed to sit out of bed and stand up according to the postoperative treatment protocol.

After that, Group A patients were given breathing exercises through acapella device and Group B patients received breathing exercises through incentive spirometer. The exclusion criteria of this study were patients who required more than 24 hours of intubation after surgery; patients who needed re-intubation; Patients who had emergency CABG; patients who had a history of respiratory tract infection within three months and patients with any neuromuscular disease; patients with severe renal dysfunction, previous open-heart surgery, hemodynamic instability; uncooperative patients. The 3 outcome measures were taken in the study to assess the efficacy of the treatment in both the groups i.e. SPO<sub>2</sub>, PEFr, and NRS.<sup>26</sup>

## PROCEDURE

Detailed subjective assessments were done to rule out any abnormalities before proceeding for treatment. The purpose of this study and the treatment were preoperatively explained to the entire subject population and were educated regarding the same. Subjects in group A and group B were informed and practised the breathing technique through ACAPELLA and INCENTIVE SPIROMETER respectively preoperatively. The exercise protocol was started after the patient was referred to physiotherapy after extubation with stable vitals. (2nd postoperative day).

The patient was instructed to don the chest belt with a chest pad to support and prevent unusual pressure on sutures. If needed the subject was asked to cough to expel out secretions collected in the upper airways anytime during performing an exercise. The patients were instructed to perform deep breathing in a sitting position, if possible. In some subjects, the sitting was not comfortable due to drain tubes in situ, so they were asked to perform the exercise in semi fowlers' position.

For group A, the exercise session included three sets of deep breaths. Each set includes 30 repetitions which were followed by 30 to 60 seconds pause in between. Subjects were instructed to performed slow maximal inspiration, while expiration was done through acapella in a prolonged forceful manner to minimize airway closure and alveolar collapse. In the Acapella device, resistance was increased continuously on each successive day.

For group B, the session lasted for 15-20 minutes. During this session, the subjects were instructed to perform breathing exercise through incentive spirometer with 30 repetitions/set. The rest is given for 30-60 seconds in between each set. Total 3 sets/session were given each day for the next 3 consecutive days. The breath was asked to hold for 2,3,4,5 seconds in between inspiration and expiration each successive day respectively.

Before and after the session, on day first, of treatment, measurements of SPO2 levels, PEFR and NRS scores for dyspnea were taken from the individual subject of both groups by a pulse oximeter, peak flow meter and NRS respectively. This procedure is followed for consecutive 3 days.

The data was recorded, tabulated and inferences were drawn. the paired t-test was used to compare the pre-post effects within the groups and unpaired t-test was used to compare the effects between group A and group B. The results were analysed and interpretations established to check the significance.

## RESULTS

**For age-wise distribution,** In Group A - Majority of the patients i.e. 7 (46.67 %) were reported in the age group 50 to 60 years, followed by 6 (40 %) patients observed in the age group 60 to 70 years, 1 (6.67 %) patient was observed in the age group 40 to 50 years, and another 1 (6.37 %) patient was reported in the age group 70 to 80 years. Where in Group B – Majority of the patients i.e.7 (46.67 %) were reported in the age group 50 to 60 years, followed by 5 (33.33 %) patients observed in the age group 60 to 70 years, 2 (13.33 %) patients were observed in the age group 40 to 50 years, and 1 (6.37 %) patient was reported in the age group 70 to 80 years.

**For gender-wise distribution,** In Group A– Maximum 9 (60 %) patients were male and 6 (40 %) patients were Female. While in Group B – Majority of patients i.e. 11 (73.33 %) were Male and 4 (26.67 %) patients were Female. Table no 1 shows Pre and post-treatment comparison within the groups.

## Effect of Acapella Device

**Table 1: pre-post comparison of outcome measures within group A**

Symptom	Spo2	PEFR	NRS
Mean Score, B.T.	98.53	167.97	4.6
Mean Score, A.T.	98.53	171.25	3.85
S.D. (+)	0	9.89	0.42
S.E. (+)	0	2.55	0.109
Paired t test	-	-5.19	6.87
p value	>0.05	<0.05	<0.05
Result	Insignifi- cant	Significant	Signifi- cant

As shown in table 1, paired t-test was used to compare the pre and post-treatment effects of breathing through acapella device on SPO2, PEFR and NRS scores. For SPO2, the mean scores were 98.53, 98.53 respectively before and after treatment with p-value >0.05 suggestive of insignificant difference in SPO2 levels. While for PEFR and NRS score it p-value was <0.05 considered significant in after treatment than before with mean scores 171.25 -167.97 with S.D.  $\pm$ 9.89 and 3.85- 4.6 with S.D.  $\pm$  0.42 respectively.

**Table 2: Effect of Incentive Spirometry: pre-post comparison of outcome measures within group B**

Symptom	Spo2	PEFR	NRS
Mean Score, B.T.	94.71	176.55	4.58
Mean Score, A.T.	98.38	178.5	2.85
S.D. (+)	1.04	9.74	0.42
S.E. (+)	0.27	2.51	0.11
Paired t test	-13.57	-0.77	15.7
P value	<0.05	>0.05	<0.05
Result	Significant	Insignificant	Significant

As shown in table 2, a paired t-test was used to compare the pre and post-treatment effects of breathing through incentive spirometer on SPO2, PEFR and NRS scores. For SPO2, the mean scores were 94.71, 98.38 with S.D.  $\pm$ 1.04 respectively before and after treatment with p-value <0.05 suggestive of significant difference in SPO2 levels. For PEFR, the p-value was >0.05 considered insignificant in after treatment than before with mean scores 178.5- 176.55with S.D.  $\pm$ 9.74. While for and NRS score, the p-value was <0.05 considered significant with mean scores 4.58to 2.85 before and after with S.D.  $\pm$  0.42 respectively.



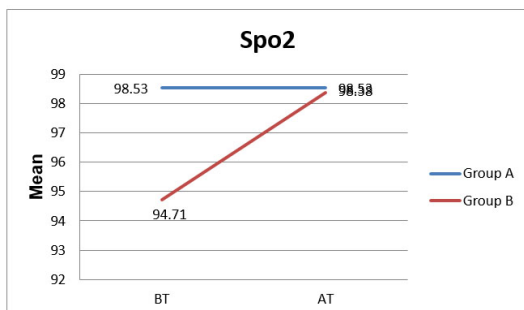
### Post-treatment comparison between group A and group B:

All the values obtained are calculated by using unpaired t test for the outcome measures i.e. SPO2, PEFR and NRS score.

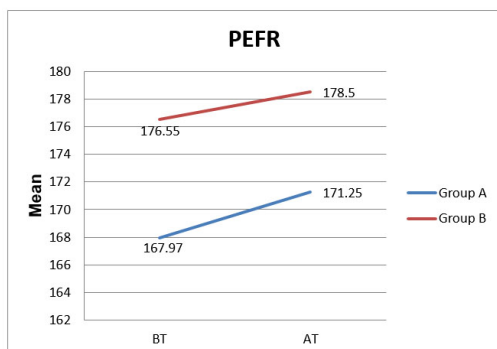
**Table 3: Post treatment values comparison of outcome measures between group A and group B.**

Symptom	Spo2	PEFR	NRS
Mean Difference Score, Group A	0	-13.3	0.75
Mean Difference Score, Group B	-3.67	-1.95	1.73
Combined S.D. (+)	0.74	9.82	0.42
S.E. (+)	0.27	3.58	0.15
Unpaired t	13.56	-3.16	-6.33
p value	>0.05	<0.05	>0.05
Result	Insignificant	Significant	Insignificant

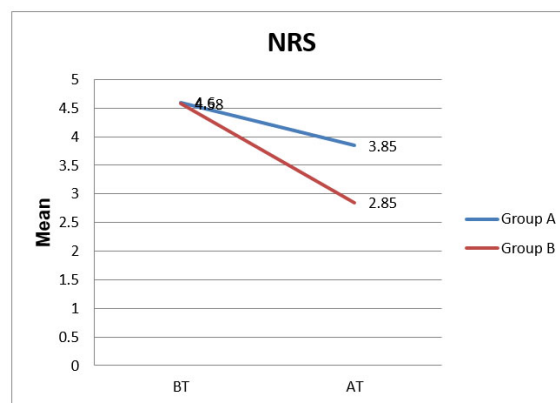
As shown in table 3 and graph 1,2,3 the comparison between the group A and group B for SPO2, PEFR and NRS scores showed that there was a significant increase in PEFR values in group A than in group B with p-value <0.05. while the comparison for SPO2 and NRS scores was insignificant with p-value >0.05 showing there was no greater difference in these outcomes with both group treatments.



**Graph 1:** Pre- post-treatment mean values of SPO2 in group A and group B.



**Graph 2:** Pre- post-treatment mean values of PEFR in group A and group B.



**Graph 3:** Pre- post-treatment mean values of NRS score in group A and group B.

## DISCUSSION

During CABG, healthy artery or vein from the body is connected or grafted to the blocked coronary artery. Usually, the graft is taken from a saphenous vein or sometimes from the mammary vein.

This creates new path for blood to flow to the heart. During CABG, aponeurosis of pectoralis major muscle gets dissected which results in weakening of pectoralis major. Splitting of sternum causes reduction in thoracic expansion and cough accumulation and other complications.

Anesthesia, intubation and surgical trauma contribute to changes in pulmonary mechanics, decrease in FRC and changes in the production of surfactant on the postoperative of CABG surgery.<sup>11</sup> These factors, associated with immobility, pain<sup>11,27</sup> and fear, favor the adoption of a monotonous breathing pattern without performing sporadic sighs to total lung capacity, promoting alveolar collapse.<sup>11,28</sup> Also, damage to cough and bronchial hygiene lead to atelectasis development, causing a ventilation-perfusion disorder with changes in blood oxygenation and predisposing to the occurrence of lung infections.<sup>11,28</sup>

The study laid very interesting results which are supported by the findings of previous studies; further, some new results were also elicited. The effect of Acapella Device (Group A) before and after treatment was significant at p<0.05 for PEFR, and NRS. While it was insignificant at p>0.05 for Spo2 levels showed in Fig no 1, 2, and 3. That means, the parameter peak expiratory flow rate has greater improvements in the treatment with breathing through acapella, also the NRS score for dyspnea or shortness of breath was tapered down suggestive of the subjects reported ease from shortness of breath after treatment. There was an increase in the levels of spo2, but not significantly before and after treatment within group A.

After surgery, mucociliary clearance is adversely affected because of general anaesthesia, intubation and analgesia. Expiratory flow rate is directly proportional to lung volume and therefore, coughing will be less effective when lung volumes are decreased, in the postoperative period. Acapella is an airway clearance device which works on the principle of equal pressure point. It causes an increase in pulmonary pressures which results in an increased functional residual capacity. Clearing the secretions results in an increase in lung volume and thus increases expiratory flow rate. This further helps to relieve dyspnea symptoms and eases breathing. This phenomenon justifies the results obtained in group A i.e. breathing through Acapella.

The before and after treatment of breathing through Incentive spirometer (Group B) laid some specific results. The values of SPO<sub>2</sub> were significantly increased along with the significant lowering of NRS score for dyspnea (relief from shortness of breath) after the treatment with  $p < 0.05$  whereas the PEFR measurements improved but not to a significant level ( $P > 0.05$ ) after treatment in Group B.

The reason might be, Using incentive spirometer after surgery help keeping lungs clear. Deep inhalations promote the mobilization of secretions and the opening up of lung areas that may have become collapsed. The oxygen-carrying capacity is increased with breathing through Incentive Spirometer thus justifies the significant rise in SPO<sub>2</sub> levels than PEFR. Also, it exercises the lungs, keeping them active, especially during the recovery from surgery.<sup>(21)</sup> This technique is beneficial to improve shortness of breath on NRS score as it provides visual positive feedback and immediate improvement in oxygen saturation.

This is again supported by Ahmadreza et al in their study showed that the IS caused significant improvement in the arterial blood gas parameters (PaO<sub>2</sub>, SaO<sub>2</sub>, and PaCO<sub>2</sub>) on the third postoperative day<sup>8</sup>. A systematic review was conducted by Agostini *et al.* of seven studies about IS after thorax surgery. Three studies reported that IS can improve gas exchange and others stated that IS is ineffective after thorax surgery. Finally, they concluded that IS can promote oxygenation and gas exchange after thorax surgery.<sup>30</sup>

On comparison of the post-treatment results between Group A and Group B, it was inferred that the effect of Acapella Device (Group A) is significant than Incentive Spirometry (Group B) in improving peak expiratory flow rate (PEFR). Where there is no significant difference compared to Incentive Spirometry (Group B) for outcome measures Spo<sub>2</sub> and normal respiratory secretions (NRS).

Acapella helps to clear secretions by improving mucociliary clearance as per the principle of equal pressure point. thus improving PEFR readily whereas Incentive Spirometer also helps to loosen and mobilizing secretions but in an indirect

manner. It increases pulmonary volume, prevent or diminish atelectasis, assists in sputum clearance and subsequently increases oxygenation. The results obtained are supported by the work of other researchers.

In the previous study, oscillation and vibration of the chest wall improved oxygenation and Forced expiratory volume (FEV<sub>1</sub>) in patients who underwent lobectomy as compared to standard physiotherapy.<sup>29</sup> According to the study by masood alam et al., incentive spirometry and Acapella both improved blood gases.<sup>22</sup>

In our study, both groups also received standard physiotherapy in addition to these interventions, it could be due to this that both groups achieved similar improvement in SPO<sub>2</sub> and NRS score.

It was found that on the day one of treatment incentive spirometer was more useful for improving SPO<sub>2</sub> levels than Acapella, the reason might be, suture pain and anxiety leads to shallow breathing, in which incentive spirometry is more useful as compare to Acapella. This suggests the introduction of breathing exercises to post-operative CABG patient on 1<sup>st</sup> treatment day should be started with the incentive spirometer. Once the patient is adjusted to the treatment session subsequent session should be started with incentive and acapella both for an effective outcome.

There are many differences in the conclusion of various studies regarding the role of incentive spirometer and acapella in the prevention of early PPCs followed by CABG.

Brage stated that improvement in blood oxygenation by respiratory exercises is temporary and is reversible after a short time; so, for improvement in oxygenation repetitive exercises are needed<sup>(31)</sup>. Carvalho *et al.* in systematic review study reviewed 30 studies concerning IS. They reported that there was no power evidence to support the use of IS after CABG, and there is a need for studies to clarify the effect and justify the use of this technique. The study evidence of T J Overend et al does not support the use of IS for decreasing the incidence of PPCs following cardiac or upper abdominal surgery.<sup>33</sup>

According to the research studies, the current devices of respiratory physiotherapy including acapella and incentive spirometer are effective in improving pulmonary function, lung oxygenation, clearing mucus from bronchi and making feasible better compliance of patients in treatment. Also, they decrease respiratory complications. The incentive spirometer is thought to be an important factor in the reduction or prevention of postoperative pulmonary complications and its use in those patients is frequent.<sup>21</sup>

The results of one of the studies showed that breathing exercises, including deep breathing, effective perforation and use of motivational spirometry, were more effective in reducing

atelectasis after coronary artery bypass grafting compared to routine hospital performance. This finding is in line with the study by Shaban *et al.*, which suggests that pre-operative breathing exercise reduces the incidence of atelectasis and improves ventilation status.<sup>34</sup>

Acapella technique helps in increasing lung volume along & prevents alveolar collapse. It also helps with mobilization of secretion, favouring expectoration thus preventing further accumulation of secretions & thus decreases the chances of infection. It can be also used to improve respiratory muscle strength thus preventing its atrophy. It is used to increase pulmonary volume and facilitates the release of pulmonary secretion. Acapella device allows more air to enter in the peripheral airways via collateral channels, to allow pressurized air to go behind the secretions afterwards moving them towards larger airways from where they can easily be expelled and to prevent alveoli from collapsing. Incentive spirometry which is also known as sustained maximal inspiration is the chief component to improve respiratory muscle strength. It is primarily designed to mimic natural sighing or yawning mechanism by encouraging the patient to take long, slow and deep breaths. It increases pulmonary volume, prevent or diminish atelectasis, assists in sputum clearance.

A previous study mentioned that a significant decrease of atelectatic area, increase in the aerated lung area and a small increase in PaO<sub>2</sub> were found after the performance of 30 deep breaths through incentive spirometer.<sup>35</sup> Our study supports the statement that if administered early the immediate effects of breathing through acapella and incentive spirometer, help in prevention and early recovery from early PPCs.

Begam affrin and colleagues stated that the main rationale for giving deep breathing exercises with Acapella and incentive spirometry is that they prevent postoperative complications in coronary artery bypass grafting patients, improves and facilitates cardiorespiratory function & thus prevents further deterioration of the patient.<sup>13</sup>

In our study we specify that the immediate effects of breathing through Acapella and Incentive Spirometer play a major role in prevention and if at all encountered, early recovery from early PPCs followed by CABG.

## CONCLUSION

In this study it is concluded that the breathing exercises through Acapella and Incentive Spirometer are effective in preventing early PPCs followed by CABG by improving PEFR (mostly through acapella), SPO<sub>2</sub> levels and reduction of shortness of breath, thus improving quality outcome. Further studies can be carried out for efficacy and comparison of various devices altogether in the early prevention of PPCs.

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