EFFECTS OF BREATHING EXERCISES AND INCENTIVE SPIROMETRY IN IMPROVING LUNG CAPACITY ON INDIVIDUALS WITH LUNG FIBROSIS

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Abstract: Actual aim of“this review article is to study and to make a report an overview on the efj“ects of“ breathing exercises and incentive spirometry in improving lung capacity on individuals with lung fibrosis. Incentive spirometer is a device that ofj“ers patients with visual and other positive response. Incentive Spirometry is exercises that have been used to enhance lung expansion. Incentive Spirometry is essential to the thoracotomy patients by increasing inspiratory capacity and improves inspiratory muscle strength in patients. The risk and severity of“ complications can be reduced by the use of“ therapeutic maneuvers that increase lung volume. Incentive spirometry has been routinely considered a part of“ the perioperative respiratory therapy strategies to prevent or treat complications. Incentive spirometry is designed to mimic natural sighing or yawning by encouraging the patient to take long, slow, deep breaths. People living with chronic lung diseases, such as chronic obstructive pulmonary disease (C’OPD), C’OVID 19, emphysema and pulmonary fibrosis, experience similar lung disease symptoms. Shortness of“breath and decreased lung function make breathing difficult. Sometimes, doctors recommend their patients use an incentive spirometer. Incentive spirometers are prescribed af“ter surgery or as part of“a lung disease treatment plan. Here are the f“acts you need to know about incentive spirometry benefits.

Keywords: Breathing pattern, breathing exercises, chronic lung diseases and pulmonary fibrosis, spirometry, incentive spirometer.

INTRODUCTION

Incentive spirometer (IS) is a feedback system to encourage patients to take a deep breath and produce a sustained maximal inspiration for the primary purpose of opening and stabilizing atelectasis areas of the lung [1]. It provides low-level resistive training while minimizing the potential of fatigue to the diaphragm muscle. Generally, this treatment is performed frequently up to every hour, and its purpose is to treat and prevent atelectasis, especially in postoperative thoraces and abdominal patients [2]. It is simple to use and provides the patient with visual feedback on flow and volume [3]. Physiotherapists also use breathing exercises to promote secretion removal, increase thorax mobility, enhance relaxation, control breathlessness [4], increase pulmonary ventilation, and improve mobilization of the chest wall [5]. There are many types of breathing exercises such as diaphragmatic breathing, pursed lip breathing, segmental breathing, low-frequency breathing, sustained maximal inspiration breathing, and breathing exercises connected with postural exercises [6]. Resisted breathing exercises programs in the form of inspiratory resistive muscle training and abdominal weights training are very effective for respiratory training and improvement in pulmonary function [7].

It is frequently observed in thoracotomy patients when performing Incentive Spirometry, which the performance varies with patients of different age group, gender, history of smoking, pulmonary disorders, associated problems, diagnosis, type of incision, type of surgery, pain and pulmonary complications. Incentive Spirometry is the most preferred lung expansion therapy used in all patients undergoing thoracotomy irrespect of the cause. It is commonly noticed that the performance of Incentive Spirometry in post thoracotomy and abdominal surgery patients varies depending upon the age, gender, patients with history of smoking, pulmonary problems, post pulmonary complications, pain, clinical diagnosis of the patient, type of surgery and incision made. Moreover no studies have been done on the influencing factors in Incentive Spirometry; this study is done to find out the positive and negative influencing factors on Incentive Spirometry [8-11].

Postoperative pulmonary complications are reported in the range of 2-39% and include atelectasis, pneumonia, and respiratory failure. Upper-abdominal surgical procedures are associated with a higher risk of complications, followed by lower-abdominal surgery and thoracic surgery. Preoperative and postoperative respiratory therapy aims to prevent or reverse atelectasis and improve airway clearance. This decreases pleural pressure, promoting increased lung expansion and better gas exchange. When the procedure is repeated on a regular basis, atelectasis may be prevented or reversed. Expiratory maneuvers such as positive expiratory pressure (PEP) and vibratory PEP do not mimic the sigh. While incentive spirometry is widely used clinically as a part of routine prophylactic and therapeutic regimen in perioperative respiratory therapy, its clinical efficacy remains controversial [12-17].

Dysfunctions of the breathing pattern can be first indicators of a problem within the human body, be it of mechanical, physiological or mental kind. Incorrect breathing can be caused by blocked ribs or vertebra, dysfunction of breathing and stabilising muscles, allergies, lung diseases, heart failures and above all excessive stress. Major role also belongs to a change in posture control or changed dynamic spine stabilisation. The breathing process is perfectly coordinated and controlled by the brainstem and *medulla oblongata.* Breathing movements happen automatically, induced by the autonomous nerves, although the depth and rhythm of the breathing can be consciously regulated. This otherwise spontaneous activity can thus be influenced by will. Breathing and breathing movements maintain not only the fundamental metabolic processes connected to gas exchange but they also strongly influence body posture. This implies that breathing influences posture stability while at the same time the quality of postural stability influences breathing [17-20].

According to Kolar et a1. [21] postural stability is defined as the ability to maintain upright body posture and at the same time have the ability to react on changed external and internal forces so as to prevent an unintentional or uncontrolled fall. Dylevsky, Druda and Mrazkova described postural stability as a balanced and coordinated posture of the body as a unit and as a highly specialised process of maintaining body balance and position of the body and its parts in a constantly changing environment. It is a musculoskeletal regulatory body mechanism that precedes every movement and afterwards seeks to maintain the reached position. It is therefore not a simple taking of a position but a continuous maintaining of its stability. Furthermore, breathing movements are influenced not only by internal and external environment but also by the state of mind. While happiness undermines extensive body posture and increases breathing movements, sadness and depression are exhibited by flexed body posture and hindrance of breathing movements [18-22].

People living with chronic lung diseases, such as chronic obstructive pulmonary disease (COPD), emphysema and pulmonary fibrosis, experience similar lung disease symptoms. Shortness of breath and decreased lung function make breathing difficult. Sometimes, doctors recommend their patients use an incentive spirometer. Incentive spirometers are prescribed after surgery or as part of a lung disease treatment plan. Here are the facts you need to know about incentive spirometry benefits [23].

Incentive spirometers gently exercise the lungs and aid in keeping the lungs as healthy as possible. The device helps retrain your lungs how to take slow and deep breaths. An incentive spirometer helps increase lung capacity and improves patients' ability to breathe. Tying to manage medications, doctors' instructions and your lung disease symptoms can feel overwhelming and like you have no control over your healthcare. Using an incentive spirometer lets you take charge of your lung health. When you use your incentive spirometer as instructed by your doctor, you actively help your lungs learn how to work better [23].

Benefits of Incentive Spirometer [IS]

The name sounds complicated. But this is a simple handheld gadget that helps keep your lungs clear when you're off your feet for a while. Maybe you've had surgery on your chest or belly, or you've fractured your ribs and find it painful to take deep breaths. Or you have pneumonia or a lung condition like chronic obstructive pulmonary disease (COPD) or cystic fibrosis. The breaths you take may not be as deep as usual. That means the air in your lungs may not move much and may not clear out any infections. You inhale through an incentive spirometer to exercise your lungs and to get air into every nook and cranny. Your doctor may also call it a manual incentive spirometer. It's made of plastic and is about the size of a small notebook. It has a mouthpiece that looks like a vacuum tube. When you inhale with it, the suction will move a disc or a piston up inside a clear cylinder. The deeper you breathe, the higher the piston rises. Most spirometers have numbers on the cylinder to show how much air you take in. They also may have a gauge to tell if you're inhaling at the right pace [25].

Uses of IS in Patients with COVID-19 [25]

For many patients admitted to the hospital with COVID-19, surviving the virus is only half of the battle. Once deemed virus-free and ready to be sent home, the often-long road to recovery including rebuilding lung capacity and overall respiratory health-begins. Two Cedars-Sinai respiratory therapists explain what roadblocks these hospital-admitted patients face when it comes to lung health and offer tips for non-patients looking to improve their overall respiratory health. “Patients with COVID-19 tend to be sicker for much longer than other patients with respiratory-related illnesses and, on average, stay on a ventilator for a longer duration,” said Dagoberto Naranjo, RRT, a respiratory therapist in the Department of Respiratory Therapy at Cedars-Sinai. These ventilated patients also take longer to react, or benefit from, oxygenation efforts, according to Naranjo. “When patients are intubated for long periods, it’s usually because they have accompanying or underlying medical conditions,” said Naranjo. “Patients who are healthy usually are intubated only to get them over the hump of requiring high levels of oxygen. This virus has proved to be unique, requiring different techniques and treatments than traditional standards of care.”

Because of the high levels of oxygen these patients require, coupled with the length of time they rely on ventilation, the road to a full recovery after leaving the hospital can be long for some patients. “Although most patients recover without long-term effects, some patients experience persistent symptoms after discharge,” said Christina Rogers, RRT, also a respiratory therapist in the Department of Respiratory Therapy. “These symptoms include difficulty breathing, fatiguing easily and experiencing weakness due to their limited ability to participate in regular physical activity.”

A patient using a spirometer [26]:

To combat these symptoms, Rogers and Naranjo suggest patients be sent home with an incentive spirometer device, which measures how deeply an individual can breathe in, and helps encourage taking slow, deep breaths to increase lung capacity. “This tool can also help prevent secondary lung problems, such as pneumonia,” said Rogers. The therapists also recommend that patients focus on nutrition to increase energy levels, and if deemed appropriate by a physician, incorporate mild exercise, such as walks, into their daily routines. For healthy people without COVID-19, Rogers and Naranjo say it’s never a bad idea to increase overall lung capacity and improve overall respiratory health. “Don’t underestimate the practice of simple deep breathing,” said Rogers. “Most people only use a small part of their lung capacity. By increasing the length of your inhalations and exhalations, you can increase your lung capacity and strengthen your

European Journal of Molecular & Clinical Medicine
ISSN 2515-8260 Volume 7, Issue 2, 2020

breathing, which improves the exchange of oxygen and carbon dioxide, ultimately improving lung capacity."

Cardio workouts are also recommended to improve respiratory health. "To improve lung capacity, cardio workouts, like speed-walking, jump rope, stationary bike-riding or running can make a big impact," said Naranjo. "However, every patient — including healthy individuals without COVID-19 — should consult a doctor to ensure their physical limitations aren't pushed to the extreme."

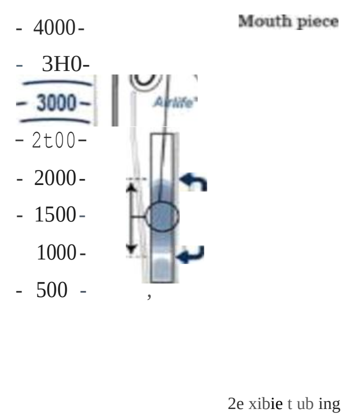

Figure 1: Parts of incentive spirometer [26]

To use your incentive spirometer, follow the steps below [26,27]:

1. Sit upright in a chair or in bed. Hold the incentive spirometer at eye level.

O If you had surgery on your chest or abdomen (belly), hug or hold a pillow to help splint or brace your incision (surgical cut) while you're using the incentive spirometer. This will help decrease pain at your incision.

2. Put the mouthpiece in your mouth and close your lips tightly around it. Slowly breathe out (exhale) completely.
3. Breathe in (inhale) slowly through your mouth as deeply as you can. As you take the breath, you will see the piston rise inside the large column. While the piston rises, the indicator on the right should move upwards. It should stay in between the 2 arrows (see Figure 1).
4. Try to get the piston as high as you can, while keeping the indicator between the arrows.

O If the indicator doesn't stay between the arrows, you're breathing either too fast or too slow.

5. When you get it as high as you can, hold your breath for 10 seconds, or as long as possible. While you're holding your breath, the piston will slowly fall to the base of the spirometer.
6. Once the piston reaches the bottom of the spirometer, breathe out slowly through your mouth. Rest for a few seconds.
7. Repeat 10 times. Try to get the piston to the same level with each breath.
8. After each set of 10 breaths, try to cough, holding a pillow over your incision, as needed. Coughing will help loosen or clear any mucus in your lungs.
9. Put the marker at the level the piston reached on your incentive spirometer. This will be your goal next time.

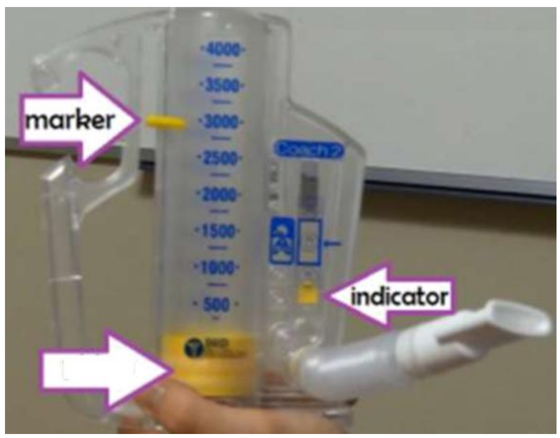

Figure 2: Main parts of incentive spirometer [27]

Figure 3: Marketed product of incentive spirometer [28]

Risks and Complications [28-30]:

In general, there are very few risks or possible complications with regular incentive spirometer usage, but it's important to stop if you find yourself becoming lightheaded.

There are rare reports of collapsed lung (pneumothorax) that have been associated with very aggressive spirometry in people with emphysema. If any of the following apply, you shouldn't use an incentive spirometer:

- You've recently had eye surgery: The pressure of breathing forcefully may affect your eyes.
- You have a collapsed lung
- You have an aneurysm (ballooning blood vessel) in the chest, abdomen, or brain

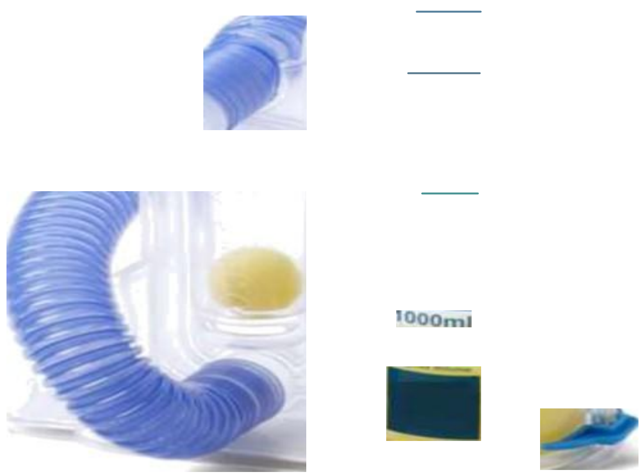

Figure 4: Marketed product of incentive spirometer [29]

Actual aim of this review article is to study and to make a report an overview on the effects of breathing exercises and incentive spirometry in improving lung capacity on individuals with lung fibrosis.

SURVEY OF LITERATURE

R. Malatova ct al., 2019, [31] reported that breathing difficulties are abundant throughout the whole population spectrum. Breathing pattern dysfunctions are frequent despite the fact that correct breathing is a necessary prerequisite for optimal functioning of the musculoskeletal apparatus, correct body posture and mental well-being. Furthermore, good breathing ventilation is immensely important in endurance sports. The quality of breathing stereotype also influences vital lung capacity. Incorrect breathing can be caused by blocked ribs and vertebra, dysfunction

of breathing and stabilization muscles, allergies, lung diseases, heart failure and above all excessive stress. When stimuli causing unsuitable breathing stereotype prevail too long, the dysfunction becomes fixated and must be eliminated and consciously corrected (using compensation exercises). In this research, muscle dynamometer MD03 was utilized for examination of the breathing stereotype, followed by Spirometric measurements of forced exhalation of the vital capacity and exhalation volume values for 1 second. Two months intervention of targeted breathing exercises was applied on a group of adolescent athletes (19 individuals contributing to the intervention and 18 used as a control group) aged on average
17.26 + 1.80. Factual as well as statistically significant influence on the involvement and strengthening of breathing muscles activated during diaphragmatic breathing at rest, as well as during deep breathing was shown. Improved values of FVC (forced expiratory vital capacity) by 6 % from 4.51 + 1.13 L to 4.78 + 1.12 L were obtained together with improved FEV1 (the forced expiratory volume in 1 second) by 6.1 % from 3.54 + 0.71 L.s-1 to 3.76 + 0.66 L.s-1. Both changes are both factually and statistically significant although the factual change displays only a slight effect, only minimal change could be sees for the control group where FVC increased by 0.45 % and FEV1 by 0.86 %. The test group also showed significant increase in breathing volumes. This study has confirmed that a two-month intervention of targeted breathing exercises has both factually and statistically significant influence on the activation and strengthening of breathing muscles.

Shao-Kai Sum ct al., 2019, [32] reported that an incentive spirometer (IS) is a mechanical device that promotes lung expansion. It is commonly used to prevent postoperative lung atelectasis and decrease pulmonary complications after cardiac, lung, or abdominal surgery. This study explored its effect on lung function and pulmonary complication rates in patients with rib fractures. Between June 2014 and May 2017, 50 adult patients with traumatic rib fractures were prospectively investigated. Patients who were unconscious, had a history of chronic obstructive pulmonary disease or asthma, or an Injury Severity Score (ISS) > 16 were excluded. Patients were randomly divided into a study group (n = 24), who underwent IS therapy, and a control group (n = 26). All patients received the same analgesic protocol. Chest X-rays and pulmonary function tests (PFTs) were performed on the 5th and 7th days after trauma. The groups were considered demographically homogeneous. The mean age was 55.2 years and 68% were male.

Mean pretreatment ISSs and mean number of ribs fractured were not significantly different (8.23 vs. 8.08 and 4 vs. 4, respectively). Of 50 patients, 28 (56%) developed pulmonary complications, which were more prevalent in the control group (80.7% vs. 29.2%; p = 0.001). Altogether, 25 patients had delayed hemothorax, which was more prevalent in the control group (69.2% vs. 29.2%; p = 0.005). Two patients in the control group developed atelectasis, one patient developed pneumothorax, and five patients required thoracostomy. PFT results showed decreased forced vital capacity (FVC) and forced expiratory volume in 1 s (FEVI) in the control group. Comparing pre- and posttreatment FVC and FEV1, the study group had significantly greater improvements (p 0.001). In conclusion, the use of an IS reduced pulmonary complications and improved PFT results in patients with rib fractures. The IS is a cost-effective device for patients with rib fractures and its use has clinical benefits without harmful effects.

Paltiel Weiner ct al., 1997, [33] predicted postoperative forced expiratory volume in 1 second (FEVI) of less than 800 ml or 40% of predicted is a common criterion for exclusion of patients from lung resection for cancer. Usually, the predicted postoperative lung function is calculated according to a formula based on the number of lung segments that will be resected. Incentive spirometry and specific inspiratory muscle training are two maneuvers that have been used to enhance lung expansion and inspiratory muscle strength in patients with chronic obstructive pulmonary disease and after lung operation. Thirty-two patients with chronic obstructive pulmonary disease who were candidates for lung resection were randomized into two groups: 17 patients received specific inspiratory muscle training and incentive spirometry, 1 hour per day, six times a week, for 2 weeks before and 3 months after lung resection (group A) and 15 patients were assigned to the control group and received no training (group B). Results: Inspiratory muscle strength increased significantly in the training group, both before and 3 months after the operation. In group B, the predicted postoperative FEV1 value consistently underestimated the actual postoperative FEVI by approximately 70 ml in the lobectomy subgroup and by 110 ml in the pneumonectomy subgroup. In group A, the actual postoperative FEV 1 was higher than the predicted postoperative FEV by 570 ml in the lobectomy subgroup and by 680 ml in the pneumonectomy subgroup of patients. In patients undergoing lung resection the simple calculation of predicted postoperative FEV underestimates the actual postoperative FEV1 by a small fraction. Lung functions can be increased significantly when incentive spirometry and specific inspiratory muscle training are used before and after operation.

Ludmila Tais Yazbek Gomieiro ct al., 2011, [34] evaluated to the effects of a respiratory exercise program tailored for elderly individuals with asthma. Asthma in older adults is frequently under diagnosed, as reflected by approximately 60% of asthma deaths occurring in people older than age 65. We are not aware of any other reports examining breathing exercises in this population. Fourteen patients concluded the 16-week respiratory exercise program. All the patients were evaluated with regard to lung function, respiratory muscle strength, aerobic capacity, quality of life and clinical presentation. After 16 weeks of this open-trial intervention, significant increases in maximum inspiratory pressure and maximum expiratory pressure (27.6% and 20.54%, respectively) were demonstrated. Considerable improvement in quality of life was also observed. The clinical evaluations and daily recorded-symptoms diary also indicated significant improvements and fewer respiratory symptoms. A month after the exercises were discontinued, however, detraining was observed. In conclusion, a respiratory exercise program increased muscle strength and was associated with a positive effect on patient health and quality of life. Therefore, a respiratory training program could be included in the therapeutic approach in older adults with asthma.

Eman M. Othman ct al., 2016, [35] reported that radical cystectomy at times involves respiratory physical therapy aiming to reverse pulmonary dysfunction, thus avoiding postoperative pulmonary complications that increase hospital morbidity. The aim of this study was to investigate the effects of resisted breathing exercise versus incentive spirometer (IS) training on vital capacity (VC) outcomes in postoperative radical cystectomy cases. Forty male and female patients between 40 and 80 years of age who had undergone radical cystectomy participated in this study. Patients were randomly assigned into two equal groups of 20 each; both groups received traditional physical approaches. In addition, group A (19 men and 1 woman) received IS training for l5min daily for 6 weeks, and group B (16 men and 4 women) received resisted breathing exercise for l5min daily, for 6 weeks. The primary outcome was VC, which was measured using an electronic spirometer. This study showed a significant increase (P+0.05) in VC in both groups on comparing pretreatment and post-treatment values within each group.

After 6 weeks of treatment, between-group statistical analysis showed equal improvements in VC (P=0.52). Nevertheless, the percentage of improvement in VC was 43.5% (2.46a0.64), higher than that in the resisted breathing exercise group at 23.9% (2.34a0.53). IS produced better objective improvement in VC compared with the usage of resistive breathing exercise? However, both are considered as a gold therapeutic tool in the management of pulmonary complication after radical cystectomy.

Naglaa Bakry Elkhateeb ct al., 2015, [36] evaluated the role of PR program to: Improve functional capacity as assessed by 6MWD test, improve dyspnea level as assessed by MRC dyspnoea scale, improve PFT and improve ABG. COPD has significant extrapulmonary effects as weight loss, nutritional abnormalities, and skeletal muscle dysfunction. Pulmonary rehabilitation (PR) programs are beneficial to COPD in order to improve exercise capacity, muscle force, symptoms, and health-related quality of life. It was performed on forty-five COPD patients. They are divided into: 15 patients for aerobic training group, 15 patients for respiratory training group and 15 patients were control group. Regarding aerobic training group: There was a statistically significant improvement in 6MWD (Pvalue 0.001), BODE score (P-value 0.001) and both FEV1 (P-value 0.006) and FVC (P-value 0.002). Also there was a highly significant improvement of FVC% (P-value 0.006) than the respiratory training group. There was a higher % of improvement (66.7%) of dyspnea score grade within the respiratory training group than aerobic training and control groups. Although there was no statistically significant difference of both physiological parameters and ABG variables between control and respiratory training groups, there was a significant improvement of both FVC (P-value 0.001) and FEV1 (P-value 0.047) and PO_2 (P-value 0.001) and Sat O_2 (P-value 0.001) within the respiratory training group. Short-term PR program (6-8 weeks) especially aerobic training program has the capacity to: Break the vicious circle of dyspnea, increasing inactivity and exercise intolerance. Improve physiological parameters (FVC and FEV1) and improve some components of BODE index.

Ruben D Restrepo &, Leo Wittnebel, 2011, [37] searched the MEDLINE, CINAHL, and Cochrane Library databases for articles published between January 1995 and April 2011. The update of this clinical practice guideline is the result of reviewing a total of 54 clinical trials and systematic reviews on incentive spirometry. The following recommendations are made following the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) scoring system. 1: Incentive spirometry alone is not recommended for routine use in the preoperative and postoperative setting to prevent postoperative pulmonary complications. 2: It is recommended that incentive spirometry be used with deep breathing techniques, directed coughing, early mobilization, and optimal analgesia to prevent postoperative pulmonary complications. 3: It is suggested that deep breathing exercises provide the same benefit as incentive spirometry in the preoperative and postoperative setting to prevent postoperative pulmonary complications. 4: Routine use of incentive spirometry to prevent atelectasis in patients after upper-abdominal surgery is not recommended. 5: Routine use of incentive spirometry to prevent atelectasis after coronary artery bypass graft surgery is not recommended. 6: It is suggested that a volume-oriented device be selected as an incentive spirometry device.

Sachin Chaudhary ct al., 2020, [38] compared the immediate effects of deep breathing with acapella and incentive spirometer in preventing early postoperative pulmonary complications followed by CABG. 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. 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. The study obtained very discrete findings. Out of 4 days recordings of the outcome, the SP 2 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. 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), SP 2 levels and reduction of shortness of breath, thus improving quality outcome.

Gregory Reychler ct al., 2016, [39] reported on the effects of a 4-week program of IS on respiratory muscle strength, chest wall mobility, and lung function in healthy elderly adults was compared with those of a program of IMT. Based on a 10-cm H2O difference in MIP after 4 weeks of training, 15 subjects per group were needed to have sufficient statistical power to detect a treatment effect. Analysis of variance and chi-square tests were used to compare initial characteristics and improvement in outcomes. Forty-eight subjects were randomized. The three groups had similar characteristics at the onset of the study. Changes in respiratory muscle strength, CE, and lung function with training. MIP improved by 38.0% in the IMT group, 49.9% in the IS group, and 22.7% in the control group ($P > .05$). Only lower CE improvement was significantly greater in the IS group than the control group. Lung function parameters improved by at least 10% only in the IMT group. Mean inspired volume tended to increase every week (1,932, 2,046, 2,150, 2,121 mL, $P = .18$).

Gopala Krishna Alaparthi ct al., 2016, [40] evaluated on the effects of diaphragmatic breathing exercises and flow and volume-oriented incentive spirometry on pulmonary function and diaphragm excursion in patients undergoing laparoscopic abdominal surgery. They selected 260 patients posted for laparoscopic abdominal surgery and they were block randomization as follows: 65 patients performed diaphragmatic breathing exercises, 65 patients performed flow incentive spirometry, 65 patients performed volume incentive spirometry, and 65 patients participated as a control group. All of them underwent evaluation of pulmonary function with measurement of Forced Vital Capacity (FVC), Forced Expiratory Volume in the first second (FEVI), Peak Expiratory Flow Rate (PEFR), and diaphragm excursionmeasurement by ultrasonography before the operation and on the first and second postoperative days. With the level of significance set at p 0.05. Pulmonary function and diaphragm excursion showed a significant decrease on the first postoperative day in all four groups (p 0.001) but was evident more in the control group than in the experimental groups.On the second postoperative day pulmonary function (Forced Vital Capacity) and diaphragmexcursion were found to be better preserved in volume incentive spirometry and diaphragmatic breathing exercise group than in the flow incentive spirometry group and the control group. Pulmonary function (ForcedVital Capacity) and diaphragmexcursion showed statistically significant differences between volume incentive spirometry and diaphragmatic breathing exercise group (p 0.05) as compared to that flow incentive spirometry group and the control group. Volume incentive spirometry and diaphragmatic breathing exercise can be recommended as an intervention for all patients pre- and postoperatively, over flow-oriented incentive spirometry for the generation and sustenance of pulmonary function and diaphragm excursion in the management of laparoscopic abdominal surgery.

Fagevik Ols'en ct al. reviewed forty-four studies in order to evaluate the effects of chest physiotherapy interventions in laparoscopic and open abdominal surgery. But the results showed that breathing exercises were efficacious in preventing postoperative pulmonary complications in patients undergoing open surgery. The review also showed that laparoscopic procedures impair respiratory function to a considerably lower degree than open surgery. One study in the review showed that routine treatment is not called for in upper gastrointestinal features such as, for instance, fundoplication and vertical banded gastroplasty [41].

El-Marakby ct al. carried out a study on two experimental groups of patients in order to evaluate the effects of aerobic exercise training and incentive spirometry in controlling pulmonary complications following laparoscopic cholecystectomy. One group was given aerobic walking raining and incentive spirometry as well as traditional physical therapy (Group A); the other (Group B) was given traditional physical therapy. Results indicated a significant reduction in heart rate, SaO_2, and inspiratory capacity for both groups. The researchers concluded that aerobic exercise and incentive spirometry were beneficial in reducing the postoperative pulmonary complications after laparoscopic cholecystectomy[42].

Kundra ct al. carried out a comparative study on the effect of preoperative and postoperative incentive spirometry on the pulmonary function of fifty patients who had undergone laparoscopic cholecystectomy. The study group had to carry out incentive spirometry fifteen times before surgery, every four hours, for one week. However, the control group underwent incentive spirometry only during the postoperative period. Pulmonary function was recorded before surgery and 6, 24, and 48 hours postoperatively and at the time of discharge. Result showed that pulmonary function improvement was seen after preoperative incentive Spirometry. The authors concluded that pulmonary function iswell-preserved with preoperative than postoperative incentive spirometry [43].

Cattano ct al. studied forty-one morbidly obese to assess use of incentive spirometry preoperatively which could help patients to preserve their pulmonary function (inspiratory capacity) better in the postoperative period following laparoscopic bariatric surgery. Subjects were randomly sorted into two groups (the exercise and the control group).The exercise group used the incentive spirometer for ten breaths, five times per day. The control group used incentive spirometer three breaths, once per day. Pulmonary function (inspiratory capacity) was recorded at the day of surgery and postoperative day 1. The author concluded that preoperative use of the incentive spirometer does not lead to significant improvement of pulmonary function (inspiratory capacity) [44].

Rafaqat A ct al., 2016, [45] compared the effectiveness of Balloon Blowing exercise and incentive spirometry in patients with chest intubation after trauma. It was a randomized controlled trial. The participants were selected on the basis of chest trauma with chest intubations who were admitted. A questionnaire which consisted of demographic (age and gender) data and measuring variables (Force vital capacity, forced expiratory volume in 1 second, oxygen saturation, respiration rate and chest expansion) was filled from the participants. Study duration was 6 weeks and patients were divided in two groups of 30 in each group. Group 1 used incentive spirometry method and group 2 used balloon blowing exercise method. So it is concluded that the pre and post treatment differences are found statistically significant. The pre and post differences in incentive spirometry group and balloon blowing group found a significant improvement in breathlessness with the p-value is 0.00 for FVC, FEV1, SPO, RR and Chest Expansion. The post treatment differences between two groups are found statistically insignificant. The p-values for FVC, FEV1, SPO, RR and Chest Expansion are 0.660, 1.00, 0.216, 0.927 and 0.636 respectively. Comparing these p-values at significance level 0.05 is insignificant. So conclusion of the study implies that both incentive spirometry and balloon blowing exercise are equally effective.

A retrospective study analysis was done on 515 cases of chest trauma injury. They found that thoracic morbidity rate was 36% and mortality rate was 15.5%. Majority of the patients with blunt trauma had a lot of other injuries along with chest trauma. In this study only 84 patients had isolated thoracic injuries and 431 patients had multi trauma injuries with chest trauma. In all, 287 patients who had hemothorax, pneumothorax (unilaterally and bilaterally) and their combined complications developed like pulmonary contusions, cardiac contusions, ruptured diaphragms, ruptured aortas, cardiac rupture, thoraceobronchial injury, pulmonary vessels and great vessels injury. Morbidity was mainly due to atelectasis then pneumonia, acute respiratory distress syndrome, emphysema, recurrent pneumothorax and aspiration. Mortality rate is due to late arrival of patients to hospital with no vital sign or cardiac arrest and also due to acute respiratory distress syndrome developed after 72 hours of hospitalization [46].

Another study was conducted to quantitatively assess the efficacy of incentive spirometry (IS), intermittent positive pressure breathing (IPPB), and deep breathing exercises (DBEX) in postoperative pulmonary complications prevention in patients who had upper abdominal surgery. Method of database was performed and collects through the relevant citations through computerized searches and the cumulative Index to Nursing and Allied Health. Citations were based on the following selected and relevant criteria of patients undergo any type of upper abdominal surgery, any combination of IS, IPPB, and DBEX, a pulmonary complications outcome and randomized trials. Results were in favor of incentive spirometry. An incentive spirometry verse no physical activity was 0.44 and results of deep breathing exercise versus no physical activity was 0.43. Both findings were significant. Comparison between the IS verses IPPB is 0.76 (95%), IS verses DBEX is 0.91 (955) and IPPB verses DBEX is 0.94 (95%). Therefore the result is quite clear that Incentive spirometry and DBEX is found to be more effective than no physical therapy intervention in postoperative pulmonary complications prevention [47].

Lung volume therapy with the VoldyneRo device can improve lung volume and has a nonsignificant benefit on respiratory muscle strength via the slow deep-breathing technique (SDBT); whereas respiratory muscle training with a respiratory muscle trainer via the fast deep-breathing technique (FDBT) has produced a significant improvement in people with COPD. Thus, the aim of this study was to compare the efficiency of lung volume therapy with the

VoldyneRo device with the SDBT and FDBT on pulmonary function, respiratory muscle strength, oxidative stress, cytokines, walking capacity, and quality of life (QoL) in people with COPD. A total of 30 COPD patient volunteers with mild (stage I) to moderate (stage II) severity were randomized into two groups: SDBT (n=15) and FDBT (n=15). Pulmonary function (FVC, FEV1, and FEVl/FVC), maximal inspiratory mouth pressure (PImax), oxidative stress status (total antioxidant capacity [TAC], glutathione [GSH], malondialdehyde [MDA], and nitric oxide [NO]), inflammatory cytokines (tumor necrosis factor-alpha [TNF-o] and IL-6), 6-minute walking distance (6MWD), and total clinical COPD questionnaire (CCQ) score were evaluated before and after 4 weeks of training. All the parameters had no statistical difference between the groups before training. The PImax, TAC, IL-6, total QoL score, and 6MWD changed significantly in the SDBT group after the 4-week experiment as compared to those in the pre-experimental period, whereas FVC, FEV1, FEV1%, FEV1/FVC%, PImax, TAC, MDA, NO, TNF-n, IL-6, 6MWD, and total CCQ score changed significantly in the FDBT group as compared to those in the pre-experimental period. The FEV1%, PImax, TNF-o, IL-6, and total CCQ score differed significantly in the FDBT group in the post-experimental period as compared to those in the SDBT group. This preliminary study concluded that the application of incentive spirometry with the VoldyneRo device via fast deep breathing possibly improved respiratory muscle strength and QoL and reduced inflammatory cytokines, MDA, and NO better than that via slow deep breathing among people with COPD [48].

Pulmonary complications are the most frequently occurring complications following cardiac surgeries. Chest physiotherapy along with incentive spirometry after surgery is directed towards maximal inspiration in an attempt to prevent atelectasis. Incentive spirometry is a device with visual feedback designed to achieve and sustained maximal inspiration. Various factors like age, gender, pulmonary complications, clinical diagnosis, type of surgery, type of incision, pain, etc., has an influence on the performance of incentive spirometry. To find out factors influencing incentive spirometry values in patients undergoing thoracotomy. Non experimental study design, observational type, 25 subjects with thoracotomy surgery were approached an inform consent was taken. All the subjects were given incentive spirometer along with conventional physiotherapy and incentive spirometry values are noted on 1st post-operative day and 7th post-operative day from the patients. Statistical analysis was done by using chi-square test which showed statistically no significant association ($p>0.05$) between smoking, pulmonary disorders, associated problems, diagnosis, type of surgery and incentive spirometry values in the thoracotomy patient on 1st and 7th post-operative day. It shows statistically significant association ($p+0.05$) of gender with incentive spirometry values on 7th post-operative. This study concluded that there is association between gender and performance of incentive spirometry but other factors like pain, age, diagnosis, type of incision, pulmonary complications does exhibit influence on the performance of incentive spirometer, which can be demonstrated with extensive study in future [49].

METHODOLOGY

Breathing Exercises: Using a Manual Incentive Spirometer

Breathing can be hard after you've had surgery, when you have a lung disease like COPD, or if you're on bed rest. You may find that you can only take small, shallow breaths. Breathing this way makes it harder to get air into your lungs and can cause fluid and mucus to build up in your lungs. This could cause a serious lung infection like pneumonia. Using an incentive spirometer can help you practice taking deep breaths, which can help open your airways, prevent fluid or mucus from building up in your lungs, and make it easier for you to breathe [24].

How do you use an incentive spirometer [24,50]?

When you use an incentive spirometer, you'll breathe in air through a tube that is connected to a large air column containing a piston or ball. As you breathe in, the piston or ball inside the column moves up. The height of the piston or ball shows how much air you breathed in. You may feel lightheaded when you breathe in deeply for this exercise. If you feel dizzy or like you're going to pass out, stop the exercise and rest. You may only be able to raise the piston or ball a short distance up the column at first. As you use the spirometer, you should be able to breathe in more air over time and get back to the level that is normal for you.

1. Move the slider on the outside of the large column to the level that you want to reach or that your doctor recommended.
2. Sit or stand up straight, and hold the spirometer in front of you. Be sure to keep it level.
3. To start, breathe out normally. Then close your lips tightly around the mouthpiece. Make sure that you don't block the mouthpiece with your tongue.

4. Take a slow, deep breath. Breathe in as deeply as you can. As you breathe in, the piston or ball inside the large column will move up. Try to move the piston or ball as high up as you can or to the level your doctor recommended. When you can't breathe in anymore, hold your breath for 2 to 5 seconds.
5. Relax, remove the mouthpiece, and then breathe out normally. Repeat steps 1 through 5 as many times as your doctor tells you to. Then go to step 6.
6. After you've taken the recommended number of breaths, try to cough a few times. This will help loosen any mucus that has built up in your lungs. It will make it easier for you to breathe. If you just had surgery on your belly or chest, hold a pillow over your incision when you cough. This will support your belly or chest and reduce your pain. Repeat steps 1 through 6 as many times a day as your doctor tells you to.

Each time you do this exercise, keep track of your progress by writing down how high the piston or ball moves up the large column. This will help you and your doctor know how well your lungs are working.

Incentive spirometry, also referred to as sustained maximal inspiration, is accomplished by using a device that provides feedback when the patient inhales at a predetermined flow or volume and sustains the inflation for at least 5 seconds. The patient is instructed to hold the spirometer in an upright position, exhale normally, and then place the lips tightly around the mouthpiece. The next step is a slow inhalation to raise the ball (flow-oriented) or the piston plate (volume-oriented) in the chamber to the set target. At maximum inhalation, the mouthpiece is removed, followed by a breath-hold and normal exhalation. Instruction of parents, guardians, and other health caregivers in the technique of incentive spirometry may help to facilitate the patient’s appropriate use of the technique and assist with encouraging adherence to therapy.

HAZARDS AND COMPLICATIONS [24]

- Ineffective unless performed as instructed
- Hyperventilatiomrespiratory alkalosis
- Hypoxemia secondary to interruption of prescribed
- oxygen therapy
- Fatigue

- Pain

INDICATIONS [51-72]

- Preoperative screening of patients at risk for postoperative complications to obtain baseline flow or volume.
- Respiratory therapy that includes daily sessions of incentive spirometry plus deep breathing exercises, directed coughing, early ambulation, and optimal analgesia may lower the incidence of postoperative pulmonary complications.
- **Presence of pulmonary atelectasis or conditions predisposing to the development of pulmonary atelectasis when used with:**

4 Upper-abdominal or thoracic surgery

4 Lower-abdominal surgery

4 Prolonged bed rest

4 Surgery in patients with COPD

4 Lack of pain control

4 Presence of thoracic or abdominal binders

4 Restrictive lung defect associated with a dysfunctional diaphragm or involving the respiratory musculature

  - Patients with inspiratory capacity of 2.5 L
  - Patients with neuromuscular disease
  - Patients with spinal cord injury

- Incentive spirometry may prevent atelectasis associated with the acute chest syndrome in patients with sickle cell disease.
- In patients undergoing coronary artery bypass graft

4 Incentive spirometry and positive airway pressure therapy may improve pulmonary function and 6-minute walk distance and reduce the incidence of postoperative complications.

When you empty out and refill the air in your lungs, you get rid of fluid and germs that can lead to an infection. You also exercise your lungs, so that they're able to put more oxygen into your body. That helps you to heal and avoid lung infections. If you're having surgery, your doctor may want you to start using your spirometer at home before you head to the hospital. If you strengthen your lungs, you're less likely to pick up an infection there. Experts debate the advantages of incentive spirometry. Studies show that deep breathing exercises appear to work just as well. Your doctor will suggest what may work best for you.

CONCLUSION

Incentive spirometry is also referred to as sustained maximal inspiration. This essential component is used in patients preoperatively and postoperatively in thoracotomy surgeries to prevent respiratory complications. The incentive Spirometry increases the intra pleural pressure and intra alveolar pressure after a deep inhalation and by increasing Tran's pulmonary pressure gradient, which is sustained for a few seconds with a breath hold. Atelectasis can frequently be prevented or treated by increasing the Trans pulmonary pressure gradient and further expanding the alveoli.

REFERENCES

[1] Su MY, Chiang CD, Huang WL, Li SJ, King SL, Peng FK. A new device of incentive spirometry. Zhonghua Yi Xue Za Zhi (Taipei), 1991; 48:274-277.

[2] Dean EW, Frownfelter DL. Clinical case study guide to accompany principles and practice of cardiopulmonary physical therapy. 3rd ed. St Louis, MO: Mosby Year Book Medical Pub; 1996. 749-760.

[3] Hough A. Physiotherapy in respiratory care: an evidence-based approach to respiratory and cardiac management. 3rd ed. Cheltenham Nelson Thornes, Cengage Learning, 2001.

[4] Hsiao SF, Wu YT, Wu HD, Wang TG. Comparison of effectiveness of pressure threshold and targeted resistance devices for inspiratory muscle training in patients with chronic obstructive pulmonary disease. J Formos Med Assoc, 2003; 102:240—245.

[5] Mzezewa, S., Setati, M., Netshiongolwe, T., & Sinoamadi, V. " Prevalence of breast cancer in reduction mammoplasty specimens, in women of African origin: preliminary histology results at Mankweng and Polokwane hospitals. *Journal of Medical Research*

and Health Sciences, 3(10) (2020), 1109-1113. https://doi.org/10.15520/jmrhs.v3i10.264

[6] A.S. (Ph.D), O., & V.A, O. (2018). The Knowledge and Practices of Women of Child Bearing Age towards Safe Motherhood in Ekiti State. Journal of Current Medical Research and Opinion, 1(09), 47-65. https://doi.org/10.15520/jcmro.v1i09.113

[7] Asmsen E. Exercise and regulation of ventilation. In: Circulation research. Philadelphia, PA: Lippincott Williams & Wilkins; 1967. 132-145.

[8] Romer LM, Mcconnell AK. Specificity and reversibility of inspiratory muscle training. Med Sci Sports Exerc 2003; 35:237-244.

[9] Celli BR. Perioperative respiratory care of the patient undergoing upper abdominal surgery. Clin Chest Med 1993; 14:253-261.

[10] Cattano D, Altamirano A, Vannucci A, Melnikov V, Cone C, Hagberg CA. Preoperative use of incentive spirometry does not affect postoperative lung function in bariatric surgery. 2010;156(5):265-72.

[11] ElShanti, A., EL syed Etewa, B., Dhair, A., & Abo Samra, N. " Risk Factor of Intra-Uterine Fetal Death in Gaza Governmental Hospitals:Case-Control Study (2018-2019). *Jotirnal of Medical Research and Health Sciences*, 3(10) (2020). https://doi.org/10.15520/jmrhs.v3i10.275

[12] Celli BR, Rodriguez KS, Snider GL. A controlled trial of intermittent positive pressure breathing, incentive spirometry, and deep breathing exercises in preventing pulmonary complications after abdominal surgery. 1984; 130(1):12-5.

[13] Ray, S., Jha, A., Afreen Islam, A., & Sengupta, M. (2020). Study of prognostic and diagnostic significance of P53 and PTEN mutation in proliferative lesions of endometrium. Journal of Current Medical Research and Opinion, 3(08), 563-569. https://doi.org/10.15520/jcmro.v3i08.321

[14] Agostini P, Calvert R, Subramanian H, Naidu B. Is incentive spirometry effective following thoracic surgery. 2008;7(2):297-300.

[15] Touyz, L. Z., & Touyz, S. J. " Kissing, Saliva and Human Papilloma Virus: Principles, Practices, and Prophylaxis. *Jotirnal of Medical Research and Health !?ciences,* 3(9) (2020), 1078-1086. https://doi.org/10.15520/jmrhs.v3i9.245

[16] MD, PhD, J. F., & Scorza, MD, F. A. (2018). Do urine heteroplasmy rates predict the outcome of the m.3243A>G mutation?. *Journal of I'urrent Medical Research and Opinion*, 1(09), 40-41. https://doi.org/10.15520/jcmro.v1i09.107

[17] Guimarñes MM, El Dib R, Smith AF, Matos D. Incentive spirometry for prevention of postoperative pulmonary complications in upper abdominal surgery. 2009;3.

[18] Fisher BW, Majumdar SR, McAlister FA. Predicting pulmonary complications after nonthoracic surgery: a systematic review of blinded studies. Am J Med 2002;112(3):219-225.

[19] Kagoiyo, N. S., Wanjiku, M. S., & Kagoiyo, S. W. (2020). Evidence Based Health Demographic Assessment of URIRI Sub-County in Migori County, Kenya. Journal of Current Medical Research and Opinion, 3(08). https://doi.org/10.15520/jcmro.v3i08.325

[20] Gatti G, Cardu G, Lusa AM, Pugliese P. Predictors of postoperative complications in high-risk octogenarians undergoing cardiac operations. Ann Thorac Surg 2002;74(3):671-677.

[21] Renault JA, Costa-Val R, Rossetti MB. Respiratory physiotherapy in the pulmonary dysfunction after cardiac surgery. Rev Bras Cir Cardiovasc, 2008;23(4):562-569.

[22] Mzezewa, S. " The plight of women with cleft lips-A case report. *Jotirnal of Medical Research and Health !?ciences,* 3(9) (2020)., 1087-1089. https://doi.org/10.15520/jmrhs .v3i9.251

[23] Wilkins RL. Lung expansion therapy. In: Wilkins RL, Stoller JK, Kacmarek RM, editors. Egan's fundamentals of respiratory care, 9'h edition. St. Louis: Mosby Elsevier; 2009:903-920.

[24] Westwood K, Griffin M, Roberts K, Williams M, Yoong K, Digger T. Incentive spirometry decreases respiratory complications following major abdominal surgery. Surgeon 2007; 5(6):339-342.

[25] Rosie re J, Vader JP, Cavin MS, Grant K, Larcinese A, Voellinger R, ct al. Appropriateness of respiratory care: evidence-based guidelines. Swiss Med Wkly 2009; 139(27-28):387-392.

[26] Mishra, D. R., Sharma, D., Barpande, D. J., Kumari, D. N., & Mehta, D. H. (2020). Anaesthetic Management of Cytoreductive Surgery with Hyperthermic Intraperitoneal

Chemotherapy (CRS/HIPEC): A True Challenge To an Anaesthetist. Journal of Current Medical Research and Opinion, 3(07), 503-507. https://doi.org/10.15520/jcmro.v3i07.307

[27] Clifton-Smith T, Rowley J (2011) Breathing pattern disorders and physiotherapy: inspiration for our profession. *Physical Therapy Reviews* 16: 75-86.

[28] Baltich J, von Tscharner V, Nigg BM (2015) Degradation of postural control with aging. *Proc Inst Mech Eng H* 229: 638-644.

[29] Karakoyun DO, Ozkaya M, Okutan VC, Dalgip A, Belen D, et a1. (2015) Biomechanical comparison of unilateral semi-rigid and dynamic stabilization on ovine vertebrae. *Proc Inst Mech Eng H* 229: 778-785.

[30] Kolar P, Bitnar P, Dyrhonova O, Horacek O, Kriz J, Adamkova M ... Zumrova I (2009) Rehabilitation in Clinical Practice. Prague: Galén.

[31] Véle F (2012) Investigation of motor functions from a neurophysiological point of view: a guide for therapists working in neurorehabilitation. Prague: Triton.

[32] https://lunginstitute.com/blog/incentive-spirometry-benefits/

[33] Healthwise Staff, Medical Review, June 9, 2019, https://www.mottchildren.org/health-library/abj5949

[34] Improving Lung Capacity Pre- and Post-COVID-19, https://www.cedars-sinai.org/newsroom/improving-lung-capacity-pre--and-post-covid-19/

[35] https://www.mskcc.org/cancer-care/patient-educationhow-use-your-incentive

[36] https://www.registerednursern.com/incentive-spirometer-nclex-review/

[37] https://www.verywellhealth.com/how-to-use-an-incentive-spirometer-914988

[38] https://www.meaok.com/incentive-spirometer.html

[39] https://www.verywellhealth.com/how-to-use-an-incentive-spirometer-914988

[40] R. Malatova, P. Bahensky, J. Kanasova and J. Stumbauer, Intervention Breathing Exercises and Their Effect on Breathing Stereotype and Vital Lung Capacity, *ARE'H Women Health I'are,* 2019, 2(1): 1-6.

[41] Shao-Kai Sum, Ya-Chuan Peng, Shun-Ying Yin, Pin-Fu Huang, Yao-Chang Wang, Tzu-Ping Chen, Heng-Hsin Tung and Chi-Hsiao Yeh, Using an incentive spirometer reduces pulmonary complications in patients with traumatic rib fractures: a

randomized controlled trial, Trials, 2019, 20:797, https://doi.org/10.1186/s13063-019-3943-x

[42] Paltiel Weiner, Abraham Man, Margalit Weiner, Marinella Rabner, Joseph Waizman, Rasmi Magadle, Doron Zamir, Yoel Greiff, The effect of incentive spirometry and inspiratory muscle training on pulmonary function after lung resection, The Journal of Thoracic and Cardiovascular Surgery, 113, 3, 1997;113:552-7.

[43] Ludmila Tais Yazbek Gomieiro, Andre' ia Nascimento, Luciana Kase Tanno, Rosana Agondi, Jorge Kalil, Pedro Giavina-Bianchi, Respiratory exercise program for elderly individuals with asthma, Clinics, 2011;66(7):1165-1169 DOI:10.1590/S1807-59322011000700007

[44] Eman M. Othman, Shaimaa A. Abaas, Hamada H. Hassan, Resisted breathing exercise versus incentive spirometer training on vital capacity in postoperative radical cystectomy cases: a pilot randomized controlled trial, Bulletin of Faculty of Physical Therapy, 2016, 21:61-67.

[45] Naglaa Bakry Elkhateeb, Ahmed A. Elhadidi, Hosam H. Masood, Amany R. Mohammed, Pulmonary rehabilitation in chronic obstructive pulmonary disease, Egyptian Journal of Chest Diseases and Tuberculosis, 2015, 64, 359-369.

[46] Ruben D Restrepo &, Leo Wittnebel, AARC Clinical Practice Guideline, Incentive Spirometry: 2011, Respiratory Care, 2011, 56, 10, 1600-1604.

[47] Sachin Chaudhary, Neha Ingale Chaudhary, Babaji Ghewade, Gaurav Mahajan, The Immediate Effects of Breathing Exercises with Acapella and Incentive Spirometer on Preventing Early Pulmonary Complications Following Cabg. - A Comparitive Study, International Journal of Current Research and Review, 2020, 12, 17, 51-58.DOI: http://dx.doi.org/10.31782/IJCRR.2020.121710

[48] Gregory Reychler, Sophie Delacroix, Donatienne Dresse, Thierry Pieters, Giuseppe Liistro, Randomized controlled trial of the effect of inspiratory muscle training and incentive spirometry on respiratory muscle strength, chest wall expansion, and lung function in elderly adults, The American Geriatrics Society, 2016,64,5: 1128-1151.

[49] Gopala Krishna Alaparthi, Alfred Joseph Augustine, R. Anand, and Ajith Mahale, Comparison of Diaphragmatic Breathing Exercise, Volume and Flow Incentive Spirometry, on Diaphragm Excursion and Pulmonary Function in Patients Undergoing

Laparoscopic Surgery: A Randomized Controlled Trial, Hindawi Publishing Corporation Minimally Invasive Surgery, Volume 2016, Article ID 1967532, 12 pages, http://dx.doi.org/10.1155/2016/1967532.

[50] M. Fagevik Ols'en, K. Josefson, and H. L"onroth, "Chest physiotherapy does not improve the outcome in laparoscopic fundoplication and vertical-banded gastroplasty," *Surgical Endoscopy*, vol. 13, no. 3, pp. 260-263, 1999.

[51] A. A. El-Marakby, A. Darwiesh, E. Anwar, A. Mostafa, and A. Jad, "Aerobic exercise training and incentive spirometry can control postoperative pulmonary complications after laparoscopic cholecystectomy," *Middle East Journal of Scientific Research,* vol. 13, no. 4, pp. 459W63, 2013.

[52] P. Kundra, M. Vitheeswaran, M. Nagappa, and S. Sistla, "Effect of preoperative and postoperative incentive spirometry on lung functions after laparoscopic cholecystectomy," *Surgical Laparoscopy, Endoscopy and Percutaneous Techniques,* vol. 20, no. 3, pp. 170-172, 2010.

[53] D. Cattano, A. Altamirano, A. Vannucci, V. Melnikov, C. Cone, and C. A. Hagberg, "Preoperative use of incentive spirometry does not affect postoperative lung function in bariatric surgery," *Translational Research,* vol. 156, no. 5, pp. 265-272, 2010.

[54] Rafaqat A, Mushtaq Z, Tahir A, Shahzad MF,Comparison between Balloon Blowing Exercise and Incentive Spirometry in Patients with Chest Intubation after Trauma. J Nov Physiother,2016, S3: 013. doi:10.4172/2165-7025.S3-013

[55] Alrehaili, A. " Assessing the Understanding and Perception of the Significance of Seasonal Immune Care among the Taif Population during the Pilgrimage Seasons: Emphasis on Influenza and Meningitis Vaccines. *Comma/ of Medical Research and Health !?ciences*, 3(4) (2020), 931-940. https://doi.org/10.15520/jmrhs.v3i4.175

[56] Kovacevic P, Ugrenovic S, Kovacevic T, Anatomical study in human fetuses and cadavers. Vascularisation of pectoralis maior myocutaneous flap. 1996, Bosn J Basic Med Sci 8: 183-187.

[57] Thomas JA, Mcintosh JM, Are incentive spirometry, intermittent positive pressure breathing, and deep breathing exercises effective in the prevention of postoperative pulmonary complications after upper abdominal surgery? A systematic overview and meta-analysis. Phys Ther, 1994, 74: 3-10.

[58] Jirakrit Leelarungrayub, Rungthip Puntumetakul, Thanyaluck Sriboonreung, Yothin Pothasak, Jakkrit Klaphajone, Preliminary study: comparative effects of lung volume therapy between slow and fast deep-breathing techniques on pulmonary function, respiratory muscle strength, oxidative stress, cytokines, 6-minute walking distance, and quality of life in persons with COPD, International Journal of COPD 2018:13 3909-3921.

[59] Anandhi D and Divya P, Influence of various Factors on the Incentive Spirometry Values in Patients Undergoing Thoracotomy, Annals of Physiotherapy Clinics, 2018, 1, 1, 1003,1-5.

[60] https://www.webmd.com/lung/lung-incentive-spirometer

[61] Agostini P, Calvert R, Subramanian H, Naidu B. Is incentive spirometry effective following thoracic surgery? Interact Cardiovasc Thorac Surg 2008; 7(2):297-300.

[62] Kips JC. Preoperative pulmonary evaluation. Acta Clin Belg 1997; 52(5):301-305.

[63] Larson CM, Ratzer ER, Davis-Merritt D, Clark JR. The effect of abdominal binders on postoperative pulmonary function. Am Surg 2009; 75(2):169-171.

[64] Pappachen S, Smith PR, Shah S, Brito V, Bader F, Khoury B. Postoperative pulmonary complications after gynecologic surgery. Int J Gynaecol Obstet 2006; 93(1):74-76.

[65] Bellet PS, Kalinyak KA, Shukla R, Gelfand MJ, Rucknagel DL. Incentive spirometry to prevent acute pulmonary complications in sickle cell disease. NEJM 1995;333(11):699-703.

[66] Weindler J, Kiefer RT. The efficacy of postoperative incentive spirometry is influenced by the device-specific imposed work of breathing. Chest 2001;119 (6):1858-1864.

[67] Ahmed, M. S., Naznin, N., & Alam, M. J. " Adaptation of Apraxia Battery for Assessing the Patient with Apraxia. *Jotirnal of Medical Research and Health !?ciences*, 3(10) (2020), 1114-1123. https://doi.org/10.15520/jmrhs.v3i10.263

[68] Chureemas G, Kovindha A. The use of sustained maximal inspiration (SMI) to improve respiratory function in spinal cord injury. J Thai Rehabil 1992; 2(1):20-25.

[69] Hsu LL, Batts BK, Rau JL. Positive expiratory pressure device acceptance by hospitalized children with sickle cell disease is comparable to incentive spirometry. Respir Care 2005; 50(5):624-627.

[70] Ya'nez-Brage I, Pita-Ferna'ndez S, Juffe'-Stein A, Martinez-Gonza'lez U, Pe'rtega-Diaz S, Mauleo'n-Garcia A. Respiratory physiotherapy and incidence of pulmonary complications in off-pump coronary artery bypass graft surgery: an observational follow-up study. BMC Pulm Med 2009; 9:36.

[71] Haeffener MP, Ferreira GM, Barreto SS, Arena R, Dall'Ago P. Incentive spirometry with expiratory positive airway pressure reduces pulmonary complications, improves pulmonary function and 6-minute walk distance in patients undergoing coronary artery bypass graft surgery. Am Heart J, 2008; 156(5):900.e1-e900.

[72] Ferreira GM, Haeffner MP, Barreto SS, Da11'Ago P. Incentive spirometry with expiratory positive airway pressure brings benefits after myocardial revascularization. Arq Bras Cardiol, 2010; 94(2):230-235.