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Influence of Various Factors on the Incentive Spirometry Values in Patients Undergoing Thoracotomy

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Abstract

Background: 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.

Objective: To find out factors influencing incentive spirometry values in patients undergoing thoracotomy.

Methods: 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.

Outcome measure: Incentive spirometry values.

Results: 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.

Conclusion: 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.

Keywords: Incentive spirometry; Thoracotomy; Age; Gender, Type of incision; Pulmonary complications

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Introduction

Cardio Vascular Diseases (CVD) has been leading cause of morbidity and mortality in India. Cardiovascular diseases have a major share in the incidence of non-communicable diseases. CVD is also one of the leading causes of deaths in India. Recent trends indicate that the disease has escalated to younger age groups also. It has a significant presence in males and females in both rural and urban population.Among that Coronary Artery Disease (CAD) is rampant in Indians and that its prevalence is several folds higher than in industrialized nations [1].

Global Burden of Diseases gave an estimate of around 30 million patients suffering from CAD in India as per the study done in 2000. Annually, 50000 cases of carcinoma lung and 20000 cases of esophageal cancers are diagnosed in India. Annually, approximately 60000 open-heart surgeries are performed in India, and most of these are for coronary artery and valvular heart disease. Almost 5,000 surgeries are being performed for congenital heart diseases alone [2,3].

Thoracotomy is the process of making of an incision into the chest wall to gain access to the heart, lungs, mediastinum, oesophagus and great vessels.

Thoracotomy is a major surgical procedure requiring a thorough understanding of cardiorespiratory mechanics and maintenance of very vital organ function such as the heart and lungs. The postoperative care requires a high dependency environment with full physiological monitoring capabilities and trained, well-experienced staffs.

Figure 1: Incentive Spirometry Performed.

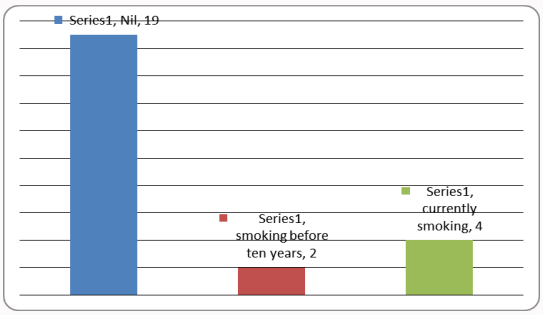

Figure 2: Frequency and Distribution of Patients with History of Smoking, COPD, Pulmonary Disorder, Asthma.

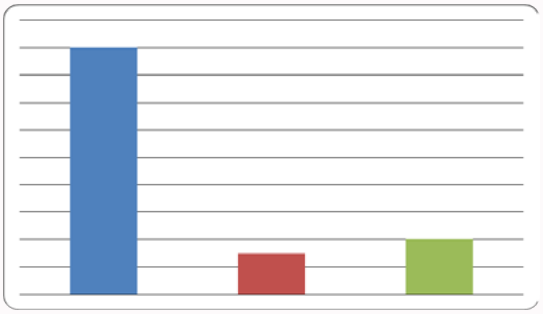

Figure 3: Frequencies and Distribution of Patients with Associated Problems.

Thoracotomy incision may be made on the side, under the arm (axillary thoracotomy) on the front, through the breast bone (median sternotomy), slanting from the back to the side (posterolateral thoracotomy) or under the breast (anterolateral thoracotomy).

The indications for thoracotomy include the management of Mediastinal tumors, bronchogenic carcinoma, blunt chest trauma (including cardiac injury) trans Mediastinal gunshot injuries, stab wounds of the chest, encysted empyema and fibro thorax, recurrent pneumothorax with bullae, diaphragmatic hernia repair, and oesophageal pathology, osteomyelitis, coronary bypass graft, neurosurgical procedures that require access to thoracic vertebral bodies or discs for treatment of fracture, neoplasm, bone cysts, osteomyelitis, spinal medullary tumours, discitis, or herniated nucleus pulposus.

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. Incentive spirometer is a device that provides patients with visual and other positive feedback. Incentive Spirometry is maneuvers 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 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.

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 [4-7].

The main aim of this study is to establish the influence of various factors on the Incentive Spirometry values in patients undergoing thoracotomy.

Methodology

Non experimental, observational type of study. Post Thoracotomy patients, both male and female, between 18-70 years, undergoing thoracotomy for the first time were included in this study and ventilator patients, history of recurrent surgeries, unstable cardiac status, history of Cerebrovascular accident were excluded from the study.

In this study, Twenty five post thoracotomy patients were selected based on inclusion and exclusion criteria Department of Cardiothoracic Surgery, SRM Medical College Hospital and Research Centre. Institution ethical clearance certificate was obtained. The subjects were informed about the study and an informed consent was obtained from each of the willing patients. Data was collected from the patients including age, gender, history of smoking, COPD, asthma, pulmonary disorder, associated problems (hypertension, diabetes mellitus), Diagnosis, Type of surgery, Date of surgery, type of incision and pain (VAS).

Adequate instructions were given on the use of incentive spirometer. The tri-ball incentive Spirometry (flow-oriented) was used which has three chambers with different colour balls. Each ball represents the value of 600 cc, 900 cc and 1,200 cc. The patients were asked to sit comfortably and to take deep inspiration and expiration normally and then place the mouthpiece around their lips tightly. Instruction was given not to block the opening in the mouthpiece. The patient is asked to inhale slowly and deeply to raise the ball in the chamber one by one to reach maximum of 1200 cc. Inhaling was continued to raise the ball indicator to the level of the graduation or as high as possible. Inhale longer, and then hold the breath for

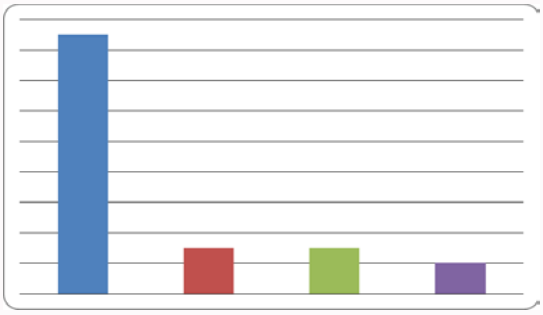

Figure 4: Frequencies and Distribution of Patients with Diagnosis.

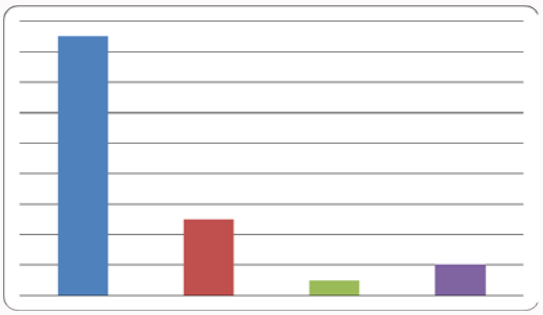

Figure 5: Frequencies and Distribution of Patients with Type of Surgery.

two to three seconds, and then slowly let the air out. Patient should breathe in and out through the mouthpiece (not through their nose) Incentive spirometer was given 4 times per day (15 repetitions) preoperatively. Post operatively the patients underwent conventional chest physiotherapy along with incentive Spirometry every 2 hours (15 repetitions). Constant encouragement is provided by the therapist throughout the treatment session. The incentive Spirometry values of each of the patients was collected on 1st post-operative day, 7th post-operative day for all the patients undergoing any thoracotomy surgery in Department of Cardio thoracic Surgery, SRM Medical College Hospital and Research Centre, Kattankulatur. The collected data was tabulated and statistically analyzed.

Discussion

Physiotherapy interventions after cardiac surgeries have been regularly utilized in the prevention and treatment of both pulmonary and musculoskeletal complications. Pre-operative and post-operative respiratory therapy aims to prevent or reverse atelectasis and improve the airway clearance of the patients. Incentive spirometry has been routinely considered a part of the pre-operative 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. 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.

Incentive spirometry remains a widely used technique for the prophylaxis and treatment of respiratory complications in post-surgical patients. O'Donohue surveyed its use in the United States and reported that 95% of hospitals in which cardio thoracic and abdominal surgery was performed used incentive spirometry in post-operative care [8]. Jenkins and soutar reported a usage rate of 44% in hospitals in which Coronary Artery Bypass Graft (CABG) surgery was carried out in the United Kingdom. More recently Wattie repeated this survey and found that the usage rate had increased to 70% despite recent publications that have cast doubt on both the need for incentive spirometry in patients undergoing CABG surgery and the effectiveness of IS in this population.

During the inspiratory phase of spontaneous breathing, the drop in pleural pressure caused by expansion of the thorax is transmitted to the alveoli. With alveolar pressure now negative, a pressure gradient is created between the airway opening and the alveoli. This Trans respiratory Pressure Gradient (Prs) causes gas to flow from the airway into the alveoli.

Alveolar expansion during spontaneous inspiration (equivalent to the change in volume) is proportional to the difference between the alveolar and pleural pressures at end inspiration. The difference between the alveolar and pleural pressures at end inspiration is called the Trans pulmonary pressure gradient. The increase in the Trans pulmonary pressure gradient 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.

During the patient's spontaneous expiration, the lungs and chest wall recoil, pleural pressure becomes less negative, and alveolar pressure rises above atmospheric. This reverses the Trans respiratory pressure gradient. With alveolar pressure now greater than pressure at the airway opening, gas flows out from the alveoli to the atmosphere.

Till date articles about incentive spirometry used in thoracotomy surgeries is scanty. Therefore evidence is lacking for benefits of incentive spirometry in reducing pulmonary complications and in decreasing the negative effects on pulmonary function in patients undergoing thoracotomy. Moreover no studies have been done on the factors such as gender, history of smoking, COPD, pulmonary disorders, asthma, associated problems, diagnosis, and type of surgery, type of incision, pain and post-operative complications influencing incentive spirometry. Hence this study is focussed on factors influencing incentive spirometry values in patients undergoing thoracotomy.

According to William D, Mc Ardle et al. who demonstrated that the ability to increase breathing depth during lung volume measurement depends on the gender of the individual. Incentive spirometry can vary with age, gender, body size and composition but particularly with stature.

Smokers also have decreased dynamic lung function, which in severe instance manifests itself in COPD. For adolescent smokers; relatively little chronic cigarette smoking obstructs the airways and slow normal lung function development, with greater defects in girls than boys. Hence smoking may demonstrate influence on incentive spirometry values (Table 1and Figure 1).

John C Hall et al. stated that deep breathing exercises are suitable for low risk patients and incentive spirometry is most efficient regime of treatment for high risk patients. As incentive spirometry gives visual feedback, by encouraging and giving confidence to the patient. Hence it is more effective for high risk patients [9,10].

Josef Weindler et al. States that recovery from major surgery is primarily endangered by post-operative pulmonary complications e.g., atelectasis, pneumonia or pulmonary dysfunction which remains the major cause of post-operative morbidity and mortality [11].

Table 1: Showing the frequency distribution, percentage and incentive spirometry values between 1st and 7th post-operative day.

S.No.	Factors Influencing Incentive Spirometry Values	Frequency	Percentage	Incentive spirometry values Pod-1			Incentive spirometry values Pod-7		
				600	900	1200	600	900	1200
1	**Gender**								
	Male	15	60%	12	3	0	0	7	8
	Female	10	40%	10	0	0	7	2	1
	History Of Smoking/COPD/Pulmonary Disorder/Asthma								
2	NIL	19	76%	17	2	0	7	6	6
	Smoking Before 10 Years	2	8%	1	1	0	0	2	0
	Currently Smoking	2	8%	2	0	0	0	1	1
	Smoking for Ten Years	2	8%	2	0	0	0	0	2
3	**Associated Problem**								
	NIL	18	72%	16	2	0	7	5	6
	SHTN	3	12%	3	0	0	0	2	1
	DM	4	16%	3	1	0	0	2	2
	Diagnosis								
4	CAD	17	68%	14	3	0	2	8	7
	RHD	3	12%	3	0	0	2	0	1
	MS	3	12%	3	0	0	2	1	0
	ASD	2	8%	2	0	0	1	0	1
5	**Type Of Surgery**								
	CABG	17	68%	14	3	0	2	8	7
	MVR	5	20%	5	0	0	3	1	1
	DVR	1	4%	1	0	0	1	0	0
	ASD	2	8%	2	0	0	1	0	1
6	**Type Of Incision**								
	Median Sternotomy	25	100%	22	3	0	7	9	9
7	**Post-Operative Complication**	25	100%	22	3	0	7	9	9

Table 2: Associations of Factors Influencing Incentive Spirometry Values on Pod 1 and Pod 7.

S.No	Factors Influencing Incentive Spirometry Values	Chi-Square Test	P<0.05
1	Gender Pod 1 Pod 7	 2.273 14.815	 0.132 0.001
2	History Of Smoking, COPD, Pulmonary Disorder, Asthma Pod 1 Pod 7	 3.319 8.626	 0.345 0.196
3	Associated Problem Pod 1 Pod 7	 1.063 4.321	 0.588 0.364
4	Diagnosis Pod 1 Pod 7	 1.604 8.855	 0.658 0.182
5	Type Of Surgery Pod 1 Pod 7	 1.604 8.590	 0.658 0.198

The manifold variables, whether patient-related (e.g. age, constitution or concomitant pulmonary disease) or care-related (e.g. type of surgery, anaesthesia or analgesia) are supposed to have an impact on the efficacy of respiratory care and yielded inconsistent results. This proves that factors like age, gender, pulmonary complications; type of surgery, type of incision has an influence on the performance of incentive spirometry (Table 1 and Figure 1-4).

Jackle A Thomas and John M McIntosh concluded that effect of incentive spirometry and deep breathing exercises appears to be more effective than no physical therapy intervention in the prevention of post-operative pulmonary complications [12].

There exist no association of factors like Gender, History Of Smoking/ COPD/ Pulmonary Disorder/ Asthma, associated Problems, Diagnosis, Type of Surgeryinfluencing incentive spirometry values on pod 1 and pod 7 because of small sample size (Table 2). Also there is no correlation shown between the VAS and incentive spirometry value on the 1st post-operative day and on 7th post-operative day (Table 3).

Table 3: Correlations between VAs and Incentive Spirometry Values on 1st And 7th post-operative day.

Test Name	MEAN	SD	DF	R VALUE	P<0.05 Sig. (2-tailed)
VAS-1 1st POD	10 636	0 99.49	23 23	-	-
VAS-7 7thPOD	4.68 924.00	.556 243.72	23 23	0.310 0.310	0.132 0.132

Future studies can be done with a large sample size; different age groups and volume oriented incentive spirometry can be taken for study.

Hence knowledge about factors influencing the performance of incentive spirometry will help the physiotherapist to administer and teach incentive spirometry with respect to individual patients.

Conclusion

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.

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