Original Research Paper

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Pulmonary Medicine

ASSESSING THE EFFECTIVENESS OF OSCILLATING POSITIVE EXPIRATORY PRESSURE DEVICE VERSUS USUAL AIRWAYCLEARANCE TECHNIQUES IN PATIENTS WITH CHRONIC PULMONARY DISEASE AND ICU PATIENTS

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KEYWORDS :

INTRODUCTION

Mucociliar clearance is an innate defense mechanism that protects the pulmonary system from the harmful consequences of inhaled agents, including those of biological, chemical, and physical nature. Ciliated cells, which line the surface epithelium of the airways, provide the force necessary for mucociliary clearance by the coordinated beating of their cilia. These highly specialized cells are therefore critical to the health and function of the pulmonary system. In this article, the basic biology of ciliated cells and the structure of the cilium are described. Their function and interaction with other components of the mucociliary system and the importance of mucociliary clearance to respiratory disease such as airway epithelium, Asthma, Bronchitis, Chronic obstructive pulmonary disease, Cilia, Ciliary beat frequency, Mucociliary clearance and Primary ciliary dyskinesia.

The management of bronchial secretions is one of the main problems encountered in a wide spectrum of medical conditions ranging from respiratory disorders (e.g., COPD, bronchiectasis, cystic fibrosis) to neuromuscular disorders (e.g., ALS) to patients undergoing either thoracic or abdominal surgery. The term airway clearance techniques (ACTs) refers to a variety of different strategies used to eliminate excess secretions. Their aimis to reduce airway obstruction caused by secretions occupying the airway lumen and so prevent respiratory tract infections, re-expand the collapsed areas of the lung, thus improving gas exchanges and decreasing the inflammatory response.

The late 1970s, the use of Positive Expiratory Pressure (PEP) as an airway clearance strategy, introduced in Denmark, became widespread. PEP therapy consists in exhaling against a flow or a resistance at the threshold in order to produce positive pressure in the airways throughout the expiratory phase. The rationale behind this therapy is that it promotes, during inspiration, the flow of air beyond the obstruction through the collateral channels, causing the accumulation of a greater volume of air behind the secretions. This should create a pressure gradient astride the obstruction, which would favor the movement of the secretions in a centripetal direction. Furthermore, during exhalation, the positive pressure generated prevents premature collapse of the peripheral airways.

The PEP therapy most used in clinical practice is the low-pressure type (also referred to as "low PEP").It consists in maintaining a relatively low expiratory pressure in the mouth, between 10 and 20 cmH_2O. Inspiration is required for a slightly larger volume of air than the tidal volume, with a pause at the end of inspiration (to allow the physiological mechanisms of Pendel luft flow, interdependence and collateral ventilation) and then a slightly active exhalation against resistance. A variant of PEP therapy, used much less frequently in clinical practice, is high-pressure PEP ("HiPEP"). It is used especially in patients who have an airway instability during forced expiration. Pressures ranging from 40 to 120 cmH_2O are used, thus allowing to perform a forced expiratory maneuver (FET). The application then of a PEP during a FET is to avoid the premature collapse of the airway during the maneuver, thus allowing the patient to exhale a volume greater than his/her usual forced vital capacity (FVC). There are many different devices on the market designed to provide PEP therapy. Some combine PEP with high frequency oscillations of the airflow, the therapy being defined in this case as Oscillatory PEP (OPEP). Among the OPEP devices we mention Flutter, Acapella, RC-Cornet, Lung Flute and the PEP Bottle.

All these devices are characterized by breathing against intermittent expiratory resistance to induce oscillations of variable frequency (depending on the device or use), which are transmitted to the respiratory tract during the expiratory cycle. The PEP component encourages the flow of air behind the secretions, while the oscillation induces vibrations within the bronchial walls to move the secretions into the lumen, and the repeated accelerations of the expiratory flow facilitate the movement of the secretions from the peripheral airways to the central ones.

Gravity-assisted drainage (GAD), which uses specific positioning of broncho pulmonary segments to facilitate sputum clearance. GAD and manual techniques are often combined as an ACT. Manual techniques, including any combination of percussion, vibration, rib springing, or rib shaking, apply external forces to the chest wall to encourage mobilisation of mucus.

Active cycle of breathing technique (ACBT), which utilises a combination of thoracic expansion exercises, breathing control (BC) and the forced expiration technique(FET) to maximize collateral channel ventilation and sputum movement, and which may be applied with or without GAD and manual techniques.

The main aim of this study is to assess the effectiveness of oscillating positive expiratory pressure device in comparison to usual airway clearance techniques in patients with chronic pulmonary disease and patients in intensive care unit Out come measures were performed pre and post of PEFR, MMRC Grade on day one and end day of therapeutic sessions. All patients proforma, one sputum containers calibrated with a scale measuring 0–50 Ml and a Borg scale for perception of breathlessness.

Hence , The aim of this study is to assess the effectiveness of FLUTTER device in comparison to usual airway clearance techniques in patients with chronic pulmonary diseases.

REVIEW OF LITERATURE

Sarah Svenningsen, Gregory A. Paulinet al., performed a study on topic "Oscillatory Positive Expiratory Pressure in Chronic Obstructive Pulmonary Disease" in the year 2015shows the number and proportion of sputum producer and non-sputum-producer subjects that exceeded minimumclinicallyimportant-difference(MCID)measurementsfor FEV 1 (32), 6MWD (33) and SGRQ (34), and a single point score improvement for PEQ (26) and SDD for VDP (≥3%), post-OPEP. A significantly greater proportion of sputum-producers versus non-sputum- producers reported clinically relevant post-OPEP improvements forPEQ-ease-bringing-up sputum (p=0.04) and PEQ-patient-global- assessment(p = 0.006).

Corhay JL , Vincken W , Schlesser M , Bossuyt P , ImschootJet al., performed a study on topic "Chronic bronchitis in COPD patients is associated with increased risk of exacerbations: "in the year 2013, a cross-sectional multicentrestudy that have resulted The 974 patients included were on average 67.8 ± 9.6 years old; 72% were male, FEV1 was 52.5 ± 15.8% of predicted. The prevalence of CB was 64% (622/974).Inpatients with CB,thenumberof pack-years smokedandthe prevalence of chronic respiratory failure, cachexia and skeletal muscle wasting were significantly higher, whereas FEV1 and FEV1 /VC were lower. The prevalence of CB increased with GOLD stage and was

higher in patients with emphysema and those exposed to occupational risk factors. The CB group had more exacerbations, a higher percentage of patients with frequent exacerbations(37.3%vs.14.2%ofpatients;p< 0.0001),increasedCOPD-related,non-intensivecare unithospitalisations and all-cause hospitalisation rates. In multiple logistic regressionanalysis, frequent exacerbation was the most important independent variable associated with CB, followed by current smoking, chronic respiratory failure, COPD duration and age.

Burgel PR , Nesme-Meyer P , Chanez P ,et al., performed a study on topic " Cough and sputum production are associated with frequent exacerbations and hospitalizations in COPD subjects" in the year 2009 that have resulted No significant difference was observed betweengroups for age, FEV(1), body mass index, and comorbidities. Subjects with chronic cough and sputum production had increased total mean numbers of exacerbations per patient per year (2.20 +/- 2.20 vs 0.97 +/- 1.19, respectively; p < 0.0001), moderate exacerbations (1.80 +/- 2.07 vs 0.66 +/- 0.85, respectively; p < 0.0001), and severe exacerbations requiring hospitalizations(0.43+/-0.95vs0.22+/-0.56, respectively;p < 0.02). The total number of exacerbations per patient per year was the only variable independently associated with chronic cough and sputum production. Frequent exacerbations (two or more per patient per year) occurred in 55% vs 22% of subjects, respectively, with and without chronic cough and sputum production (p < 0.0001). Chronic cough and sputum production and decreased FEV(1) were independently associated with an increased risk of frequent exacerbations and frequent hospitalizations.

Cegla UH , Bautz M , Fröde G , Werner T .el at.,"Physical therapy inpatientswithCOPDandtracheobronchialinstability–comparisononof 2 oscillating PEP systems (RC-Cornet, VRP1 Desitin)"Results of a randommizedprospectivestudyof90patientshaveresultedthatsubjectiv e improvement of sputum, dyspnoea and acceptance of the method of physiotherapy was statistically significant better for RC- Cornet. Regarding cough the significance was just failed by p < 0.055. RC-Cornet is a comfortable, effective, small accepted tool for the long term physiotherapy of patients with COAD and tracheobronchial instability.

AIMS&OBJECTIVES

Aims:

The aim of this study is to assess the effectiveness of oscillating positive expiratory pressure device in comparison to usual airway clearance techniques in patients with chronic pulmonary disease and patients in intensive care unit

Objectives:

1. Assessing the effects of flutter device on airway resistance inchronic pulmonary disease patients after 4 week of therapeutic session.
2. Comparing the effectiveness of Oscillatory PEP therapy by measuring PEFR and MMRC Grade.
3. Comparing spo2 range, HR, PEFR and MMRC Grade in pre and post therapeutic sessions.

MATERIALS AND METHODOLOGY

Site and study Design :Tagore Medical College and Hospital

It is a Prospective study design conducted between Feb2023 to April 2024 with 208 study population.Sample size can be estimated using following:

	Kelsey	Fleiss	Fleiss with CC
Sample size-exposed	95	94	104
Sample size non- exposed	95	94	104
Total sample size	190	188	208

Inclusion Criteria:

Patients with mucus producing respiratory conditions, including: Atelectasis, Bronchitis, Bronchiectasis, Cystic Fibrosis, Chronic Obstructive Pulmonary Disease (COPD)or other conditions producing retained secretions.

Exclusion Criteria:

Patients known to have pneumothorax or overtright-sided heartfailure.

Data Collection Method:

This is a prospective tele study performed in the Department of Respiratory Medicine. The participants are in both sexes. The participants receive a detailed explanation about the study and their cooperation and willingness will be obtained with an informed consent.

Methods

The study was performed assessing the efficiency of Flutter device on the variables given below

- Sputum color
- Peak Expiratory Flow Rate
- MMRC grading
- Spo2
- Borg's Scale

Participants with chronic pulmonary disease who are prescribed and guided to use the flutter device. They will be explained in detail about the study and their willingness to participate in the study were obtained. Patients whoever consented to participate in this study will be included in the study. On the first day of enrollment, the study variables on PEFR and MMRC grade will be measured. The patients were instructed to use the device regularly for a period of 4 weeks for 2 times a day. Follow up to confirm patient's performance of breathing technique. After4 weeks, the patients were asked to repeat the PEFR and MMRC grading was observed along with Heart rate and SPo2 readings.

Statistical Analysis

The collected data were analysed with IBM SPSS Statistics for Windows, Version 23.0.(Armonk, NY: IBM Corp).To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables. To find the significant difference between the bivariate samples in Paired groups the Paired sample t-test was used& for Independent groups the Unpaired sample t-test was used. To find the significance in categorical data Chi-Square test was used. In all the above statistical tools the probability value .05 is considered as significant level.

RESULTS

The sample included 198 patients with chronic pulmonary diseases. The parameters were represented in figure 1 - In that 60.2% of male and39.8%of female patients received Flutter device, 59.0% of male and 41.0%of female patients received usual airway clearance technique. Based on the final diagnosis patients were categorized into COPD and bronchiectasis.Flutter device was used among 44.9% of COPD and 41% received usual airway clearance technique, in bronchiectasis 55.1% used flutter device and 59% received usual airway clearance technique.

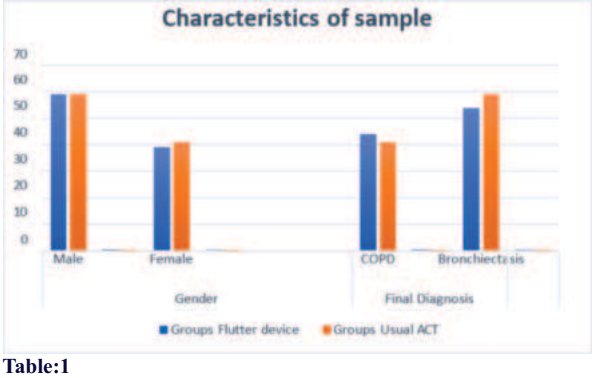

Table:1

	Groups		
		Flutter device	Usual ACT
Spo2Pre	95-100 %	38 38.8%	34 34.0%
	91-94 %	24 24.5%	34 34.0%
	<90%	36 36.7%	32 32.0%
Hr Pre	60-70	12 12.2%	7 7.0%
	71-80	10 10.2%	15 15.0%
	81-90	29 29.6%	26 26.0%
	91-100	22 22.4%	30 30.0%

	101- 110	25 25.5%	22 22.0%
PefrPre	100- 200	38 38.8%	27 27.0%
	200- 300	40 40.8%	33 33.0%
	300- 400	20 20.4%	30 30.0%
	400- 500	0 0.0%	10 10.0%
MmrcPre	2	25 25.5%	24 24.0%
	3	69 70.4%	70 70.0%
	4	4 4.1%	6 6.0%

Table:2

	Groups		Flutter device	Usual ACT
Spo2 Post	95-100%	Count %	46 46.9%	34 34.0%
	91-94 %	Count %	52 53.1%	66 66.0%
Hr Post	60-70	Count %	5 5.1%	3 3.0%
	71-80	Count %	12 12.2%	29 29.0%
	81-90	Count %	40 40.8%	39 39.0%
	91-100	Count %	32 32.7%	28 28.0%
	101 -110	Count %	9 9.2%	1 1.0%
PefrPost	200-300	Count %	7 7.1%	8 8.0%
	300 -400	Count %	41 41.8%	55 55.0%
	400 -500	Count %	35 35.7%	34 34.0%
	500 -600	Count %	15 15.3%	3 3.0%
Mmrc Post	1	Count %	10 10.2%	2 2.0%
	2	Count %	59 60.2%	50 50.0%
	3	Count %	29 29.6%	48 48.0%

The table:1 and table:2 showscomparison of pre and post Spo2, Heart Rate, peak expiratory flow rate (PEFR) and the modified medical research council (MMRC) shows the improvement in assessment ofvitals signs and dyspnea scales in both group of patients with flutter device group and usual airway clearance technique group.

DISCUSSION

Airway clearance methods such as oscillating positive expiratory pressure (PEP) are proposed to provide benefit in patients with chronic obstructive pulmonary disease(COPD) and bronchiectasis by mobilizing secretions and enhancing mucous movement.

A four-week cross-over study was performed in 204 subjects out of which 6 subjects were uncooperative and excluded, the remaining 198 subjects (n=85COPD, n=113 bronchiectasis) were randomized to Oscillating PEP therapy (Flutter) two-times daily.
The subjects were categorized into two groups, one group received Oscillating PEP therapy and another group received usual Airway Clearance Therapy. Spo2, Heart Rate, peak expiratory flow rate (PEFR) and the modified medical research council (MMRC)were used to evaluate therapy effects pre and post procedure.

The duration between the pre and post was four weeks. The patients were recommended to cough and expectorate after performing airway clearance therapy. The expectorated sputum is observed for volume, colour and consistency and the observation is compared between first to fourth week to analyze the effects of therapy.

SputumVolume1W*SputumVolume4WCrosstabulation

Groups				SputumVolume 4W			Total
				0-10	11-20	21 -30	
Flutter device	Sputum Volume1W	0-10	Count %	2 2.0%	14 14.3%	2 2.0%	18 18.4%
		11-20	Count %	11 11.2%	11 11.2%	4 4.1%	26 26.5%
		21-30	Count %	15 15.3%	13 13.3%	4 4.1%	32 32.7%
		31-40	Count %	0 0.0%	22 22.4%	0 0.0%	22 22.4%
		Total	Count %	28 28.6%	60 61.2%	10 10.2%	98 100.0%
UsualACT	Sputum Volume1W	0-10	Count %	16 16.0%	8 8.0%	2 2.0%	26 26.0%
		11-20	Count %	12 12.0%	4 4.0%	9 9.0%	25 25.0%
		21-30	Count %	6 6.0%	13 13.0%	12 12.0%	31 31.0%
		31-40	Count %	1 1.0%	4 4.0%	13 13.0%	18 18.0%
	Total		Count %	35 35.0%	29 29.0%	36 36.0%	100 100.0%

Consistancy1W*Consistancy4W Crosstabulation

Groups				Consistancy4W			Total
				Mucoid	Mucopurulent	Purulent	
Flutter device	Consistancy 1W	Mucoid	Count	4	2		6
			%	4.1%	2.0%		6.1%
		Mucopurulent	Count	0	35		35
			%	0.0%	35.7%		35.7%
		Purulent	Count	14	43		57
			%	14.3%	43.9%		58.2%
	Total		Count	18	80		98
			%	18.4%	81.6%		100.0%
Usual ACT	Consistancy 1W	Mucoid	Count	3	7	13	23
			%	3.0%	7.0%	13.0%	23.0%
		Mucopurulent	Count	8	15	6	29
			%	8.0%	15.0%	6.0%	29.0%
		Purulent	Count	12	25	11	48
			%	12.0%	25.0%	11.0%	48.0%
	Total		Count	23	47	30	100
			%	23.0%	47.0%	30.0%	100.0%

Colour1W*Colour4WCrosstabulation

Groups				Colour4W				Total
				Yellow/ Green	White	Charcoal/ Gray	Brown	
Flutter device	Colour 1W	Yellow/ Green	Count	28	15		1	44
			%	28.6%	15.3%		1.0%	44.9%
		Pink/ Red	Count	0	1		0	1
			%	0.0%	1.0%		0.0%	1.0%
		White	Count	10	5		0	15
			%	10.2%	5.1%		0.0%	15.3%
		Charcoal/ Gray	Count	0	4		0	4
			%	0.0%	4.1%		0.0%	4.1%
		Brown	Count	9	18		7	34
			%	9.2%	18.4%		7.1%	34.7%
	Total		Count	47	43		8	98
			%	48.0%	43.9%		8.2%	100.0%
Usual ACT	Colour 1W	Yellow/ Green	Count	21	17	0	1	39
			%	21.0%	17.0%	0.0%	1.0%	39.0%
		Pink/ Red	Count	0	1	0	0	1
			%	0.0%	1.0%	0.0%	0.0%	1.0%
		White	Count	3	25	0	2	30
			%	3.0%	25.0%	0.0%	2.0%	30.0%
		Charcoal/ Gray	Count	0	1	2	0	3
			%	0.0%	1.0%	2.0%	0.0%	3.0%
		Brown	Count	0	7	0	20	27
			%	0.0%	7.0%	0.0%	20.0%	27.0%
	Total		Count	24	51	2	23	100
			%	24.0%	51.0%	2.0%	23.0%	100.0%

CONCLUSION

Previous study on "Oscillatory Positive Expiratory Pressure in Chronic Obstructive Pulmonary Disease", Sarah Svenningsen[12], concluded daily oPEP use in patients with COPD and provide evidence to support the use of oPEPin sputum-producers based on significant improvements in the ease-in- bringing-up-sputum, FVC, quality-of-life and 6MWD. Post-oPEP changes in the PEQ-ease-in-bringing-up-sputum were related to improved ventilation, providing mechanistic evidence to support oPEP use in COPD patients with chronic sputum production.

The present study demonstrated in subjects with COPD and bronchiectasis, four weeks of Oscillating PEP therapy was well tolerated and there was improved Saturation of oxygen, Heart Rate, peak expiratory flowrate (PEFR) and the modified medical research council(MMRC) in both group of patients with flutter device and usual airway clearance technique. But significant improvement is recorded among the patients who received Oscillating PEP (Flutter device).

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