ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 12, Issue, 02, pp.10112-10115, February, 2020

DOI: https://doi.org/10.24941/ijcr.37982.02.2020

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

IMMEDIATE EFFECT OF BLOW BOTTLE POSITIVE EXPIRATORY PRESSURE (BBPEP) DEVICE ON OXYGEN SATURATION IN PATIENTS WHO UNDERWENT OPEN HEART SURGERY- A RANDOMIZED PILOT STUDY

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ARTICLE INFO

Article History:
Received 14th November, 2019
Received in revised form
20th December, 2019
Accepted 09th January, 2020
Published online 28th February, 2020

Key Words:
BBPEP,
Open Heart Surgery,
Oxygen Saturation.

ABSTRACT

Background: Open heart surgery patients usually develop pulmonary complications such as atelectasis, pneumoniain early postoperative period. Literature reported that to prevent or reduce these complications we can use Positive Expiratory Pressure (PEP) therapy techniques with Conventional Physiotherapy Treatment (CPT). **Methods:** The study design was Randomized Pilot Study. 20 patients included (n=20), 10 patients in each group, Control and Interventional group. Control Group received CPT while Interventional Group received CPT with Blow Bottle PEP (BBPEP) on Post-operative Day (POD) 1 and 2, twice a day and oxygen saturation noted pre and post treatment. Unpaired-t test was used. **Result:** The therapist made cost-effective and easily BBPEP therapy showed a short-term improvement in oxygen saturation with significant p-value 0.03. **Conclusion:** BBPEP device is effective in improving oxygenation in early POD i.e. on 1st and 2nd after open-heart surgery.

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Citation: ***Abhaya S. Mahadik, Arijit Kumar Das, Abhijit D. Diwate.*** **2020.** "Immediate effect of blow bottle positive expiratory pressure (bbpep) device on oxygen saturation in patients who underwent open heart surgery- a randomized pilot study", *International Journal of Current Research*, 12, (02), 10112-10115.

INTRODUCTION

Open heart surgery is the type of surgery in which anterior midline incision is taken to get a surgical assess of the heart, it includes Coronary Artery Bypass Surgery (CABG), Valve Replacement Surgery, and Surgery for Arterial Fibrillation (Rady, 1997). Patients who have undergone open-heart surgery have a high rate of risk to develop atelectasis and a severe reduction in lung volumes and oxygenation in the early postoperative period (Rady, 1997; Tenling *et al*., 1998). The initial postoperative phase is the most important period because an impairment in pulmonary function remains for several months after surgery (Graetz, 2015; Vargas, 1997; Braun *et al*., 1978). Chest physiotherapy has an important component of postoperative care, which prevents or reduce pulmonary complications after surgery. Impairments are at electasis, pneumonia, sputum retention, and gas exchange impairments. Early mobilization has been accepted as the most important therapy after surgery in the prevention and treatment of pulmonary impairment.

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The conventional physiotherapy protocol includes early mobilization, incentive spirometry, deep breathing exercises (Overend, 2001; Pasquina, 2003). In current days we use several mechanical positive pressure devices. There are commercial PEP devices available for the treatment such as Acapella, Flutter, but they are expensive. The therapist made 'Blow Bottle PEP' is the cost-effective device comparative to these PEP devices and it also works on the same principle. In Indian rural population patients not afford to take commercial device so the main aim of the study is to find the immediate effect of the therapist made cost-effective and easily available BBPEP Device on oxygen saturation after the open-heart surgery (Charlotte Urell, 2011).

MATERIALS AND METHODS

It is a Randomized Pilot Study, conducted in the Intensive Care Unit of Department of Cardiothoracic and Vascular Surgery in Vikhe Patil Foundation's Memorial Hospital, Ahmednagar and an Ethical Committee Approval was taken from The Institutional Ethical Committee. The patients included were of age ≥20 years with median sternotomy surgical approach with stable vitals and the patients excluded who diagnosed with respiratory pathology and any neuromuscular disease which directly affects the lung functions.

Method

The 20 patients who underwent for open heart surgery were screened and selected for the study. By using chit method patients were divided into two groups i.e. Interventional and Control group, each group consisted of 10 patients. Both groups received treatment for the first and 2nd post-operative day for twice a day and oxygen saturation was noted pre and post treatment after every session.

Control Group: Conventional Physiotherapy Treatment (CPT) included Active Range of Motion 10 repetitions, Deep Breathing exercise with 5 seconds hold 10 repetitions, Incentive Spirometer 10 repetition after every 2hrs,Splinted Coughing if required. Treatment session lasts for 30 mins.

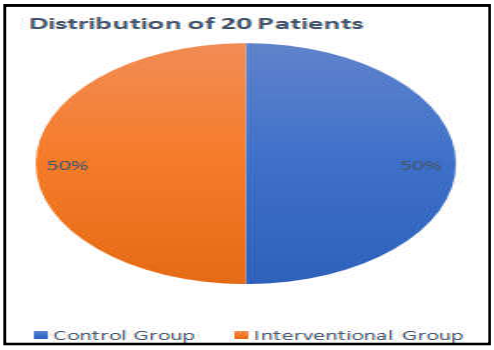
Interventional Group: This group received Conventional Physiotherapy Treatment (CPT) along with BBPEP twice a day. Therapist made a cost-effective BBPEP which generates 10 cm of H_2O PEP and it was given for 10 breaths, 3 sets with 5 second hold.

Outcome Measure: Oxygen saturation was measured by the pulse oximeter pre and post treatment session and also observed during treatment.

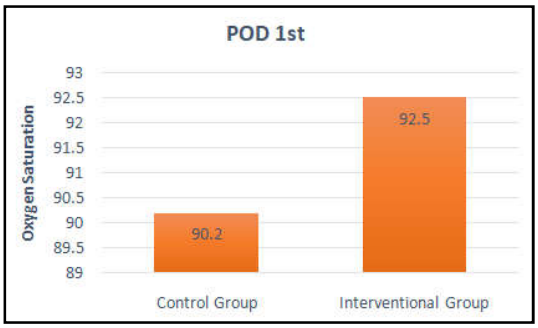
RESULTS

20 patients received treatment (Graph 1). Baseline characteristics showed in Table 1 in which there was no significant difference. The collected data were analysed by using GraphPad Software. Data were not normally distributed so non-parametric Unpaired T-test were performed and 0.05 p-value was considered significant showed in Table 2.

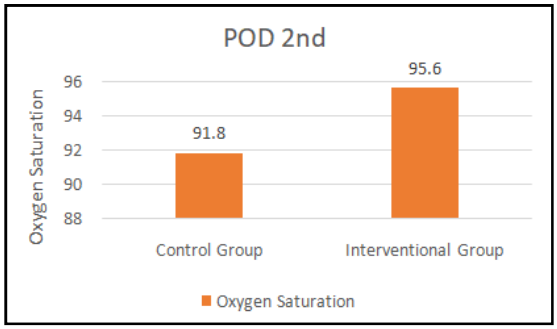
On POD 1, the Interventional Group maintained saturation above 90% during treatment and effect lasted for 5 to 10 mins and start deteriorating to 89 to 85% and patient required oxygen support. While Control Group maintained oxygen saturation above 90% during treatment but after treatment deterioration started within 5 to 10 mins and patients required oxygen support.



Graph 1. Distribution of Number of Patients



Graph 2. Oxygen Saturation on POD 1



Graph 3. Oxygen Saturation on POD 2

These findings were clinically significant not statistically showed in Graph 2.

Table 1. Baseline Characteristics

Variables	Control Group	Interventional Group
Age	49.3±66.8	47.8±65.3
Gender	5(F) and 5(M)	6(M) and 4(F)
Vitals		
Heart Rate (bpm)	75.7±97.4	76.5±92.6
Respiratory Rate (cpm)	20.0±26	20.9±26
Oxygen Saturation (%) with O_2 Support	100	100
Systolic Blood Pressure (mmHg)	106.8±123.3	110.5±127.6
Diastolic Blood Pressure (mmHg)	64.7±81.0	64.4±83.3

Table 2. **- significant p-value

Variables	Intervention Group	Interventional Group	p-value
POD 1			
Sample Size (N)	10	10	
Mean	90.2	92.5	
Standard Deviation (SD)	±1.874	±2.593	0.34>0.05
POD 2			
Sample Size (N)	10	10	
Mean	91.8	95.6	
Standard Deviation (SD)	±1.476	±0.6992	0.03<0.05**

On POD 2,the Control and Interventional Group showed similar effect as POD 1 but the treatment effect in Interventional Group was remain more the 20 mins after treatment session and which shows statistically significant p-value (0.03<0.05) which shown in Graph 3.

DISCUSSION

To the authors knowledge this is a first study conducted in Indian rural population on therapist made cost-effective and easily available BBPEP device. The given study showed that interventional group having immediate improvement in the oxygen saturation after receiving blow bottle intervention which showing transient effect. According to the literature BBPEP should be made up of plastic container (height 25 cm, width 10 cm) with an open top (so there will no pressure except atmospheric pressure against the air escaping from the tube) with an inner diameter of 8mm. The distal tip of the PEP bottle tube should be 10 cm below the surface of the water i.e., a 10-cm water column and 3 cm above the bottom of the bottle (Mestriner, 2009).

The possible mechanism behind this would be, during this technique as patient blow out and make bubbles in the water, a positive pressure is created within the tubing and it transferred to the airways of lungs. Positive pressure helps to keep the airways open and improve ventilation by recruiting the collapsed alveoli. This study showed, by using cost-effective BBPEP device with conventional physiotherapy treatment we can improve oxygenation to prevent or reduce pulmonary complications in post-operative days. The literature also showed that adding cost-effective PEP device in routine physiotherapy intervention for post-operative patients showed reduce pulmonary complications comparison to physiotherapeutic intervention alone and also easily available than Expiratory Positive Airway Pressure (EPAP) (Borghi-Silva, 2005).

Image 1. Blow Bottle PEP

Image 2. Patient receiving BBPEP

Charlotte Urell, *et al*. studied in 2011 on deep breathing exercises with positive expiratory pressure at higher rate to improve oxygenation in the early post-operative period after cardiac surgery and they found significant increased PaO2 and SaO2 in patients performing deep breaths with Blow Bottle PEP in the first two postoperative days compared with control group patients. Our study also showed similar result by using therapist made cost-effective BBPEP devicein post-operative CABG patients (Charlotte Urell, 2011). There is evidence that after CABG, PEP device is more effective compare to incentive spirometer with Expiratory Positive Airway Pressure (EPAP) to improve SpO2 and Peak Expiratory Flow Rate (PEFR) in both the groups, current study also showed that after receiving BBPEP patient showed improvement in oxygen saturation (Zaman, 2016).

Conclusion

The study concluded that there is improvement in oxygenation by using therapist made cost-effective and easily available BBPEP device in initial POD 1st and 2nd after open heart surgery.

Clinical Implication: In India the maximum population belong to the rural area where patients have limited access to the devices because they are not affordable by these patients. on other-hand BBPEP device is a therapist made cost-effective device which costs less than 1$ which is 44% less compared to other PEP devices.

Conflict of Interest: No conflict of interest.

Abbreviation

1. BBPEP- Blow Bottle Positive Expiratory Pressure
2. CABG- Coronary Artery Bypass Surgery
3. CPT- Conventional Physiotherapy Treatment
4. EPAP- Expiratory Positive Airway Pressure
5. PaO_2- Partial Pressure of Oxygen
6. PEP- Positive Expiratory Pressure
7. PEFR- Peak Expiratory Flow Rate
8. POD- Post-operative Day

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