

# Non Infective Cough in Immediate Post Cardiac Surgery Patients

Vijayakumar Koyilil<sup>1</sup>, Mohanakrishnan<sup>2</sup>, H.A. Rieyaz<sup>3</sup>, John Rajpathy<sup>4</sup>, Selvakumar P<sup>5</sup>, Deneshkumar V<sup>6</sup>

<sup>1</sup>Consultant, Department of Cardiac Surgery, <sup>2</sup>Director and Head, Department of Cardiac Surgery, <sup>3</sup>Assistant Professor, Department of Anatomy, <sup>4</sup>Professor, Department of Physiology, <sup>5</sup>Cardiac Anesthesiologist and Director Medical services, <sup>6</sup>Assistant Professor Cum Statistician, Department of Community Medicine, Velammal Medical College Speciality Hospital, Madurai Tuticorin Outer Ring Road, Anuppanadi, Madurai – 625009, Tamil Nadu, India

**Corresponding author:** Dr. John Rajpathy, Professor, Department of Physiology, Velammal Medical College Hospital & Research Institute, Madurai, Tamil Nadu, India.

DOI: <http://dx.doi.org/10.21276/ijcmsr.2019.4.4.18>

**How to cite this article:** Vijayakumar Koyilil, Mohanakrishnan, H.A. Rieyaz, John Rajpathy, Selvakumar P, Deneshkumar V. Non infective cough in immediate post cardiac surgery patients. *International Journal of Contemporary Medicine Surgery and Radiology*. 2019;4(4):D75-D80.

## A B S T R A C T

**Introduction:** Cough is seen to occur commonly in post cardiac surgery patients. This causes great discomfort by aggravating pain. Sufficient data are not available regarding the incidence and cause of this cough. Study was designed to assess the severity and progress of cough in each postoperative day, the difference in cough pattern between various cardiac diseases and surgical techniques, the influence of smoking, the relationship to fluid imbalance and the relationship to reduction of lung volume and its influence on cough pattern.

**Material and Methods:** 100 consecutive adult patients who underwent cardiac surgery in this centre were evaluated for cough. Those who needed prolonged ventilation or developed respiratory infection were excluded. The incidence and intensity of cough was compared between the type of surgeries, cardiac pathology, smoking habits, fluid balance, and the lung volume of the patient.

**Results:** Over 80% of patients were found to have cough with, intensity peaking by 3<sup>rd</sup> to 5<sup>th</sup> post operative day (POD) and gradually reducing by 8<sup>th</sup> POD. Even in 8<sup>th</sup> POD, 74 patients had cough with 11 having moderate to severe cough and 63 mild. The incidence of cough was found to be similar irrespective of technique of surgery, smoking habits and fluid balance. No significant variation with cardiopulmonary bypass (CPB) time ( $p=0.44$ ), ejection fraction ( $p=0.88$ ) and number of grafts in off pump patients ( $p=1.00$ ) were seen.

**Conclusion:** 80% of post cardiac surgery patients were found to have cough, with varying intensity. Reduction in lung volume, as assessed by breath holding capacity, was seen in majority of patients. Incidence of cough was found to occur more when breath holding capacity reduces to less than 65% of preoperative level ( $P=0.00$ ).

**Keywords:** Cardiac Surgery, Cough, CAT

## INTRODUCTION

Postoperative pulmonary complications are an important cause of morbidity following surgeries contributing to delay in post-operative rehabilitation, increases in hospital length of stay, health-care costs and quality of patients' life.<sup>1</sup> Postoperative pain and restrictive lung dysfunction are believed to be important factors associated with cough impairment. A patient's inability to cough effectively after surgery is often attributed to excessive accumulation of pulmonary secretions and increases the risk of obstructive atelectasis and respiratory infections.<sup>2</sup> Non infective post-operative cough is often seen in post-operative cardiac surgery patients and there is not much data available regarding the cause or its prevalence. This study was aimed to understand the cause and incidence of non-infective postoperative cough in patients following cardiac surgery. The possible causes thought of for post cardiac surgery

cough are cardiopulmonary bypass (CPB) and extracorporeal circulation related inflammatory reactions, cardiac pathology causing pulmonary congestion, rise of left atrial pressure during manipulation, certain cardiac and anaesthesia drugs and post operative phrenic nerve injury causing diaphragmatic palsy.

Study was hence designed to assess the severity and progress of cough in each postoperative day, the difference in cough pattern between various cardiac diseases and surgical techniques, the influence of smoking, the relationship to fluid imbalance and the relationship to reduction of lung volume and its influence on cough pattern.

## MATERIAL AND METHODS

100 consecutive adult patients (>17 years) who underwent open heart surgery were included in this study. Those who needed prolonged ventilator support (>24 hours) and those with post operative respiratory infection and multisystem

failure were excluded from the study.

**Surgery and post operative care:** The open heart surgeries done on these patients are shown in Table I. All the surgeries were performed by a surgical team with uniform techniques of median sternotomy, opening of pericardium and cardioplegia (when used) and extracorporeal circulation. Pleura if opened was drained with intercostal drainage tubes. All patients were anesthetised by the same team with uniform techniques. Post operatively all were ventilated with FIO<sub>2</sub> varying from 40 -60% and were extubated when haemodynamically stable.

Pain relief was administered to all patients by standard protocol. Intravenous Fentanyl infusion was maintained till mobilisation along with benzodiazepines on ventilator and on oral Paracetamol. Oral Tramadol and parental Tramazac were used selectively.

All patients were on a standard physiotherapy regime of breathing exercises including cough exercises and range of

motion exercises of shoulder girdle. They are made to sit up at the earliest and if off ionotropic supports, made to stand and mobilized to an arm chair. All received nebulisation with Duoline and Budecortand few who were uncomfortable with nebulisation, steam inhalation.

**Data recording:** Hospital records were used to record the demographic data. Operation notes were used to record the surgical details and intensive care unit monitoring sheet was used to collect data of intake - output balance.

The lung volume of the patient was indirectly assessed preoperatively and post operatively by breath holding test. Same person was assigned to do the test for every patient. The procedure followed was to explain the patient in detail about the test preoperatively. Following a trial the test was performed thrice and the average taken as the final value. The post operative preserved respiratory volume was expressed as a percentage of the preoperative basal breath holding capacity. The cough intensity was assessed during the classification given in Table II. Few subjective and objective parameters along with its effect on patient was used for classifying. This data was assessed with input from patient, attenders and the nursing staff.

### STATISTICAL ANALYSIS

Statistical analysis with Chi square test and Cochran armitage test was applied on the data to ascertain the significance of increasing or decreasing trends of cough with different variants.

### RESULTS

Of the 100 consecutive surgery patients studied, 71 were males and 29 females. The surgeries done on these patients are given in Table I.

The number of patients who had no cough on each post operative day is shown in Table III. Irrespective of cardiac pathology and type of surgery majority have cough of varying severity. A graph was plotted, for on pump, off pump CABGs and for valve surgeries, with X-axis showing the post operative day and Y-axis showing the number of patients having moderate to severe cough. Consistently the cough intensity was found to increase by 3<sup>rd</sup> to 5<sup>th</sup> post operative day and gradually settle thereafter (Fig 1).

Coronary artery bypass grafting - Off pump	43
Coronary artery bypass grafting - On pump	20
Combined procedures(6)	
CABG+ Atrial septal defect	1
CABG + Aortic valve replacement	2
CABG + Mitral valve replacement	2
CABG + Double valve replacement	1
Valve surgeries (22)	
Double valve replacement (Mitral & aortic)	3
Double valve replacement + Cox Maze procedure	1
Aortic valve replacement	3
Mitral valve replacement	12
Mitral valve repair	1
MVR + Cox Maze procedure	2
Others (9)	
Atrial septal defect	4
Cotriatriatum with Mitral valve repair	1
Supra cardiac type total anomalous pulmonary venous connection	2
Bentalls procedure	2
<b>Table-1:</b> Surgeries performed on 100 patients included in the study	

Parameters	No cough	Mild cough	Moderate cough	Severe cough
Frequency	Nil. only as part of breathing exercise	< 5 Bouts * / day	5- 10 bouts/ day	>10 bouts /day
Intensity	Nil	Mild intensity	Moderate produces pain	Severe with pain persisting
Discomfort	Nil	Mild	Moderate discomfort	Severe discomfort with fear of cough
Ability to lie down flat	No difficulty	No difficulty	Occasional difficulty	Not possible to lie down flat
Sleep disturbance due to cough	No disturbance	No difficulty	Occasional cough during sleep	Definite interference with sleep
Difficulty to talk	No difficulty	No difficulty	Occasional	Definitely gets cough with continuous talk
*bout of cough means multiple cough occurring in short gaps to the extent of producing discomfort				
<b>Table-2:</b> Cough classification				

Post operative day	Off pump CABG (N – 43)	On pump CABG (n- 26)	Valve surgeries (n-22)	Others (N- 9)
2	4 (9.3)	2 (7.7)	3 (13.7)	2 (22.2)
3	3 (6.9)	3 (11.5)	2 (9.1)	1 (11.1)
4	3 (6.9)	2 (7.7)	1 (4.5)	1 (11.1)
5	4 (9.3)	3 (11.5)	1 (4.5)	1 (11.1)
6	8 (18.6)	4 (15.4)	2 (9.1)	3 (33.3)
7	7 (16.3)	7 (26.3)	2 (9.1)	4 (44.4)
8	10 (23.3)	9 (34.6)	3 (13.7)	4 (44.4)

**Table-3:** Number of patients without cough (within bracket is the% of that category)

Balance	->-500ml		-500 -200ml		-200 – 0 ml		0 - +200ml		+200-500ml		>+500ml	
	Nil	Moderate severe	Nil	Moderate severe	Nil	Moderate severe	Nil	Moderate severe	nil	Moderate to severe	nil	Moderate severe
On pump (n-26)	17.7	23.5	19.1	31.9	30.3	15.2	11.8	32.4	17.4	19.6	20	26.7
Off pump (n-40)	23.5	20.6	13.6	34.6	7.35	38.2	5.8	34.6	4.8	22.6	7.14	42.8

**Table-4:** Comparison of severity of cough based on fluid balance, between off pump and on pump CABGs (% of patients having no cough and moderate to severe cough is shown in relation to their fluid balance)

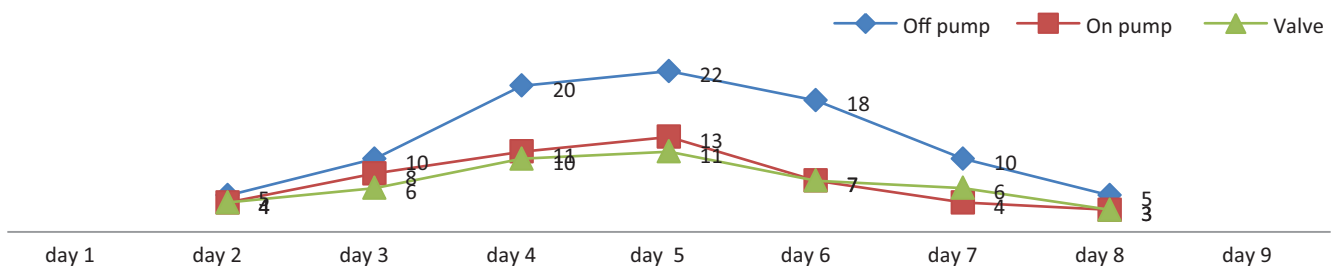
% of preoperative breath holding capacity	No cough	Mild cough	Moderate cough	Severe cough
< 50%(N 12)	-	4	7	1
50 -65% (N 63)	2	29	27	5
65 -80% (N 17)	5	6	5	1
>80%(N8)	3	4	1	-

**Table-5:** Relationship between breath holding capacity and cough (number of patients with the each type of cough is given).

	No Cough	Mild Cough	Moderate Cough	SevereCough	Total
Below 65%	2 (7.50)	33 (32.25)	34 (30.00)	6 (5.25)	75
Above 65%	8 (2.50)	10 (10.75)	6 (10.00)	1 (1.75)	25
Total	10	43	40	7	100

The P-value is .000306. The result is significant at P< .05.

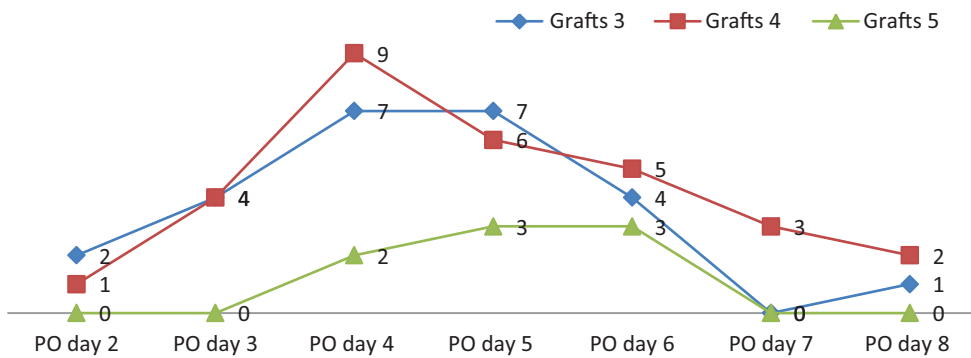
**Table-6:**



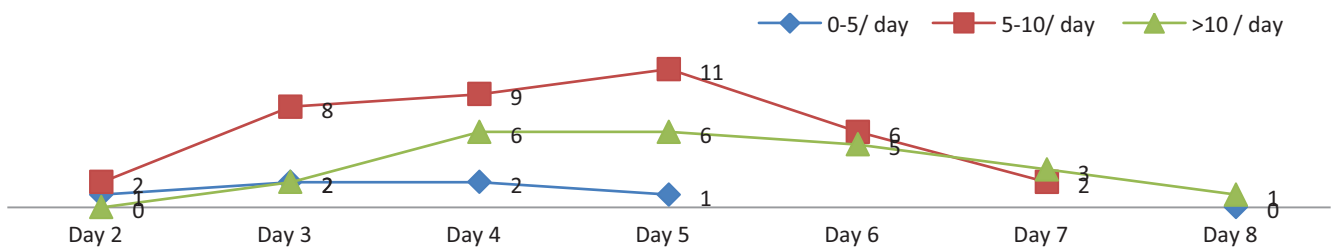
**Figure-1:** Graph depicting the number of patients having moderate to severe cough in each post operative day among three categories of surgical patients

As far as CABGs on pump were concerned we tried to see if the CPB duration has any influence on cough. Of 26 patients who had on pump CABG 11 had a CPB time > 120 minutes (mts) and of this 6 had moderate to severe cough (54.5%). 12 patients had 90- 120mts CPB time and of this 5 had moderate to severe cough (41.7%). Of the 3 who had CPB time between 60 - 90 mts, 1 had moderate to severe cough(33%). When LV function was considered, of 11 patients who had ejection fraction below 50%, 5 (45.5%) had

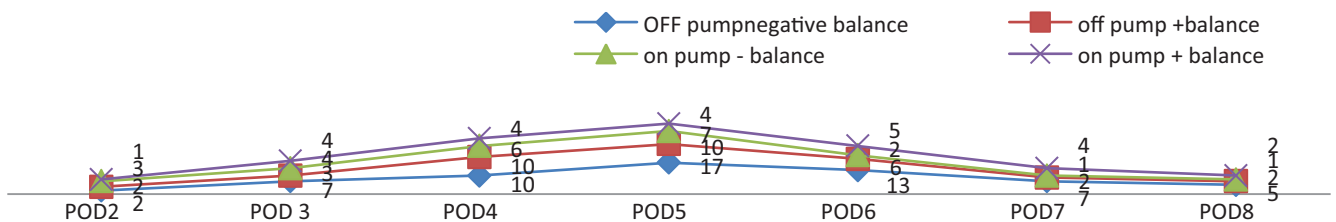
moderate to severe cough and of 15 patients with ejection fraction over 50%, 7 (46.7%) had moderate to severe cough. The incidence of cough and severity, applying Cochrane armitage test, was thus seen not to be influenced by duration of CPB (p=0.44) and LV function (p=0.88). In off pump CABGs the duration of manipulation of heart depends on the number of distal anastomosis. So the severity of cough was compared to number of grafts and they were plotted with post operative days in X axis and number of



**Figure-2:** Graph depicting the number of patients having moderate to severe cough in each post operative day, among off pump CABG patients in relation to number of grafts



**Figure-3:** Graph depicting the number of patients having moderate to severe cough in each post operative day among smokers



**Figure-4:** Graph depicting the number of patients having moderate to severe cough in each post operative day with relation to their fluid balance, and surgical technique.

patients with moderate to severe cough in Y axis (Fig 2). Here too the cough severity peaks by 3-5 days and comes down by 7th day. Majority of patients had 4 grafts (20), 12 patients had 3 grafts, 7 had 5 grafts and 2 patients had 6 grafts and another 2 had 2 grafts. Moderate to severe cough occurred in 7 of 12 (58.3%) patients with 3 grafts and 9 of 20 patients (45%) with 4 grafts 3 of 7 (42.9%) patients with 5 grafts. Thus there was a uniform incidence of cough and its severity unaffected by the extent of manipulation.(p-1.00) Cough pattern in smokers too was found to be identical. They were categorized as those taking less than 5 cigars a day(4 patients), 5-10cigars /day (22 patients) and more than 10 cigars a day (12 patients). The graph plotted showed the same pattern of cough intensity.(Fig 3)(p-0.95) Moderate to severe cough occurred in patients irrespective of their fluid balance and showed the same pattern of peaking (Fig 4) around 3-5 days, the percentage being almost same in all categories. In off pump CABG patients, number of patients without cough was found to be more in those with more than 500ml negative balance.(Table IV) All patients were found to have decrease in their lung volume after surgery. The breath holding capacity was considered as a measure of the lung volume. The postoperative preserved lung capacity was calculated as percentage of the preoperative

capacity and it was tabulated against the intensity of cough. (Table V). The incidence of cough increases when the respiratory capacity decreases below 65% of the preoperative level. 25 patients had maintained > 65% of their respiratory capacity, while 75 had reduction of their respiratory capacity below 65% of the preoperative level. Of the 25 with > 65% capacity only 7 had moderate to severe cough (28%) while 8 had no cough(32%). Of the 75 patients who had reduction of their respiratory capacity, 40 (53%)had moderate to severe cough, and only 2 (2.7%) had no cough,remaining had minimal cough.(Table IV). By applying the statistical test of significance this increase in intensity of cough with reduction in respiratory capacity was found to be significant. (P- 0.000306)

## DISCUSSION

Cough is one of the main defensive reflex which protects the airway from particulate and chemical pollutants, along with mucous secretions and ciliary movement. If there is hypersecretion of mucous or any ciliary dysfunction clearance by normal air movement may not be sufficient and cough becomes a necessity.<sup>3</sup> The mucus layer gets thinner as you go down the airway and the mucus secreting cells also decrease to such an extent that there are no mucus producing cells



in bronchioles. In alveoli the trapped materials are removed by macrophages or are removed by cough.<sup>4</sup> In the absence of ciliary movement cough becomes the major protective mechanism. This explains the cough which occurs in smokers. The mechanical events during cough are of three phases – inspiratory phase when air is drawn in to generate the sufficient volume, compression phase when the larynx closes and the muscles of chest wall, diaphragm and abdominal wall contracts to generate the intra thoracic pressure and then the final expiratory phase when glottis opens up and expels the high airflow with cough sound.<sup>5</sup>

During vigorous coughing, intrathoracic pressures may reach 300 mm of Hg and expiratory velocities may approach 800 km per hour.<sup>6</sup> This high pressures help expel the particulate matters and organisms with mucous. Though protective this high pressure causes discomfort, in postoperative situation after sternotomy, producing severe pain and distress. Cough induced rib fractures have been reported in literature especially in women with decreased bone densities.<sup>7</sup>

Assessing the severity of cough, is difficult, as it is a subjective matter in most situations. Questionnaires were developed by various groups, to quantify cough as “cough severity index” published by Shembel AC et al.<sup>8</sup> Margret Vernon et al<sup>9</sup> had suggested that to address the severity of cough the three dimensions of cough namely frequency, intensity and disruptiveness must be considered. This aspect was taken care of in developing the assessment of cough in this study, and is given in Table II. 100 consecutive patients who underwent open heart surgery were followed throughout their hospital stay and was, assessed for cough severity, their breath holding capacity and their fluid balance.

We used simple bedside modified Sabraez breath holding test to assess the respiratory volume as the patient compliance for spirometric equipment may not be good.<sup>10</sup> Patients were asked to hold breath after an usual deep inspiration. The duration of holding is noted. This gives an idea of their lung volume. Roughly > 25 sec is considered as normal and 15 -25 sec as limited reserve and less than 15 sec as very poor reserve. Studies correlating the breath holding capacity and the vital capacity had shown contradicting results. But here we compared the test result of the same patient before and after the surgery, hence the test can be reliably used for assessing the variation in effective lung volume.

All post cardiac surgery patients were observed for presence of cough and its severity was quantified. This data was analysed for any influence of type of surgery and the basic cardiac pathology in cough pattern. During cardioplegic arrest and cardiopulmonary bypass with extracorporeal circulation inflammatory responses may be stimulated leading to excessive secretions and reduced ciliary motion, which in turn may cause postoperative cough. However our data showed no significant difference between short and prolonged duration of CPB and in those who underwent surgery without CPB.

During coronary artery surgery done with off pump beating heart technique, inflammatory activation by extracorporeal circulation is avoided. Here pulmonary effect can be attributed to manipulation of heart leading to rise in left atrial pressure,

which in turn increases the pulmonary venous pressure causing extravasations of fluid and added secretions. This can be a cause for cough in beating heart surgery. Manipulation will be more if the number of coronary grafts are more. This study compared the incidence of cough in patients with varying number of grafts and found the incidence and pattern to be identical.

Smokers are known to have excessive secretions and ciliary motility abnormalities. In these patients cough is a necessity to expel the excess mucous. We expected the smokers to have excessive cough postoperatively but found the incidence of cough similar to non-smokers.

Cardiac patients in general develop pulmonary edema with fluid overloading secondary to failure. The chance of pulmonary complications and cough are high when fluid balance becomes positive. However there was no significant correlation between cough severity and intake output balance.

Similar to other studies we found, there was a reduction in lung volume following cardiac surgery irrespective of cardiac pathology, the type of surgery and the technique. The breath holding test, revealed marked reduction to the extent of 65% of preoperative capacity in 75% post operative patients. Incidentally these were the patients who had more cough. Hence the cause of cough may be due to lung volume reduction.

A reduction in Forced Vital capacity (FVC) and Forced expiratory volume in 1 second (FEV1) was reported in most post cardiac surgery patients. While Nicholson et al reported a reduction of 40 -50% in FEV1 and FVC on first and second POD.<sup>11</sup> Matte et al reported a reduction of 53% on second post operative day.<sup>12</sup> Charlotte Urell et al observed 40% reduction in lung volume by second POD, in all patients irrespective of smoking habits. We found cough too peaks by third postoperative day. Lung volume reduction leads to peripheral atelectasis or airway constriction causing pooling of mucus. Cough may be a protective measure to expel the pooled mucus.<sup>10</sup>

This study too revealed reduction in respiratory volume in post operative patients and the incidence of cough was found to be more when the volume reduced to below 65% of preoperative level. Statistically using chi-square test it was found to be significant with p value .000306. This points to the fact that cough is related to the lung volume reduction probably due to peripheral atelectasis. Atelectasis may cause mucus secretion to accumulate, which gets expelled by cough. Intensity varying with the amount of accumulation of mucus and the efficiency of ciliary motility.

So to reduce cough in post cardiac surgery situation measures have to be taken to prevent post operative lung volume reduction. A combination of physiotherapy with breathing exercises, broncho dilatation by nebulisers and optimal pain management should be the main stay for managing this type of non infective cough.

## CONCLUSION

The incidence of postoperative cough was found to be over 80% following open heart surgery, irrespective of the

basic cardiac pathology, and the surgery performed. Cough was found to peak between 3<sup>rd</sup> and 5<sup>th</sup> postoperative day. The severity of cough was not significantly correlated with basic cardiac pathology, the type of surgery performed, the duration of cardiopulmonary bypass or the basic left ventricular function. The duration of manipulation of the heart in off pump CABGs and postoperative fluid balance and the smoking status of the patient too had no influence. All patients had a reduction in their lung volume and correlated significantly with severity of cough. A lung volume reduction to less than 65% of the preoperative level resulted in more severe cough. We conclude that post cardiac surgery cough primarily results from lung volume reduction following surgery. So control of this cough should be aimed at prevention of postoperative lung volume reduction.

**Source of Support:** Nil; **Conflict of Interest:** None

**Submitted:** 17-09-2019; **Accepted:** 15-10-2019; **Published online:** 13-11-2019

## REFERENCES

1. Smetana GW, Lawrence VA, Cornell JE. Preoperative pulmonary risk stratification for noncardiothoracic surgery: systematic review for the American College of Physicians. *Ann Intern Med* 2006;144(8):581-595
2. Smith MC, Ellis ER. Is retained mucus a risk factor for the development of postoperative atelectasis and pneumonia? Implications for the physiotherapist. *Physiother Theory Pract* 2000;16(2):69-80.
3. Rubin B.K. Physiology of airway mucous clearance; *Respir Care* 2002;47(7):761-768
4. Richardson M. The physiology of mucus and sputum production. *Nurs Times* 2003;99(23):63-64.
5. McCool FD: Global physiology and pathophysiology of cough: ACCP evidence based clinical practice guidelines. *Chest* 2006;129 (1 Suppl):48S – 53S.
6. Ford PA, Barnes PJ, Usmani OS: Chronic cough and Holmes-Adie syndrome. *Lancet* 2007, 369; 342.
7. Polverino et al Anatomy and neuro-pathophysiology of the cough reflex arc, *Multidisciplinary respiratory medicine* 2012;7(2):5-10.
8. Shembel A.C., Rosen CA, Zullo TG, Gartner-Schmidt JL. Development and validation of the cough severity index: a severity index for chronic cough related to upper airway: *Laryngoscope* 2013;123(8):1931-6.
9. Margaret Vernon, Nancy Kline Leidy, Alise Nacson, Lind Nekson: Measuring cough severity; Perspectives from the literature and from the patients with chronic cough. *Cough* 2009(5) 5
10. Charlotte Urell et al. Clinical study Lung function before and two days after open heart surgery; *Critical care research and practice* 2012;id 291628.
11. Nicholson DJ, Kowalski SE, Hamilton GA, Mayers MP et al. Postoperative pulmonary function in coronary artery bypass graft surgery patients undergoing early tracheal extubation: a comparison between short term mechanical ventilation and early extubation. *Journal of Cardiothoracic and vascular anaesthesia* 2002;16(6):27-31.
12. Matte P, Jacquet L, Van Dyke M, Goenen M. Effects of conventional physiotherapy, continuous positive airway pressure and non invasive ventilatory support with bilevel positive airway pressure after coronary artery bypass grafting. *Acta Anaesthesiologica Scandinavica* 2000;44(6):75-81.