

## Preoperative Respiratory Physiotherapy and Postoperative Complications Following Valve Replacement Surgery

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Received: July 05, 2017; Published: August 01, 2017

### Abstract

**Background:** Valve replacement surgery has increased over the last decade. A number of strategies for prevention and treatment have been developed to reduce postoperative complications.

**Objective:** The aim of this study was to determine if preoperative respiratory physiotherapy (PRP) could contribute to reduce the incidence of postoperative complications.

**Methods:** Observational retrospective study of 138 patients who underwent open surgical valve replacement with cardiopulmonary bypass at the University Hospital Puerta de Hierro-Majadahonda (Spain). Patients' clinical reports were reviewed from the time of admission until hospital discharge. A multivariate analysis model was carried out to identify confusion and interaction variables.

**Results:** Sixty-three patients received preoperative respiratory physiotherapy. Both groups, whether they received preoperative physiotherapy or not, did not significantly differ in age, gender, risk factors or preoperative hospital stay. The most frequent postoperative complications were pulmonary: 68 patients (49.3%); simple pleural effusion was the most common 34.1%. Those who did not receive preoperative physiotherapy were more likely to have postoperative complications than patients who did (68,0% vs. 52,4%; P = 0,06) (OR = 1.82; 95% CI: 0.89, 3.71).

**Conclusions:** Preoperative respiratory physiotherapy was related with a 23% relative risk decrease of postoperative complications. In addition, a reduction of atelectasis and simple pleural effusion could be attributable to postoperative physiotherapy. Both interventions show potential beneficial effects on patients undergoing valve replacement surgery.

**Keywords:** Heart Valve; Postoperative Complications; Physical Therapy Modalities

### Introduction

The burden of valvular diseases has increased substantially over the last decade [1]. This trend leads to an increased amount of valve replacement surgery [2]. This intervention requires, as many cardiovascular surgeries, invasive procedures like median sternotomy incision and cardiopulmonary bypass which lead to a number of characteristic complications that include cardiac abnormalities, neurological damage, coagulopathies, renal failure or pulmonary complications [3-5]. These postoperative pulmonary complications (PPC) are the most frequent and entail greater cost in both cardiac and non-cardiac surgery [6,7].

Amongst the causes of PPC seem to be involved a reduced lung volume [8], shallow breaths and increased respiratory rate due to postoperative pain, diaphragmatic dysfunction, inhibition of cough, altered mucociliar clearance and residual effect of anaesthesia leading to respiratory depression, resulting in an increase of hypoxemia, atelectasis or pneumonia [9].

With the expectation to reduce these postoperative complications a number of strategies for prevention and treatment are developed, among which, respiratory physical therapy appear to be beneficial [10]. However, there are still controversies in the literature about its usefulness [11], and what techniques and methods should be applied to achieve better outcomes in morbidity and hospital costs, varying by country and custom [12-14].

In an attempt to improve the evolution of our patients undergoing cardiac surgery, we added preoperative respiratory physiotherapy (PRP) to the postoperative physiotherapy program previously offered by our institution. The aim of this study is to evaluate the incidence of complications after valve replacement surgery in our center and the effectiveness of the PRP on postoperative complications in hospital patients undergoing this surgery.

### Methods

#### Subjects

This is an observational retrospective cohort study conducted between 1 January 2010 and 31 December 2010 at the University Hospital Puerta de Hierro-Majadahonda to evaluate the incidence of postoperative complications after PRP in patients undergoing valve replacement surgery. All patients undergoing open surgical valve replacement with cardiopulmonary bypass who received postoperative physiotherapy were studied. Exclusion criteria included valve surgery combined with coronary artery bypass surgery (CABG), valve surgery associated with other cardiac surgery (malformation) and percutaneous valve replacement.

Sample size (n = 139) was estimated with a security of 95%, an statistical power of 80% and 1% loss count in order to detect a difference of 16% vs. 37% in the incidence of postoperative complications between those patients in the PRP group and those without PRP [15].

#### Procedure and measurements

The clinical report of all patients was reviewed from the time of admission until hospital discharge. We evaluated the clinical course, radiological tests, the inclusion or not in the PRP group and the final diagnosis of complications established by medical criteria in the discharge report. Each patient inclusion in the PRP group was conducted by the Rehabilitation Unit on an individual basis after consultation of the Cardiovascular Unit.

We also checked if patients continued physiotherapy during the postoperative phase which was case-by-case determined by the rehabilitation physician in successive evaluations of the patients one day after surgery and once a week until hospital discharge. Postoperative physiotherapy was carried out daily including weekends.

The PRP program, carried out one hour the day before surgery under the supervision of a trained therapist, included training in the use of incentive spirometer (IS), learning techniques to protect the surgical wound, forced exhalation with the glottis open (Huffing), diaphragmatic deep breathing exercises and lung-expansion manoeuvres.

The variables studied were sex, age, risk factors including type of surgery, obesity, tobacco use and previous pathology, pre and postoperative physiotherapy sessions, postoperative complications especially pulmonary complications, mortality and hospital length. Risk factors were based on surgical risk rating scales EuroSCORE, STS-PROM [2], Ambler score [16], those referred in previous studies [17-19] and others considered by the authors.

**Statistical analysis**

A descriptive study was performed to identify the demographic and clinical characteristics of patients. Qualitative variables were described using frequency distribution and compared using the Chi-square measure or Fisher exact test. Quantitative variables were expressed as mean and standard deviation (SD) and compared with Student t-test or Mann-Whitney test if required. Quantitative variables with more than two categories were analysed with the study of variance (ANOVA) or the nonparametric Kruskal-Wallis test when the criteria were not met.

Clinical relevance of the PRP was estimated by calculating the relative risk (RR), the Absolute Risk Reduction (ARR), the Relative Risk Reduction (RRR) and the Number Needed to Treat (NNT). A multivariate analysis model was carried out to determine confusion and interaction variables. All descriptive and analytical data were described with a 95% confidence interval. Significance level was defined as P value less than 0.05. Statistical software Epidat v3.1 (Xunta de Galicia. A Coruña, Spain) and SPSS v20.0 (IBM Corp. Armonk, NY) were used for the analysis.

**Results**

In total, 138 patients that underwent valve replacement with cardiopulmonary bypass were studied, 79 (57.2%) women and 59 (42.8%) men. Mean age was 69.1 (SD = 11.7) years. Women were predominantly older 71.6 (SD = 10.9) years vs. 66.8 (SD = 12.2) years (P = 0.03). Sixty-two percent of patients had pre-surgical risk factors; smoking use was the most prevalent (31.9%), followed in order of frequency by previous decompensation (23.2%) and obesity (22.5%). Median admission time before surgery was 2 (IQR = 3) days.

Both groups, independently of whether they received preoperative physiotherapy or not, did not significantly differ in age, gender, risk factors or preoperative hospital stay (Table 1).

	Preoperative respiratory physiotherapy		P
	No (n = 75)	Yes (n = 63)	
<b>Age (years)*</b>	70.2 (11.3)	68.0 (12.1)	0.26
<b>Gender</b>			
Female	46 (61.3)	33 (52.4)	0.29
Male	29 (38.7)	30 (47.6)	
<b>Type of surgery</b>			
Univalve	60 (80.0)	44 (69.8)	0.27
Bivalve	14 (18.7)	16(25.4)	
Trivalve	1 (1.3)	7 (4.8)	
<b>Risk factors</b>			
Obesity	48 (64.0)	38 (60.3)	0.65
Tobacco	17 (22.7)	14 (22.2)	0.95
Asthma	19 (25.3)	25 (39.7)	0.07
COPD	3 (4.0)	2 (3.2)	0.58
Pulmonary hypertension	4 (5.3)	7 (11.1)	0.21
OSA	6 (8.0)	2 (3.2)	0.20
Pulmonary embolism	1 (1.3)	0 (0.0)	0.54
Previous decompensation	3 (4.0)	2 (3.2)	0.58
Preoperative hospital stay (days)†	20 (26.7)	12 (19.0)	0.29
	2 (4)	2 (2)	0.97

**Table 1:** Sample characteristics of patients with preoperative respiratory physiotherapy or not. Values are presented as n (%). \*Values are means (SD). †Values are median (IQR). COPD: Chronic Obstructive Pulmonary Disease; OSA: Obstructive Sleep Apnea.

Postoperative complications occurred in 84 (60.1%) patients, the most frequent postoperative complications were pulmonary complications: 68 (49.3%) patients, followed by cardiac complications: 5 (3.6%) patients. Among pulmonary complications simple pleural effusion was the most common 34.1% (Table 2). Mortality rate was 8%. Main causes of death were heart failure (2.9%), deep sternal wound (1.4%), neurological complications (1.4%) and pulmonary complications (1.4%).

	n	%	95% CI
Postoperative complications	84	60.1	(52.36, 69.37)
Deep sternal wound	6	4.3	(0.58, 8.11)
Cardiac	5	3.6	(1.19, -8.25)
Neurological	3	2.2	(0.45, 6.22)
Digestive	2	1.4	(0.18, 5.14)
Simple pleural effusion	47	34.1	(25.79, 42.33)
Complicated pleural effusion	9	6.5	(2.04, 11.0)
Pneumonia	7	5.1	(1.05, 9.09)
Atelectasis	4	2.9	(0.79, 7.28)
ARDS	1	0.7	(0.02, 3.97)
Death	11	8.0	(3.09, 12.85)

**Table 2:** Incidence of postoperative complications after surgery.  
*CI: Confidence Interval; ARDS: Acute Respiratory Distress Syndrome*

In the univariate analysis, postoperative complications were associated with age and preoperative hospital stay (Table 3). Postoperative complications were present in 67.1% of the female patients and 52.5% of the male patients. (P = 0.08).

	Postoperative complications		P
	No (n = 54)	Yes (n = 84)	
Age (years)*	65.7 (13.3)	71.5 (9.9)	< 0.01
Gender			
Female	26 (48.1)	53 (63.1)	0.08
Male	28 (51.9)	31 (36.9)	
Type of surgery			
Univalve	39 (72.2)	65 (77.4)	0.55
Bivalve	14 (25.9)	16 (19.0)	
Trivalve	1 (1.9)	3 (3.6)	
Risk factors	31 (57.4)	55 (65.5)	0.34
Obesity	9 (16.7)	22 (26.2)	0.19
Tobacco	20 (37)	24 (28.6)	0.29
Asthma	0 (0.0)	5 (6.0)	0.08
COPD	4 (7.4)	7 (8.3)	0.84
Pulmonary hypertension	3 (5.6)	5 (6.0)	0.61
OSA	1 (1.9)	0 (0.0)	0.39
Pulmonary embolism	3 (5.6)	2 (2.4)	0.30
Previous decompensation	9 (16.7)	23 (27.4)	0.14
Preoperative hospital stay (days)†	2 (0)	2 (5)	0.03

**Table 3:** Patients characteristics according to the presence of complications or not.  
*Values are presented as n (%). \*Values are means (SD). †Values are median (IQR).  
 COPD: Chronic Obstructive Pulmonary Disease; OSA: Obstructive Sleep Apnea.*

When comparing the group that received PRP with those that did not, the analysis revealed a lower incidence of postoperative complications in the treated group (52.4% vs. 68.0%) although this difference was not statistically significant (P = 0.06) (Table 4).

	Preoperative respiratory physiotherapy		P	RR	95% CI
	No (n = 75)	Yes (n = 63)			
Postoperative complications	51 (68.0)	33 (52.4)	0.06	1.29	(0.98, 1.72)
Non-respiratory complications	11 (14.7)	5 (7.9)	0.21	1.84	(0.68, 5.04)
Deep sternal wound	2 (2.7)	4 (6.3)	0.41	0.42	(0.08, 2.21)
Cardiac	4 (5.3)	1 (1.6)	0.37	3.36	(0.38, 29.29)
Neurological	3 (4.0)	0 (0.0)	0.25	-	-
Digestive	2 (2.7)	0 (0.0)	0.50	-	-
Respiratory complications	40 (53.3)	28 (44.4)	0.29	1.20	(0.85, 1.70)
Simple pleural effusion	30 (40.0)	17 (27.0)	0.10	1.48	(0.91, 2.42)
Complicated pleural effusion	6 (8.0)	3 (4.8)	0.50	1.68	(0.44, 6.45)
Pneumonia	2 (2.7)	5 (7.9)	0.24	0.33	(0.07, 1.67)
Atelectasis	2 (2.7)	2 (3.2)	1.00	0.84	(0.12, 5.79)
ARDS	0 (0.0)	1 (1.6)	0.45	-	-

**Table 4:** Presence of complications with or without preoperative physiotherapy.

Values are presented as n (%). RR: Relative Risk Non-Treated vs. Treated; CI: Confidence Interval; ARDS: Acute Respiratory Distress Syndrome

Patients who did not receive preoperative therapy had a higher risk of postoperative complications RR = 1.29 (95% CI: 0.98, 1.72). The impact of preoperative physiotherapy estimated that the Absolute Risk Reduction (ARR) was 16%, the Relative Reduction Risk (RRR) was 23%, and the Number Needed to Treat (NNT) to prevent one event was 7 (Table 5).

		95% CI
RR	1.29	(0.98, 1.72)
ARR	15.6%	(-0.6, 31.8)
RRR	23%	(-2.1, 41.9)
NNT	7	(3.1, 162.6)

**Table 5:** Measure of impact of preoperative physiotherapy in postoperative complications.

CI: Confidence Interval; RR: Relative Risk; ARR: Absolute Risk Reduction; RRR: Relative Risk Reduction; NNT: Number Needed to Treat.

In the multivariate analysis, after adjusting for age, patients who did not receive preoperative physiotherapy were more likely to have postoperative complications than patients who did, although this difference was not statistically significant OR = 1.82 (95% CI: 0.89, 3.71) (Table 6). Patients who did not receive preoperative physiotherapy also had a higher risk of developing pulmonary complications, although this difference was not statistically significant OR = 1.42 (95% IC: 0.72, 2.80).

Variable	OR	95% CI	P
Non-preoperative physiotherapy vs. preoperative physiotherapy	1.82	(0.89, 3.71)	0.09
Age	1.04	(1.01, 1.07)	< 0.01

**Table 6:** Multivariate analysis to estimate risk of postoperative complications.

OR: Odds Ratio; CI: Confidence Interval

## Discussion

Valvular heart diseases are less common compared with coronary heart disease (CAD), heart failure (HF) or hypertension, however often require surgery [20]. Improvements in surgical techniques have increased the number of interventions at an older age. The percentage of patients who underwent heart valve surgery over 70 years is more than 30% of the cardiovascular surgical activity [21]. In the present study, we found that more than 60% patients aged over 70 years and more than 38% patients aged over 75 years. As a consequence, we expected an increased risk of postoperative complications and mortality due to a higher frequency of comorbidity and lower resilience after intervention [22,23].

The incidence of postoperative complications (49.3%) did not differ significantly from those reported by other authors. Simple pleural effusion was 34.1%, whose values range from 27% to 98% in the literature [18]. The incidence of pneumonia (5.1%) was similar to what was recorded by Weismann et al. (between 2% and 22%) [9], the same as acute respiratory distress syndrome (ARDS) with 0.7% [24]. Related to non-pulmonary complications, deep sternal wound was 4.3% whose reported incidence by other authors ranges from 0.5% to 6.8% [25,26], or neurological complications (2.2%) which did not differ from the literature [27]. The mortality in this study (8.0%) did not differ from other series that ranged from 7.5% to 8.9% [21,28-30].

One of the findings of this study was the low incidence of atelectasis compared to the literature which ranges between 16% and 73% [18]. Since all patients received physical therapy during the postoperative period this might cause their lower incidence [31], however, our results were also different from other studies which apply postoperative respiratory physiotherapy with atelectasis ranges between 4.3% and 17% [32-34]. This variation might be explained by different definition criteria of pulmonary complications.

Whereas both groups received postoperative rehabilitation and the effects of both interventions pre and post might not be considered separated, our study highlighted that there were fewer complications in the PRP group (52.4% vs. 68%) ( $P = 0.06$ ) with an increased complications likelihood of 29% in the untreated group. This makes us consider that, despite the PRP was applied only the day before surgery, a very short period compared with other studies in which the program duration time was 2 weeks before surgery, [15] it could help to get better results.

An additional point of this study is that approximately 50% of patients were referred for preoperative physiotherapy the first year this program was implanted. Taking into account the underutilization of cardiac rehabilitation programs and prevention programs whose participation ranges from 20% to 30% of patients [35], we believe it shows a good acceptance by the Cardiovascular Surgery Unit.

## Limitations

A few points have to be mentioned which limited the comparison between the results of our study and the data from the literature. First, the interpretation of our results may be biased because it is a retrospective observational study. Determination of complication was based on medical records and, therefore, the quality of them may vary from one professional to another. Second, although we took into account multiple variables based on various scales of surgical risk, not every that influence in the complications development could be assessed. Finally, the patient population in the literature usually is heterogeneous (e.g. patients having coronary artery disease, CABG,

percutaneous interventions, associated with valve surgery) which may also lead to differences with our findings because our study only included valve surgery.

### Conclusion

This study shows a lower frequency of atelectasis and simple pleural effusion in both groups which may be related with the postoperative physiotherapy. And, although there were not significant differences between both groups, the preoperative respiratory physiotherapy group was related with fewer postoperative complications. Therefore, based on these results, the beneficial effects on dyspnea, functional capacity and respiratory muscles strength that chest physiotherapy strategies generate in patients with heart disease [36-38], and that preoperative programs appear to contribute to reduce the risk of postoperative complications [12], we considered that a randomized clinical trial after improvements in the intervention, with an increased duration of the preoperative sessions and addition of aerobic training to improve the preoperative functional capacity, might help to demonstrate the effectiveness of the intervention and increase the knowledge about specific strategies of physical therapy in valve surgery [20,39].

### Acknowledgements

To Yolanda Mera-Hernández who collaborated with data record.

### Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

### Conflict of Interest Statement

The Author(s) declare(s) that there is no conflict of interest.

### Bibliography

1. Nkomo VT, *et al.* "Burden of valvular heart diseases: a population-based study". *The Lancet* 368.9540 (2006): 1005-1011.
2. O'Brien SM, *et al.* "The Society of Thoracic Surgeons 2008 cardiac surgery risk models: part 2--isolated valve surgery". *Annals of Thoracic Surgery* 88.1 (2009): S23-S42.
3. Laffey JG, *et al.* "The systemic inflammatory response to cardiac surgery: implications for the anesthesiologist". *Anesthesiology* 97.1 (2002): 215-252.
4. Esper SA, *et al.* "Pathophysiology of Cardiopulmonary Bypass: Current Strategies for the Prevention and Treatment of Anemia, Coagulopathy, and Organ Dysfunction". *Seminars in Cardiothoracic and Vascular Anesthesia* 18.2 (2014): 161-176.
5. Ng CS, *et al.* "Pulmonary dysfunction after cardiac surgery". *Chest* 121.4 (2002): 1269-1277.
6. Dimick JB, *et al.* "Hospital costs associated with surgical complications: a report from the private-sector National Surgical Quality Improvement Program". *Journal of the American College of Surgeons* 199.4 (2004): 531-537.
7. Smetana GW, *et al.* "Preoperative pulmonary risk stratification for non-cardiothoracic surgery: systematic review for the American College of Physicians". *Annals of Internal Medicine* 144.8 (2006): 581-595.
8. Matheus GB, *et al.* "Inspiratory muscle training improves tidal volume and vital capacity after CABG surgery". *Revista Brasileira de Cirurgia Cardiovascular* 27.3 (2012): 362-369.
9. Weissman C. "Pulmonary complications after cardiac surgery". *Seminars in Cardiothoracic and Vascular Anesthesia* 8.3 (2004): 185-211.



10. Makhabah DN, *et al.* "Peri-operative physiotherapy". *Multidisciplinary Respiratory Medicine* 8 (2013): 4.
11. Pasquina P, *et al.* "Prophylactic respiratory physiotherapy after cardiac surgery: systematic review". *British Medical Journal* 327 (2003): 1379.
12. Cassidy MR, *et al.* "I cough: Reducing postoperative pulmonary complications with a multidisciplinary patient care program". *JAMA Surgery* 148.8 (2013): 740-745.
13. Renault JA, *et al.* "Respiratory physiotherapy in the pulmonary dysfunction after cardiac surgery". *Revista Brasileira de Cirurgia Cardiovascular* 23.4 (2008): 562-569.
14. Valkenet K, *et al.* "The effects of preoperative exercise therapy on postoperative outcome: a systematic review". *Clinical Rehabilitation* 25.2 (2011): 99-111.
15. Hulzebos EH, *et al.* "Preoperative physical therapy for elective cardiac surgery patients". *Cochrane Database of Systematic Reviews* 11 (2012): CD010118.
16. Ambler G, *et al.* "Generic, simple risk stratification model for heart valve surgery". *Circulation* 112.2 (2005): 224-231.
17. Geissler HJ, *et al.* "Risk stratification in heart surgery: comparison of six score systems". *European Journal of Cardio-Thoracic Surgery* 17.4 (2000): 400-406.
18. Wynne R and Botti M. "Postoperative pulmonary dysfunction in adults after cardiac surgery with cardiopulmonary bypass: clinical significance and implications for practice". *American Journal of Critical Care* 13.5 (2004): 384-393.
19. Rosenhek R, *et al.* "ESC Working Group on Valvular Heart Disease Position Paper: assessing the risk of interventions in patients with valvular heart disease". *European Heart Journal* 33 (2012): 822-828.
20. Joint Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology (ESC), European Association for Cardio-Thoracic Surgery (EACTS), *et al.* "Guidelines on the management of valvular heart disease (version 2012)". *European Heart Journal* 33.19 (2012): 2451-2496.
21. Rodríguez R, *et al.* "Cirugía cardíaca en el anciano". *Revista Española de Cardiología* 55.11 (2002): 1159-1168.
22. Prêtre R and Turina MI. "Cardiac valve surgery in the octogenarian". *Heart* 83.1 (2000): 116-121.
23. Sasaki N, *et al.* "Postoperative respiratory muscle dysfunction: pathophysiology and preventive strategies". *Anesthesiology* 118.4 (2013): 961-978.
24. Milot J, *et al.* "Incidence and predictors of ARDS after cardiac surgery". *Chest* 119.3 (2001): 884-888.
25. Filsoufi F, *et al.* "Epidemiology of deep sternal wound infection in cardiac surgery". *Journal of Cardiothoracic and Vascular Anesthesia* 23.4 (2009): 488-494.
26. Kubota H, *et al.* "Deep sternal wound infection after cardiac surgery". *Journal of Cardiothoracic Surgery* 8 (2013): 132.
27. Carrascal Y, *et al.* "Neurological complications after cardiopulmonary bypass: An update". *European Neurology* 41.3 (1999): 128-134.
28. Langanay T, *et al.* "Aortic valve replacement in the elderly: the real life". *Annals of Thoracic Surgery* 93.1 (2012): 70-78.
29. Langanay T, *et al.* "Current hospital mortality of aortic valve replacement in octogenarians". *Journal of Heart Valve Disease* 15 (2006): 630-637.



30. Shapira OM, *et al.* "Prognosis and quality of life after valve surgery in patients older than 75 years". *Chest* 112.4 (1997): 885-894.
31. Westerdahl E, *et al.* "Deep-breathing exercises reduce atelectasis and improve pulmonary function after coronary artery bypass surgery". *Chest* 128.5 (2005): 3482-3488.
32. Yañez-Brage I, *et al.* "Respiratory physiotherapy and incidence of pulmonary complications in off-pump coronary artery bypass graft surgery: an observational follow-up study". *BMC Pulmonary Medicine* 9 (2009): 36.
33. Herdy AH, *et al.* "Pre- and postoperative cardiopulmonary rehabilitation in hospitalized patients undergoing coronary artery bypass surgery: a randomized controlled trial". *American Journal of Physical Medicine and Rehabilitation* 87.9 (2008): 714-719.
34. Brasher PA, *et al.* "Does removal of deep breathing exercises from a physiotherapy program including pre-operative education and early mobilisation after cardiac surgery alter patient outcomes?" *Australian Journal of Physiotherapy* 49.3 (2003): 165-173.
35. Temporelli PL and Giannuzzi P. "Cardiac rehabilitation after cardiac surgery: a valuable opportunity that should not be missed". *European Journal of Cardiovascular Prevention and Rehabilitation* 15 (2008): 128-129.
36. Moalla W, *et al.* "Effect of exercise training on respiratory muscle oxygenation in children with congenital heart disease". *European Journal of Cardiovascular Prevention and Rehabilitation* 13.4 (2006): 604-611.
37. Palau P, *et al.* "Effects of inspiratory muscle training in patients with heart failure with preserved ejection fraction". *European Journal of Preventive Cardiology* 21.12 (2013): 1465-1473.
38. Piepoli MF, *et al.* "Secondary prevention through cardiac rehabilitation: from knowledge to implementation. A position paper from the Cardiac Rehabilitation Section of the European Association of Cardiovascular Prevention and Rehabilitation". *European Journal of Cardiovascular Prevention and Rehabilitation* 17.1 (2010): 1-17.
39. Branson RD. "The scientific basis for postoperative respiratory care". *Respiratory Care* 58.11 (2013): 1974-1984.

**Volume 4 Issue 3 August 2017**

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