Echocardiography based cardiac evaluation in the patients suffering from chronic obstructive pulmonary disease

B Shrestha, S Dhungel and R Chokhani

Department of Internal Medicine, Nepal Medical College Teaching Hospital, Attarkhel, Jorpati, Kathmandu, Nepal.

Corresponding author: Dr. Balaram Shrestha MD, PhD, Department of Internal Medicine, Nepal Medical College Teaching Hospital, Attarkhel, Jorpati, Kathmandu, Nepal, email: balaramshresthajsps@yahoo.com

ABSTRACT

Chronic obstructive pulmonary disease (COPD) is the most common medical problem in Nepal. Echocardiography based cardiac evaluation in COPD is rare in Nepal. The purpose of this study is to evaluate the echocardiography based cardiac function in consecutively admitted COPD patients (507) in medical wards of Nepal Medical College Teaching Hospital during 13th April 2007 to 12th April 2008. Male female ratio was 0.9:1. Age (mean ± SD) was 66.1 ± 10.9 yr. *Brahman* and *Chhetri* ethnic group comprised of more than half of total COPD patients followed by similar number of patients in *Newar* (22.1%) and *Mongolian* ethnic groups (21.5%). More than half of the COPD patients were in age group 60-75 years, followed by less number of patients (approximately 20.0%) in both 45-59 years and 75-89 years age groups. Of the total patients (507), 141 patients underwent echocardiographic evaluation. Among them significant number of patients had poor LVEF (29, 20.6%) with statistically significant difference in LVEF (36.0 +/- 10.5 vs. 64.3 +/- 8.5 %, p value <0.01). More than half of the total patients showed features of chronic cor pulmonale (56.3%), followed by valvular heart disease (49.3%), diastolic dysfunction (38.7%) and left ventricular hypertrophy (14.1%). Mild pulmonary artery hypertension (PAH) was detected in approximately half of patients (49.1%), followed by moderate PAH in 17.6% patients. Transthoracic echocardiography was found to be very useful to identify various concomitant cardiac abnormalities demanding special treatment consideration in managing clinically COPD like patients.

Keywords: *COPD, Chronic cor pulmonale, echocardiograph, DCM, PAH.*

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) has been defined by the presence of airways obstruction, which does not change markedly over several months and unlike asthma, is not fully reversible.[1,2]Chronic cough, chronic sputum production, dyspnea and history of exposure to risk factors like tobacco smoking are the clues for the diagnosis of COPD.[3] Global Initiative for Chronic Obstructive Lung Disease (GOLD) has described COPD as a disease that is preventable and curable.[2] Estimates suggest that COPD will rise from the sixth rank as the cause of death in 1990[3] to the third rank as the most common cause of death worldwide by 2020.[2-4]

COPD is the most common medical problem in Nepal according to a hospital-based evaluation and has significant morbidity and mortality.[5] Echocardiography based evaluation of cardiac function is less known in Nepal. Here we present our echocardiography based cardiac evaluation in admitted COPD patients using our newly introduced echocardiography database and data management system.[6]

MATERIALS AND METHODS

Consecutive 507 patients who had suffered from acute exacerbation of chronic obstructive pulmonary disease (COPD) and were admitted in medical wards of Nepal Medical College Teaching Hospital during Baisakh 2064 to Chaitra 2064 (13th April 2007 to 12th April 2008) were included as patient population. Out of them, 141 patients underwent echocardiographic evaluation as per the judgement of the treating physician. Echocardiographic examination was undertaken as per the recommendation of American Society of Echocardiography.[7, 8] Echocardiography machine used for this study was LOGIQ 400 MD MR3 Version 4.31 (GE). Based on left ventricle ejection fraction (LVEF) calculated, patients were subdivided into good LVEF and poor LVEF groups. Unpaired t test was performed and $p < 0.05$ was considered statistically significant. Estimated systolic pulmonary artery pressure (PAP) has been calculated as previously recommended (4v2 +10).[7,8] PAP has been arbitrarily sub-grouped in mild (40-60 mm Hg), moderate (60-80 mm Hg) and severe (>80 mm Hg) groups.

RESULTS

Five hundred and seven patients who had suffered from acute exacerbation of chronic obstructive pulmonary disease (COPD) and were admitted in medical wards of Nepal Medical College Teaching Hospital during Baisakh 2064 to Chaitra 2064 (13th April 2007 to 12th April 2008) were included as patient population. Out of them 141 patients underwent echocardiographic evaluation. Male female ratio was 0.9:1. Age (mean ±SD) was 66.1±10.9 yr.

COPD patients from across Nepal, were admitted in the medical wards of Nepal Medical College Teaching Hospital as shown in Fig 1. Majority of patients were from areas around Kathmandu. COPD patients from Eastern and Far Western region of Nepal did not attend NMCTH.

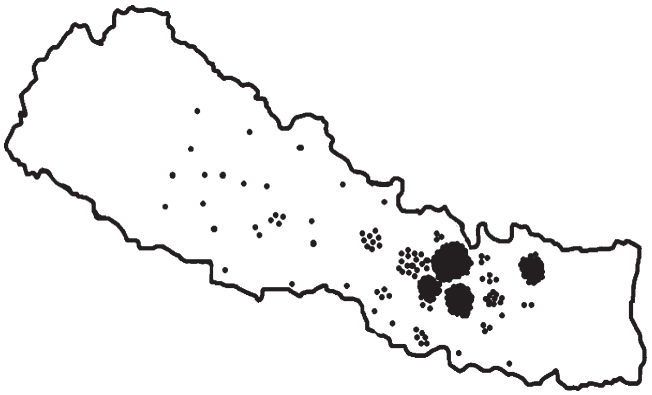

Fig. 1. Flow of COPD patients from across Nepal to NMCTH
(One dot represents one patient in the map).

Fig. 2 shows the ethnic group wise distribution of COPD patients at NMCTH (2064).

Brahman and *Chhetri* ethnic group comprised of more than half of total COPD patients followed by *Newar* (22.1%) and *Mongolian* ethnic groups (21.5%) as shown in Fig 2.

More than half of the COPD patients were in age group 60-75 years, followed by 45-59 years and 75-89 years age groups (approximately 20.0%) as shown in Fig 3.

Table 1 shows the concomitant diseases (n = 675) among admitted COPD patients (N = 507) as per clinical diagnosis. A significant number of patients (27.3%) had already developed features of chronic cor pulmonale clinically. Organic heart diseases demanding special treatment considerations were detected in significant number of patients such as HTN (9.9%), DCM, VHD, IHD collectively in 5.5% patients. Features of heart failure (right and left heart failure) was detected in 4.9% patients. All concomitant diseases are shown in Table-1.

Table-1: Other concomitant disease in COPD

Concomitant diseases	Number	(%)
Chronic corpulmonale	184	27.3
Type II respiratory failure	70	10.4
HTN	67	9.9
DCM	16	2.4
VHD	10	1.5
IHD	11	1.6
CCF	21	3.1
LVF	12	1.8
Other cardiovascular diseases	22	3.3
DM	25	3.7
PTB	14	2.1
Chest infection	22	3.2
Bronchogenic carcinoma	6	0.9
Other respiratory diseases	25	3.7
CKD	8	1.2
Other renal diseases	51	7.6
Hematological diseases	14	2.1
AGE	7	1
APD	15	2.2
Hepatobiliary diseases	34	5
Neurological diseases	11	1.6
Others	30	4.4
Total	675	100.0

(Abbreviations: HTN hypertension, DCM dilated cardiomyopathy, VHD valvular heart disease, IHD ischemic heart disease, CCF congestive cardiac failure, LVF left ventricular failure, DM diabetes mellitus, PTB pulmonary tuberculosis, CKD chronic kidney disease, AGE acute gastroenteritis, APD acid peptic disease)

Among the 141 COPD patients undergoing echocardiographic evaluation, they could be sub grouped into good LVEF (112, 79.4%) and poor LVEF (29,

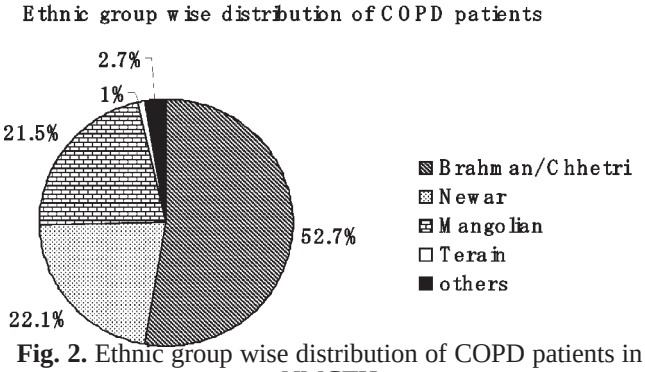

Fig. 2. Ethnic group wise distribution of COPD patients in NMCTH

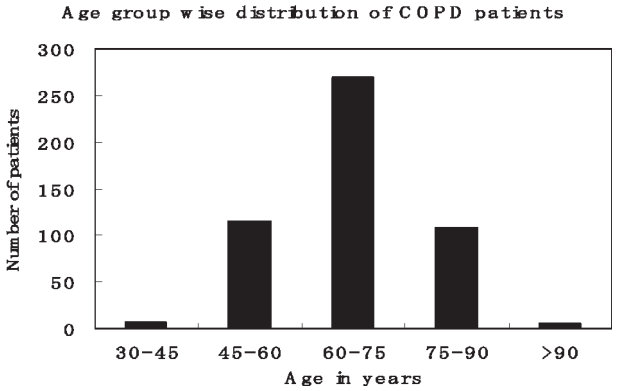

Fig. 3. Age group wise distribution of COPD patients in NMCTH

20.6%) groups with statistically significant difference in LVEF (64.3 +/- 8.5 % vs. 36.0 +/- 10.5, p value <0.01) as shown in Fig 4. Approximately in one in five patients of clinically diagnosed COPD patients had other diseases like DCM, VHD and had poor LVEF.

Out of total admitted COPD patient (n= 507), 141 patients underwent echocardiographic evaluation as per the instruction of treating physician. Out of them, more than half patients had features of chronic corpulmonale (80, 56.3%), followed by valvular heart disease (70, 49.3%), left ventricular hypertrophy [LVH (20, 14.1%)]. Approximately one out of nine patients (17, 12.0%) showed features of dilated cardiomyopathy. Other findings were as shown in table 2. As a single patient may have more than one echocardiography-based diagnoses, total may be more than the number of patients undergoing echocardiography (n=141).

Table-2: Echocardiographic diagnoses in COPD patients

Echo findings	Number	(%)
Corpulmonale	80	56.3
DCM	17	12.0
LVH	20	14.1
VHD	70	49.3
Pericardial effusion	17	12
Diastolic dysfunction	55	38.7
Normal echo	5	3.5
MAC	5	3.5
Thickened AV	13	9.2
Thickened MV	2	1.4
PFO	1	0.7
Total, n=141		

(Abbreviations: DCM dilated cardiomyopathy, LVH left ventricular hypertrophy, VHD valvular heart disease, MAC mitral annular calcification, AV aortic valve, MV mitral valve, PFO patent foramen ovale).

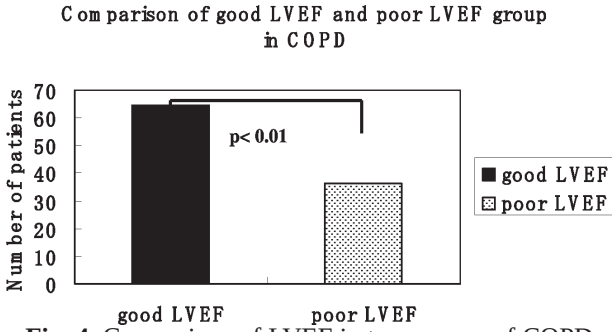

Fig. 4. Comparison of LVEF in two groups of COPD patients

Mild pulmonary artery hypertension (PAP 40-59 mm Hg) was detected in approximately half of patients (49.1%), followed by moderate PAH (PAP 60-79 mm Hg) in 17.6% patients as shown in Fig 5. Severe PAH was detected in few patients (3.7%).

DISCUSSION

COPD is the most common medical problem in Nepal according to a hospital based evaluation and has significant morbidity and mortality.[5] Echocardiography based evaluation of cardiac function is less known in Nepal. We present here our echocardiography based cardiac evaluation in admitted COPD patients using our newly introduced echocardiography data base and data management system.[6]

Male female ratio was 0.9:1 meaning more female were affected with COPD. This finding is similar to the previous report from another teaching hospital. [5] Almost equal number of female smoke in Nepalese society and almost all female are additionally engaged with domestic pollution due to use of wood for cooking. Even though urban ladies use gas for cooking, they are more exposed to vehicle emission in the improperly managed traffic system in narrow roads and excessive dust, dirt and garbage exposures.

The cause for higher number of COPD patients in *Brahman* and *Chhetri* ethnic group as shown in Fig 2, is not known. Possible causes are domestic pollution,

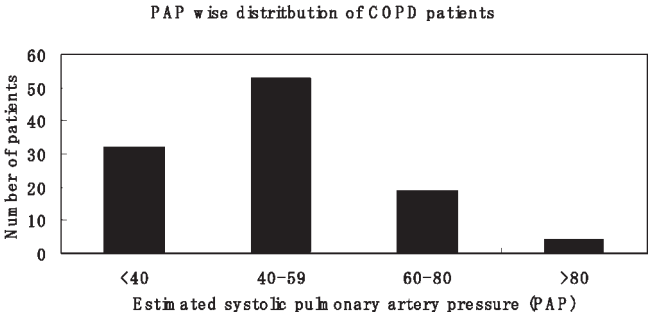

Fig. 5. Estimated systolic pulmonary artery pressure (PAP) based division of patients with feature of chronic cor pulmonale

outdoor vehicle emission, air pollution and use of dhups (scented sticks) during puja in *Brahman* ethnic group and smoking.

Age group wise distribution of COPD as shown in Fig. 3, showed patients of COPD appeared dramatically after the age of 45 years, and peaking at the age group 60-75 years. COPD is a chronic illness taking more than 10 packs year of smoking to develop it.[1] As Nepalese people start smoking in late childhood or early adolescence, involvement of COPD in 40s or 50s of their age in this study seems to be a true representation of COPD in Nepalese society.

Chronic cor pulmonale is an important complication of COPD[9] and the development of pulmonary hypertension is associated with higher mortality and morbidity.[10]Long-term oxygen therapy is beneficial in COPD with chronic cor pulmonale.[11-14]Significant proportion of COPD patients had features of chronic cor pulmonale (Table-1,2). This data supports the excessive need of domiciliary oxygen therapy. As cylinder based oxygen supply is available in big cities only and are quite expensive for ordinary poor Nepalese people, management of COPD is not that easy in Nepal as health insurance service is almost non existent and purchasing power of ordinary Nepalese is very poor. Though oxygen concentrator machines are recently introduced in big cities, frequent electric power cuts affects patients with good purchasing power as well. Introduction of liquid oxygen will be very useful milestone in the management of COPD, as it will help really ambulatory oxygen therapy to COPD patients.

Among the patients undergoing echocardiographic evaluation, significant proportion of patients (29, 20.6%) had poor LVEF (36.0 ± 10.5) as shown in Fig 4. In poor LVEF groups, the presence of severe global hypokinesia, presence of other valvular lesions, treatment becomes a difficulty as beta-blockers are usually not preferred in COPD.

Carvedilol,[15,16] Metoprolol[17] and Bisoprolol[18] has been found to be very useful medicines in heart failure. Presence of concomitant COPD creates problem in using beta blockers as they can exacerbate the bronchospasm. Carvedilol is reported to be better than Metoprolol in managing heart failure.[19,20] However, it being a nonselective betablocker may exacerbate bronchospasm more. Hence it may be less preferable in the background of COPD and low LVEF.

COPD is usually managed with inhaled bronchodiltors like rapid acting and slow acting beta 2 adrenoceptor agonists like salbutamol,[21] salmeterol,[22] formoterol,[23] anticholinergic drugs like ipratropium,[21,24] tiotropium[25] and steroid like fluticasone.[26] Combination of beta 1 specific betablocker should be more compatible with beta 2 stimulant bronchodilators in comparison to nonspecific beta blocker like carvedilol as nonspecific beta blocker like Carvedilol may have beta2 blocking effect canceling the efficacy of bronchodilators like Salbutamol, Terbutaline, Salmeterol etc.

When component of heart failure is prominent, it may be good to introduce gradually specific beta 1 blocker like Metoprolol or Bisoprolol[27] along with inhalational bronchodilator therapy after optimizing the heart failure therapy with drugs like angiotgensin converting enzyme inhibitor, digoxin and diuretic as specific beta 1 blocker may be more appropriate and compatible with beta 2 stimulants e.g. Salbutamol, Terbutaline, Salmeterol. Specific beta 1 blockers loose their specificity at higher dose, demanding extreme care in avoiding higher dose.

Improved clinical outcomes has been previously reported with long term oxygen therapy. Significant number of COPD patients in this study had mild to moderate PAH shown in Fig 5, reflecting the high oxygen demand in poor patients. Though the reports of improved cardiopulmonary function in severe COPD are available with the combination of nitric oxide and oxygen,[28-31] these strategies are not yet practiced in Nepal but should be used in selected severe COPD patients if it is affordable.

Though critically ill COPD patients requiring mechanical ventilation have higher mortality, non-invasive mechanical ventilation is better in terms of mortality.[32-34] Non-invasive pressure support ventilation is gaining popularity in Nepal as well.

Use of echocardiography based cardiac evaluation in COPD to evaluate the status of pulmonary arterial hypertension and other concomitant cardiac lesions, is very valuable in the management of COPD. [35] Selecting patients with moderate or severe pulmonary arterial hypertension for long term oxygen therapy with or without nitric oxide and selecting poor LVEF patients for optimizing heart failure therapy has the potential to have further improvement in severe COPD patients having apparently poor response in usual COPD management.

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REFERENCES

1. Innes JA, Reid PT. Respiratory disease: Chronic Obstructive Pulmonary Disease (COPD). In Boon NA, Colledge NR, Walker BR, Hunter JAA, editors. Davidson's Principles and

Practice of Medicine (20th Ed). Edinburg: Churchill Livingstone Elsevier 2006; 678-84.

2. Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management and prevention of chronic obstructive pulmonary disease. Executive summary. *Medical Communications Resources, Inc* 2007; 1-43.
3. Lopez AD, Murray CC. The global burden of disease, 1990-2020. *Nature Med* 1998; 4: 1241-3.
4. Reilly JJ, Silverman EK, Shapiro SD. Chronic obstructive pulmonary disease. In Kasper DL, Braunwald E, Fauci AS, Hauser SL, Longo DL, Jameson JL, editors. Harrison's Principles of Internal Medicine (16th ed.). New York: McGraw-Hill Medical Publishing Division 2005; 1547-54.
5. Sayami A, Shrestha B. Critical Care (Manual of ICU and CCU of TU Teaching Hospital). 1st ed. Kathmandu: JICA Medical Education Project 1995: 5-11.
6. Shrestha B, Dhungel S. Experience of newly constructed echocardiography-database with video clips, color still images and comments for verifiable reporting system at the Echocardiography lab of Nepal Medical College, Teaching Hospital. *Nepal Med Coll J* 2008; 10: 180-83.
7. Schmailzl KJG. Conventional Echocardiography: Examination Procedure, Fundamental measurement and Assessment Tasks. In Schmailzl JG, Ormerod O, Editors. Ultrasound in Cardiology (1st ed.). Berlin: Blackwell Science 1994; 49-8.
8. Oh JK, Seward JB, Tajik AJ. The Echo Manual: the Mayo Clinic (13rd ed.). New Delhi: Lippincott Williams 2006; 7-28.
9. Rich S, McLaughlin VV. Pulmonary Hypertension Associated with Disorders of the Respiratory System: Chronic Obstructive Pulmonary Disease In Zipes DB, Libby P, Bonow RO, Braunwald E , editors. Braunwald's Heart Disease: A textbook of cardiovascular medicine (7th ed) Philadelphia: Elsevier Saunders 2005: 1831-5.
10. Weitzenblum E, Hirth C, Ducolone A *et al*. Prognostic value of pulmonary artery pressure in chronic obstructive pulmonary disease. *Thorax* 1981; 36: 752-8.
11. Siafakas NM, Vermeire P, Pride NB *et al*. Optimal assessment and management of chronic obstructive pulmonary disease (COPD). The European Respiratory Society Task Force. *Eur Respir J* 1995; 8: 1398-420.
12. Medical Research Council Working Party. Long term domiciliary oxygen therapy in chronic hypoxic corpulmonale complicating chronic bronchitis and emphysema. *Lancet* 1981; 1: 681-6.
13. Nocturnal Oxygen Therapy Trial Group. Continuous or nocturnal oxygen therapy in hypoxemic chronic obstructive lung disease: a clinical trial. *Ann Intern Med* 1980; 93: 391-8.
14. Weitzenblum E, Sautegeau A, Ehrhart M *et al*. Long-term oxygen therapy can reverse the progression of pulmonary hypertension in patients with chronic obstructive pulmonary disease. *Am Rev Respir Dis* 1985; 131: 493-8.
15. Packer M, Bristow MR, Cohn JN *et al*. The effect of carvedilol on morbidity and mortality in patients with chronic heart failure. *N Engl J Med* 1996; 334: 1349-55.
16. Packer M, Coats AJS, Fowler MB *et al*. The effect of carvedilol on the survivial in severe chronic heart failure. *New Engl J Med 2001*; 344: 1651-8.
17. MERIT-HT Study Group. Effect of metoprolol CR/XL in chronic heart failure: Metoprolol CR/XL Randomised Intervention Trial in congestive heart failure (MERIT-HF). *Lancet* 1999; 353: 2001-7.
18. CIBIS II Investigators and Committees. The Cardiac Insufficiency Bisoprolol Study II (CIBIS II): a randomized trial. *Lancet* 1999; 353: 9-13.
19. Poole-Wilson PA, Swedberg K, Cleland JGF *et al*. Comparison of carvedilol and metoprolol on clinical outcomes in patients with chronic heart failure in the Carvedilol Or Metoprolol European Trial (COMET): randomized controlled trial. *Lancet* 2003; 362: 7-13.
20. Remme WJ, Cleland JG., Di Lenarda A *et al*. Carvedilol better protects against vascular events than metoprolol in heart failure: results from COMET. *J Amer Coll Cardiol* 2007; 49: 963-71.
21. Jenkins CR, Chow CM, Fisher BL, Marlin GE. Comparison of ipratropium bromide and salbutamol by aerosolized solution. *Aust N Z J Med* 1981; 11: 513-6.
22. Jarvis b, Markham A. Inhaled salmeterol: a review of its efficacy in chronic obstructive pulmonary disease. *Drugs Aging* 2001; 18: 441-72.
23. Cheer SM, Scott LJ. Formoterol: a review of its use in chronic obstructive pulmonary disease. *Amer J Respir* Med 2006; 1: 285-300.
24. Brown IG, Chan CS, Kelly CA, Dent Ag, Zimmerman PV. Assessment of the clinical usefulness of nebulised ipratropium bromide in patients with chronic airflow limitation. *Thorax* 1984; 39: 272-6.
25. Keam SJ, Keating GM. Tiotropium bromide. A review of its use as maintenance therapy in patients with COPD *Treat Respir Med* 2004; 3: 247-68.
26. Soriano JB, Kiri VA, Pride NB, Vestbo J. Inhaled corticosteroids with/ without long-acting beta-agonists reduce the risk of rehospitalization and death in COPD patients. *Amer J Respir Med* 2003; 2: 67-74.
27. Khan MG. Cardiac drug therapy: Beta-Blockers: The Cornerstone of Cardiac Drug Therapy. 6th ed. USA: Saunders 2003; 1-52.
28. Germann P, Ziesche R, Leitner C *et al*. Addition of nitric oxygen to oxygen improves cardiopulmonary function in patients with severe COPD. *Chest* 1998; 114: 29-35.
29. Yashida M, Taguchi O, Gabazza EC *et al*. Combined inhalation of nitric oxide and oxygen in chronic obstructive pulmonary disease. *Amer J Respir Crit Care Med* 1997; 155: 526-9.
30. Katayama Y, Higenbottam TW, Diaz de Atauri MJ *et al*. Inhaled nitric oxide and arterial tension in patients with chronic obstructive pulmonary disease and severe pulmonary hypertension. *Thorax* 1997; 52: 120-4.
31. Vonbank K, Ziesche R, Higenbottam TW *et al*. Controlled prospective randomized trial on the effects on pulmonary haemodynamics of the ambulatory long term use of nitric oxide and oxygen in patients with severe COPD. *Thorox* 2003; 58: 289-93.
32. Limthongkul S, Wongthim S, Udompanich V, Charoenlap P, Nuchprayoon CJ. Mechanical and non-mechanical ventilation of respiratory failure in chronic obstructive pulmonary disease. *J Med Assoc Thai* 1993; 76: 1-8.
33. Vitacca M, Clini E, Rubini F, Nava S, Foglio K, Ambrosino N. Non-invasive mechanical ventilation in severe chronic obstructive lung disease and acute respiratory failure: short- and long-term prognosis. *Intensive Care Med* 1996;22: 94-100.
34. Vitacca M, Rubini F, Foglio K, Scalvini S, Nava S, Ambrosino N. Non-invasive modalities of positive pressure ventilation improve the outcome of acute exacerbations in COLD patients. *Intensive Care Med* 1993; 19: 450-5.
35. Arcasoy SM, Christie JD, Ferrari VA *et al.* Echocardiographic assessment of pulmonary hypertension in patients with advanced lung disease. *Amer J Respir Crit Care Med* 2003; 167: 735.0