Research Journal of Medical Sciences 9 (4): 249-255, 2015
ISSN: 1815-9346

The Association of Some Demographic Variables with Pulmonary Complications among a Sample of Jordanianpost Coronary Artery Bypass Graft Surgery Patients

Osama A. Alkouri
King Abdulla University Hospital, Department of Catheterization, Irbid, Jordan

Abstract: Cardiac surgery caused the highest rates of PPCs with an estimated rate of up to 39.6% as compared to 31% in thoracic surgery. Determine the prevalence of PPCs among a sample of Jordanian post coronary artery bypass graft surgery patients and to explore the possible association between PPCs and some demographic variables. This study was descriptive, retrospective. Study sample included 150 files of patients with CABG. Data was collected through constructing a questionnaire. Data was analyzed through the use of SPSS Version 20. Chi-square was used to examine the relationship between variables. Significance was considered at alpha level <0.05. The prevalence of PPCs was 60%. Demographic variables were associated significantly with PPCs. Age was significantly associated with atelectasis ($p = 0.000$), pneumonia ($p = 0.001$), pulmonary effusion ($p = 0.012$), pulmonary edema ($p = 0.006$) and pneumothorax ($p = 0.034$). The rest complications did not show any significant variation with age.gender associated significantly with pulmonary embolism ($p = 0.008$) and females are more likely to develop pulmonary embolism compared with males. BMI was associated significantly with atelectasis, pulmonary effusion, pulmonary edema and bronchospasm. The results of the present study showed that the prevalence of PPCs was 60%. Demographical variables including age, gender and obesity were associated significantly with some PPCs.

Key words: Post pulmonary complication, cardiac surgery, thoracic surgery, CABG, gender, age

INTRODUCTION

Pulmonary complications: Postoperative Pulmonary Complications (PPCs) have been defined as "any pulmonary abnormality occurring in the postoperative period that produce identifiable disease or dysfunction that is clinically significant and that adversely affects clinical course" (Hulzebos *et al*., 2003).

Wynne and Botti (2004) found that cardiac surgery caused the highest rates of PPCs with an estimated rate of up to 39.6% as compared to 31% in thoracic surgery. There are many physiological and mechanical changes in the pulmonary system that might occur due to the nature of surgery such as median sternotomy, depressed cardiac function, phrenic nerve injury and manipulation of thoracic contents. Pulmonary complications may occur as intrinsic originating in lung such as atelectasis and pneumonia, extrinsic related to depressed cardiac function leading to pulmonary problems such as pulmonary edema. On pump surgery with CPB also can lead to pulmonary edema and ARDS (Wynne and Botti, 2004).

Morsch conducted a study for 108 patients undergoing CABG surgery in Brazil from 2006-2007 at the Cardiology Institute of Rio Grande do Sul (ICFUC) to assess the ventilatory profile for those patients. The study found that Forced Expiratory Volume (FEV) and Forced Vital Capacity (FVC) were noticeably decreased on the 6th day after the surgery comparing to the preoperative levels. The other findings included decreased ventilatory strength muscles, reduced pulmonary volumes and lung capacity.

Types and incidence of pulmonary complications following CABG: Postoperative pulmonary complications are the most complications occurring post CABG surgery (Al-Qubati *et al*., 2010). In Yemen, Al-Qubati *et al*. (2010) conducted a study for 179 Yemini patients from 2004-2009 to identify the incidence of these complications post CABG surgery. The study found that pulmonary complications occurred with an estimated incidence of up to 15.08% with mortality rate of about 18.5% among those patients. The major pulmonary complications that developed following surgery are atelectasis ocurred in 3.35% of the patients, pneumonia in 2.79%, pneumothorax in 0.55%, pleural effusion in 2.22% and ARDS in 3.35%. The study also explored the most predictors of these complications and included blood transfusion, cardiopulmonary bypass and increased length of stay in the intensive care unit.

Jensen and Yang (2007) conducted a retrospective study of 315 medical records for patients who underwent CABG surgery to explore the main pulmonary

complications following the surgery. The comprehensive findings included 99.4% equivalent to 313 patients who underwent PPCs. A total of 0.3% being one patient incurred pulmonary embolism with the same percentage of 0.3%, one patients incurred hemothorax, 23 patients equivalent to 7.3% incurred a pneumothorax, 10.5% totaling 33 patients endured pulmonary edema. The 11.7% of the patients equivalent to 37 endured pneumonia while 7.37% of patients developed atelectasis with pleural effusion, 75.6% with plueral effusion and or 97.5% developed atelectasis.

Through an inductive literature review and analysis of extensive studies of PPCs following CABG surgery. A similar study to Jensen conducted by Schuller and Morrow (2000) revealed that after coronary revasvularization the most common pulmonary complications are pneumonia, pulmonary edema, hemothothorax, atelectasis and pleural effusion. The literature review found that the most common PPCs post CABG surgery were.

Pleural effusion: Is an expected pulmonary problem that might occur post CABG surgery. Following this surgery patients may develop small effusions not requiring medical intervention and resolve with time progress. There are many causes associated with occurrence of pleural effusion such as bleeding, pneumonia, atelectasis and pulmonary edema (Light *et al*., 1999; Lee *et al*., 2001).

It has been found that incidence of pulmonary effusion in Australia is 89% during the first week after the surgery and 11.4% during the first 6 weeks (Lee *et al*., 2001). Most of the pleural effusions detected by radiographs imaging were found at left side (Lee *et al*., 2001). Light *et al*. (2002) studied 30 patients who underwent CABG surgery and performed imaging procedures on the second and seventh day following surgery. The study reported that the higher incidence of pleural effusion occurred during the first 48 h after the surgery.

Pneumothorax: Pneumothorax is a potential complication that might develop following CABG surgery. Douglas and Spaniol (2002) reported that incidence of pneumothorax following CABG was ranging from 0.7-1.7% in Colombia.

Positive pressure associated with mechanical ventilator may cause tension pneumothorax which is a life threatening condition caused by air trapping in the intra-pleural space without extracting resulting in lung collapse, increased intrapulmonary pressure, impaired ventilation and eventually causing hypoxemia. There are some other contributing factors for pneumothorax such as chronic obstructive pulmonary disease, decreased lung integrity, infections and lung damage attributed to surgical procedure (Anzueto *et al*., 2004).

ARDS: Severe lung injury associated with respiratory failure is very serious issue post CABG surgery. Asimakopoulos *et al*. (1999). Found that 12 (0.5%) out of 2.464 patients developed ARDS post CABG and eleven (91.6%) of these patients developed multiple organ failure and eventually died and one of them developed ARDS without organ failure. In Canada, Milot *et al*. (2001) conducted a study on 3.278 patients who underwent on-pump surgery with CPB. The study found that 0.4% (13) patients developed ARDS and 2 of ARDS patients 15% eventually died and one of the 2 deaths developed multiple organ failure.

ARDS might be caused by many intra-operative triggering factors such as CBP, anesthesia, surgical trauma, previous cardiac surgery and blood transfusion. Canver and Chanda (2003) studied 8802 American patients undergoing coronary artery bypass graft surgery to identify the major risk factors that significantly contribute to lung injury and respiratory failure. Study found that respiratory failure developed in patients placed on mechanical ventilator longer than 72 h post CABG, 491 (5.6%) of respiratory failure patients were associated with other serious conditions such as sepsis, endocarditis, renal failure, gastrointestinal bleeding and mediastinitis. The major intra-operative risk factor for developing respiratory failure is cardiopulmonary bypass use.

Respiratory failure: Respiratory failure is one of the major pulmonary complications post CABG surgery (Smetana, 2009). It's the main morbid condition and contributing predicting factor for further complications and death. The main indication for postoperative respiratory failure is the patients need to mechanical ventilator for longer than 48 h post-surgery (Johnson *et al*., 2007). Johnson *et al*. (2007) explored the main postoperative complications associated with respiratory failure in patients who underwent CABG as compared to patients without respiratory failure. The study found that 26% of respiratory failure patients died within 30 days, 6% developed myocardial infarction, 35% developed pneumonia and 3% pulmonary embolism.

Pulmonary edema: Pulmonary edema is due to left ventricular failure and considered one of the major preoperative risk factors for postoperative pulmonary complications (Castelli *et al*., 2001). Patients with heart failure and pulmonary edema usually need prolonged mechanical ventilation after surgery considered another

important leading factor for pneumonia and other pulmonary complications (Castelli *et al*., 2001). In order to support the cardiac failed, patients my need intra-aortic balloon pump that might increase patient need for prolonged mechanical ventilation and increased length of stay at hospital (Castelli *et al*., 2001; Weissman, 2004). Such patients have high mortality rates and at high risk for developing respiratory failure (Weissman, 2004).

Preoperative predicting risk factors

Age: Studies found that patients whose age older than 60 years old are at higher risk for postoperative pulmonary complications after CABG attributed to decrease in the tolerance of low oxygen level and systematic hypoxemia. Old patients undergoing CABG surgery are at higher risk for ICU readmissions as compared to younger ages (Hulzebos *et al*., 2003; Cwynar *et al*., 2009; Rajaei and Dabbagh, 2012).

In Netherland, Hulzebos *et al*. (2003) conducted a study on 117 patients who underwent CABG in 2003 at the University Medical Center Utrecht to explore the preoperative risk factors for postoperative pulmonary complications. The study found that people older 70 years old are at high risk for pulmonary complications following the surgery.

Obesity: Obesity is one of the most important risk factors for respiratory problems (Leeper, 2009). The incidence of obesity has increased from 4.7-5.9% in the US leading to increased health care expenditure on postoperative cardiac and pulmonary complications. Leeper (2009) conducted a retrospective study on 200 patients who underwent CABG selected randomly to determine if the obesity has an influence on the period of intubation after this surgery. The body mass index was >30 for obese patients. The study found that 42% of obese patients had delayed extubation and some of those patients were not properly extubated. The 46% of obese patients had been extubated in <2 h as compared to 63% in non-obese patients, 98% of non-obese patients had been extubated for 6 h as compared to 85% of obese patients extubated for 12 h.

Obesity is the major contributing factor for pulmonary complications post CABG causing a decrease in lung compliance and elasticity which require high diaphragmatic activity and increase in cardiac workload (Davidson *et al*., 2003; Charlebois and Wilmoth, 2004).

The study found that obese patients have low expiratory reserve volume related to continuous weight gain. Obese patients are at high risk for fatigue muscles and respiratory failure because these muscles should meet the daily activity living by working harder than non-obese muscles (Leeper, 2009).

Obese patients may have Obstructive Sleep Apnea (OSA) due to accumulation and deposition of body fats exerting on diaphragmatic area which results in increased respiration workload and tidal volume. All of these changes may contribute to respiratory failure so patients scheduled for CABG must be assessed for OSA before the surgery (Leeper, 2009; Davidson *et al*., 2003).

Gender: A prospective study of 960 consecutive adult patients who underwent CABG surgery was conducted in Iran by Yazdanian *et al*. (2012) to determine if the gender has an impact on mortality and morbidity before the surgery. The study found that women older than 50 years old are at high risk for morbidity including pulmonary complications and mortality after the surgery as evidence by need a higher inotropic support and higher rates of heart failure and pulmonary edema.

In the USA, Woods *et al*. (2003) conducted a prospective cohort study of 1742 women and 3582 men who underwent CABG surgery to determine if the sex difference has an influence on the outcomes of the surgery. The study results concluded that women had higher risks for morbidity, pulmonary complications and mortality after the surgery.

Kim *et al*. (2007) conducted a randomized control trials from 1985-2005 to explore the difference in the outcomes following CABG surgery specified particularly for postoperative pulmonary complications. The study found that women developed higher rates of pulmonary complications than men and constituted 6.2% among women as compared to 4.5% among men.

Study objectives: The main objectives of the current study were to determine the prevalence of PPCs among a sample of Jordanian post coronary artery by pass graft surgery patients and to explore the possible association between PPCs and some demographic variables.

MATERIALS AND METHODS

Study design and setting: The design of this study was a descriptive, retrospective and conducted at King Abdulla University Hospital (KAUH).

Study sample: Study sample included 150 files of patients who underwent cardiac surgery.

Data collection and procedures: After the study was approved by IRB from KAUH, the researcher contacted the head of cardiology department. Researcher was given access to patients medical records that included

past 2010-2014. Data collection included constructing structured questions. Researcher identified and chose records that are in alignment with research study and excluded any files that do not pertain to the research purpose. The researcher sought echo reports, ECG and image results and documented each in accordance with the research criteria.

Statistical analysis: A descriptive statistical approach was implemented to obtain standard deviation, means and percentages. Chi squared was used examine the association between study variables, logistic regression was used to predict the involved predictors of postoperative pulmonary complications. The significance was examined at alpha level <0.05.

RESULTS

The frequency and distribution of pulmonary complications among Jordanian post-CABG Surgery Patients: As seen in Table 1, out of 150 patients undergoing surgery, 90 patients (60%) developed pulmonary complications.

Pulmonary complications were numerous and the most prominent complications included pleural effusion, atelectasis and pulmonary edema (Fig. 1).

The association between demographic variables and PPCs

The association between age and PPCs: As shown in Table 2, age associated positively with atelectasis

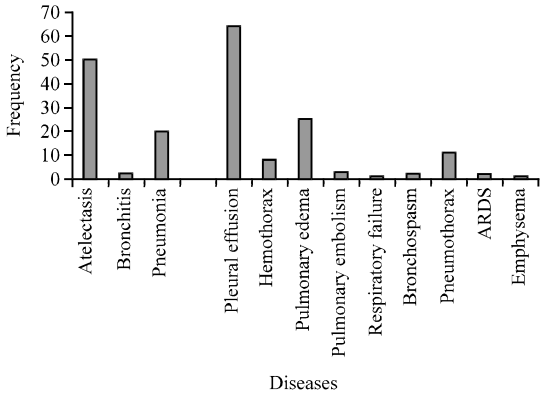

Fig. 1: The frequency of PPCs among patients with CABAG

Table 1: Pulmonary Complications among 150 Jordanian post-CABG Surgery Patients

Variables	Frequency (N)	Percentage (%)
PPCs		
Yes	90	60
No	60	40

(p = 0.000), pneumonia (p = 0.001), pulmonary effusion (p = 0.012), pulmonary edema (p = 0.006) and pneumothorax (p = 0.034). The rest complications did not show any significant variation with age.

The association between gender and PPCs: As shown in Table 3, gender associated significantly with pulmonary embolism (p = 0.008) and females are more likely to develop pulmonary embolism compared with males. Respiratory failure also associated significantly with gender (p = 0.013) and also females were more likely to develop respiratory failure. The other complications did not significantly associate with gender.

The association between BMI and PPCs: As shown in Table 4 associated significantly with BMI (p = 0.041) and those who were overweight and obese were more likely to develop atelectasis. Pulmonary effusion also associated significantly with BMI (p = 0.015) and overweight and

Table 2: The association between age and PPC

	Age						
	>45		45-60		>60		
Variables	N	(%)	N	(%)	N	(%)	p-values
Atelectasis							
Yes	0	0	19	21.8	31	56.4	0.000
No	8	100	68	78.2	24	43.6	-
Bronchitis							
Yes	0	0	1	1.1	1	1.8	0.892
No	8	100	86	98.9	54	98.2	-
Pneumonia							
Yes	0	0	5	5.7	15	27.3	0.001
No	8	100	82	94.3	40	72.7	-
Pulmonary effusion							
Yes	2	25	30	34.5	32	58.2	0.012
No	6	75	57	56.5	23	41.8	-
Hemothorax							
Yes	0	0	4	4.6	4	7.3	0.621
No	8	100	83	95.4	51	92.7	-
Pulmonary edema							
Yes	0	0	9	10.3	16	29.1	0.006
No	8	100	78	89.7	39	70.9	-
Pulmonary embolism							
Yes	0	0	2	2.3	1	1.8	0.899
No	8	100	85	97.7	54	98.2	-
Respiratory failure							
Yes	0	0	0	0	1	1.8	0.419
No	8	100	87	100	54	98.2	-
Bronchospasm							
Yes	0	0	1	1.1	1	1.8	0.892
No	8	100	86	98.9	54	98.2	-
Pneumothorax							
Yes	0	0	3	3.4	8	14.5	0.034
No	8	100	84	96.6	47	85.5	-
ARDS							
Yes	0	0	0	0	2	3.6	0.174
No	8	100	87	100	53	96.4	-
Pulmonary arrest							
Yes	0	0	0	0	1	1.8	0.419
No	8	100	87	100	54	98.2	-

Table 3: The association between gender and PPC

	Gender				
	Male		Female		
Variables	N	(%)	N	(%)	p-values
Atelectasis					
Yes	42	32.6	8	38.1	0.822
No	87	77.4	13	61.9	-
Bronchitis					
Yes	2	1.6	0	0.0	0.566
No	127	98.4	21	100.0	-
Pneumonia					
Yes	17	13.2	3	14.3	0.890
No	112	86.8	18	85.7	-
Pulmonary effusion					
Yes	57	44.2	7	33.3	0.351
No	72	55.8	14	66.7	-
Hemothorax					
Yes	7	5.4	1	4.8	0.689
No	122	94.6	20	95.2	-
Pulmonary edema					
Yes	23	17.8	2	9.5	0.344
No	106	82.8	19	90.5	-
Pulmonary embolism					
Yes	1	0.8	2	9.5	0.008
No	128	99.2	19	90.5	-
Respiratory failure					
Yes	0	0	1	4.8	0.013
No	129	100	20	95.2	-
Bronchospasm					
Yes	2	1.6	0	0.0	0.566
No	127	98.4	21	100.0	-
Pneumothorax					
Yes	11	8.5	0	0.0	0.164
No	118	91.5	21	100.0	-
ARDS					
Yes	2	1.6	0	0.0	0.566
No	127	98.4	21	100.0	-
Pulmonary emphysema					
Yes	1	0.8	0	0.0	0.686
No	128	99.2	21	100.0	-

Table 4: The association between BMI and PPC

	BMI						
	Normal		Overweight		Obese		
Variables	N	(%)	N	(%)	N	(%)	p-values
Atelectasis							
Yes	10	18.9	24	38.1	16	47.1	0.041
No	43	81.1	39	61.9	18	52.9	-
Bronchitis							
Yes	1	1.9	1	1.6	0	0.0	0.736
No	52	98.1	62	98.4	34	100.0	-
Pneumonia							
Yes	4	7.5	11	17.5	5	14.7	0.284
No	49	92.5	52	82.5	29	85.3	-
Pulmonary effusion							
Yes	15	28.3	29	46.0	20	58.8	0.015
No	38	71.7	34	54.0	14	41.2	-
Hemothorax							
Yes	2	3.8	3	4.8	3	8.8	0.572
No	51	96.2	60	95.2	31	91.2	-
Pulmonary edema							
Yes	3	5.7	15	23.8	7	20.6	0.026
No	50	94.3	48	76.2	27	79.4	-
Pulmonary embolism							
Yes	0	0	2	3.2	1	2.9	0.432
No	53	100	61	96.8	33	97.1	-
Respiratory failure							
Yes	0	0	0	0.0	1	2.9	0.180
No	53	100	63	100.0	33	97.1	-
Bronchospasm							
Yes	0	0	0	0.0	2	5.9	0.031
No	53	100	63	100.0	32	94.1	-
Pneumothorax							
Yes	1	1.9	7	11.1	3	8.8	0.154
No	52	98.1	56	88.9	31	91.2	-
ARDS							
Yes	0	0	2	3.2	0	0.0	0.247
No	53	100	61	96.8	34	100.0	-
Pulmonary emphysema							
Yes	0	0	1	1.6	0	0.0	0.499
No	53	100	62	98.4	34	100.0	-

occurring in the lung with aging including decreased elastic recoil and compliance of the lung, decreased the obese patients were more likely to develop pulmonary effusion compared with normal weight patients. The same trend was observed in pulmonary edema ($p = 0.026$) and bronchospasm ($p = 0.031$).

DISCUSSION

The results of the present study showed that the prevalence of PPCs was 60%. This finding agrees with other studies in which PPCs varied from 5-90% (Weissman, 2004).

The data of the present study showed that age to be a predictor for several PPCs including atelectasis ($p = 0.000$), pneumonia ($p = 0.001$), pulmonary effusion ($p = 0.012$), pulmonary edema ($p = 0.006$) and pneumothorax ($p = 0.034$). These findings are in line with many reported studies (Weissman, 2004; Clementino and Silva, 2012). Patients who underwent CABG surgery are usually in the elderly people whose ages are above 60 years old due to physiological changes strength and performance of respiratory muscles which in turn increase breathing workload (Wiegmann *et al*., 2010).

The data showed that gender is a predictor for pulmonary embolism ($p = 0.008$) and females are more likely to develop pulmonary embolism compared with males. Respiratory failure is also associated significantly with gender ($p = 0.013$) and also females were more likely to develop respiratory failure. As previously argued, it is not an easy to establish such a relationship based on the number of females included in the present study but as guidelines, these findings are worth to be taken to investigated in other studies.

The data of the present study showed that BMI to be a predictor of some PPCs including atelectasis ($p = 0.041$) and those who were overweight and obese were more likely to develop atelectasis, pulmonary

effusion (p = 0.015), pulmonary edema (p = 0.026) and bronchospasm (p = 0.031). These findings are in line with several studies reported in literature in which obesity was considered one of the risk factors for coronary artery disease (Weissman, 2004; Clementino and Silva, 2012). In another study, the prevalence of obesity has been increased in the last 10 years in the United Kingdom which was one of the major risk factors for developing pulmonary complications post CABG surgery (Akdur *et al*., 2006). Obesity is a risk factor for developing various and chronic conditions including DM, hypertension and obstructive sleep apnea considered leading factors for PPCs (Mendonca *et al*., 2014).

CONCLUSION

The results of the present study showed that the prevalence of PPCs was 60%. Demographical variables including age, gender and obesity were associated significantly with some PPCs.

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