

Predictors of Pulmonary Complications among Jordanian Post Coronary Artery Bypass Graft Surgery Patients

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Abstract: Coronary artery disease is the main contributing factor for death globally. Despite advancement and highly used of technology in surgical procedures, anesthesia and health care plans and interventions established for patients post open heart surgery, postoperative pulmonary complications are considered one of the major complications leading to severe morbidity and mortality. After a thorough review of the literature regarding predictors of pulmonary complications following CABG surgery, a retrospective study was conducted to identify and types, incidence and predictors of pulmonary complications post CABG surgery among Jordanian patients. A descriptive retrospective design was used to collect data from medical records of 150 Jordanian patients whose ages are 25 years old or above and 1st time undergoing CABG surgery. The main results of the study included that 60% of the sample studied developed pulmonary complications during the first week post CABG surgery. The most predominant PPCs were plural effusion (42.7%), atelectasis (33.3%) and pulmonary edema (16.7%). The most predictors of PPCs were hypertension, obesity, length of hospital stay.

Key words: Coronary artery bypass graft surgery, pulmonary complications, predictors, risk factors, PPC, hospital

INTRODUCTION

Coronary Artery Disease (CAD) has been defined as narrowing or blockage of coronary artery with fat deposits and waxy substance called plaque that occlude of the artery and impairs perfusion of oxygenated blood to the heart (Mann *et al.*, 2014). Coronary artery disease is a major contributing factor for death globally and responsible for 17 million deaths throughout the world (Mann *et al.*, 2014). In 2007, CAD was responsible for every six deaths in the Unites States (Roger *et al.*, 2011) and in the European Union, it was responsible for >2 million deaths every year since 2005 until 2008 (Rayner and Petersen, 2008).

The major risks factors for CAD are modifiable factors such as smoking, obesity and sedentary lifestyle and non-modifiable factors such as age and gender in addition to co-morbid conditions such as diabetes and hypertension.

Cardiac surgery is a common surgery performed on the heart and/or great vessels. This surgery is usually carried out in cases such as CAD, correcting congenital heart disease or treating valvular heart disease due to different causes such as endocarditis (Iung *et al.*, 2003). Coronary artery bypass graft surgery is considered as a common surgical treatment for cardiovascular disease (Deb *et al.*, 2014).

Patients post CABG surgery are at risk for many complications that can be fatal (Thom *et al.*,

2006). Postoperative Pulmonary Complications (PPCs) are the major complications occurring post CABG and defined as “the development of one or more of following conditions: acute bronchitis, bronchospasm, atelectasis, pneumonia, adult respiratory distress syndrome, pleural effusion, pneumothorax, hemothorax, pulmonary embolism, pulmonary edema, emphysema, pulmonary arrest and acute respiratory failure” (Smetana *et al.*, 2006).

Weissman (2004) conducted a study on 51, 351 patients in the United states who underwent CABG surgery from 1999-2002 to explore the incidence of postoperative pulmonary complications, the findings included that 4.86% of those patients developed adult respiratory distress syndrome, 0.78% developed pneumonia and 2.96% had other pulmonary complications such as pneumothorax, pulmonary embolism and pulmonary edema.

There are many pulmonary complications that may occur after this surgery and lead to mortality and morbidity such as pneumonia and atelectasis. Starks and Harbert (2011) found that pneumonia contributes to 50% of mortalities and increases the length of stay in the intensive care unit.

There are many factors that increase the incidence of pulmonary complications post CABG surgery and included preoperative, intra-operative and postoperative factors (Hulzebos *et al.*, 2003; Rajaei and Dabbagh, 2012). The preoperative factors: such as preexisting chronic obstructive pulmonary disease, blood transfusion and

volume balance, anticoagulants, preexisting heart failure, age, obesity, ethnic factors, female gender, smoking, preexisting renal failure, preexisting arrhythmias, peripheral arterial disease, administration of preoperative inotropic agents and patient risk classification status, diabetes mellitus, preexisting hypertension (anesthesiology and pain medicine). The intraoperative factors: sternotomy, pleurotomy due to insertion of left internal thoracic artery, phrenic nerve injury with or without Cardiopulmonary Bypass Pump (CPB), CPB time, type of surgery (elective or urgent), number of grafts and duration of surgery, blood transfusion, amount and type of anesthesia used. The postoperative: time of placing patient on mechanical ventilator, acute myocardial infarction (new Q wave infarction within 48 h, the need for intra-aortic balloon pump, need for nasogastric tube, length of stay in intensive care unit (Hulzebos *et al.*, 2003; Jensen and Yang, 2007; Rajaei and Dabbagh, 2012).

Study objectives: The purpose of this study is to identify types, incidence and risk factors of pulmonary complications post CABG surgery for Jordanian people.

MATERIALS AND METHODS

Research design: To identify the factors for pulmonary complications post CABG surgery, a descriptive, retrospective approach that entails identifying factors sought through existing open heart patients database.

Population and sample: Study sample included Jordanian patients who underwent CABG surgery. A total of 400 medical records were accessible of which 150 files were analyzed for the purpose of this research. Inclusion criteria included data consisting from the year 2010-2014, sample demographics selected using ages 25 years or above, Jordanian nationality of which included 1st time underwent surgery and either inpatients or outpatients. Exclusion criteria included patients with a previous lung dysfunction, pulmonary surgeries and immuno compromised patients.

Setting: Informational data collected for the study was retrieved through a medical records database that included seeking specifically for patients who underwent CABG surgery. To attain this required data, the researcher gained approval from the top management of study hospital.

Hospital is the largest medical institute serving approximately, 1 million people living in North Jordan. The hospital is staffed with full time health care providers including nurses, physicians and surgeons. The hospital

has a bed capacity of 800 in an emergency bases. The overall structure of hospital is composed of 15 floors. Patients post CABG surgery are transferred to cardiac intensive care unit for about 3-6 days. This department is highly equipped with all medical equipment required for patient's recovery.

Data collection and procedures: With an approved IRB and approval from KAUH, the researcher conducted head of Cardiology Department. After careful review, the head of department approved the data collection process. Researcher was give access to patients medical records that included past 2010 and present 2014. The procedural data collection protocol included quantitative approach consisting of 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.

Data collection was completed during 3 months from 1-10-2014 to 1-12-2014. Four hundred files were reviewed of which 180 files matched the criteria of this study. About 30 files did not have adequate information and were excluded. About 100 and 50 files were included in the present study.

Statistical analysis: To obtain answers to questions one and two and to identify patients who underwent CABG surgery, the SPSS Version 16 was applied to analyze existing data. A descriptive statistical approach was implemented to obtain standard deviation, means and percentages. To examine the association of dependent and independent variables, the chi squared was used to predict the involved predictors of postoperative pulmonary complications and to answer question number 3, the binary logistic regression analysis was applied. To dichotomous variables (Categorical variables) from a set of predictors variables and to find the association between dependent and independent variable, the binary logistic regression was also applied.

RESULTS AND DISCUSSION

General characteristics of study participants: As shown in Table 1, the present study included 150 patients, the majority of ages (87, 58%) are in the interval of 45-60 years. Males patients were predominant (129, 86%). The distribution of BMI showed that 42% of the sample were overweight. Smoking was reported by about 61% of patients.

Table 1: General characteristics of study participants (N = 150)

Variables	Frequency (N)	Percentage
Age (years)		
<45	8	5.3
105	87	58.0
>60	55	36.7
Gender		
Male	129	86.0
Female	21	14.0
BMI		
Normal	53	35.3
Overweight	63	42.0
Obese	34	22.7
Smoking		
Yes	92	61.33
No	58	38.67
Hypertension		
Yes	102	68.00
No	48	32.00
Diabetes		
Yes	75	50.00
No	75	50.00
Angina		
Yes	105	70.00
No	45	30.00
Previous MI		
Yes	123	82.00
No	27	18.00
Heart failure		
Yes	14	9.30
No	136	90.70
COPD		
Yes	18	12.00
No	132	88.00
Bronchitis		
Yes	18	12.00
No	132	88.00
Pneumonia		
Yes	0	0.00
No	150	100.00
Asthma		
Yes	15	10.00
No	135	90.00
Tuberculosis		
Yes	0	0.00
No	150	100.00
Pulmonary edema		
Yes	1	0.70
No	149	99.30

Regarding chronic diseases, 68% of patients had hypertension, 50% had diabetes, 70% had angina, 82% had previous MI and 9.3% had heart failure. COPD and bronchitis were observed in 12% of patients asthma in 10% and pulmonary edema in 0.7%.

Intraoperative factors associated with 150 patients post CABG surgery: As shown in Table 2, all patients had the CABG as a cardiac procedure, of whom 85.3% required bypass machine. Bypass time average was 83.54±35.36 min. Total operation time average was 3.62±0.84 h. The number of vessels bypassed ranged from 1-5 and 4 vessels by passed were more common (66 patients, 44%). Regarding type of conduit, saphenous alone was observed in about 23%, lima in about 7% while saphenous and lima were carried out for about 69% of patients.

Table 2: Intraoperative factors associated with 150 patients post CABG surgery

Variables	Mean	SD	N	%
Type of cardiac procedure				
CABG				
Yes			150	100.0
No			0	0.0
Bypass machine				
Yes			128	85.3
No			22	14.7
Bypass time (min)	83.54	35.36		
Total time (h)	3.62	0.84		
No of vessels bypassed				
1			11	7.3
2			20	13.3
3			40	26.7
4			66	44.0
5			13	8.7
Type of conduit				
Saphenous			35	23.3
Lima			11	7.3
Saphenous and lima			104	69.4
Radial			0	0.0

Distribution of post-operative pulmonary complications:

Post-operative pulmonary complications included atelectasis (33.3%), bronchitis (1.3%), pneumonia (13.3%), pleural effusion (42.7%), hemohorax (5.3%), pulmonary edema (16.7%), pulmonary embolism (2%), respiratory failure (0.7%), bronchospasm (1.3%), pneumothorax (7.3%), ARDS (1.3%), emphysema (0.7%) and no case with pulmonary arrest (Table 3).

Factors predicting the occurrence of PPCs:

Table 4 showed the binary logistic regression to analyze factors associated with any post-operative complications. Predictors included according to their importance: length of hospital stay (p = 0.000), obesity (p = 0.002), hypertension (p = 0.039) and body mass index (p = 0.004).

Obesity was associated with increased odds of any PPCs. Compared to those with normal body mass index, obese patients were 8.4 times more likely to develop at least one PPCs. Hypertensive patients were 2.7 times more likely to develop any PPCs. For each additional day of stay at hospital, the PPCs are more likely to occur twice compared with people with normal length of stay.

Epidemiological studies, conducted in various areas have shown that coronary artery disease is the major contributing factor for death globally (Mann *et al.*, 2014; Roger *et al.*, 2011). Coronary Artery Bypass Graft (CABG) is the surgical treatment of choice for cardiovascular disease (Deb *et al.*, 2014). Postoperative Pulmonary Complications (PPCs) are considered the major complications occurring post CABG (Smetana *et al.*, 2006).

In the light of the previous context, the present study was conducted to identify types, incidence and risk factors of pulmonary complications post CABG surgery for Jordanian people.

Table 3: Pulmonary Complications among 150 Jordanian post-CABG surgery patients

Variables	Frequency (N)	Percentage
PPCs		
Yes	90	60.0
No	60	40.0
Atelectasis		
Yes	50	33.3
No	100	66.7
Bronchitis		
Yes	2	1.3
No	148	98.7
Pneumonia		
Yes	20	13.3
No	130	86.7
Pleural effusion		
Yes	64	42.7
No	86	57.3
Hemothorax		
Yes	8	5.3
No	142	94.7
Pulmonary edema		
Yes	25	16.7
No	125	83.3
Pulmonary embolism		
Yes	3	2.0
No	147	98.0
Respiratory failure		
Yes	1	0.7
No	149	99.3
Bronchospasm		
Yes	2	1.3
No	148	98.7
Pneumothorax		
Yes	11	7.3
No	139	92.7
ARDS		
Yes	2	1.3
No	148	98.7
Pulmonary arrest		
Yes	0	0.0
No	100	100.0
Emphysema		
Yes	1	0.7
No	149	99.3

Table 4: Regression analysis of factors associated with any post-operative complications

Variables	OR	95% confidence interval		p-values
		Lower limit	Upper limit	
Body mass index				
Normal	1.0	-	-	0.004
Overweight	0.9	0.3	2.5	0.864
Obesity	8.4	2.1	32.8	0.002
Hypertension	2.7	1.1	7.1	0.039
Length of hospital stay	1.8	1.4	2.3	0.000

General characteristics of participants: The data of our study showed that the majority of patients were above 45 years and the trend of CABG surgery increased with age. These findings are in line with other reported studies in literature (Hulzebos *et al.*, 2003; Rajaei and Dabbagh, 2012). The finding of this study showed that number of males undergoing CABG surgery is more than

females. This is not consistent with other studies (Hulzebos *et al.*, 2003; Jensen and Yang, 2007; Rajaei and Dabbagh, 2012) in which females are more likely to undergo CABAG surgery.

Overweight and obese patients accounted for about two thirds of the total patients. This is consistent with the findings of other studies (Davidson *et al.*, 2003) in which obesity was considered one of the risk factors for coronary artery disease. Smoking was reported by about 61% of patients who underwent CABG surgery. These findings are consistent with other studies (Hulzebos *et al.*, 2003; Jensen and Yang, 2007; Rajaei and Dabbagh, 2012). Hypertension was also reported by 68% of CABAG patients. This finding agrees with other studies (Hulzebos *et al.*, 2003; Jensen and Yang, 2007; Rajaei and Dabbagh, 2012). Half of patients who underwent CABAG surgery had diabetes. Diabetes has been considered as a predisposing factor for coronary artery disease in many reported studies in literature (Hulzebos *et al.*, 2003; Jensen and Yang, 2007; Rajaei and Dabbagh, 2012).

Angina was reported in files of 70% of CABG surgery patients. Our data are in line with other studies in which angina was a risk factor for coronary artery disease (Thom *et al.*, 2006). Myocardial infarction was reported among 82% of patients which is also consistent with other studies (Finegold *et al.*, 2012). Heart failure was shown in 9.3% of CABG patients. Other studies put emphasis on the importance of heart failure as a risk factor leading to CABG surgery (Jensen and Yang, 2007; Rajaei and Dabbagh, 2012). The prevalence of COPD among CABG surgery patients was 12%. Several studies have pointed to the significance of the involvement of COPD in developing the disease process leading to CABG surgery (Woods *et al.*, 2010). Patients with bronchitis constituted 12% of the total patients who underwent CABG surgery. Several studies have confirmed that bronchitis is a preoperative risk factor of coronary artery disease and CABG surgery as a consequence (Smetana *et al.*, 2006). Asthma was encountered in 10% of CABAG patients. It has been shown through various studies that asthma has its impacts on coronary artery disease and can lead to development of PPCs (Starks and Harbert, 2011).

Factors predicting the occurrence of PPCs: The strongest predictor for PPCs in the present study was in hospital stay (p = 0.000). This result agrees with other studies in which pulmonary complications increase the duration of hospitalization after surgery that result in increased hospital costs. Starks found that hospitalized patient develop pulmonary complications after CABG

surgery costs \$10,000-58000 US dollars (Starks and Harbert, 2011). Other studies confirm our results and showed that PPCs are the main contributing factors for sever morbidity resulting in increased length of stay at hospital, increased readmission rates and health care cost (Weissman, 2004). Prolonged length of stay at hospital is considered leading factor for developing pulmonary complications following CABG surgery. There are several causal factors associated with prolonged hospitalization including prolonged supine position, prolonged mechanical ventilation and decreased mobility (Covino *et al.*, 2001).

Our data showed that obesity as a predictor of PPCs ($p = 0.002$). The results of the present study is consistent with the study by Akdur *et al.* (2006) who found that severe obesity is predisposing factor for pulmonary complications post CABG surgery such as lower respiratory infection and atelectasis which ultimately lead to increase lead to increase length of stay in intensive care unit and financial burdens of hospital.

Hypertension has been found to be another predicting factor for PPCs ($p = 0.039$). The odds ratios to develop PPCs following CABG were more 2.7 times among patients with hypertension compared with those without hypertension. This result is consistent with other studies which showed that hypertension to be one of the most important risk factors that might lead to cardiovascular and pulmonary complications following CABG surgery (Lahtinen, 2007). We also agree with other studies reported in literature and found that hypertension developing in patients undergoing CABG is a leading factor for arrhythmia, myocardial infarction and heart failure that might contribute to pulmonary hypertension and pulmonary edema (Lahtinen, 2007). In a study by Parashar *et al.* (2012), patients with hypertension (OR, 0.58; 95% CI, 0.43-0.78) were less likely to participate in developing PPCs. 95% CI, 0.74-0.97), smokers (OR, 0.59; 95% CI, 0.44-0.80) and patients with economic burden (OR, 0.56; 95% CI, 0.38-0.81) were less likely to participate. Caucasians (OR, 1.73; 95% CI, 1.16-2.58) and educated patients (OR, 1.81; 95% CI, 1.42-2.30) were more likely to participate at 6 months. Patients with previous percutaneous interventions were less likely to participate at both 1 and 6 months post-AMI.

CONCLUSION

The study concluded that PPCs were predominant post CABG surgery as evidence by developing of PPCs in 60% of the sample studied. Identifying the predictors of PPCs may assist health care providers including physicians and nurses to establish and develop new health care plans and measures to reduce the incidence of these complications.

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