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Post-CABG pneumonia incidence and risk factors

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Abstract

Background: Coronary atherosclerotic heart disease (CHD) is highly prevalent and deadly globally. Coronary artery bypass grafting (CABG) aims to restore blood flow, alleviate angina, and reduce mortality in CHD patients. Despite its benefits, CABG often leads to complications, particularly pulmonary infections, which significantly impact patient prognosis and impose substantial financial and social burdens. Effective interventions focus on promoting lung function recovery. This study aims to assess the prevalence and risk factors of post-CABG pneumonia in an Egyptian sample to mitigate these risks.

Methods: This retrospective study analyzed 137 patients undergoing isolated CABG at Beni-Suef University Hospital from January 2018 to January 2024. Patients were subgrouped based on postoperative pneumonia occurrence. Data analysis included Pearson's Chi-square, t-test, Mann-Whitney U test, and binary logistic regression using SPSS v20, with $p<0.05$ considered significant.

Results: In this study of 137 CABG patients, 10.9% developed pneumonia. Significant risk factors included older age, higher BMI, diabetes, hypertension, lower ejection fraction, longer CPB and operative times, prolonged ventilation, re-intubation, re-opening, extended ICU stays, and increased IABP use.

Conclusion: Pneumonia significantly impacts CABG outcomes. Key risk factors include advanced age, obesity, diabetes, low ejection fractions, prolonged surgery and ventilation, reintubation, extended ICU stays, and IABP use.

Keywords: CABG, Pneumonia, risk factors, cardiac surgery

Introduction:

Globally, coronary atherosclerotic heart disease (CHD) ranks high among the most prevalent and deadly medical conditions [1, 2]. The goals of coronary artery bypass grafting (CABG) surgery are to restore blood flow to the heart muscle, alleviate symptoms of angina pectoris, and lower the mortality rate associated with coronary heart disease. This procedure is being used more and more in adult cardiac surgery, and it is a frequent operation overall. A coronary heart disease epidemic is on the rise [3-5]. After CABG, many patients have complications such as atelectasis, infection, coughing, etc. The most prevalent risk after coronary artery bypass grafting (CABG) is pulmonary infection, a potentially life-threatening condition with a fast onset. The prognosis of patients is greatly affected by it. [6-8]. As a result, families and society as a whole bear a disproportionate share of the financial burden and suffer a significant loss of human labor [9]. As a result, therapeutic intervention also centers on how to encourage patients' lung function recovery [10, 11]. We can further limit the prevalence of lung infection in patients having CABG by evaluating the variables that impact it and then providing nursing interventions and invasive examination approaches. So, our study aims to assess the prevalence and risk factors associated with post-CABG pneumonia in an Egyptian sample to avoid those risk factors in the future.

Patients and Methods:

A retrospective study was conducted on 137 patients who underwent CABG in the Department of Cardiothoracic Surgery, Faculty of Medicine Beni-Suef University Hospital. From January 2018 to January 2024, the patients were subgrouped subsequently according to the occurrence of postoperative pneumonia. We followed up the studied patients till discharge from hospital.

Inclusion criteria:

The patient underwent isolated CABG.

Exclusion criteria:

Patients undergoing endo-cardiac surgery, those with pre-operative pulmonary infections, those with significant adverse cardiac and cerebrovascular events, the family refused cooperation, and those with mental illness are all considered to be in a severe condition requiring urgent CABG before surgery

All patients were subjected to full history, such as age, BMI, smoking, history of diabetes mellitus, history of hypertension and preoperative investigations in addition to echocardiography. Ejection fraction, intraoperative time, Cardiopulmonary bypass time, intra-aortic balloon pump, re-intubation, re-opening, mechanical ventilation time, ICU stay and following up of pneumonia. Pneumonia prevalence was followed till patients' discharge from the hospital.

Surgical Technique:

For every instance, a complete median sternotomy was used to do CABG. Across its midline, from top to bottom, the sternum was split. Care was taken to avoid removing all of the periosteum from the margins while cauterizing bleeding spots in the sternal periosteum.

At the same time as the sternotomy was performed, the saphenous vein harvesting began. After dividing the sternum, the ITA was harvested.

Prior to performing cardiopulmonary bypass (CPB) using the distal ascending aorta and right atrium cannulation, systemic anticoagulation was accomplished. An intravenous injection of 300 to 400 U/kg of unfractionated heparin was then administered before dividing the ITA. The heart was protected by administering blood cardioplegia by an antegrade infusion. Normally, 7-0 or 8-0 polypropylene suture was used to build coronary anastomoses. After the distal anastomoses were completed, all of the saphenous vein proximal anastomoses to the aorta were done.

Data Analysis and Statistics:

Numbers and percentages of patients were given for categorical variables, which were then compared across subgroups using Pearson's Chi-square test.

Subgroup differences in continuous variables were determined by calculating their mean ± standard deviations and medians (interquartile range) according to their normal distribution; then, using the independent t-test or Mann-Whitney U test, we compared the subgroups according to the distribution of the scale variables. Binary logistic regression analysis was used to run the multivariate analysis for the detection of the associated risk factors with post-CABG pneumonia. We used IBM's SPSS version 20 statistical software for our analysis. A P value of 0.05 was considered statistically significant.

Ethical considerations:

This study protocol was revised and approved by the research ethics committee of the Faculty of Medicine of Beni-Suef University. The study followed the Helsinki Declaration for research ethics standards.

Results:

In this study, we analyzed data from 137 patients who underwent coronary artery bypass grafting (CABG). The mean age of the patients was 59.0 years, with a predominance of females (56.9%). The mean BMI was 26.7, and 49.6% of the patients were smokers. Additionally, 18.2% had diabetes mellitus, 27.0% had hypertension, and the mean ejection fraction (EF) was 53.3%. The mean cardiopulmonary bypass (CPB) time was 70.8 minutes, and the mean operative time was

217.5 minutes. The mean ventilation time was 10.4 hours, with 5.1% requiring re-intubation and 5.8% requiring re-opening. The mean ICU stay was 3.4 days, and 3.6% of patients required an intra-aortic balloon pump (IABP). The prevalence of pneumonia in the study cohort was 10.9%. **Table 1.**

Table (1) Descriptive data of the studied patients

Items	Value (no=137)	
	No.	%
Age Mean±SD	59.0±6.3	
Median(min-max)	59.0(39.0-75.0)	
Sex Male	59	43.1
female	78	56.9
BMI Mean±SD	26.7±3.59070	
Median(min-max)	27.0(19.0-36.0)	
Smoking	68	49.6
DM	25	18.2
HTN	37	27.0
E F Mean±SD	53.3±8.2	
Median(min-max)	55.0(29.0-68.0)	
CPB Mean±SD	70.8±18.0	
Median(min-max)	70.0(25.0-125.0)	
Operative time Mean±SD	217.5±31.9	
Median(min-max)	216.0(145.0-311.0)	
Ventilation time Mean±SD	10.4±11.5	
Median(min-max)	7.0(1.50-72.0)	
Re-intubation	7	5.1
Re-opening	8	5.8
ICU stay Mean±SD	3.4±2.3	
Median(min-max)	2.5(1.5-13.0)	
IABP	5	3.6
Pneumonia prevalence	15	10.9

DM: Diabetes mellitus, HTN: hypertension, EF: ejection fraction, CPB: Cardiopulmonary bypass, IABP: intra-aortic balloon pump, ICU: intensive care unit

Univariate analysis revealed significant associations between post-CABG pneumonia and several factors. Patients who developed pneumonia were older (mean age 66.8 vs. 58.1 years, p<0.001), had higher BMI (mean 30.1 vs. 26.2, p<0.001), and were more likely to have diabetes (40.0% vs. 15.6%, p=0.021) and hypertension (53.3% vs. 23.8%, p=0.015). They also had lower EF (mean 45.3% vs. 54.3%, p<0.001), longer CPB times (mean 100.8 vs. 67.1 minutes, p<0.001), and longer operative times (mean 270.8 vs. 211.0 minutes, p<0.001). Furthermore, pneumonia patients had significantly longer ventilation times (mean 37.1 vs. 7.1 hours, p<0.001), higher rates of re-intubation (40.0% vs. 0.8%, p<0.001) and re-opening (40.0% vs. 0.8%, p<0.001), extended ICU stays (mean 9.3 vs. 2.7 days, p<0.001), and increased use of IABP (26.7% vs. 0.8%, p<0.001) **Table 2**.

Table (2) univariate analysis for factors associated with post-CABG pneumonia in the studied patients

Items	No pneumonia (no=122)	Pneumonia (no=15)	P-value
Age	58.1±5.7	66.8±5.5	<0.001*
Sex			0.765
Male	52(42.6%)	7(46.7%)	
Female	70(57.4%)	8(53.3%)	
BMI	26.2±3.4	30.1±3.1	<0.001*
Smoking	59(48.4%)	9(60.0%)	0.359
DM	19(15.6%)	6(40.0%)	0.021*
HTN	29(23.8%)	8(53.3%)	0.015*
E F	54.3±7.5	45.3±9.4	<0.001*
CPB	67.1±14.9	100.8±11.5	<0.001*
operative time	211.0±26.5	270.8±21.1	<0.001*
Ventilation time	7.1±4.1	37.1±17.1	<0.001*
Re-intubation	1(0.8%)	6(40.0%)	<0.001*
Re-opening	1(0.8%)	6(40.0%)	<0.001*
ICU stay	2.7±0.9	9.3±1.9	<0.001*
IABP	1(0.8%)	4(26.7%)	<0.001*

*P-value is significant

After excluding multicollinear variables, we analyzed age, diabetes mellitus, and ventilation time as potential risk factors using a binary logistic regression model. Only ventilation time was found to be a significant risk factor affecting the incidence of post-CABG pneumonia with an odds ratio of 1.36. **Table 3**

Table (3) multivariable analysis for factors associated with post-CABG pneumonia in the studied patients.

Independent variables	P-value	OR	95% C.I. for OR	
			Lower	Upper
Age	0.295	1.138	.893	1.450
DM	0.817	1.426	.071	28.736
Ventilation time	0.001*	1.362	1.141	1.627

OR: Odds ratio   CI: Confidence interval

*P-value is significant

Discussion

Pneumonia is a significant complication following coronary artery bypass grafting (CABG), impacting patient outcomes and necessitating preventive measures and effective management strategies. Factors such as prolonged mechanical ventilation, impaired respiratory function, and post-surgical infection heighten the risk of pneumonia in CABG patients [12-14]. Studies report increased morbidity, a 27% mortality rate, and a fourfold higher death rate among those with pneumonia post-CABG [15, 16]. Furthermore, pneumonia extends hospitalization by threefold compared to patients without it [15].

This retrospective study was conducted on 137 patients who underwent CABG to identify the potential risk factors for developing pneumonia as a postoperative complication. We conducted a univariate analysis to explore the possible association between a variety of conditions and the development of pneumonia after CABG. Overall, we found a significant association between the condition and age, obesity, DM, hypertension, lower ejection fractions, the length of the operation, and prolonged ventilation times. Moreover, significant associations were present between the development of pneumonia and reintubation, prolonged ICU stay, and the use of intra-aortic balloon pumps. Nevertheless, we found no significant association when analyzing gender and smoking. As for multivariate regression, only longer ventilation time was a significant risk for pneumonia, with an odds ratio of 1.36.

Previous studies have identified multiple risk factors for developing pneumonia after CABG. Zhang et al. revealed that advanced age is a significant risk factor for postoperative pneumonia through both uni- and multivariate analyses [17]. Similarly, Wang et al. emphasized the impact of advanced age on the risk of postoperative pneumonia [18]. At the same time, Vernon-Platt et al. noted that age over 65 years increases the incidence of postoperative complications, including pneumonia [19].

Obesity is another critical risk factor for pneumonia following CABG. Чарышкин & Yudin identified obesity as a risk factor for pyoinflammatory complications, including pneumonia, in post-cardiac surgery patients [20]. Kinlin et al. also recognized obesity as a general risk factor for

nosocomial infections [21]. Moreover, Alwaqfi et al. concluded that obesity is an independent predictor of pneumonia after CABG [22].

Contrary to our findings, research by Zhang found that smoking is a significant risk factor for pneumonia following CABG [17]. Similarly, Wang et al. (2022) emphasized smoking as a predictor for pneumonia after cardiovascular surgery [18]. Furthermore, Urbanowicz et al. discussed the impact of COPD on postoperative complications following CABG, noting that while short-term mortality rates were similar between patients with and without COPD, those with COPD had a higher risk of complications, including pneumonia [23]. This association suggests that respiratory conditions like COPD, which are typically precipitated by smoking, increase susceptibility to pneumonia. In addition, Oz et al. noted that patients with moderate COPD are particularly vulnerable to lower respiratory tract infections due to the immunosuppressive effects of cardiopulmonary bypass (CPB) and their unique respiratory flora [24].

The findings regarding DM and ejection fraction matched those from our study. Alwaqfi et al. (2012) identified diabetes mellitus as a significant risk factor, in addition, they found similar associations with peripheral vascular disease and emergency surgery [22]. Wang et al. found that lower left ventricular ejection fraction is associated with a higher risk of postoperative pneumonia after CABG. Żukowska et al. and Martin et al. further supported the significance of reduced LVEF as a risk factor for both decreased long-term survival and postoperative pulmonary complications, including pneumonia [25, 26]. Heart failure also increases the risk of pneumonia following CABG due to compromised cardiac function and immune response. Ibrahim et al. noted that patients undergoing surgeries for end-stage heart failure, such as left ventricular assist device insertion and heart transplantation, are at an ultrahigh risk of developing postoperative pneumonia [27].

Previous literature indicates that ICU stay, intubation duration, and ventilation use significantly impact the risk of pneumonia following CABG. Zhang found that longer operation times and tracheal intubation durations were risk factors for pneumonia. Similarly, Ibrahim et al. noticed that patients developing pneumonia postoperatively tend to have prolonged ICU stays [27]. Jensen et al. identified previous myocardial infarction, ventilation for more than 10 hours, and hospital stays exceeding five days as significant predictors of pneumonia. Prolonged mechanical ventilation bypasses the natural defenses, increasing the risk of pneumonia, especially for patients requiring ventilation for more than 12 hours [21, 27]. Overall, prolonged ICU stays and extended ventilation times are critical factors contributing to the increased risk of pneumonia after CABG.

LIMITATIONS

Conclusion

In conclusion, pneumonia remains a significant complication following coronary artery bypass grafting (CABG), substantially impacting patient outcomes. The study identified several risk factors associated with the development of postoperative pneumonia, including advanced age, obesity, diabetes mellitus, lower ejection fractions, prolonged operation and ventilation times,

reintubation, extended ICU stays, and the use of intra-aortic balloon pumps. While the study did not find significant associations with gender and smoking, previous research underscores the importance of these factors. Effective preventive measures and management strategies are essential to mitigate the risk of pneumonia in CABG patients, emphasizing the need for early detection and tailored interventions to improve clinical outcomes.

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