Volume 3, Issue 5, 2025

Frontier in Medical & Health Research

ISSN: (e) 3007-1607

RISK FACTORS OF PULMONARY COMPLICATIONS AFTER CORONARY ARTERY BYPASS GRAFTING (CABG)

Kaab Ahmed Jidda[*1], Ahmed Abdalla Ibrahim Abdelmagid[2], Mirza Ahmad Raza Baig[3]

[*1]*Anesthesia Specialist (Non-Physician), Hail Cardiac Center (HCC), Saudi Arabia*
[2] *(Master Degree in Anesthesia, European Diploma of Cardiac Anesthesia And ICU, Arab Board in Anesthesia and ICU, Consultant Anesthesia at SCFHS And DHA, Consultant Cardiac Anesthesia and Head of Cardiac Anesthesia, Hail Cardiac Center (HCC), Saudi Arabia.*
[3] *Cardiac Perfusion Specialist, Hail Cardiac Center (HCC), Saudi Arabia*

[*1]kaabahmedjidda@gmail.com

DOI:https://doi.org/10.5281/zenodo.20761552

Keywords
Coronary artery bypass grafting, pulmonary complications, Risk factors.

Article History
Received: 10 April 2025
Accepted: 25 June 2025
Published: 19 July 2025

Corresponding Author: *
Kaab Ahmed Jidda

Abstract

Objective: *To assess the incidence and risks of post-operative pulmonary complications (PPCs) after coronary artery bypass grafting (CABG) in a tertiary care cardiac center.*

Methods: *This study conducted a retrospective observational analysis to determine the incidence and risk factors of PPCs in 70 patients who underwent CABG under general anesthesia. The primary goal was to evaluate the occurrence of PPCs within 7 days after surgery. This study used the European Perioperative Clinical Outcome (EPCO) definitions to diagnose and categorize PPCs.*

Results: *Pulmonary complications (PPCs) occurred in 19 patients (27.1%), while 51 patients (72.9%) did not experience PPCs. Among the types of PPCs, pleural effusion was the most common, occurring in 14 cases (73.6%). Over 65 years old was found in 71.0% of PPC patients (19 individuals) vs. 28.2% of non-PPC patients (51 individuals), with an odds ratio of 6.22 (95% CI: 2.21-17.48), p<0.0001. Prolonged bypass over 120 minutes was in 45.2% of PPC patients vs. 10.3% of non-PPC, with an odds ratio of 7.21 (95% CI: 2.04-12.43), p=0.002. Smoking was present in 25.8% of PPC patients compared to 10.3% in non-PPC patients, with an odds ratio of 3.04 (95% CI: 0.81-11.4) and a p-value of 0.09.*

Conclusion: *Advanced age of >65 years, prolonged duration of surgery were significant risk factors of PPCs after CABG. While smoking was a moderate risk factor of PPCs.*

INTRODUCTION:

In recent years, there has been a yearly increase in the prevalence of coronary artery disease, largely due to the aging population and changing lifestyle habits.[1] Coronary artery bypass grafting (CABG) has become a standard treatment for complex cases involving multiple vessel blockages, aiming to enhance both symptoms and survival rates.[2, 3] However, the procedure carries risks of pulmonary and functional complications during recovery, which can be caused by invasive mechanical ventilation, cardiopulmonary bypass, and patient immobility, often resulting in extended hospital stays.[4]

Frontier in Medical & Health Research

ISSN: (e) 3007-1607

Despite notable progress in surgical methods and perioperative management, postoperative pulmonary complications (PPCs) continue to be common, affecting between 11% and 40% of patients undergoing coronary artery bypass grafting (CABG).[5, 6] Due to the compromised cardiopulmonary function typical of CABG patients, the development of PPCs significantly impedes their recovery and compromises perioperative safety, playing a major role in increasing perioperative mortality.[4, 7]

The development of pulmonary complications following cardiopulmonary bypass involves multiple factors. These include changes in the function of the chest muscles and wall due to median sternotomy, the systemic inflammatory response triggered during the initiation of bypass, phrenic nerve injury caused by the application of cold saline in the pericardial cavity during cardiac arrest, and alveolar edema resulting from left ventricular distension and increased pressure within the pulmonary vasculature.[8]

Despite the frequent occurrence of PPCs following CABG surgeries—conditions that significantly hinder patients' post-operative recovery—research specifically addressing the risk factors for CABG remains limited. Consequently, this study aimed to assess the incidence and risks of PPCs after CABG in a tertiary care cardiac center.

METHODS:

This study conducted a retrospective observational analysis to determine the incidence and risk factors of PPCs in 70 patients who underwent CABG under general anesthesia. Informed consent was waived due to its retrospective design. Inclusion criteria encompassed patients of any age and gender who had CABG, whether on an urgent or elective basis, from January 2024 to January 2025. Exclusion criteria were patients with pre-existing severe pulmonary complications as per PPCs standards and those who had any thoracic procedure within 30 days before the CABG surgery.

The primary goal was to evaluate the occurrence of PPCs within 7 days after surgery. This study used the European Perioperative Clinical Outcome (EPCO) definitions, which were jointly proposed by ESA and ESICM in 2015.[9] The EPCO standard defines PPCs as a broad range of adverse pulmonary events that can happen after surgery. These include pleural effusion, respiratory infections, pneumothorax, atelectasis, respiratory failure, bronchospasm, and aspiration pneumonitis. This group of complications significantly threatens the perioperative survival of surgical patients, especially by increasing their risk of death. As a widely accepted standard, the EPCO definition offers a consistent way to identify and classify PPCs, helping ensure data collection in clinical studies is consistent and comparable.

Demographic details, comorbidities, laboratory examinations, anesthesia information, surgical data, and postoperative outcomes for all patients were collected from the hospital's electronic records. In this study, the intraoperative and postoperative variables analyzed included CPB time, cross-clamp time, and the need for blood transfusions.

Data analysis was performed using SPSS version 23.0. Patients were divided into two groups depending on whether PPCs were present or not. Continuous variables were compared with Student's t-test, while categorical variables were analyzed using Chi-square or Fisher's exact tests when appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS:

The baseline characteristics indicate that the study population had a mean age of 57.5 years (±7.9) and an average body surface area of 1.84 m^2 (±0.18). Males constituted 84.3% of participants, while females accounted for 15.7%. Most patients (92.9%) were classified as ASA class <III, and 7.1% were ASA class ≥III. Diabetes was present in 64.2% of participants, 17.1% had a history of smoking, 44.3% had hypertension, and 31.4% had dyslipidemia. Regarding surgical details, 70% of patients received 2 or 3 grafts, whereas 30% received 4 or more grafts (Table 1).

Pulmonary complications (PPCs) occurred in 19 patients (27.1%), while 51 patients (72.9%) did not experience PPCs. Among the types of PPCs, pleural effusion was the most common, occurring in 14 cases (73.6%). Infections were reported in 2

Frontier in Medical & Health Research

ISSN: (e) 3007-1607

cases (10.5%), pneumothorax in 3 cases (15.8%), bronchospasm in 1 case (5.2%), and atelectasis in 1 (5.2%) cases (Table 2).

Table 3 presents the risk factors associated with PPCs. Over 65 years old was found in 71.0% of PPC patients (19 individuals) vs. 28.2% of non-PPC patients (51 individuals), with an odds ratio of 6.22 (95% CI: 2.21-17.48), p<0.0001. Prolonged bypass over 120 minutes was in 45.2% of PPC patients vs. 10.3% of non-PPC, with an odds ratio of 7.21 (95% CI: 2.04-12.43), p=0.002. An ASA score of III or higher was seen in 16.1% of PPC patients and 17.9% of those without PPCs, with an odds ratio of 0.88 (95% CI: 0.25-3.08) and a p-value of 0.84. Smoking was present in 25.8% of PPC patients compared to 10.3% in non-PPC patients, with an odds ratio of 3.04 (95% CI: 0.81-11.4) and a p-value of 0.09. Female gender was noted in 22.6% of PPC patients and 5% of non-PPC patients.

Table 1. Baseline Characteristics.

Age (Y)	57.5±7.9
BSA (m^2)	1.84±0.18
Gender (%)	
Male	59 (84.3%)
Female	11 (15.7%)
ASA Class (%)	
<III	65 (92.9%)
≥III	05 (7.1%)
Diabetes	45 (64.2%)
Smoking	12 (17.1%)
Hypertension	31 (44.3%)
Dyslipidemia	22 (31.4%)
***Number of Grafts** (%)*	
2-3	49 (70%)
≥4	21 (30%)

Table 2. Incidence and Types of Pulmonary Complications.

PPCs (%)	
Yes	19 (27.1%)
No	51 (72.9%)
Type of PPC (%)	
Pleural Effusion	14 (73.6%)
Infections	2 (10.5%)
Pneumothorax	03 (15.8%)
Bronchospasm	01 (5.2%)
Atelectasis	01 (5.2%)
Respiratory failure	01 (5.2%)

Table 3. Risk Factors of PPCs.

Risk Factor	PPCs (N=19)	No PPCs (N=51)	OR (95% CI)	P-value
Advanced Age (>65 Years)	13 (71.0%)	14 (28.2%)	6.22 (2.21-17.48)	<0.0001
Prolonged Bypass Time (>120 mins)	9 (45.2%)	5 (10.3%)	7.21 (2.04-12.43)	0.002
ASA ≥III	3 (16.1%)	9 (17.9%)	0.88 (0.25-3.08)	0.84

Frontier in Medical & Health Research

ISSN: (e) 3007-1607

Smoking	5 (25.8%)	5 (10.3%)	3.04 (0.81-11.4)	0.09
Female Gender	4 (22.6%)	5 (10.3%)	2.55 (0.66-9.89)	0.17

DISCUSSION:

After on-pump cardiac surgery, it's quite common to see a noticeable decline in several lung functions, even in patients who had normal lung health before the operation.[10] In our study, PPCs occurred in 27.1% patients. These results are closer to the study by Gurunathan et al., who reported PPCs in 32.5% patients undergoing cardiac surgery.[11] However, some studies have reported lower incidence of PPCs after cardiac surgery, the study by Naveed et al. reported PPCs in 6.2% patients and another study by Shakoor et al. reported PPCs in 13.2% patients after on-pump cardiac surgery.[12, 13] While Feng et al. reported PPCs in 48.5% patients after CABG.[14] This study only included elderly patients undergoing CABG and advanced age is a risk factor of PPCs that could be the reason of such high incidence of PPCs in their study.

Many studies have identified various risk factors for PPCs following cardiac surgery, including advanced age, smoking, COPD, diabetes, obesity, gastrointestinal bleeding, lung injury post-surgery, phrenic nerve damage during the procedure, sternal wound infections, and the need for re-exploration.[12, 15] Ji Q et al. found that older age, preoperative heart failure, low preoperative PaO2, longer CPB time, and phrenic nerve injury are among the most common risk factors.[16] Conversely, Al-Qubati et al. reported that extended ICU stays, significant blood transfusion needs, and re-exploration after surgery are key risk factors for PPCs surgery.[17] A recent study by Krdzalic et al. reported diabetes, smoking, hypertension, prolonged surgery duration and mechanical ventilation and need of >500 ml blood transfusion within the first 24 hours of surgery as significant risk factors of PPCs.[18]

Cardiopulmonary bypass (CPB) is a significant risk factor for post-operative complications following cardiac surgery because it triggers systemic inflammatory response syndrome (SIRS).[19] This leads to neutrophil activation, compliments system activation, and the generation of oxygen free radicals, all of which harm various organs. The lungs are particularly vulnerable to damage from SIRS, which can cause postoperative pulmonary complications (PPCs), longer mechanical ventilation, and extended ICU stays. Developing intra-operative strategies to reduce SIRS and protect the phrenic nerve during surgery could help lower the incidence of PPCs.[20]

CONCLUSION:

Advanced age of >65 years, prolonged duration of surgery were significant risk factors of PPCs after CABG. While smoking was a moderate risk factor of PPCs.

REFERENCES

1. Weir-McCall JR, Williams MC, Shah ASV, Roditi G, Rudd JHF, Newby DE, et al. National Trends in Coronary Artery Disease Imaging: Associations With Health Care Outcomes and Costs. JACC Cardiovasc Imaging. 2023;16(5):659-71.
2. Bansal A, Hiwale K. Updates in the Management of Coronary Artery Disease: A Review Article. Cureus. 2023;15(12):e50644.
3. Elbadawi A, Elzeneini M, Elgendy IY, Megaly M, Omer M, Jimenez E, et al. Coronary artery bypass grafting after acute ST-elevation myocardial infarction. J Thorac Cardiovasc Surg. 2023;165(2):672-83.e10.
4. Souza AV, da Cunha Carvalho R, da Cruz Dias D, Santana DGT, de Cássia Mascarenhas H, Cordeiro ALL, et al. Clinical and functional outcomes associated with pulmonary complications after coronary artery bypass grafting. J Cardiothorac Surg. 2024;19(1):92.
5. Xiang Y, Zhao Q, Luo T, Zeng L. Inspiratory muscle training to reduce risk of pulmonary complications after coronary artery bypass grafting: a systematic review and meta-analysis. Front Cardiovasc Med. 2023;10:1223619.

Frontier in Medical & Health Research

ISSN: (e) 3007-1607

6. Khallikane S, Seddiki R, Serghini I. Postoperative Infectious Pneumonia in Cardiothoracic Surgery: A Systematic Review and Meta-Analysis. F1000Res. 2025;14:588.
7. Pooria A, Pourya A, Gheini A. Postoperative complications associated with coronary artery bypass graft surgery and their therapeutic interventions. Future Cardiol. 2020;16(5):481-96.
8. Kumar R, Jamaleddin Ahmad FA, Fattouh MAS, Issimdar IA, Ghosh A, Ahmed AOA, et al. Postoperative complications of coronary artery bypass grafting: a narrative review on pathophysiology, management strategies, and the emerging role of artificial intelligence. Cardiovasc Diagn Ther. 2026;16(1):10.
9. Jammer I, Wickboldt N, Sander M, Smith A, Schultz MJ, Pelosi P, et al. Standards for definitions and use of outcome measures for clinical effectiveness research in perioperative medicine: European Perioperative Clinical Outcome (EPCO) definitions: a statement from the ESA-ESICM joint taskforce on perioperative outcome measures. Eur J Anaesthesiol. 2015;32(2):88-105.
10. Roncada G, Dendale P, Linsen L, Hendrikx M, Hansen D. Reduction in pulmonary function after CABG surgery is related to postoperative inflammation and hypercortisolemia. Int J Clin Exp Med. 2015;8(7):10938-46.
11. Gurunathan U, Loo V, Naidoo R, Sivalingam S, Yerkovich S, Mullany D. Pulmonary Complications After Cardiac Surgical Procedures: A Tertiary Centre Audit of Elective and Urgent Cases. Ann Thorac Surg Short Rep. 2025;3(4):1141-5.
12. Naveed A, Azam H, Murtaza HG, Ahmad RA, Baig MAR. Incidence and risk factors of Pulmonary Complications after Cardiopulmonary bypass. Pak J Med Sci. 2017;33(4):993-6.
13. Shakoor T, Iqtdar R, Zia K, Shah I, Ahmed A, Iqbal A. Incidence and Risk Factors of Postoperative Pulmonary Complications Following On-Pump Cardiac Surgery at a Tertiary Care Center in Pakistan. Pakistan Heart Journal. 2025;58(s2):62-7.
14. Feng G, Jia Y, Zhao G, Zhang Y, Wang T. Risk factors for postoperative pulmonary complications following coronary artery bypass grafting in elderly patients: a retrospective study. J Cardiothorac Surg. 2025;20(1):312.
15. Jensen L, Yang L. Risk factors for postoperative pulmonary complications in coronary artery bypass graft surgery patients. Eur J Cardiovasc Nurs. 2007;6(3):241-6.
16. Ji Q, Mei Y, Wang X, Feng J, Cai J, Ding W. Risk factors for pulmonary complications following cardiac surgery with cardiopulmonary bypass. Int J Med Sci. 2013;10(11):1578-83.
17. Al-Qubati FAA, Damag A, Noman T. Incidence and outcome of pulmonary complications after open cardiac surgery, Thowra Hospital, Cardiac center, Sana'a, Yemen. Egyptian Journal of Chest Diseases and Tuberculosis. 2013;62(4):775-80.
18. Krdzalic A, Skakić A, Avdagić H, Pašić F, Odobašić T, Krdžalić G. Risk factors for developing respiratory complications after coronary artery bypass surgery. Med Glas (Zenica). 2025;22(2):207-11.
19. Imazio M, Brucato A, Ferrazzi P, Pullara A, Adler Y, Barosi A, et al. Colchicine for prevention of postpericardiotomy syndrome and postoperative atrial fibrillation: the COPPS-2 randomized clinical trial. Jama. 2014;312(10):1016-23.
20. Banerjee D, Feng J, Sellke FW. Strategies to attenuate maladaptive inflammatory response associated with cardiopulmonary bypass. Front Surg. 2024;11:1224068.