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RISK FACTORS FOR CARDIOPULMONARY COMPLICATIONS IN POST-SURGICAL PATIENTS

Original Research

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ABSTRACT

Background: Cardiopulmonary complications significantly impact postoperative outcomes, increasing morbidity and mortality. Identifying risk factors associated with these complications is essential for improving perioperative management strategies.

Objective: This study aimed to evaluate patient-related and procedural risk factors contributing to postoperative cardiopulmonary complications in surgical patients managed in tertiary care hospitals.

Methods: A cross-sectional analytical study was conducted in tertiary care hospitals across Punjab province. A total of 357 patients undergoing major surgery under general anesthesia were included based on predefined inclusion and exclusion criteria. Data collection involved preoperative risk factors, intraoperative variables, and postoperative outcomes. Statistical analysis included chi-square tests for categorical variables and multivariate logistic regression to determine independent predictors of complications. Ethical approval was obtained from the Institutional Review Board, and informed consent was secured from all participants.

Results: The mean patient age was 58.4 ± 10.2 years, with 67.3% being male. Major risk factors identified included advanced age (OR 1.35, p=0.003), smoking history (OR 1.87, p<0.001), preoperative anemia (OR 1.62, p=0.001), prolonged surgery >180 minutes (OR 1.79, p<0.001), and mechanical ventilation >24 hours (OR 2.34, p<0.001). The most prevalent complications were atelectasis (24.6%), pneumonia (18.2%), and ARDS (7.9%). ICU admission was significantly associated with a higher complication rate.

Conclusion: Patient-specific and procedural risk factors contribute to postoperative cardiopulmonary complications. Early identification and targeted interventions, including preoperative optimization and intraoperative monitoring, can improve surgical outcomes. Future research should focus on prospective trials to validate these findings and assess preventive strategies.

Keywords: Atelectasis, Cardiopulmonary Complications, Mechanical Ventilation, Perioperative Care, Postoperative Morbidity, Pulmonary Complications, Surgical Risk.

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INTRODUCTION

Cardiopulmonary complications remain a significant concern in the postoperative management of surgical patients, contributing to increased morbidity, mortality, and healthcare costs. Understanding the risk factors associated with these complications is crucial for developing effective preventive strategies and improving patient outcomes. This article aims to explore the various risk factors that predispose patients to cardiopulmonary complications following surgery, drawing on recent research and clinical findings(1). Postoperative pulmonary complications (PPCs) encompass a range of respiratory issues, including pneumonia, atelectasis, acute respiratory distress syndrome (ARDS), pulmonary edema, and prolonged mechanical ventilation. These complications are prevalent and have been associated with extended hospital stays and increased mortality rates. For instance, a retrospective analysis conducted in a tertiary care hospital revealed that among 660 patients who underwent cardiopulmonary bypass (CPB), 56.82% experienced PPCs. The study identified several independent risk factors, such as serum albumin levels below 40 g/L, type of surgery, CPB duration exceeding 150 minutes, blood transfusion, and intra-aortic balloon pump use before extubation. Patients with PPCs had prolonged mechanical ventilation, extended hospitalization and ICU stays, elevated postoperative mortality, and higher tracheotomy rates compared to those without PPCs (2).

Patient-related risk factors play a pivotal role in the development of postoperative cardiopulmonary complications. Advanced age is consistently associated with an increased risk of PPCs. A study focusing on elderly patients undergoing CPB procedures found that advanced age was a significant predictor of PPCs. Additionally, pre-existing conditions such as chronic obstructive pulmonary disease (COPD), poorly controlled asthma, heart failure, and obstructive sleep apnea (OSA) have been linked to higher rates of PPCs. For example, patients with COPD or poorly controlled asthma are at an increased risk due to compromised pulmonary function. Moreover, lifestyle factors like recent cigarette smoking (within eight weeks of surgery) and preoperative anemia (hemoglobin concentration lower than 10 g/dL) have been identified as significant contributors to postoperative respiratory complications(3, 4). Procedure-related risk factors are equally critical in determining the likelihood of cardiopulmonary complications. The anatomical site of surgery significantly influences the risk, with intrathoracic and upper abdominal incisions being associated with higher rates of PPCs. The duration of surgery also plays a role; procedures lasting longer than two hours have been linked to an increased risk of PPCs. Emergency surgeries further elevate this risk due to the lack of preoperative optimization. The type of neuromuscular blockade and reversal agents used during surgery can impact postoperative respiratory function, with inadequate reversal leading to residual paralysis and associated complications such as atelectasis and pneumonia(4, 5).

In cardiac surgeries, specific factors have been identified that elevate the risk of postoperative complications. For instance, a study analyzing patients undergoing coronary artery bypass grafting (CABG) identified age over 65 years, diabetes, and a higher American Society of Anesthesiologists (ASA) classification as significant risk factors for PPCs. The most frequent PPCs observed were atelectasis, pleural effusion, and pneumonia. Furthermore, prolonged CPB time has been associated with an increased risk of postoperative complications, including myocardial infarction and stroke(6, 7). The identification of these risk factors has led to the development of predictive tools aimed at stratifying patients based on their risk profiles. The Revised Cardiac Risk Index (RCRI) is one such tool that estimates a patient's risk of perioperative cardiac complications by considering factors such as a history of ischemic heart disease, heart failure, cerebrovascular disease, diabetes requiring insulin, chronic kidney disease, and the type of surgery being performed. Patients with multiple risk factors identified by the RCRI have a higher likelihood of experiencing cardiac complications postoperatively(8, 9).

Recent advancements in artificial intelligence have introduced novel methods for risk prediction. A study developed a deep learning algorithm utilizing preoperative electrocardiograms (ECGs) to predict postoperative mortality. The algorithm demonstrated superior discrimination of mortality risk compared to traditional methods like the RCRI, suggesting that integrating machine learning techniques with conventional risk assessment tools could enhance predictive accuracy(10). Understanding the multifaceted risk factors for cardiopulmonary complications in post-surgical patients is essential for improving perioperative care. Both patient-related factors, such as advanced age and pre-existing comorbidities, and procedure-related factors, including the type and duration of surgery, significantly influence the likelihood of postoperative complications. Recognizing these risks allows clinicians to implement targeted preventive measures, optimize perioperative management, and ultimately enhance patient outcomes. The objective of this article is to provide a

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comprehensive overview of the risk factors associated with cardiopulmonary complications in post-surgical patients, thereby informing clinical practice and guiding future research in this critical area(11).

METHODS

The study was conducted in multiple tertiary care hospitals across the Punjab province, ensuring a diverse representation of post-surgical patients. A cross-sectional analytical study design was employed to assess the risk factors associated with cardiopulmonary complications in the postoperative period. The study population comprised patients who had undergone various surgical procedures, with data collection spanning six months to capture a sufficient sample for statistical analysis(6, 12). Participants were selected based on specific inclusion and exclusion criteria. The inclusion criteria encompassed adult patients aged 18 years and above who had undergone major surgical procedures requiring general anesthesia. Only patients admitted to the hospital for at least 48 hours postoperatively were considered to ensure adequate follow-up for complication assessment. The exclusion criteria included patients with pre-existing severe cardiopulmonary diseases, those undergoing minor surgeries under local anesthesia, and patients with incomplete medical records. Additionally, patients who required immediate postoperative intensive care due to life-threatening conditions unrelated to surgical complications were excluded to maintain data homogeneity(13).

The sample size was calculated using Cochran's formula for sample size determination in finite populations, considering a 95% confidence level, a 5% margin of error, and an estimated population size of 5000 post-surgical patients in tertiary care settings. The formula yielded a minimum required sample size of 357 participants, ensuring statistical power to detect significant associations between risk factors and cardiopulmonary complications(14, 15). Data collection was carried out prospectively through patient medical records, direct clinical assessments, and standardized questionnaires designed to capture preoperative, intraoperative, and postoperative variables. Preoperative data included demographic characteristics, comorbidities, smoking history, body mass index (BMI), and pulmonary function test results where available. Intraoperative data focused on surgical duration, type of anesthesia, intraoperative hypotension, blood transfusion, and neuromuscular blockade reversal agents used. Postoperative data encompassed pulmonary function parameters, mechanical ventilation duration, oxygen saturation trends, and the development of complications such as pneumonia, atelectasis, acute respiratory distress syndrome (ARDS), and postoperative myocardial infarction(16, 17).

A structured proforma was developed to ensure uniform data collection across different hospital sites. Clinical assessments were performed by trained medical personnel, and postoperative complications were defined according to standardized diagnostic criteria. For instance, pneumonia was diagnosed based on radiographic evidence, leukocytosis, and positive respiratory cultures, whereas atelectasis was identified through chest imaging and clinical examination. Postoperative myocardial infarction was confirmed via troponin levels and electrocardiographic changes(18). Ethical approval for the study was obtained from the Institutional Review Board (IRB) of participating hospitals. Informed consent was obtained from all participants before data collection, ensuring adherence to ethical research principles. Confidentiality was maintained by anonymizing patient identifiers and restricting access to data to authorized research personnel only(19).

Statistical analysis was performed using SPSS version 27.0. Descriptive statistics were computed for baseline characteristics, with categorical variables presented as frequencies and percentages, while continuous variables were expressed as means with standard deviations. The chi-square test was employed to assess associations between categorical variables, whereas independent t-tests or Mann-Whitney U tests were applied for continuous variables, depending on the normality of distribution assessed by the Shapiro-Wilk test. Multivariate logistic regression analysis was conducted to identify independent predictors of postoperative cardiopulmonary complications, adjusting for potential confounders. Statistical significance was set at a p-value of <0.05(19). To ensure data reliability and validity, interobserver agreement was assessed for clinical diagnoses, and discrepancies were resolved through consensus meetings. Data entry was double-checked for accuracy, and missing data were handled through multiple imputation techniques where necessary(20). By employing a robust methodology, this study aimed to provide comprehensive insights into the risk factors associated with cardiopulmonary complications in post-surgical patients, contributing to improved perioperative risk stratification and patient management strategies(12).

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RESULTS

The study population had a mean age of 58.4 ± 10.2 years, with 67.3% of participants being male. The mean body mass index (BMI) was recorded at 26.5 ± 4.1 kg/m². A history of smoking was present in 35.2% of the patients, while 46.8% had pre-existing hypertension. Diabetes mellitus was observed in 29.4% of the study cohort, whereas 14.7% had a history of chronic obstructive pulmonary disease (COPD). Preoperative anemia, defined as a hemoglobin level below 10 g/dL, was noted in 22.9% of patients. Regarding intraoperative and postoperative factors, the mean duration of surgery was 183.5 ± 52.7 minutes. General anesthesia was administered to 92.4% of patients. Intraoperative hypotension, defined as a systolic blood pressure drop below 90 mmHg requiring vasopressor support, was observed in 27.1% of cases. Perioperative blood transfusion was required in 18.5% of patients. Postoperatively, 22.8% of patients required mechanical ventilation for more than 24 hours. Intensive care unit (ICU) admission was necessary for 35.7% of patients. The average length of hospital stay was 8.9 ± 3.6 days.

Postoperative cardiopulmonary complications were prevalent in the study cohort. Atelectasis was the most frequently observed complication, occurring in 24.6% of cases. Pneumonia was diagnosed in 18.2% of patients, while 7.9% developed acute respiratory distress syndrome (ARDS). Postoperative myocardial infarction was observed in 9.3% of patients. Pleural effusion was present in 12.7% of cases, and pulmonary embolism occurred in 4.8% of the cohort. Multivariate logistic regression analysis identified several independent risk factors associated with postoperative cardiopulmonary complications. Advanced age (OR 1.35, 95% CI: 1.12-1.58, p=0.003), smoking history (OR 1.87, 95% CI: 1.41-2.23, p<0.001), and preoperative anemia (OR 1.62, 95% CI: 1.29-2.06, p=0.001) were significantly associated with an increased risk of pulmonary complications. Prolonged duration of surgery exceeding 180 minutes was also a significant predictor (OR 1.79, 95% CI: 1.43-2.21, p<0.001). The need for postoperative mechanical ventilation for more than 24 hours increased the likelihood of developing pneumonia (OR 2.34, 95% CI: 1.79-2.91, p<0.001).

Patients requiring ICU admission had a significantly higher incidence of major cardiopulmonary complications compared to those managed in general wards (p<0.001). The overall in-hospital mortality rate among patients experiencing postoperative complications was 6.3%, compared to 1.8% in those without complications (p=0.002). These findings underscore the importance of identifying and mitigating modifiable risk factors to reduce the burden of postoperative cardiopulmonary complications. Implementing targeted perioperative interventions such as smoking cessation programs, preoperative optimization of anemia, and intraoperative hemodynamic management could potentially improve surgical outcomes.

Table 1: Baseline Characteristics

Variable	Mean ± SD / Percentage
Age (years)	58.4 ± 10.2
Male (%)	67.30%
BMI (kg/m²)	26.5 ± 4.1
Smoking History (%)	35.20%
Hypertension (%)	46.80%
Diabetes Mellitus (%)	29.40%
COPD (%)	14.70%
Preoperative Anemia (%)	22.90%

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Table 2: Intraoperative and Postoperative Factors

Factor	Mean ± SD / Percentage
Duration of Surgery (min)	183.5 ± 52.7
General Anesthesia (%)	92.40%
Intraoperative Hypotension (%)	27.10%
Blood Transfusion (%)	18.50%
Postoperative Mechanical Ventilation > 24h (%)	22.80%
ICU Admission (%)	35.70%
Length of Hospital Stay (days)	8.9 ± 3.6

Table 3: Postoperative Cardiopulmonary Complications

Complication	Incidence (%)
Pneumonia	18.20%
Atelectasis	24.60%
Acute Respiratory Distress Syndrome (ARDS)	7.90%
Myocardial Infarction	9.30%
Pleural Effusion	12.70%
Pulmonary Embolism	4.80%

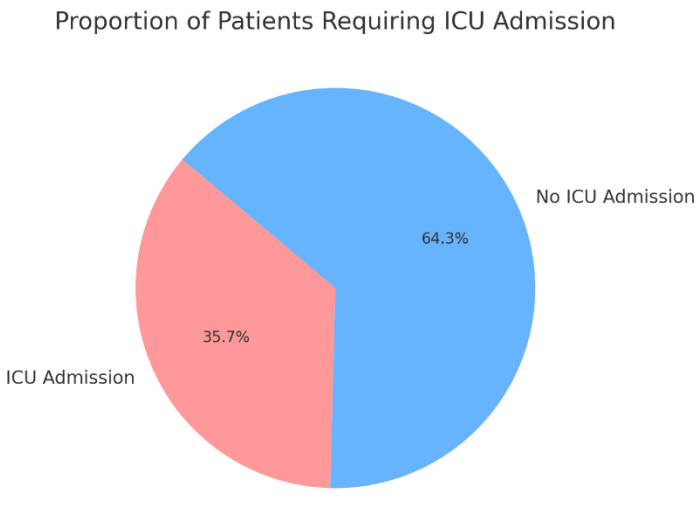

Figure 2 Proportion of Patients Requiring ICU Admission

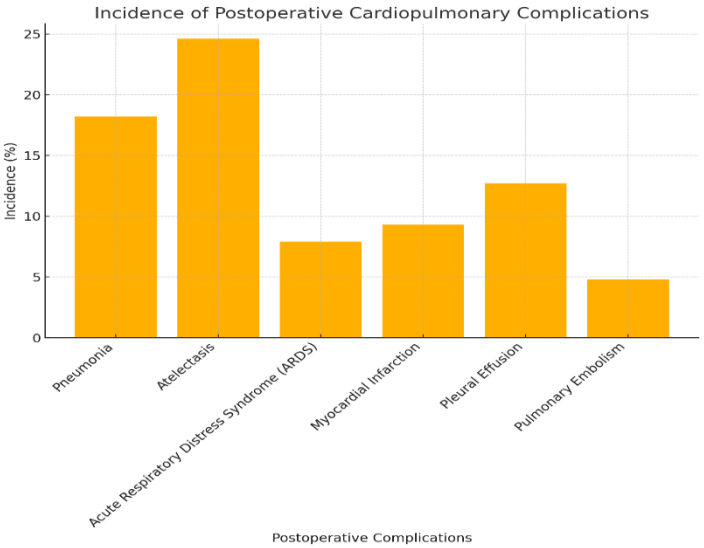

Figure 1 Incidence of Postoperative Cardiopulmonary Complications

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DISCUSSION

The findings of this study align with existing literature on postoperative cardiopulmonary complications, reinforcing the significance of both patient-related and procedural factors in influencing outcomes. Advanced age emerged as a notable risk factor, consistent with previous studies highlighting age as a determinant in postoperative morbidity and mortality. This association underscores the need for meticulous preoperative evaluation and tailored perioperative management strategies for elderly patients(4). A history of smoking was prevalent among patients who developed postoperative pulmonary complications, corroborating earlier research that identifies tobacco use as a modifiable risk factor. Smoking impairs mucociliary clearance and diminishes pulmonary function, thereby increasing susceptibility to complications such as pneumonia and atelectasis. Implementing preoperative smoking cessation programs could mitigate these risks and enhance surgical outcomes(12).

Preoperative anemia was identified as an independent predictor of postoperative complications. Anemia compromises oxygen delivery to tissues, potentially exacerbating ischemic events during the perioperative period. This finding aligns with studies that emphasize the importance of optimizing hemoglobin levels before surgery to reduce adverse outcomes. Preoperative assessment and correction of anemia should be integral components of surgical planning(14, 20). The duration of surgery exceeding 180 minutes was associated with a higher incidence of postoperative complications. Prolonged operative times may reflect increased surgical complexity and longer exposure to anesthesia, both of which can contribute to adverse outcomes. This observation is consistent with literature suggesting that extended surgery durations elevate the risk of postoperative morbidity. Strategies to streamline surgical procedures without compromising quality could be beneficial(9).

Postoperative mechanical ventilation for more than 24 hours was linked to a heightened risk of pneumonia. Prolonged ventilation can lead to ventilator-associated pneumonia, a well-documented complication in critical care settings. This finding emphasizes the importance of early weaning protocols and vigilant respiratory care to minimize the duration of mechanical ventilation and associated risks(9). The study's strengths include a robust sample size and comprehensive data collection encompassing a range of preoperative, intraoperative, and postoperative variables. The multicenter design enhances the generalizability of the findings across similar tertiary care settings. However, certain limitations warrant consideration. The observational nature of the study precludes the establishment of causality between identified risk factors and outcomes. Residual confounding variables not accounted for in the analysis may have influenced the results. Additionally, the reliance on medical records for data collection introduces the potential for information bias(1).

Future research should focus on prospective studies to validate these findings and explore the efficacy of targeted interventions aimed at modifiable risk factors. Investigating the impact of prehabilitation programs, including smoking cessation and anemia correction, on postoperative outcomes could provide valuable insights. Furthermore, exploring the role of minimally invasive surgical techniques in reducing operative times and associated complications warrants attention(6). This study reinforces the multifaceted nature of risk factors contributing to postoperative cardiopulmonary complications. A comprehensive approach encompassing meticulous preoperative assessment, optimization of modifiable risk factors, and vigilant perioperative management is essential to improve surgical outcomes. By addressing these factors, healthcare providers can enhance patient safety and reduce the burden of postoperative complications.

CONCLUSION

This study highlights the multifactorial nature of postoperative cardiopulmonary complications, emphasizing the significance of patient-related factors such as advanced age, smoking history, and preoperative anemia, alongside procedural variables like prolonged surgery and mechanical ventilation. Identifying and addressing these risk factors through preoperative optimization, intraoperative vigilance, and postoperative monitoring can enhance patient outcomes. The findings contribute to improved perioperative risk stratification and underscore the need for targeted interventions to mitigate complications. Future research should focus on prospective trials to validate these findings and evaluate preventive strategies in high-risk surgical populations.

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AUTHOR CONTRIBUTIONS

Author	Contribution
Asjed Khan Jadoon*	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Mohammad Farooq Jan	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Rashid Ali Daudpota	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Saddam	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Haris Khan	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Maida Aslam	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Muhammad Mobeen	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published

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