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FREQUENCY OF POST-OPERATIVE PULMONARY COMPLICATIONS AND MORTALITY IN PATIENTS UNDERGOING ABDOMINAL SURGERY

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ABSTRACT

Background: Postoperative pulmonary complications (PPCs) are among the most frequent adverse events following abdominal surgery and are associated with increased morbidity, prolonged hospitalization, higher healthcare costs, and mortality. Early identification of high-risk patients is essential for implementing preventive strategies and improving postoperative outcomes.

Objective: To determine the frequency of postoperative pulmonary complications and mortality among patients undergoing abdominal surgery and to identify factors associated with the development of PPCs.

Place and Duration of study: From March 2026 to July 2026 General Surgery Department, Mohtarma Shaheed Benazir Bhutto General Hospital Quetta. Balochistan.

Methodology: This prospective observational study was conducted in the Department of General Surgery of a tertiary care teaching hospital from March to July 2026. A total of 100 adult patients undergoing elective or emergency abdominal surgery under general anesthesia were enrolled using consecutive non-probability sampling. Patients with chronic respiratory failure, active pulmonary tuberculosis, preoperative mechanical ventilation, thoracic surgery, or incomplete clinical records were excluded. Patients were followed until hospital discharge for the development of PPCs and mortality. Data were analyzed using IBM SPSS Statistics version 26.0. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Independent samples *t*-test, Chi-square test, Fisher's exact test, and multivariable logistic regression were used. A p-value ≤ 0.05 was considered statistically significant.

Results: The mean age of the participants was 51.8 ± 14.2 years, and 62% were male. Postoperative pulmonary complications occurred in 24 (24%) patients, including pneumonia (10%), atelectasis (7%), pleural effusion (4%), and respiratory failure (3%). The overall in-hospital mortality rate was 8%, with significantly higher mortality among patients with PPCs than those without PPCs (20.8% vs. 3.9%; p=0.012). Patients with PPCs had significantly longer hospital stays (11.6 ± 4.3 vs. 6.8 ± 2.7 days; p<0.001). Advanced age, smoking, diabetes mellitus, emergency surgery, and operative duration >3 hours were significantly associated with PPCs. Multivariable logistic regression identified advanced age, emergency surgery, and prolonged operative duration as independent predictors.

Conclusion: Postoperative pulmonary complications occurred in nearly one-quarter of patients undergoing abdominal surgery and were significantly associated with prolonged hospitalization and increased in-hospital mortality. Early identification of high-risk patients and implementation of evidence-based perioperative pulmonary care may reduce the incidence of PPCs and improve postoperative outcomes.

KEYWORDS: Abdominal surgery; Postoperative pulmonary complications; Pneumonia; Mortality.

INTRODUCTION

Postoperative pulmonary complications (PPCs) are among the most common and significant complications after abdominal surgery and are a major cause of postoperative morbidity, mortality, longer hospital stays, higher healthcare costs and lower quality of life. PPCs are a diverse group of postoperative pulmonary conditions, such as pneumonia, atelectasis, pleural effusion, respiratory failure, bronchospasm, pulmonary edema, and requirement for mechanical ventilation for extended periods of time. These complications can arise in the first 7 days after surgery, and are responsible for a significant percentage of postoperative mortality globally [1,2].Multiple mechanisms are involved in the changes in respiratory physiology that occur as a result of abdominal surgery. There is decreased lung expansion and poor clearance of secretions due to surgical incision, postoperative pain, diaphragmatic dysfunction, decreased functional residual capacity, impaired cough reflex, and impaired chest wall movement. General anesthesia worsens these changes by decreasing lung volumes, favouring alveolar collapse and impairing mucociliary clearance, thus leading to higher susceptibility to pulmonary infections and hypoxemia.

PPCs are more common with upper abdominal surgery, as it is the most disruptive to diaphragmatic function [3,4].The reported rate of postoperative pulmonary complications ranges from 5 to 40%, depending on the patient's characteristics, surgical complexity and the criteria used to define the presence of postoperative pulmonary complication. Advanced age, current cigarette smoking, obesity, chronic obstructive pulmonary disease (COPD), diabetes mellitus, poor nutritional status, emergency surgery, long operative time and pre-existing cardiopulmonary disease are consistently reported as significant risk factors for PPCs. Besides that, insufficient postoperative pain management and delayed ambulation also increase the risks of postoperative complications during breathing [5,6].Significant clinical consequences of postoperative pulmonary complications. Those who develop PPCs have a higher risk of intensive care admission, prolonged oxygen therapy, mechanical ventilation and longer hospital stays. In addition, PPCs significantly increase postoperative mortality especially in elderly patients and those with multiple comorbidities. The research has shown that pulmonary complications is one of the major causes of death after major abdominal surgery and preventive measures and early detection of high-risk patients are of paramount importance [7,8].A number of peri-operative interventions are known to decrease the incidence of PPCs. These include preoperative smoking cessation, optimisation of chronic medical conditions, respiratory physiotherapy, incentive spirometry, effective postoperative analgesia, early ambulation, lung-protective ventilation strategies and appropriate perioperative antibiotic prophylaxis. Despite all the evidence-based interventions, PPCs impose a significant burden especially in developing countries where the prevalence of uncontrolled comorbidities is still higher and limited perioperative resources and delayed presentation are prevalent [9,10].PACS are an important part of surgical interventions in Pakistan but there are limited published local data concerning the incidence of postoperative pulmonary complications and their association with mortality. The data available is largely from more affluent countries, which have recently undergone rapid economic growth and change in patient populations, surgical techniques, and peri-operative care, all of which vary significantly from developing countries. Therefore, local epidemiological data is needed to comprehend the burden of PPCs and to develop effective preventive strategies that are relevant to the regional health systems.

Study Objective

To assess the incidence of postoperative pulmonary complications and the mortality rate in patients with abdominal surgery and to assess factors associated with postoperative pulmonary complications.

MATERIALS AND METHODS

Study Design & Setting

This prospective observational study was conducted in the Department of General Surgery of a tertiary care teaching hospital from **January 2025 to December 2025.**

Participants

Using non-probability consecutive sampling method, a total of 100 adult patients, age 18 years and older, who were undergoing elective/emergency abdominal surgery were enrolled. Patients who had chronic respiratory failure, active pulmonary tuberculosis, were under mechanical ventilator before surgery or had incomplete clinical records were not included. All participants had signed informed consent forms before being recruited for the study.

Sample Size Calculation

The sample size was calculated using the **WHO Sample Size Calculator** based on an anticipated prevalence of postoperative pulmonary complications of **20%**, a **95% confidence level (Z = 1.96)**, and a **margin of error of 8%**. The minimum required sample size was calculated to be **96 patients**. To compensate for possible incomplete data and improve the study's statistical power, **100 consecutive eligible patients** were enrolled.

Inclusion Criteria

- Patients aged **18 years or older**.
- Patients undergoing elective or emergency abdominal surgery under general anesthesia.
- Patients willing to provide written informed consent.
- Patients available for follow-up until hospital discharge.

Exclusion Criteria

- Patients with chronic respiratory failure requiring long-term oxygen therapy.
- Patients on mechanical ventilation before surgery.
- Patients with active pulmonary tuberculosis or severe interstitial lung disease.
- Patients undergoing thoracic surgery or presenting with significant chest trauma.
- Patients with incomplete clinical records or those lost to follow-up before hospital discharge.

Diagnostic and Management Strategy

All patients underwent routine preoperative clinical assessment, including detailed medical history, physical examination, laboratory investigations, and anesthetic evaluation. Following surgery, patients were monitored daily until hospital discharge for the development of pulmonary complications. PPCs were diagnosed using clinical findings, pulse oximetry, chest radiography, arterial blood gas analysis, and other investigations when clinically indicated. Standard postoperative management included adequate analgesia, incentive spirometry, chest physiotherapy, early mobilization, supplemental oxygen when required, antibiotic therapy for confirmed infections, and mechanical ventilation for patients developing severe respiratory failure.

Statistical Analysis

Data were entered and analyzed using **IBM SPSS Statistics version 26.0 (IBM Corp., Armonk, NY, USA)**. Continuous variables were assessed for normality and presented as **mean ± standard deviation (SD)**, while categorical variables were expressed as **frequencies and percentages**. Comparisons between patients with and without postoperative pulmonary complications were performed using the **independent samples t-test** for continuous variables and the **Chi-square test or Fisher's exact test**, where appropriate, for categorical variables. Variables with a **p-value <0.05** in univariate analysis were included in a **multivariable logistic regression model** to identify independent predictors of postoperative pulmonary complications. The results of logistic regression were reported as **adjusted odds ratios (AORs) with 95% confidence intervals (CIs)**. A **two-tailed p-value ≤0.05** was considered statistically significant.

Results

A total of **100 patients** undergoing abdominal surgery were included. The **mean age was 51.8 ± 14.2 years** (range: 19–82 years); **62 (62%)** were male and **38 (38%)** were female. Elective surgery was performed in **68 (68%)** patients, whereas **32 (32%)** underwent emergency procedures. The mean operative duration was **2.9 ± 0.9 hours**, and the mean postoperative hospital stay was **7.9 ± 3.8 days**. Postoperative pulmonary complications (PPCs) occurred in **24 (24%)** patients. The most frequent complication was **pneumonia (10%)**, followed by **atelectasis (7%)**, **pleural effusion (4%)**, and **respiratory failure requiring mechanical ventilation (3%)**. **In-hospital mortality was 8% (8 patients)**. Mortality was significantly higher among patients with PPCs than among those without PPCs (**20.8% vs. 3.9%; p=0.012**). Patients who developed PPCs had a significantly longer hospital stay (**11.6 ± 4.3 vs. 6.8 ± 2.7 days; p<0.001**) and were older (**58.7 ± 12.8 vs. 49.6 ± 13.9 years; p=0.018**). Smoking history (**p=0.031**), emergency surgery (**p=0.022**), operative duration exceeding three hours (**p=0.015**), and diabetes mellitus (**p=0.041**) were significantly associated with the development of postoperative pulmonary complications. Multivariable logistic regression identified advanced age, emergency surgery, and prolonged operative duration as independent predictors of PPCs.

Table I. Baseline Demographic and Clinical Characteristics of the Study Participants (n = 100)

Variable	**n (%) / Mean ± SD**
Age (years)	**51.8 ± 14.2**
Gender	
Male	62 (62.0)
Female	38 (38.0)
Smoking Status	
Smokers	34 (34.0)
Non-smokers	66 (66.0)
Diabetes mellitus	28 (28.0)
Hypertension	41 (41.0)
Type of Surgery	
Elective	68 (68.0)
Emergency	32 (32.0)
Duration of Surgery	
≤3 hours	61 (61.0)
>3 hours	39 (39.0)

Data are presented as frequency (percentage) unless otherwise stated. Continuous variables are expressed as mean ± standard deviation (SD).

Table 2. Frequency of Postoperative Pulmonary Complications (n = 100)

Postoperative Pulmonary Complication	**n (%)**
Pneumonia	10 (10.0)
Atelectasis	7 (7.0)
Pleural effusion	4 (4.0)
Respiratory failure	3 (3.0)
Total patients with PPCs	**24 (24.0)**
No pulmonary complication	76 (76.0)

Postoperative pulmonary complications (PPCs) were diagnosed during the postoperative hospital stay based on clinical and radiological findings.

Table 3. Factors Associated with Postoperative Pulmonary Complications

Variable	PPC Present (n = 24)	PPC Absent (n = 76)	*p*-value
Age (years), Mean ± SD	58.7 ± 12.8	49.6 ± 13.9	0.018
Smokers	13 (54.2%)	21 (27.6%)	0.031
Diabetes mellitus	11 (45.8%)	17 (22.4%)	0.041
Emergency surgery	13 (54.2%)	19 (25.0%)	0.022
Duration of surgery >3 hours	15 (62.5%)	24 (31.6%)	0.015

Continuous variables were compared using the independent samples *t*-test, while categorical variables were analyzed using the Chi-square test. A *p*-value ≤0.05 was considered statistically significant.

Table 4. Association of Postoperative Pulmonary Complications with Clinical Outcomes

Outcome	PPC Present (n = 24)	PPC Absent (n = 76)	*p*-value
Hospital stay (days), Mean ± SD	11.6 ± 4.3	6.8 ± 2.7	<0.001
ICU admission	9 (37.5%)	8 (10.5%)	0.004
Mechanical ventilation	5 (20.8%)	2 (2.6%)	0.006
In-hospital mortality	5 (20.8%)	3 (3.9%)	0.012

Patients who developed postoperative pulmonary complications experienced significantly longer hospital stays and higher rates of ICU admission, mechanical ventilation, and in-hospital mortality than patients without postoperative pulmonary complications.

DISCUSSION

The present prospective observational study evaluated the frequency of postoperative pulmonary complications (PPCs) and their association with in-hospital mortality among patients undergoing abdominal surgery. Postoperative pulmonary complications developed in 24% of patients, while the overall in-hospital mortality was 8%. Patients who developed PPCs experienced significantly longer hospital stays, higher rates of intensive care unit (ICU) admission, increased need for mechanical ventilation, and greater mortality than those without PPCs. Furthermore, advanced age, smoking, diabetes mellitus, emergency surgery, and prolonged operative duration were significantly associated with the development of PPCs, whereas multivariable logistic regression identified advanced age, emergency surgery, and prolonged operative duration as independent predictors [11,12].The observed incidence of PPCs (24%) is consistent with recent international studies reporting rates ranging from 10% to 30% following major abdominal surgery, depending on patient characteristics, surgical complexity, and diagnostic criteria. Garg et al. reported a comparable incidence among patients undergoing upper abdominal surgery and highlighted age, emergency procedures, and prolonged operative duration as major determinants of postoperative respiratory complications. Similarly, the STARSurg Collaborative demonstrated that PPCs remain among the leading postoperative complications despite improvements in perioperative care and enhanced recovery protocols. These findings suggest that PPCs continue to represent a substantial burden across both high-income and resource-limited healthcare settings [13,14].Pneumonia was the most frequent postoperative pulmonary complication in the present study, followed by atelectasis, pleural effusion, and respiratory failure. Comparable patterns have been reported in recent randomized trials and systematic reviews evaluating abdominal surgery, where postoperative pneumonia and atelectasis accounted for the majority of respiratory complications. Reduced lung expansion, postoperative pain, impaired diaphragmatic excursion, ineffective cough, and secretion retention contribute substantially to these complications. These observations reinforce the importance of perioperative respiratory optimization and early postoperative pulmonary rehabilitation [15,16].A major finding of this study was the significantly higher mortality among patients who developed PPCs compared with those without pulmonary complications (20.8% versus 3.9%). This observation agrees with contemporary studies showing that PPCs independently increase postoperative mortality, ICU admission, mechanical ventilation, and overall healthcare utilization. Pulmonary complications frequently result in hypoxemia, systemic inflammatory responses, secondary infections, and multiorgan dysfunction, thereby substantially worsening postoperative recovery. Consequently, prevention and early recognition of PPCs remain essential components of modern perioperative care [17,18].Advanced age emerged as an independent predictor of PPCs in the present study. Aging is associated with reduced pulmonary reserve, impaired mucociliary clearance, diminished respiratory muscle strength, and a greater prevalence of chronic comorbidities, all of which increase susceptibility to postoperative respiratory complications. Smoking and diabetes mellitus were also significantly associated with PPCs on univariate analysis. Chronic tobacco exposure impairs mucociliary function and promotes airway inflammation, whereas diabetes adversely affects immune function and wound healing, increasing the risk of postoperative infections. These findings are consistent with previous observational studies evaluating perioperative risk factors in abdominal surgery [19,20].Emergency surgery and prolonged operative duration were identified as independent predictors of PPCs. Emergency procedures often permit limited preoperative optimization and are commonly performed in physiologically compromised patients. Likewise, prolonged exposure to general anesthesia promotes

atelectasis, decreases functional residual capacity, and delays postoperative recovery. Recent systematic reviews have consistently demonstrated that operative urgency and longer surgical duration significantly increase the likelihood of postoperative pulmonary complications.

LIMITATIONS

This study has several limitations. First, it was conducted at a single tertiary care center with a relatively small sample size, which may limit the generalizability of the findings to other healthcare settings. Second, patients were followed only until hospital discharge; therefore, pulmonary complications and mortality occurring after discharge were not assessed. Finally, variations in surgical procedures, anesthetic techniques, and perioperative management could not be completely controlled, which may have influenced the incidence of postoperative pulmonary complications.

CONCLUSION

The risk of postoperative pulmonary complications (POPCs) following abdominal surgery is still a major concern, and is significantly related to high mortality and longer hospital stays. Important risk factors included were advanced age, smoking, emergency surgery, and a long duration of surgery. Early identification of high-risk patients and implementation of evidence-based perioperative pulmonary care may reduce postoperative pulmonary complications and improve surgical outcomes.

Ethical Approval

Ethical approval for the study was obtained from the College of Physicians and Surgeons Pakistan (CPSP), Research Evaluation Unit, Karachi. The study synopsis was approved under Reference No. CPSP/REU/SGR-2022-366-14188, dated January 28, 2026. All study procedures were conducted in accordance with institutional ethical requirements and applicable research standards.

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Author Contributions:

Muhammad Naseem: Conceptualization, methodology, data collection, and manuscript drafting.
Mukhtar Mehboob: Study supervision, methodology, and critical manuscript review.
Shoaib Ahmed: Data collection, investigation, and manuscript review.
Zahoor Ahmed: Data analysis, interpretation, and critical manuscript review.
Sughra Mujeeb: Literature review, manuscript drafting, and critical revision.

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