

A Retrospective Observational Cohort Study: The Aetiology and Consequences of Post-operative Pulmonary Complications Following Abdominal Surgery

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Abstract:

Introduction: Following abdominal procedures, pulmonary complications play a substantial role in resource utilisation as well as overall post-operative morbidity and mortality. According to estimates, the prevalence of post-operative pulmonary complications (PPC) following abdominal procedures may be between 5 and 40%.

Methods: The patients for the current study were chosen from the general surgery department at Anil Neerukonda Hospital, which is affiliated with NRI Institute of Medical Sciences in Visakhapatnam, India. The patients who were hospitalised with abdominal complaints and required surgery, either electively or urgently, were included in the study.

Results: The study comprised 50 patients having abdominal surgery at the NRI Institute of Medical Sciences in Visakhapatnam. The age group of more than 50 years makes up about 50% of the sample's socio-demographic data, followed by age groups of 48–60 years and 35–47 years. Patients included 25 males and 25 females, or 50% each. Basal lung atelectasis, which was present in 31 (14%) individuals and absent in 19 (2%), was the most frequent cause causing PPC in our investigation.

Conclusions: 30% of abdominal procedures result in post-operative respiratory complications, with pleural effusion being the most frequent (24%) followed by pneumonia (22%) and atelectasis (16%), with respiratory failure being the least common (4%). Because there is a complex interplay of underlying pathogenic mechanisms that facilitate one another, these difficulties happened in combination rather than as distinct ones. In patients who are elderly, have pre-existing lung disorders, have a history of smoking, are undergoing longer duration surgeries, or have large abdominal incisions, where most PPC are seen in the current study, post-operative pulmonary problems should be expected.

Keywords: Pulmonary complication, PPC, abdominal surgery, Lung infection, atelectasis.

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Introduction

The overall post-operative morbidity, mortality, and resource utilisation are greatly influenced by pulmonary problems following abdominal procedures. According to estimates, between 5 and 40% of patients who undergo abdominal procedures may develop post-operative pulmonary problems (PPC). PPC is an umbrella term for respiratory tract conditions that can negatively impact the patient's clinical condition after surgery. For the observed issue, several mechanisms have been proposed. Some of them include anaesthesia's effects, poor breathing, inadequate expectoration, changes to pulmonary mechanics, pain at the operation site, an increase in post-operative oxygen demand, etc. This

can then result in modifications to the body's other organ systems, such as an increase in cardiac preload and afterload, immunosuppression, vasoconstriction, a hypermetabolic state, etc [1]. The ability to anticipate cardiac complications in pre-anaesthetic assessment for surgery is well supported by the evidence, whereas the ability to predict pulmonary complications is less well supported. Both cardiovascular and pulmonary complications contribute significantly to mortality and morbidity, but pulmonary complications are more common than cardiac ones [2].

There is no consensus regarding the post-operative complications following abdominal surgeries. Based

on clinical settings, type of operation, demographic characteristics analysed, etc., various studies have identified a range of PPCs. Post-operative pneumonia, respiratory failure, ARDS, atelectasis, profuse bronchial secretions, hypoxemia, and other complications were among those documented. Numerous other risk factors have been found in studies, including COPD, smoking history, lung infection history, obesity, OSA, nature and duration of operation, anaesthetic hazards, etc. [3, 4]. 90% of all anaesthetized patients typically have atelectasis, which develops in the basal region of the lung. Basal atelectasis can develop regardless of the anaesthesia technique, the anaesthetic agent used, or whether the patient is breathing independently or is paralysed and receiving mechanical ventilation. In a supine position, atelectasis is more likely to occur in the basal portion of the lung tissue than the apex. In

contrast to other procedures, cardiac surgery with cardiopulmonary bypass frequently results in atelectasis. There are many potential causes of pulmonary atelectasis, which have been grouped into the following processes (Fig 1)[5,6].

Previous research on post-operative pulmonary issues following abdominal procedures revealed various occurrence rates, complexities, and potential risk factors, each of which is unique to its setting and may change depending on context. The current study seeks to investigate PPC's prevalence, characteristics, and outcomes with the expectation of producing results unique to our environment. Our hospital provides tertiary care; thus, there are enough patients and investigations available to meet the goals of the study.

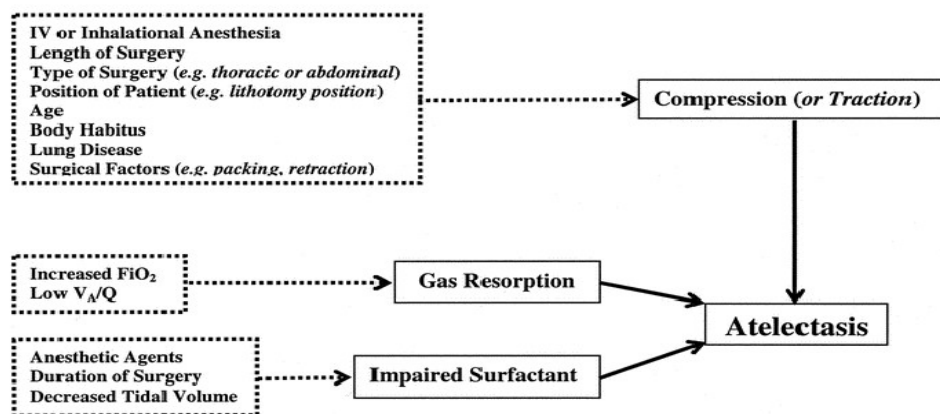


Figure 1: Showing various factors contributing to post operative atelectasis

Materials and Methods

The patients for this cross-sectional observational study were chosen from the general surgery department at Anil Neerukonda Hospital, affiliated with NRI Institute of Medical Sciences in Vishakhapatnam, India. The patients who were hospitalised with abdominal complaints and required surgery, either electively or urgently, were included in the study. Fifty patients were chosen based on the inclusion and exclusion criteria. Their comprehensive clinical histories including the respiratory system, smoking history, prior lung disorders like bronchial asthma, Chronic obstructive pulmonary disease (COPD), pneumonia, and pleural effusion were recorded.

In accordance with hospital procedures, patients must have an electrocardiogram (ECG), a full blood count, and a chest X-ray. Along with these, we also included sputum tests, chest ultrasounds, and information about the surgery, such as nature and duration of surgery (as a dichotomous variable, either 210 minutes or >210 minutes), type of

abdominal incision, any anaesthetic complications, and the type of abdominal incision. The duration of our study was over a period of two years, and our inclusion and exclusion criteria were as follows:

Inclusion Criteria

Patients were considered for inclusion in the study if they were older than 18 years old, were determined to be healthy enough for surgery based on preoperative evaluations, and were later determined to have post-operative pulmonary complications based on productive cough, pyrexia, respiratory distress, physical chest signs, and chest x-ray findings.

Exclusion Criteria

1. Patients with severe co-morbidities and requiring emergency surgical intervention
2. Patients undergoing abdominal surgery who developed cardiovascular complications following surgery.

Statistical Analysis: R Studio was used as the Integrated Development Environment (IDE) for the

statistical analysis, which was done using the R language[7]. Summary Tools [8] and gmodels [9] are R language packages that were used. Descriptive analysis was used to determine frequencies and percentages. The Chi-square test was used in inferential analysis to determine whether there was a relationship between the dependent and independent variables. A p-value of less than 0.05

was deemed significant for the study's statistical purposes.

Results

The study comprised fifty patients having abdominal surgery at the NRI Institute of Medical Sciences in Visakhapatnam. The socio-demographic characteristics of our research are presented in Table 1:

Table 1: The socio-demographic characteristics of this study

S.No	Variables	Attributes	Frequencies	Percentages
	Age	35 to 47 yrs.	25	50%
		48 to 60 yrs.	25	50%
	Sex	Male	25	50%
		Female	25	50%
	Smoking status	Smoker	23	46%
		Non-smoker	27	54%
	Lung disease	Bronchial asthma	12	24%
		Bronchitis	9	18%
		COPD	10	20%
		Nil	19	38%
	Type of incision	High	24	48%
		Low	26	52%
	Duration of surgery	<210 minutes	19	38%
		> 210 minutes	31	62%
	Lung Complications	Present	15	30%
		Absent	35	70%

The following post-operative pulmonary complications were identified in the sample:

1. Atelectasis.
2. Pneumonia.
3. Pleural effusion.
4. Respiratory failure.

Out of 50 patients undergoing abdominal surgeries, 15 patients developed post-operative pulmonary complications as demonstrated in Figure 2.

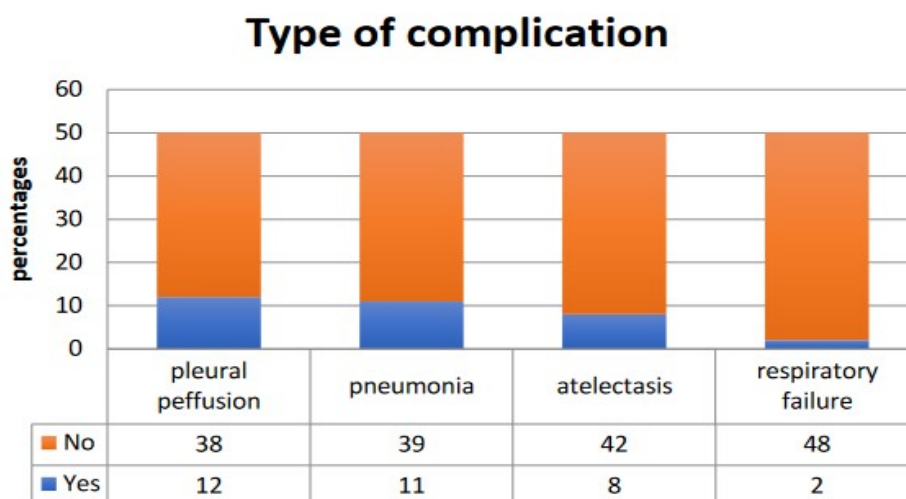


Figure 2: A stacked bar chart showing the sample's number of patients with pulmonary complications following abdominal surgeries

In the sample of 50 patients, 15 patients were affected with pulmonary complications in an overlapped manner, as shown in Table 2.

Table 2: The rates of different pulmonary complications observed in the post-operative period of abdominal surgeries. (Study group consists of 50 patients)

	Total number of complications	Specific Complications	Percentages
Pleural effusion	15	12	24%
Pneumonia	15	11	22%
Atelectasis	15	8	16%
Respiratory failure	15	2	4%

Table 3: Association of age with pulmonary complications of abdominal surgeries

Age	Total patients	Number of Complications	%	p-value
<50	30	5	10	0.027*
>50	20	10	20	

A correlation exists between age and complications. As demonstrated in Table 3, the Chi-square test was run, with a result of 4.86, 1 degree of freedom, and a p-value of 0.027.

Table 4: Association of sex with pulmonary complications

Sex	Total patients	No. of persons with complications	%	p-value
Male	25	8	16	0.757
Female	25	7	14	

The observation in Table 4 indicates that males had slightly more complications than females, but this difference was not statistically significant. Males may have more predisposing risk factors for pulmonary complications than females, including smoking, alcoholism, and other co-morbidities.

Table 5: Association of type of abdominal incisions with post-operative pulmonary complications (p-value < 0.05).

Type of incision	Total patients	No. of persons with complications	%	p-value
High	22	13	26	0.001*
Low	28	2	4	

According to the findings in Table 5, pulmonary problems and the type of incision are related. The likelihood of pulmonary problems is increased by high incision (p-value less than 0.001).

Table 6: Association of smoking with post-operative pulmonary complications following abdominal surgeries (p-value < 0.05).

Category	Total patients	No. of persons with complications	%	p-value
Smokers	23	12	24	0.004*
Non smokers	27	3	6	

As demonstrated in Table 6, both current and ex-smokers were included in the smokers group for the study. Smoking is significantly linked to the development of pulmonary complications.

Table 7: Association of pre-existing lung diseases with post-operative pulmonary complications following abdominal surgeries (P value < 0.05).

Presence of lung disease	Total patients	Number of Complications	%	p-value
Yes	31	13	26	0.004*
No	19	2	4	

The post-operative pulmonary lung problems are related to the presence of lung disease. As demonstrated in Table 7, post-operative lung problems were more likely for those who had previously had lung disease.

Table 8: Association of duration of surgeries with the development of PPCs (P value < 0.05)

Duration of surgery	Total patients	Persons with complications	%	p-value
<210 minutes	19	4	8	0.043*
>210 minutes	31	11	22	

The length of the surgery has a significant impact on the development of PPCs as shown in Table 8. There were higher odds of developing PPCs when the procedure lasted more than 210 minutes, which is statistically significant (p=0.043).

Table 9: Showing different pulmonary complications

	Complications	No of patients	% of Total Patients
1	Pleural effusion only	2	4%
2	Pneumonia only	1	2%
3	Pleural effusion + Pneumonia	4	8%
4	Atelectasis only	2	4%
5	Pleural effusion+ Atelectasis + Pneumonia	6	12%
	Total	15	30%

Regarding the post-operative pulmonary problems, patients' presentations often overlap. For instance, 20% of patients had both pleural effusion and pneumonia, as demonstrated in Table 9 (row 3 and 5), whereas 12% had atelectasis and pleural effusion. Similarly, Figure 3 demonstrates % of both individual and overlapping complications among the 15 patients.

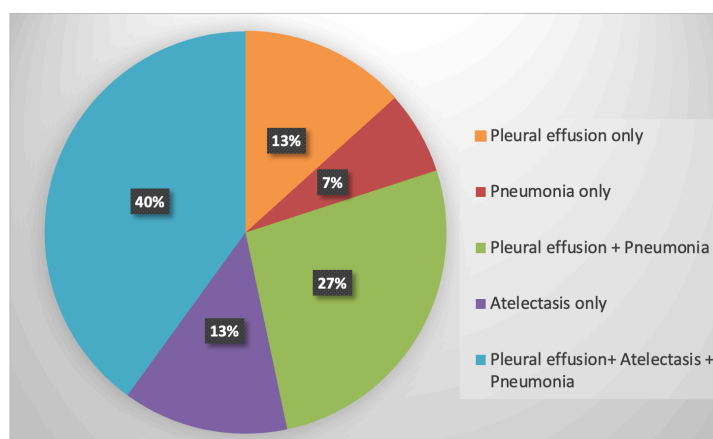


Figure 3: Total complications (individual and overlapping)

Table 10: Association of type of surgery, type of incision & duration with post-operative pulmonary complications

SNo	Type of surgery	Type of incision	Duration of surgery	No. of persons with complications			
				Atelectasis	Pneumonia	Pleural effusion	Respiratory failure
	Cholecystectomy	Upper abdominal	<210 Minutes	02	02	03	01
	Splenectomy	Upper abdominal	>210 Minutes	02	02	02	01
	Exploratory laparotomy	Upper abdominal	>210 Minutes	06	05	05	00
	Hollow viscus perforation	Upper abdominal	>210 Minutes	04	03	03	00
	Pseudopancreatic cystectomy	Upper abdominal	>210 Minutes	01	01	01	00
	Appendectomy	Lower abdominal	<210 Minutes	01	01	00	00
	Hernioplasty	Lower abdominal	<210 Minutes	01	01	00	00
	Colonic resection	Lower abdominal	>210 Minutes	01	01	01	01
	Abdominal hysterectomy	Lower abdominal	>210 Minutes	01	01	01	00
	Myomectomy	Lower abdominal	<210 Minutes	01	00	01	00
	Total			20	17	01	03

The data represented in table 10, gives an overview of association of type, duration of surgery and type of incision with the specific complications in detail.

Discussion

50 individuals who had various abdominal procedures were included in this cross-sectional observational study. The current study aimed to determine the probability or incidence of PPCs in our context using clinical characteristics based on earlier research. Of the fifty patients, the incidence of PPCs was 30% (15/50). Pleural effusion occurred in 12 patients (24%), pneumonia in 11, atelectasis in 8, and pulmonary failure in 2 individuals (4%),

among other problems. The presence of chronic obstructive pulmonary disease, advanced age, upper abdominal surgery, longer length of surgery, positive smoking history, and obesity are the key variables linked to PPCs in the current study. Age (more than 50 years, p=0.027), incision type (p=0.001), smoking status (p=0.004), lung condition (p=0.004), and surgical length (more than 210 minutes, p=0.0043) all have a statistically significant correlation. The gender of the patients

and the problems did not significantly correlate. Results of our study were compared with the data available from other previous studies in this research field.

In order to investigate the occurrence of pulmonary problems following both thoracic and abdominal procedures, Tadyanemhandu et al. [10] undertook a study in Zimbabwe. In their study PPCs affected 92 patients, or 42% of the population. Pneumonia (34%, including nosocomial and ventilator related), followed by atelectasis (6.5%), was the most frequent complication recorded. Males made up the majority of those who experienced complications (66%); however, it was noticed that there was no statistically significant connection to PPC development. The risk variables have been separated into patient-related and surgery-related categories. Patient-related variables were length of critical care stay, length of inpatient stay, co-morbid disease, and cancer-like disease. Surgery-related terms included incision length and type.

McAlister et al [11] (2015) carried out a prospective cohort research in Canada to ascertain the non-thoracic post-operative complications. Over the course of 28 months, they enrolled 1055 consecutive patients. The number of male and female patients was similar, and 28 individuals (or 2.7%) experienced pulmonary problems within a week of surgery. Nine of them had pneumonia, five of them had atelectasis, and 13 of them had respiratory failure. Only 92 patients, or 9% of their sample, had upper abdominal surgery. Higher age (more than 65 years, odds ratio of 5.9, $p = 0.001$), positive history of smoking (more than 40 pack years, $p = 0.03$), duration of anaesthesia (more than 2.5 hours, odds ratio of 3.3, $p = 0.001$), upper abdominal incision ($p = 0.002$), and lung parameters like FEV1 1L ($p = 0.05$), FVC ($p = 0.02$), and FEV1/FVC ($p = 0.001$) were all significantly associated.

In order to investigate the prevalence and risk variables related to post-operative respiratory problems among patients following non-cardiac procedures in China, 1673 patients participated in a multicenter observational study by Jin et al. [12] in 2015. They saw 237 PPC episodes in 9.7% (163 patients) of the sample. They noted that among them, 1.8% had respiratory failure (30 patients), 2.9% had bronchospasm (48 patients), 0.4% had pleural effusion (7 patients), 7.8% had pneumonia (131 patients), and 1.1% had atelectasis (19 patients). These were most frequently seen (40.4%) after thoracic surgery, then upper abdominal surgery. Statistically speaking, those with PPC had a greater mortality rate than those without PPC ($p = 0.001$), at 1.84% (3 out of 163 patients). The factors contributing to the development of PPC included older age (more than 60 years, $p = 0.001$), smoking, lung infection within the past month, co-morbid

conditions like diabetes mellitus, COPD, cirrhosis, abdominal surgery, and surgery that lasted longer than three hours. They arrived at three independent predictors of risk factors for the formation of PPCs based on the findings: recent abdominal surgery (OR 2.88, 95% CI [1.49, 5.59]), smoking (OR 2.37, 95% CI [1.27, 4.42]), and recent lung infection (OR 7.03, 95% CI [1.66, 29.80]).

A different investigation was carried out in 2016 by Kim TH et al. [13] in Korea to assess pulmonary consequences in patients with mild to moderate COPD after abdominal operations. Of them, 10.6% (41 patients) received emergency surgery, the remaining patients got elective surgery, and 71% of the surgeries were on the upper abdomen. PPCs occurred in 16.3% of patients (387 out of 487). They found that the most common consequences were 6.5% pulmonary oedema, 4.9% atelectasis, 8.3% pneumonia, and 0.5% pulmonary embolism. In 0.3% of the sample, they discovered COPD in acute exacerbation. They found no connection between PPCs and mild to moderate COPD. Increased risk of PPC was linked to conducting emergency surgery (OR= 3.93, 95% CI[1.75, 8.82], $p = 0.001$), receiving blood transfusions (OR= 1.09, 95% CI[1.05, 1.14], $p = 0.008$), and having a past history of inpatient stays for pulmonary disease (OR= 4.20, 95% CI[1.52, 11.59], $p = 0.012$). In their study, individuals with reduced BMI ($p = 0.049$), poor ASA status ($p = 0.001$), co-morbidities ($p = 0.001$), increased blood urea nitrogen ($p = 0.001$), elevated creatinine ($p = 0.009$), and prolonged duration of anaesthesia ($p = 0.001$) had a higher likelihood of developing PPCs. They used greater mortality (11.1% versus 0.6%) and longer hospital stays, assistance for mechanical ventilators, ICU admission, as outcome measures, in patients with PPC.

Kiran M. et al.[14] carried out a cross-sectional observational study in 2018 in India to assess the prevalence of post-operative pulmonary problems following abdominal surgery. A total of 100 patients had abdominal procedures, and the most frequent problems they saw were atelectasis (74%), pleural effusion (62%), pneumonia (62%), and respiratory failure (11%). In their study, problems occurred 27% of the time overall. Age (more than 50 years, $p = 0.05$), male gender, higher abdominal incision, smoking, presence of co-morbid illnesses (such as COPD and bronchial asthma), and operation length (more than 210 minutes) were all found to be significantly correlated. The following factors were included in a logistic regression for PPC: a history of underlying lung disease ($p = 0.0001$), the presence of respiratory symptoms ($p = 0.0001$), co-morbidity ($p = 0.007$), patients older than 50 years ($p = 0.03$), a surgery lasting more than 210 minutes ($p = 0.03$), a history of smoking ($p = 0.04$), and obesity ($p = 0.10$). They concluded that the occurrence of

PPCs is substantially correlated with the presence of an underlying chronic pulmonary illness, especially if the patient underwent surgery that lasted more than 210 minutes and had an underlying respiratory ailment.

Conclusion

30% of abdominal procedures resulted in post-operative respiratory complications, with pleural effusion being the most frequent (24%) followed by pneumonia (22%) and atelectasis (16%), with respiratory failure being the least common (4%). Because there is a complex interplay of underlying pathogenic mechanisms that facilitate one another, these difficulties happened in combination rather than as distinct ones. In patients who are elderly, have pre-existing lung disorders, have a history of smoking, have longer surgeries, or have large abdominal incisions, where most PPC are seen in the current study, post-operative pulmonary problems should be expected. Robust perioperative care, such as incentive spirometry, coughing, deep breathing, dental care, and head of bed elevation, should be implemented to reduce PPCs, especially pneumonia, which increases morbidity and mortality and costs more money.

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