Section: Miscellaneous

Original Research Article

# A STUDY ON FACTORS ASSOCIATED WITH POSTOPERATIVE PULMONARY COMPLICATIONS FOLLOWING THORACIC SURGERIES

***Karthik Adiga B[1], Chirag K C[2], Vijayalakshmi[3]***

*[1]Assistant Professor, Department of Pulmonary Medicine, SDS TRC and Rajiv Gandhi Institute of Chest Diseases, Bengaluru, Karnataka India.*
*[2,3]Assistant Professor, Department of Respiratory Medicine, Adichunchanagiri Institute of Medical Sciences, B G Nagara, Mandya, Karnataka India.*

***Received*** *: 04/01/2025*
***Received in revised form*** *: 04/03/2025*
***Accepted*** *: 20/03/2025*

**Corresponding Author:**
**Dr. Chirag K C,**
Assistant Professor, Department of Respiratory Medicine, Adichunchanagiri Institute of Medical Sciences, B G Nagara, Mandya, Karnataka India.
Email: chiragkc23@gmail.com

**DOI:** 10.70034/ijmedph.2025.2.69

**Source of Support:** Nil,
**Conflict of Interest:** None declared

**Int J Med Pub Health**
2025; 15 (2); 382-388

## ABSTRACT

**Background:** Post-operative pulmonary complications encompasses almost any complication occurring in the respiratory system following anaesthesia and surgery. The respiratory system takes upto 6weeks to return to its pre-operative state following general anaesthesia and major surgeries. Post-operative pulmonary complications are as prevalent as cardiac complications and contribute equally to morbidity, mortality and length of hospital stay.
**Objective:** To study of pre-operative hematological abnormalities and its effects on post-operative pulmonary complications following thoracic surgeries.
**Materials and Methods:** This Hospital based Prospective Observational Study was conducted at the Department of Pulmonary Medicine and Department of Cardio- Thoracic Surgery in Victoria Hospital, Bangalore Medical College and Research Institute (BMCRI), Bangalore.
**Results:** Postoperative pulmonary complications were seen in 20.5% of patients (16/78). The following factors were statistically significant in patients who developed postoperative pulmonary complications, when compared to 'No complications' group:

a. ASA Class > II (p= 0.023)
b. Lower Body Weight (Mean = 50.06±7.9kg, p = 0.038)
c. Lower BMI (Mean :19.82±2.48 kg/m2, p = 0.024)
d. Lower Pre-operative SpO2 (Mean = 94.94±3.34 %, p= 0.023)
e. Preoperative Tachycardia (Mean: 107.06±20.5 bpm, p = 0.044)
f. Lower pre-operative Systolic blood pressure (SBP Mean: 109.63±11.3 mmHg)
g. Pre-operative Anemia Mean Hemoglobin = 10.03±2.2g%, p = <0.001)
h. Elevated WBC counts (TLC = 12479.31±6272.57 cells/ cumm, p = 0.028)
i. Lower Serum Albumin levels (Mean = 3±0.86 g/dL, p= 0.001)
j. Smokers who quit smoking within 8weeks of Surgery (p = 0.003)

**Conclusion:** We conclude in our study that Multiple factors, which include, ASA Class > II, Lower BMI, Lower Body weight, Lower SBP, Lower Hemoglobin, Lower Serum Albumin levels and elevated WBC counts are statistically significant in the development of POPCs.
**Keywords:** Thoracic Surgery. Post-operative pulmonary Complications, Elevated WBC counts, Serum Albumin levels.

## INTRODUCTION

The post-operative care of any patient who undergoes pulmonary resection depends on three main factors – the patient selection, nature of the procedure and post-operative care. Post- operative care mainly focuses on timing of extubation, use of supplemental oxygen, judicious use of antibiotics, fluid and electrolyte management, radiographic monitoring and use and removal of chest tubes.[1]

There have been important advances in the selection and postoperative care of the lung resection patient. Postoperative analgesia with epidural catheters or patient controlled delivery devices has substantially reduced surgical pain. Vigorous pulmonary toilet exercises are used more routinely and frequently. Experience in lung volume reduction surgery and lung transplantation has increased our knowledge of how to treat critically ill patients with end-stage emphysema. There have also been changes in the way in which lung resection operations are performed. The use of muscle-sparing thoracotomy reduces post thoracotomy pain, retains shoulder girdle muscle strength, and may permit improved spirometric function in the early postoperative period compared with a standard lateral thoracotomy. Further improvements such as these may be evident with additional experience using thoracoscopic lung resection techniques. At the present time, the risk of postoperative pulmonary complications in the candidate for lung resection are evaluated with age and performance status during the initial history and physical examination and confirmed by laboratory and spirometric parameters. Despite thoughtful patient selection, meticulous intra-operative techniques and hypervigilant post-operative care, post-operative pulmonary complications are common. The five major categories of pulmonary complications include – Atelectasis, Infections, Exacerbation of underlying chronic lung disease, prolonged mechanical ventilation and respiratory failure, thromboembolic diseases.

As there are limited number of studies regarding the post-operative pulmonary complications especially following thoracic surgeries in India, this study is intended to study on pre-operative hematological abnormalities and its effects on post-operative pulmonary complications following thoracic surgeries.

## MATERIALS AND METHODS

This Hospital based Prospective Observational Study was conducted at the Department of Pulmonary Medicine and Department of Cardio-Thoracic Surgery in Victoria Hospital, Bangalore Medical College and Research Institute (BMCRI), Bangalore. Patients who underwent elective Thoracic surgeries in the Department of Cardio-Thoracic Surgery in Victoria Hospital, Bangalore Medical College and Research Institute (BMCRI), Bangalore were enrolled for the study. Duration of study was 18 months.

**Sample size:** 78 patients.

**Inclusion Criteria**

1. Age more than 18 years.
2. Patients willing to give written informed consent in their own understandable language.
3. Patients undergoing elective Thoracic Surgeries after pre-operative evaluation.
4. Patients undergoing elective Thoracic Surgeries under General, Neuraxial, Regional Anaesthesia.

**Exclusion Criteria**

1. Patients undergoing emergency thoracic surgeries.
2. Patients who required pre-operative endotracheal intubation.
3. Outpatient procedures, defined as those requiring less than 1-day stay for a patient alive at discharge.
4. Procedures where only Local, Peripheral nerve anaesthesia are used.
5. Patients requiring repeat or undergoing second thoracic surgery.
6. Patients not willing to give written informed consent.

Patients who underwent elective thoracic surgeries, meeting the inclusion criteria were enrolled after taking a written informed consent and then they were assessed a day before surgery and monitored for seven days after surgery.

**Pre-operatively patients were assessed by**

- Demographic data
- Brief Clinical history
- Smoking History
- Co-morbid conditions
- American Society of Anesthesiologists (ASA) grading
- Anthropometric measurements
- Chest Radiography and Computerized Tomography (if indicated)
- Arterial Blood gas Analysis
- Echocardiography
- Laboratory Investigations: Complete Blood counts, Blood Urea and Serum Creatinine levels, Liver function tests, Random Blood Sugar level.

If both acceptability and reproducibility criteria are met, the test can be concluded. If not manoeuvres should be repeated until either criteria are met or the patient is Unable to continue. A maximum of eight attempts is recommended. In the case of results which are acceptable but not reproducible, the largest of the acceptable measurements should be reported along with the comment that reproducibility criteria were not met.

Intra-operative factors that were considered were –

- Type of Procedure
- Type of Anaesthesia
- Duration of Surgery

- Need for Blood transfusion
- Need for Post-operative Non-invasive ventilation or Invasive mechanical ventilation.

Post-operatively patients were monitored for a period of 7 days following surgery by Clinical examination, Chest radiography and Blood tests as needed. Complications were defined as per the EPCO and other guidelines for Postoperative pulmonary complications as mentioned below.

Complications were classified as

- Immediate (0-6hours),
- Early (6-72 hours),
- Late (>72 hours) complications.

Statistical Analysis: All the data were collected and systematically entered in MS Excel spread sheet and data analysis was done using SPSS software version 22. The data collected was statistically analyzed using descriptive statistics namely, mean, standard deviations and percentage, wherever applicable. Chi Square test and Student's t test were applied to determine significant difference between two groups. The values obtained were considered significant if, p value <0.05.

## RESULTS

In our study, Among the 78 patients, Males were 56% (n=44) and Females were 44% (n=34). 35% (n=27) of the patients were from Urban areas and 65% (n=51) were from Rural areas. However, there were no statistically significant differences in the occurrence of Post-operative pulmonary complications on the basis of gender or demographic basis. Majority of the patients were of the age group between 21-50 years. 6.4% (n=5) of patients were less than 20 years of age, 23% (n=18) of patients were between 21-30 years, 23% (n=18) of patients were aged 31-40 years, 23% (n=18) of patients were of the 41-50-year age group and 10.2% (n= 8) of patients were above 60 years of age. However, there were no statistically significant differences in the occurrence of Post-Operative Pulmonary com various age groups (Chi-Square Test; p=0.034).

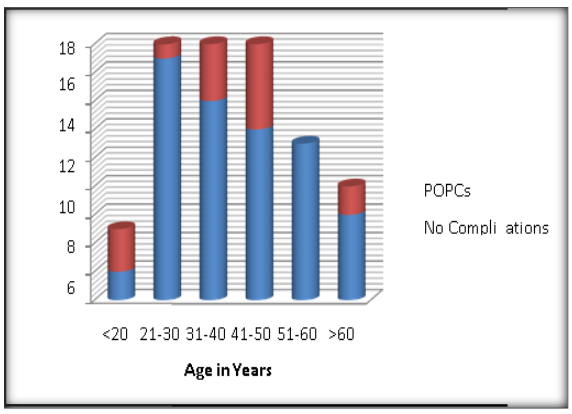


**Figure 1: Age distribution of Patients**

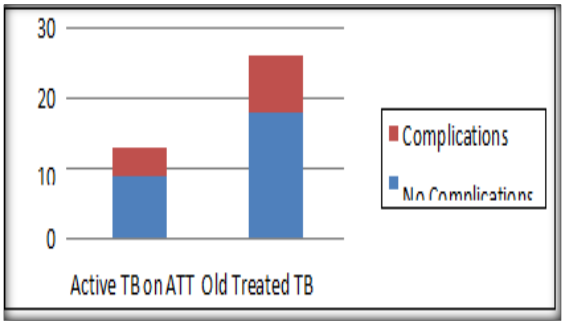


**Figure 2: History of Tuberculosis among Patients who underwent Thoracic Surgeries**

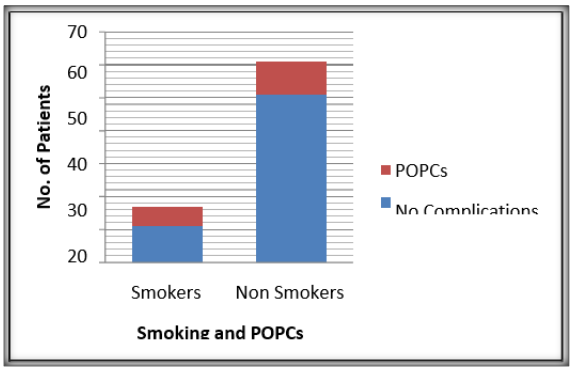


**Figure 3: POPCs among Smokers and Non smokers.**

Among 17 smokers (21.8%), were 12 Beedi smokers and 5 were Cigarette smokers. Among 17 patients who were smokers, 6 patients developed POPCs, however occurrence of POPCs in those with history of smoking beedi/cigarettes was not statistically significant at p value of 0.05 in our study (p = 0.088). Also, among 17 patients, 11 patients had quit smoking. There was significantly higher incidence of POPCs among smokers who quit smoking within 8 weeks prior to surgery, in our study (p=0.03). 8 patients had history of Tobacco chewing, among which 2 patients developed POPCs, which was however not statistically significant (p = 0.740).

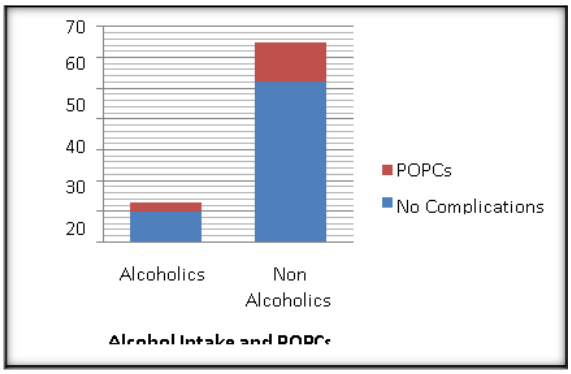


**Figure 4: Alcohol intake and POPCs**

In our study, we found that among 78 patients, 16% (n=13) of patients had history of Alcohol intake and there was no statistically significant differences in the development of POPCs among those who had history of Alcohol intake and Non alcoholics.

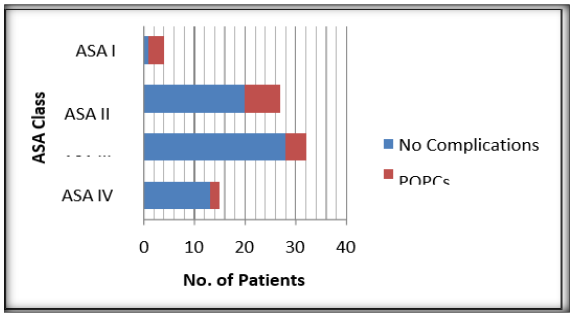


**Figure 5: ASA Class of Patients who underwent Thoracic Surgeries**

ASA class of more than II was significantly associated with higher POPCs with a 'p' value of 0.023. 2 among 15 patients with ASA Class I had POPCs, 4 out of 32 patients of ASA Class II had POPCs, 7 patients of the 27 patients with ASA Class III had POPCs, while 3 of the 4 patients with ASA Class IV developed POPCs.

Anthropometric measurements associated with higher risk of like lower body Weight and Body Mass Index (BMI) were development of Post-operative pulmonary complications. The Mean body weight of patients who developed POPCs (Mean: 50.06±7.9 Kg) was significantly lower than in patients of 'No complications' group. Lower BMI (Mean :19.82±2.48 Kg/m2) was observed in patients who developed POPCs compared to the 'No complications' group. However, there was no significant difference in Height among patients of POPC group and 'No complications' group.

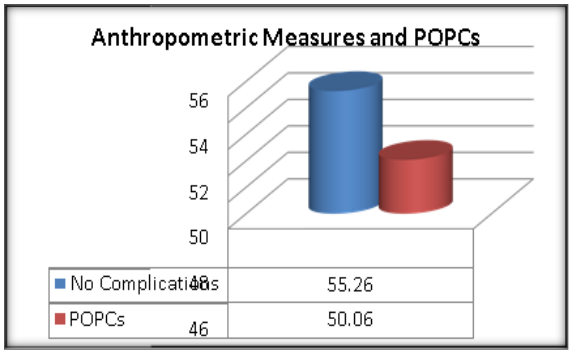


**Figure 6: Anthropometric Measures – Weight and POPCs**

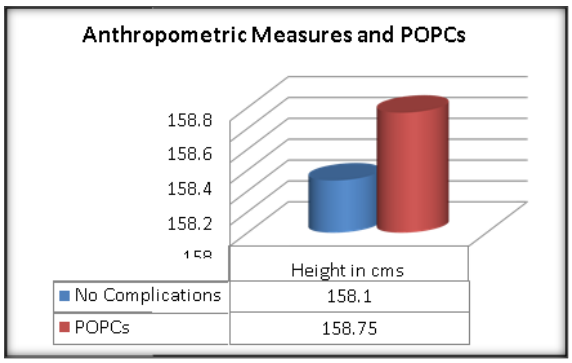


**Figure 7: Anthropometric Measures – Height and POPCs**

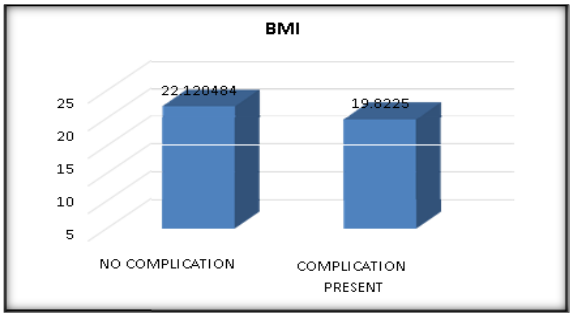


**Figure 8: BMI and POPCs**

Patients presented with varied complaints, most common symptom being Cough (n=47; 60.3%) followed by Dyspnea (n=38, 48.7%) , Chest Pain (n= 31 , 39.7%) , Expectoration (n=29 , 37.2%) , Hemoptysis (n=24 , 30.8%) , Fever (n=12; 15.4%) and others sypmtoms such as vomiting and abdominal pain (n=10 , 12.8%). The average duration of presentation was 67.16±102.53 weeks in those without POPCs, and 174.5±232.19 weeks in those with POPCs. However this was not statistically significant at p value of 0.05 (Independent 't' Test, p = 0.089).

19 patients were Diabetics (24.4%) ,6 were hypertensives (7.7%), 9 had history of Obstructive airway disease like COPD/ Post Tubercular obstructive airway disease (11.5%) and 4 patients had history of previous surgeries (5.1%), however none of these co-morbid conditions were statistically significant in causing a POPC.

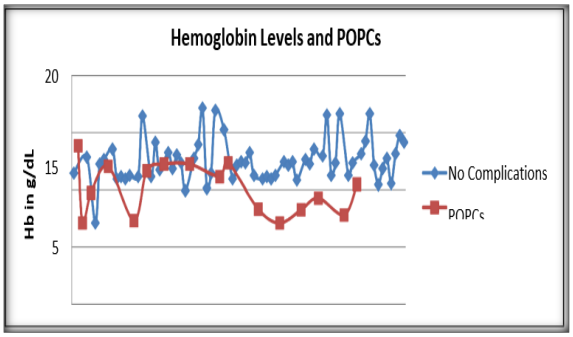


**Figure 9: Hemoglobin levels and POPCs**

In our study, we found that Mean Hemoglobin was lower in patients who developed POPCs (Mean Hb: 10.03±2.2 g/dL) than in the 'No Complications' group (Mean :12.49±1.89 g/dL).

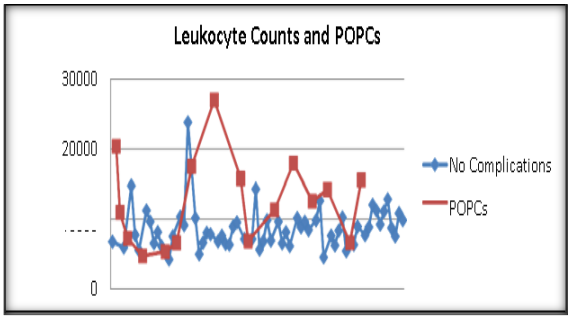


**Figure 10: WBC counts and POPCs**

Also, Higher Total Leukocyte counts were noted in the 'Complications' group (Mean TLC: 12479.31±6272.57 cells/cumm) compared to the 'No complications' group (Mean: 8610.85±2983.66 cells/cumm).

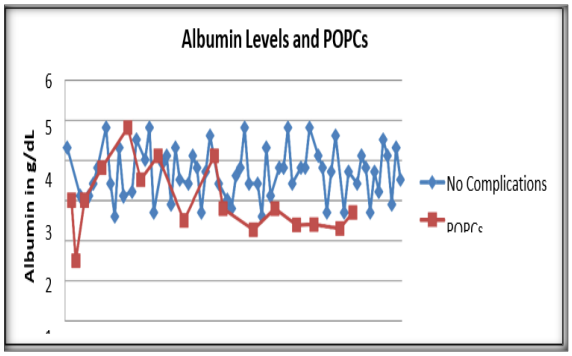


**Figure 11: Serum Albumin levels and POPCs**

Serum Albumin levels were lower in 'Complications' group (Mean S. Albumin: 3±0.86 g/dL) as compared to 'No complications' group (Mean: 3±0.86). Platelet counts, RBC Counts, Differential counts, Renal Functions, Blood Sugars did not have any statistically significant differences among the POPC and 'No complications' group. The Mean Ejection Fraction was 59.47±1.41 in patients who developed POPCs and 59.56±2.63 in 'No complications' group. Mean PASP was 33.25 ± 3.317 mmHg in POPC group and 35.645 ± 4.743 mmHg in 'No complications' group. 3 patients had Concentric Left ventricular hypertrophy, 2 patients had Hypertensive Heart disease, 1 patient had Mild to Moderate Pericardial Effusion. 15 patients had mild valvular defects of which: 7 patients had Sclerotic Aortic Valve, 5 patients had Mild Tricuspid regurgitation ,1 patient had Tricuspid Valve prolapse, 2 patients had Mild Mitral regurgitation. However none of these findings were significant risk factor for the development of POPCs

**Table 1: ASA Class of Patients who underwent Thoracic Surgeries**

| POPCs according to ASA Class | | | | |
|---|---|---|---|---|
| | | COMPLICATIONS | | Total |
| | | NO COMPLICATION | POPCs PRESENT | |
| ASA Class | I | 13 | 2 | 15 |
| | II | 28 | 4 | 32 |
| | III | 20 | 7 | 27 |
| | IV | 1 | 3 | 4 |
| **Total** | | **62** | **16** | **78** |

| Chi-Square Test | | | |
|---|---|---|---|
| | Value | df | P value (<0.05 is significant) |
| Pearson Chi-Square | 9.503 | 3 | **0.023** |

**Table 2: Physical Examination findings and POPCs**

| Physical Examination findings and POPCs | No Complication(n=62) | Complication Present(n=16) | t | p value |
|---|---|---|---|---|
| **Independent 't' Test** | **Mean ± SD** | **Mean ± SD** | | |
| Weight (in kg) | 55.26±8.96 | 50.06±7.9 | 2.115 | **0.038** |
| Height (in cm) | 158.1±6.72 | 158.75±7.31 | -0.341 | 0.734 |
| BMI (kg/m$^2$) | 22.12±3.79 | 19.82±2.48 | 2.298 | **0.024** |
| $SpO_2$ (%) | 96.6±2.31 | 94.94±3.34 | 2.326 | **0.023** |
| Pulse Rate | 97.32±15.99 | 107.06±20.5 | -2.046 | **0.044** |
| Blood Pressure (Systolic) (mmHg) | 118.53±13.72 | 109.63±11.3 | 2.393 | **0.019** |
| Blood Pressure (Diastolic) (mmHg) | 75.16±7.86 | 73.88±7.1 | 0.594 | 0.554 |

| Physical Examination findings and POPCs | No Complication(n=62) | Complication Present(n=16) | t | p value |
|---|---|---|---|---|
| **Independent 't' Test** | **Mean ± SD** | **Mean ± SD** | | |
| Weight (in kg) | 55.26±8.96 | 50.06±7.9 | 2.115 | **0.038** |
| Height (in cm) | 158.1±6.72 | 158.75±7.31 | -0.341 | 0.734 |
| BMI (kg/m$^2$) | 22.12±3.79 | 19.82±2.48 | 2.298 | **0.024** |
| SpO2 (%) | 96.6±2.31 | 94.94±3.34 | 2.326 | 0.023 |
| Pulse Rate | | | | |
| Blood Pressure (Systolic) (mmHg) | | | | |
| Blood Pressure (Diastolic) (mmHg) | | | | |

**Table 3: Laboratory Parameters and POPCs**

| Laboratory Parameters and POPCs | No Complication(n=62) | Complication Present(n=16) | t | p value |
|---|---|---|---|---|
| **Independent 't' Test** | **Mean ± SD** | **Mean ± SD** | | |
| **HEMATOLOGY** | | | | |
| Hemoglobin (g%) | 12.49±1.89 | 10.03±2.2 | 4.471 | **<0.001** |
| TLC (cells/cumm) | 8610.85±2983.66 | 12479.31±6272.57 | -2.398 | **0.028** |
| RBC (million cells /cumm) | 4.51±0.74 | 4.06±1.78 | 0.985 | 0.339 |
| Platelets (lakh cells/cumm) | 3.19±1.11 | 3.35±0.93 | -0.505 | 0.615 |
| Differential Counts: | | | | |
| Neutrophils | 69.2±12.03 | 75.88±14.39 | -1.896 | 0.062 |
| Lymphocytes | 21.38±11.37 | 17.81±11.23 | 1.119 | 0.267 |
| Eosinophils | 2.49±2.07 | 1.25±0.93 | 3.504 | 0.051 |
| Monocytes | 5.74±2.74 | 4.56±3.65 | 1.419 | 0.16 |
| **RENAL FUNCTION TESTS** | | | | |
| Urea (mg/dL) | 23.12±10.78 | 29.03±16.1 | -1.39 | 0.181 |
| Creatinine (mg/dL) | 0.87±0.21 | 0.95±0.35 | -0.859 | 0.402 |
| **Blood Sugars (mg/dL)** | 112.39±45.74 | 137±81.39 | -1.606 | 0.112 |
| **LIVER FUNCTION TESTS** | | | | |
| Total Bilirubin (mg/dL) | 0.71±0.4 | 0.74±0.64 | -0.18 | 0.857 |
| AST/SGOT (IU/L) | 22.79±9.22 | 21.85±10.43 | 0.354 | 0.724 |
| ALT/SGPT (IU/L) | 22.11±12.99 | 17.42±13.12 | 1.286 | 0.202 |
| ALP (IU/L) | 86.61±24.76 | 99.16±34.73 | -1.358 | 0.19 |
| Total Protein (g/dL) | 6.66±1.02 | 6.09±1.27 | 1.884 | 0.063 |
| Albumin (g/dL) | 3.68±0.63 | 3±0.86 | 3.55 | **0.001** |
| Globulin (g/dL) | 2.97±0.78 | 3.1±0.87 | -0.561 | 0.577 |

## DISCUSSION

General anaesthesia and surgical procedures affect the respiratory system negatively after thoracic surgical procedures. Decreased diaphragmatic activity and ventilatory response causes decreased lung volumes. These may lead to alveolar collapse, early closing of airways, ventilation/perfusion imbalance, decrease in mucus clearance and increase in bacterial colonization. These changes may result in the development of serious pulmonary complications in patients with impaired baseline pulmonary functions and underlying pre-existing medical conditions.

Nutritional status of an individual plays an important role during the post-operative period. BMI of >30kg/m2 is an established risk factor for the development of POPCs, however little is known about POPCs in underweight population. In a study by Wightman et al, they found that underweight patients were at increased risk for postoperative pulmonary and other complications, and such patients may benefit from preoperative nutritional repletion.[2] Similarly, in our study the incidence of POPCs were higher in patients with low BMI and low body weight than the 'No complications' group. (Mean BMI in POPC group :19.82±2.48 kg/m2, p = 0.024) (Mean Body weight in POPCs group = 50.06±7.9kg, p = 0.038). A study by Windsor JA et al, showed that the nutritional state, protein deficiency, low albumin levels, and recent weight loss can induce pulmonary complications. Poor nourishment can reduce respiratory muscle strength, vital capacity, and peak expiratory flow rate, resulting in the development of pneumonia and atelectasis.[3]

According to Canet et al, Preoperative SpO2 at room air a strong patient-related POPC risk factor. They considered it as a highly useful finding because SpO2 is an easily recorded objective measure. SpO2 is a reflection of both respiratory and cardiovascular functional status. Similarly, in our study we found that patients with POPCs had a low pre-operative SpO2 compared to the 'No complications' group (SpO2 Mean = 94.94±3.34 %, p= 0.023).[4]

Tachycardia has been identified as a major cause of perioperative myocardial infarction in the perioperative period. According to Riech D L et al, in prolonged non-cardiac surgeries, tachycardia is an independent predictor of adverse outcome. Similarly, in intensive care patients, prolonged periods of tachycardia were associated with adverse outcomes including cardiac death. Similarly in our study, a the mean pulse rate was higher (Mean: 107.06±20.5, p= 0.044) in patients of POPCs group than in 'No complications' group.[5]

Perioperative Hypotension refers to hypotension occurring on the day prior to surgery and during the first days after surgery. Phillip Hoppe et al, suggested that hypotension after non-cardiac surgery is common, profound, and largely undetected by routine vital monitoring in the general care ward. Hypotension is associated with adverse postoperative outcomes, especially myocardial injury, acute kidney injury, and death. They suggested that individualized blood pressure management reduces the risk of postoperative organ dysfunction compared with usual care. Similarly, in our study we found that preoperative Systolic Blood pressure values were lower (SBP Mean: 109.63±11.3 mmHg) in patients who developed POPCs than in the 'No complications' group.[6]

According to Saager et al., Anemia is an important problem during the perioperative period and is associated with myocardial infarction, decreased

glomerular filtration rate, and congestive heart failure. Furthermore, preoperative anemia puts patients at a higher risk for receiving blood transfusions. Transfusions are associated with numerous serious morbidities such as renal failure, prolonged ventilator support, increased perioperative infection risk, cardiovascular complications, and mortality.[7] Preoperative anemia defined as 'hemoglobin concentration lower than 10 g/dl' raises the risk for POPCs almost three-fold, according to a study by Beattie et al., Also, anemia is a predictor of poor outcome in critical and post-operative patients. Even minimal degrees of anemia are associated with a significant increase in the risk of 30-day postoperative mortality and cardiac events. In agreement to this, we found that the Hemoglobin levels were lower (Mean Hemoglobin = 10.03±2.2g%) in the POPCs group than in the 'No complications' group.[8]

In a study by Brown et al., WBC counts measured prior to surgery is a measure of the patient's inflammatory state and can aid clinicians in identifying patients at higher risk of 30-day readmission after discharge. Similarly, in our study we found that the POPCs were higher in patients with a higher TLC than the no complications group. (Mean TLC = 12479.31±6272.57 cells/ cumm , p = 0.028).[9]

Studies by Nakagawa et al and Kotani et al have reported that recent quitters of smoking may have a higher frequency of complications postoperatively than current smokers. This may be explained by sputum retention, delayed improvement in inflammatory functions and possible reduction in irritant induced coughing. The reduction in the frequency of perioperative complications after smoking cessation may not be seen until a period of abstinence of up to 2 months. In our study we found a significantly higher incidence of POPCs among patients who quit smoking within 8 weeks of undergoing surgery.[10,11]

Even though factors like Advanced age, Smoking, COPD, Duration and type of Surgery, Anesthesia are proven risk factors for development of POPCs; In our study, there was no significant differences in patients who developed POPCs and 'No complications' group on the grounds of these factors.

## CONCLUSION

The following factors were statistically significant among patients who developed complications postoperatively following thoracic surgeries:

a. Lower Body Weight (Mean = 50.06±7.9kg, p = 0.038)
b. Lower BMI (Mean :19.82±2.48 kg/m2, p = 0.024)
c. Lower Pre-operative SpO2 (Mean = 94.94±3.34 %, p= 0.023)
d. Preoperative Tachycardia (Mean: 107.06±20.5 bpm, p = 0.044)
e. Lower pre-operative Systolic blood pressure (SBP Mean: 109.63±11.3 mmHg)
f. Pre-operative Anemia (Mean Hemoglobin = 10.03±2.2g%, p = <0.001)
g. Elevated WBC counts (TLC = 12479.31±6272.57 cells/ cumm, p = 0.028)
h. Lower Serum Albumin levels (Mean = 3±0.86 g/dL, p= 0.001)
i. Smokers who quit smoking within 8weeks of Surgery (p = 0.003)

2. We conclude in our study that Multiple factors, which include quitting smoking within 8 weeks of surgery, ASA Class > II, Lower BMI, Lower Body weight, are statistically significant in the development of POPCs.

## REFERENCES


1. De Lisser H M, Grippi M A. Perioperative Respiartory considerations in the surgical Patient. In: Grippi M A, Elias J A, Fishman J A, Kotloff R M, Pack A I, Senior R M.Fishman's Pulmonary Diseases and Disorders.5thed.Vol 2.USA: McGraw-Hill Education; April 14,2005.p.2012.
2. Wightman SC, Posner MC, Patti MG, Ganai S, Watson S, Prachand V, Ferguson MK. Extremes of body mass index and postoperative complications after esophagectomy. Dis Esophagus 2017 May 1;30(5):1-6.
3. Windsor JA, Hill GL. Risk factors for postoperative pneumonia. The importance of protein depletion. Ann Surg 1988; 208:209–214.
4. Canet J, Gallart L, Gomar C. Prediction of postoperative pulmonary complications in a population-based surgical cohort. Anesthesiology 2010; 113:1338–1350.
5. Reich DL, Bennett-Guerrero E, Bodian CA, Hossain S, Winfree W, Krol M. Intraoperative tachycardia and hypertension are independently associated with adverse outcome in noncardiac surgery of long duration. Anesth Analg 2002; 95:273–7.
6. Hoppe P,Kouz K , Saugel B.Perioperative hypotension: clinical impact, diagnosis, and therapeutic approaches. J Emerg Crit Care Med 2020; 4:8.
7. Saager L, Turan A, Reynolds LF, Dalton JE, Mascha EJ, Kurz A. The association between preoperative anemia and 30-day mortality and morbidity in noncardiac surgical patients. Anesth Analg 2013 Oct;117(4):909-915.
8. Beattie WS, Karkouti K, Wijeysundera DN, Tait G: Risk associated with preoperative anemia in noncardiac surgery: A single-center cohort study. Anesthesiology 2009; 110:574 – 81.
9. Brown, J, Landis R, Chaisson K, Ross C, Dacey L, Boss R. Preoperative White Blood Cell Count and Risk of 30-Day Readmission after Cardiac Surgery. Int J Inflam 2013; 1:1-7.
10. Nakagawa M, Tanaka H, Tsukuma H. Relationship between the duration of the preoperative smoke-free period and the incidence of postoperative pulmonary complications after pulmonary surgery. Chest 2001; 120:705-10.
11. Kotani N, Kushikata T, Hashimoto H. Recovery of intraoperative microbicidal and inflammatory functions of alveolar immune cells after a tobacco smoke-free period. Anesthesiology 2001; 94:999-1006.