



**Indications, Types, and Peri-operative Outcomes of Pulmonary Resections: A
5-Year Retrospective Cross-Sectional Study at Tikur Anbessa Specialized
Hospital, Addis Ababa, Ethiopia**

By

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**ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES,
SCHOOL OF MEDICINE, DEPARTMENT OF SURGERY**

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Declaration

I hereby declare that the thesis is my original work and has not been presented for a degree in any other university. All sources of material used in the document have been duly acknowledged and properly cited.

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The undersigned have examined the thesis report entitled “Indications, Types, and Peri-operative Outcomes of Pulmonary Resections: A 5-Year Retrospective Cross-Sectional Study at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia.” presented by Dr. Abenezer Mekonnen with registration number GSR 2208/15, a candidate for fellowship certificate in Cardiothoracic Surgery and hereby certify that it is worthy of acceptance.

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List acronym /abbreviations

AAU	Addis Ababa University
BMI	Body mass index
COPD	Chronic obstructive pulmonary disease
CHS	College of health sciences
FEV1	Forced Expiratory Volume in 1 second
FVC	Forced Vital Capacity
HIV	Human Immunodeficiency virus
ICU	Intensive care units
LMICs	Low and middle-income countries
LVRS	Lung volume reduction surgery
MDR-TB	Multi-drug resistant TB
MIS	Minimally invasive surgery
NSCLC	Non-small cell lung carcinoma
SCLC	Small cell lung carcinoma
SES	Socio-economic status
SPSS	Statistical package for social science
TASH	Tikur Anbessa Specialized Hospital
TB	Tuberculosis
WHO	World Health Organization
XDR-TB	Extensively drug-resistant TB

Abstract

Background: Pulmonary resections are essential surgical interventions for a range of benign and malignant lung diseases. In Ethiopia, tuberculosis (TB) and HIV remain significant public health challenges, complicating pulmonary disease management. This study aimed to assess the clinical indications, types, and peri-operative outcomes of pulmonary resections performed at Tikur Anbessa Specialized Hospital (TASH) over five years (2020–2024), in a resource-limited, high TB/HIV burden setting.

Methods: A retrospective cross-sectional study was conducted on all patients who underwent pulmonary resection at TASH from 2020 to 2024. Data were collected from surgical logs, medical records, and follow-up contacts. Descriptive statistics, bivariate, and multivariate logistic regression analyses were used to evaluate factors associated with postoperative complications.

Results: A total of 100 patients underwent pulmonary resection, with a male predominance (63%) and a relatively young age profile (35% under 35 years). Lung cancer (35%) was the leading surgical indication, followed by TB-related complications (21%) and aspergilloma (18%). Over time, a trend was observed in which benign and infectious conditions were predominant early on, shifting to lung cancer in 2023 and 2024. Lobectomy (49%) and pneumonectomy (30%) were the most frequently performed procedures, all conducted via open thoracotomy. 95% of patients had no comorbidity and HIV positivity was rare (3%). Postoperative complications occurred in 12% of cases such as primarily infections and prolonged air leaks. Only one postoperative death (1%) was recorded. 62% of the patients were discharged within 8–14 days, and 79% resumed normal activity within one month. Multivariate analysis revealed that a diagnosis of lung cancer was significantly associated with reduced odds of complications (AOR = 0.065; $p = 0.016$).

Conclusion: This study reveals a shifting pattern in pulmonary resection indications from infectious to malignant diseases in Ethiopia. Surgical outcomes were favorable, with low complication and mortality rates despite resource limitations. The findings underscore the growing burden of lung cancer and highlight the need for expanded access to thoracic surgery and improved peri-operative care.

Introduction

Background of the study

The respiratory system is highly vulnerable to a variety of diseases, ranging from infections to neoplastic and obstructive conditions. Pulmonary diseases, if left untreated, can lead to respiratory failure and significantly impair an individual's quality of life. One of the most prevalent and challenging respiratory diseases globally is tuberculosis (TB), which remains a leading cause of morbidity and mortality in low- and middle-income countries, including Ethiopia. The World Health Organization (WHO) places Ethiopia among the top 30 countries with the highest TB burden, contributing significantly to pulmonary morbidity in the region (1). TB typically results in extensive lung damage, including cavitation, fibrosis, and bronchiectasis. These complications, which can arise in cases of active or chronic TB, may necessitate surgical resection when conservative medical treatment fails, especially in cases of multi-drug resistant TB (MDR-TB) or extensively drug-resistant TB (XDR-TB) (2).

Pulmonary resections are critical surgical interventions used to treat a variety of lung pathologies. The goal of these surgeries is to remove damaged or diseased lung tissue to preserve function, alleviate symptoms, and improve survival in cases where other treatments are insufficient. Common indications for pulmonary resections include malignancies, benign lesions, infections, and complications related to chronic diseases. The range of resections can vary from more limited procedures such as wedge resection to more extensive surgeries like pneumonectomy, depending on the extent of the disease. In Ethiopia, a nation burdened by high rates of tuberculosis (TB) and HIV, pulmonary diseases represent a significant public health challenge. Despite advancements in medical treatment, surgery remains a critical component in managing severe cases of pulmonary disease. (3)

Pulmonary resections are typically indicated for malignant, benign, and infectious diseases. Among these, infectious diseases, particularly TB, represent a significant proportion of indications for surgery in Ethiopia. TB causes extensive damage to the lung parenchyma, leading to the formation of cavities and scarring. In cases where the disease has not responded to medical therapy,

surgical resection can be a life-saving measure. In particular, patients with MDR-TB or XDR-TB may benefit from surgical intervention, as these forms of TB are resistant to standard anti-TB drugs, making medical management difficult (4).

Beyond TB, lung cancer also serves as an important indication for pulmonary resections. In high-income countries, lung cancer is a leading cause of cancer-related deaths, and surgical resection is commonly performed when the tumor is confined to the lungs. However, in Ethiopia, the prevalence of lung cancer is lower compared to TB-related surgeries. Nonetheless, as healthcare infrastructure improves and awareness about cancer grows, there is a need for more research into the surgical management of lung cancer in the country, particularly in early-stage patients where resections like lobectomy may improve survival rates (5).

Benign lesions such as pulmonary hydatid cysts, which are endemic in parts of Ethiopia, also warrant pulmonary resections. These cysts, caused by the parasitic infection *Echinococcus granulosus*, can lead to significant lung damage and require surgical removal to avoid rupture or secondary infection. While the incidence of such lesions is lower than that of TB, hydatid cysts still present a notable challenge in the Ethiopian context (6).

The primary consideration in deciding to perform a pulmonary resection is the patient's overall health status, which is heavily influenced by the presence of co-morbid conditions such as TB and HIV. A careful preoperative evaluation is critical, particularly in resource-constrained settings, where access to advanced diagnostic tools and post-surgical care may be limited. There are several types of pulmonary resections, each suited to different clinical indications and the extent of the disease. These procedures include wedge resection, segmentectomy, lobectomy, and pneumonectomy, each of which carries different levels of complexity and risk.

Each type of pulmonary resection is tailored to the patient's condition, the location of the disease, and the overall health of the patient (7). The surgical team must consider several factors, including the risk of postoperative complications, the preservation of lung function, and the potential for recurrence or spread of the disease. Peri-operative outcomes are a critical factor in the success of pulmonary resections. These outcomes include both short-term complications, such as infection, bleeding, and respiratory failure, as well as long-term results such as survival rates, recurrence of disease, and restoration of lung function. The peri-operative period is particularly important in

patients with co-morbidities such as TB and HIV, as these conditions can complicate both the surgical procedure and recovery (8).

For patients with TB, surgical outcomes may be influenced by factors such as the presence of active infection, the extent of lung damage, and previous treatment history. Patients with active TB may experience delayed wound healing, increased risk of postoperative infections, and difficulty in recovering from anesthesia (9). Similarly, HIV-infected patients are at higher risk for infections, which can complicate both the recovery phase and long-term outcomes. HIV compromises immune function, making these patients more susceptible to postoperative infections, which are often a significant cause of morbidity and mortality after surgery (10).

Therefore, understanding the factors that influence peri-operative outcomes in patients undergoing pulmonary resections is essential for improving patient care. By identifying the risk factors and complications associated with these surgeries, healthcare providers can implement strategies to minimize risks and improve outcomes.

Statement of the problem

Ethiopia faces a high burden of HIV infection, which has a synergistic effect on pulmonary disease. HIV, an immunosuppressive virus, predisposes individuals to a variety of respiratory infections, including opportunistic infections such as pneumonia, TB, and fungal diseases. The compromised immune system in HIV-infected patients can complicate the management of pulmonary disease, making them more prone to both primary pulmonary infections and secondary complications. These co-morbidities of TB and HIV contribute to the complexity of pulmonary resections and significantly affect peri-operative outcomes ().

Surgical management of lung diseases remains a pivotal treatment option for many patients, especially in severe cases where medical management alone is insufficient. Surgical interventions such as pulmonary resections are aimed at improving symptoms, preventing the spread of infections, and restoring lung function. However, the decision to perform surgery must be carefully weighed against the patient's overall clinical status, comorbidities, and the specific challenges posed by the underlying pulmonary pathology, particularly in a resource-limited setting such as Ethiopia.

Pulmonary resections are complex and essential surgical procedures performed to treat a variety of thoracic diseases, including primary lung cancers, metastatic lung lesions, benign pulmonary tumors, infections, and traumatic injuries. Tikur Anbessa Specialized Hospital (TASH) in Addis Ababa, Ethiopia, is the largest referral hospital in the country, with a cardiothoracic surgery unit that has 21 beds and an average of 288 cases per year. As a major surgical center, TASH, provides advanced care to patients from across the country who require these procedures.

However, there remains a scarcity of data on the clinical indications, types, and peri-operative outcomes of pulmonary resections in Ethiopia, limiting the ability of healthcare providers to base clinical decisions on locally relevant evidence. In Ethiopia, the high prevalence of tuberculosis (TB) and HIV adds a unique and pressing dimension to pulmonary disease and its management. Tuberculosis remains a leading cause of pulmonary complications, and chronic or post-tuberculous lung disease can lead to severe structural lung damage, cavities, and bronchiectasis, which often necessitate surgical intervention (2). Additionally, TB can mimic or co-exist with lung cancers, complicating diagnosis and treatment decisions (11).

Surgery in TB-affected lungs can present increased risks due to altered lung architecture and diminished pulmonary reserve, which may lead to higher peri-operative complication rates. Despite these challenges, the role of surgery in managing complex TB cases and the outcomes associated with such interventions remain under-researched in Ethiopia. Similarly, HIV infection poses a significant burden on Ethiopia's healthcare system. Patients with HIV are at increased risk of both pulmonary infections, including TB, and malignancies, such as Kaposi's sarcoma and lung cancer (12). With antiretroviral therapy (ART) improving life expectancy, there has been an increase in chronic complications among HIV-positive individuals, including non-infectious pulmonary diseases that sometimes require intervention.

HIV-related immunosuppression and potential interactions with ART can further complicate peri-operative management, leading to unique challenges in terms of post-surgical infections, wound healing, and overall recovery outcomes (13). Understanding how HIV impacts surgical outcomes is critical for improving peri-operative care and tailoring interventions to meet the specific needs of this patient population.

This research is significant because it provides an in-depth examination of pulmonary resections performed at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia. The study's findings will help illuminate the complexities of managing pulmonary diseases in a high-burden setting with infectious diseases like TB and HIV. Understanding the indications for surgery, the types of procedures performed, and the outcomes of these surgeries will provide insights into the surgical landscape of lung disease management in resource-limited settings.

Significance of the study

Given that TASH is a leading center for thoracic surgery in Ethiopia, it serves as an important resource for understanding the patterns of pulmonary disease and the outcomes of surgical interventions in TB and HIV-endemic settings. However, data on the indications, types, and peri-operative outcomes of pulmonary resections at this institution remain sparse. Without this information, clinicians lack crucial insights into the most common causes and types of pulmonary resections needed in the Ethiopian context and the risks associated with surgery in patients with TB or HIV.

This five-year retrospective cross-sectional study, spanning from 2020 to 2024, seeks to fill this knowledge gap by comprehensively analyzing cases of pulmonary resections performed at TASH. The study investigated the primary indications for surgery, the specific types of resections performed (such as lobectomies, pneumonectomies, or segmentectomies), and peri-operative outcomes, including complication rates, mortality, and length of hospital stay.

The findings from this research have important implications for clinical practice, resource allocation, and policy formulation in Ethiopia. By generating data specific to the Ethiopian context, this study will help healthcare providers make evidence-based decisions, improve peri-operative care protocols, and develop strategies for managing the complex interplay of TB, HIV, and pulmonary diseases requiring surgical intervention. Ultimately, this research will contribute to a broader understanding of thoracic surgery in low-resource, high-burden settings, with the potential to enhance the quality of care for patients undergoing pulmonary resections at TASH and similar institutions across Ethiopia.

This study was conducted to evaluate the indications, types, and perioperative outcomes of pulmonary resections performed at Tikur Anbessa Specialized Hospital in Addis Ababa, Ethiopia,

over a five-year period from 2020 to 2024. Specifically, the research aimed to identify the primary clinical indications for pulmonary resections, such as malignancies, tuberculosis, benign pulmonary lesions, and complications arising from chronic conditions including HIV. Additionally, the study sought to describe the spectrum of pulmonary resection procedures carried out at the institution such as namely wedge resections, lobectomies, segmentectomies, and pneumonectomies and to understand the clinical and resource-based factors influencing surgical decision-making.

A key objective was to assess the peri-operative outcomes of these procedures by evaluating complication rates, duration of hospital stay, and in-hospital mortality. This included analyzing common post-operative complications such as infections, bleeding, respiratory failure, and other adverse events like pneumonia or delayed wound healing, with particular attention to patients with preexisting comorbidities such as TB and HIV. The study also aimed to evaluate the impact of these comorbid conditions along with others like COPD, cardiovascular disease, and diabetes on surgical outcomes and complication rates, thereby informing future preoperative risk assessments and post-operative management strategies.

Finally, based on the comprehensive analysis of surgical indications, techniques, outcomes, and influencing factors, the study aimed to provide evidence-based recommendations for improving the management of pulmonary resections in Ethiopia. These recommendations consider the specific challenges of resource-limited settings and focus on enhancing surgical training, optimizing peri-operative care, and strengthening post-surgical follow-up systems to improve patient outcomes in similar low-resource environments.

Materials and methods

Study Design

A hospital based retrospective cross-sectional study design was employed to assess the indications, types, and peri-operative outcomes of pulmonary Resections over a five-year period, analyzing data from patients who have undergone pulmonary resection at Tikur Anbessa Specialized hospital Addis Ababa, Ethiopia.

Study Setting

The study was conducted at Tikur Anbessa Specialized Hospital (TASH) located Lideta sub city in Addis Ababa Ethiopia under the College of Health Sciences, Addis Ababa University (**Figure 1**). TASH, established in 1972, is a public teaching hospital of the AAU, CHS. It is one of the referrals and oldest public hospitals serving the entire nation in providing all forms of medical service. It is the main teaching hospital for both clinical and preclinical training of most disciplines. It is also an institution where specialized clinical services that are not available in other public or private institutions are rendered to the whole nation. The various departments, faculties and residents under specialty training in the School of Medicine provide patient care in the hospital. It is the largest referral hospital in the country with 700 in-patient beds. The hospitals provide different service range from chemotherapy to surgical services including surgery for cardiac, lung, and esophageal surgery.

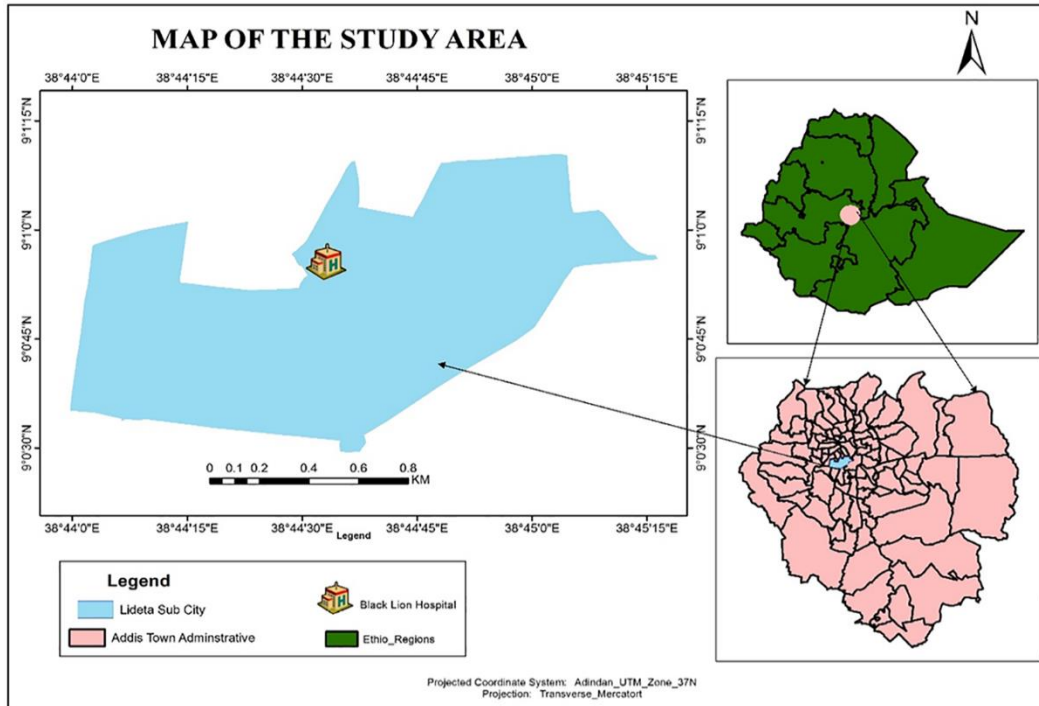


Figure 1: Map of Tikur Anbessa Specialized Hospital, Lideta Sub city, Addis Ababa Ethiopia.

Study Population

The population consisted of all patients who underwent pulmonary resection (e.g., lobectomy, pneumonectomy, segmentectomy, or wedge resection) at Tikur Anbessa Specialized hospital Addis Ababa, Ethiopia, for any indication during the specified five-year period. The study included all patients meeting these criteria, with the aim of providing a representative sample of pulmonary resection cases in the selected setting.

Inclusion and Exclusion Criteria

Inclusion Criteria:

- All patients who underwent a pulmonary resection procedure (lobectomy, pneumonectomy, segmentectomy, or wedge resection) within the study period at Tikur Anbessa Specialized hospital Addis Ababa, Ethiopia.
- Patients with documented peri-operative outcomes in their medical records, including complications, mortality, and length of stay.

- Patients aged 16 years and older at the time of surgery.

Exclusion Criteria:

- Patients with incomplete or missing data on key variables, such as demographic information, procedure type, or peri-operative outcomes (incomplete documentation of intraoperative and postoperative outcomes)
- Patients who underwent lung biopsies or non-resectional lung surgeries (e.g., pleurodesis)
- Patients undergoing pulmonary resection for trauma, as these cases typically involve unique indications and outcomes that differ significantly from the targeted study population.

Sample Size Determination

All patients who had pulmonary resection in the 5-year study period at TASH in the department of surgery were included in the study.

Given the retrospective nature of this study and the specific objective to assess the indications, types, and perioperative outcomes of pulmonary resections, a **Census Sampling Method** was employed. All patients who underwent any form of pulmonary resection (including pneumonectomy, lobectomy, bilobectomy, segmentectomy, and wedge resection) at Tikur Anbessa Specialized Hospital (TASH) from January 1, 2020, to December 31, 2024 were included, provided their records met eligibility criteria.

Study Variables

Dependent variables

Peri-operative outcomes

Independent variables

- ✓ Demographic Characteristics:
 - Age
 - Gender
 - Smoking history
 - Body Mass Index (BMI)
- ✓ Clinical Factors:

- Presence of comorbidities (e.g., diabetes, hypertension)
- HIV status (positive/negative)
- TB history (active or latent)
- Pulmonary function (spirometry results)
- Duration of illness or symptoms prior to surgery
- ✓ Indications for Surgery:
 - Malignant (e.g., lung cancer)
 - Infectious (e.g., tuberculosis)
 - Benign (e.g., lung abscess, emphysema)
- ✓ Type of Pulmonary Resection:
 - Wedge resection
 - Lobectomy
 - Segmentectomy
 - Pneumonectomy
- ✓ Peri-Operative Outcomes:
 - Post-operative complications (e.g., infection, bleeding, respiratory failure)
 - Length of hospital stay
 - Mortality rate
- ✓ Post-Surgical Recovery:
 - Wound healing (presence of infection or delayed healing)
 - Functional status (e.g., post-operative lung function, oxygen dependence)

Data Collection Tool and Procedures

A structured data extraction form was developed to ensure consistency and accuracy in data collection. Data was extracted from OR logbook, preoperative patient medical record, operation notes, pathologic record and postoperative follow up records from registries. Patients were also contacted by telephone address for additional information on their postoperative conditions.

A standardized data collection form was designed to capture all relevant variables, including patient demographics, clinical history, surgical details, and peri-operative outcomes. At least three resident physicians were selected and trained on the purpose of the study and data collection procedures. Data was filled by with the principal investigator and trained physicians.

The data collection form was piloted on a small subset of records to ensure that it captures the necessary information and to address any issues before full-scale data collection. Quality control measures, such as double-checking records and data entry validation, was implemented to minimize errors and ensure data integrity.

Data processing and analysis

Data analysis was performed using SPSS version 29.0.2.0. The analysis included descriptive, bivariate, and multivariate analyses to examine relationships between variables and identify predictors of peri-operative outcomes.

Data quality management and Quality Control

To assure the quality of data, Instruments were commented by advisors and then pretested on 5% of the sample size to identify problems on the questionnaire and correction was incorporated in the final questionnaires.

Results

Socio-Demographic Characteristics

Among the 100 patients undergoing pulmonary resection, the mean age was relatively young: 35% were under 35 years old. The sex distribution showed that 63% of the patients were male and 37% were female. The cohort was ethnically diverse, with the largest groups being Oromo (35%) and Amhara (30%), followed by Addis Ababa residents (18%), SNNPR (8%), Somali (4%), and Tigre (3%).

Table 1: Age distribution of the study participants

Age group (years)	Frequency (%)
< 35	35 (35.0)
35–44	23 (23.0)
45–54	22 (22.0)
≥ 55	20 (20.0)

Educational attainment varied among the patients, 22% had no formal education, 12% had only primary schooling, 19% completed secondary school, 17% had education above secondary level, and 30% had a college or university degree. Most patients were married (87%), followed by 11% single and 2% widowed. Regarding family size, 72% of the patients had 3 to 5 children, 12% had 6 or more, 8% had two or fewer, and another 8% did not report the number. Urban residents accounted for 63%, while 37% were from rural areas. The most common occupations included government employment (30%), housewife (18%), private worker (13%), and merchant (12%). Monthly household income was generally low, with the largest groups earning between 6,000–10,000 birr (26%) and less than 5,000 birr (25%). Only 10% of patients reported having health insurance.

Table 2: Socioeconomic characteristics of the study participants

Characteristic	Category	Frequency (%)
Education level	No formal education	22 (22.0)
	Primary school	12 (12.0)
	Secondary school	19 (19.0)
	Above secondary	17 (17.0)
	College/University	30 (30.0)
Marital status	Married	87 (87.0)
	Single	11 (11.0)
	Widowed	2 (2.0)
Number of children	≤ 2	8 (8.0)
	3–5	72 (72.0)
	≥ 6	12 (12.0)
	Not reported	8 (8.0)
Residency	Urban	63 (63.0)
	Rural	37 (37.0)
Health insurance	Yes	10 (10.0)
	No	90 (90.0)

Clinical Characteristics

Most patients had no recorded comorbidities. Specifically, 95% had no chronic illness noted. Cardiovascular disease was reported in 2 patients (2%), hypertension in 1 patient (1%), and one patient had paraneoplastic syndrome with elevated blood pressure. Only one patient had an active lung infection recorded.

Table 3: Preoperative comorbidities

Comorbidity	Frequency (%)
None	95 (95.0)
Cardiovascular disease	2 (2.0)
Hypertension	1 (1.0)
Hypertension + Paraneoplastic syndrome	1 (1.0)
Infective lung lesion	1 (1.0)

Surgical History by Year

Surgical volume increased over the study period. In 2020, only 7% of cases were performed. This rose to 20% in 2021, 23% in 2022, peaked at 26% in 2023, and slightly decreased to 24% in 2024. The trend indicates a general increase in the number of pulmonary resections conducted at the hospital.

Diagnosis and Surgical Indications

Lung cancer was the leading indication for pulmonary resection, accounting for 35% of cases. Tuberculosis complications were the second most common indication (21%). The remaining 44% were a variety of other conditions including Aspergilloma (4%), Bronchiectasis, Hydatid cyst, Lung abscess, Cystic lesions, and rare tumors; each comprising less than 2% individually.

TB and HIV History

Nearly half of the patients (49%) had a history of tuberculosis. Of these, 39% had past infection, 5% had active TB at the time of surgery, and 5% had undocumented or unknown status. HIV infection was rare: 3% were HIV-positive, and among them, two were on ART and one was not.

Tuberculosis (TB) Treatment History

Out of the 100 patients, 46% had a documented history of tuberculosis treatment, while 54% did not. Among those who had received treatment, the majority had only been treated once (36%). A

smaller group reported being treated twice (6%), three times (3%), and one even four times (1%). One patient's treatment history was unspecified.

Table 4: TB treatment history

Variable	Category	Frequency (%)
History of TB treatment	Yes	46 (46.0)
	No	54 (54.0)
Number of treatments (if Yes)	1	36 (36.0)
	2	6 (6.0)
	3	3 (3.0)
	4	1 (1.0)
	Not specified	1 (1.0)

History of Chemotherapy or Radiotherapy

A total of 13% of patients had undergone chemotherapy or radiotherapy. The most common indication was lung cancer (9%), followed by bronchogenic cancer and lung metastasis (1% each). In terms of chemotherapy frequency, most did not provide details, but seven patients received six cycles, and a few had 4 or 16 cycles.

Smoking History and Family History

Only 5% of the patients had a history of smoking. Among them, two reported 1 pack-year and another two reported 30 pack-years. Family history of respiratory conditions was rare: 1% reported a family history of asthma, and another 1% had a family history of tuberculosis.

Previous Lung Surgery and Diagnostics

Seven patients (7%) had undergone previous lung surgery. A significant number (73%) had undergone some form of diagnostic evaluation (e.g., X-ray, CT scan, bronchoscopy) prior to their surgery.

Indications for Surgery

Lung cancer was the most common indication for surgery in our study. 44% of the patients had lung cancer. Other notable conditions included aspergilloma (18%), bronchiectasis (13%), and combinations of infections and structural lung diseases (e.g., empyema, post-TB fibrosis, cysts).

Types of Pulmonary Resection

The most frequently performed procedure was lobectomy (49%), followed by pneumonectomy (30%). Other procedures included wedge resections, decortication, and segmentectomy. All surgeries were open surgeries; no minimally invasive (e.g., VATS) techniques were used.

Table 5: Surgical procedures performed during the study period (2020-2024) at TASH

Type of Resection	Frequency (%)
Lobectomy	49 (49.0)
Pneumonectomy	30 (30.0)
Wedge resection	6 (6.0)
Wedge resection + Decortication	2 (2.0)
Segmentectomy + cystectomy, others	13 (13.0)
Open surgery (total procedures)	100 (100.0)

Surgical Characteristics

Only 2% of surgeries were emergencies; 97% were planned, and one case involved both elective and emergent care. Most surgeries were performed by senior consultants, either alone (39%) or with fellows. In 20% of cases, senior fellows operated independently. The left lung was more frequently affected (54%) than the right lung (46%). Only 2% of cases involved both lungs.

Intraoperative Factors

Most surgeries (65%) lasted more than three hours; 34% lasted two to three hours. Blood transfusions were required in 6% of surgeries. Among those needing transfusions, most received 1–3 units, with one patient receiving six units.

Postoperative Complications

Postoperative complications occurred in 12% of patients. Specific complications included, pneumonia, wound infection, abscess formation, prolonged air leak, and one postoperative death possibly due to pulmonary embolism.

Table 6: Postoperative complications

Complication	Frequency (%)
None	88 (88.0)
Pneumonia	3 (3.0)
Surgical site infection	3 (3.0)
Abscess	1 (1.0)
Prolonged air leak	1 (1.0)
Surgical site discharge	1 (1.0)
Death (?PE suspected)	1 (1.0)
Other	2 (2.0)

The most commonly reported complications were pneumonia and wound infections (3% each). The remaining 88% of patients experienced no complications. Only 1% of patients required a postoperative blood transfusion, and this patient received 3 units. The remaining 99% did not require transfusion. The majority of patients (62%) had a hospital stay of 8 to 14 days, while 35% stayed for more than 14 days. Only 2% stayed for 4-7 days.

Chest Tube Management

Duration of tube placement varied, with the majority remaining in place for 3–5 days. Re-insertion was required in 3% of patients.

Respiratory Complications and Support

Postoperative breathing difficulties or need for respiratory support were reported in 10% of patients. 11% required oxygen support, and among them, 2 liters per minute was the most commonly used flow rate. Among those who did, oxygen support lasted 1 to 3 days. Three patients (3%) required reoperation or prolonged intubation. One of these cases was due to a persistent air leak. The majority of patients (97%) had no such events.

Perioperative Morbidity and Mortality

Perioperative complications during follow-up were rare and occurred in 2% of patients. Among these, wound discharge was noted. One patient (1%) died within 30 days after surgery.

Recovery and Follow-Up

Most patients (79%) resumed normal activities after more than 1 month. A smaller portion resumed activities in 3 to 4 weeks (20%), and only one patient returned to normal within 1 week. Follow-up adherence was high: 96% attended at least one follow-up visit.

Among the 100 patients studied, postoperative symptoms were infrequent. Chest pain was reported by 4 patients (4.0%) and absent in 96 (96.0%). Shortness of breath occurred in 5 patients (5.0%) and was not reported by 95 (95.0%). Fatigue was reported by 4 patients (4.0%) and absent in 96 (96.0%). These data indicate that the vast majority of patients did not experience these symptoms after surgery.

After hospital discharge, 29 patients (29.0%) required additional treatment, whereas 71 patients (71.0%) did not. Among those who required further intervention, chemotherapy was the most common treatment (12 patients, 12.0%), followed by antibiotics (4 patients, 4.0%). Other treatments, each reported by 1–3 patients, included asthma medications (2 patients, 2.0%), itraconazole (3 patients, 3.0%), and a variety of single instances including albendazole,

antipsychotics, drainage procedures, ICU admission with intubation, itraconazole combined with ciprofloxacin, radiochemotherapy, and vitamin B complex with azithromycin. Regarding short-term postoperative outcomes, 4 patients (4.0%) were readmitted to the hospital within 30 days of discharge, while the remaining 96 patients (96.0%) had no readmissions during that period.

Five-Year Trends (2020 – 2024)

Over the five-year period (2020–2024), the pattern of pulmonary diseases requiring resection showed distinct shifts.

In **2020**, the most common indication was aspergilloma (18%), followed by bronchiectasis (12%). A combination of bronchiectasis with other conditions (e.g., aspergilloma, abscess) made up several additional cases. Rare conditions like arteriovenous malformation, complicated hydatid cyst, and post-TB sequelae were also observed but in small numbers.

In **2021**, aspergilloma remained the leading diagnosis (11%), and bronchiectasis continued to appear frequently (10%). Mixed forms such as bronchiectasis with aspergilloma or abscess also contributed significantly. Other rare indications—such as empyema, bullae, bronchopleural and bronchopleurocutaneous fistulas—were seen, each in 1 or 2 patients.

2022 reflected a similar pattern to the previous years, with aspergilloma (15%) and bronchiectasis (11%) still dominating. Combinations with aspergilloma and other lesions like abscess or pneumothorax remained common. Less frequent conditions included hydatid cysts, bullae, and broncho-pleurocutaneous fistulas.

A notable shift occurred in **2023**, when lung cancer emerged as the most common surgical indication (31%). Aspergilloma and bronchiectasis were still prevalent but took a secondary position. Additional cases included endobronchial carcinoid tumors, lung abscess, and post-TB fibrosis. This marked the start of a trend toward more malignant disease requiring surgical intervention.

In **2024**, lung cancer further increased to 35%, confirming its status as the leading cause of pulmonary resections. Aspergilloma and bronchiectasis persisted but at lower frequencies. Rare

conditions like bullae, hydatid cysts, and endobronchial carcinoid were still encountered, though less frequently.

Over the five years, a clear transition is observed: the early years were dominated by benign and infectious diseases (aspergilloma, bronchiectasis, TB sequelae), while lung cancer became increasingly predominant in the later years.

Factors associated with Postoperative Complications

Bivariate logistic regression was conducted to assess the association between selected patient and clinical variables and the occurrence of postoperative complications following pulmonary resection. Variables with a p -value less than 0.20 were considered candidates for inclusion in multivariate analysis.

Although no variable reached statistical significance at the conventional threshold of $p < 0.05$, several variables demonstrated associations below the pre-specified cutoff of 0.20 as shown in table 7.

Table 7: Bivariate logistic regression of variables and postoperative complications

Variable	P-value
Sex	0.138
Age Category	0.371
Presence of Comorbidities	0.726
HIV Status	0.324
Smoking History	0.252
Diagnosis	0.128
Indication for Surgery	0.175
Bilateral Lung Involvement	>0.20

Multivariate Logistic regression of Factors Associated with Postoperative Complications

Following bivariate analysis, variables with a p-value less than 0.20 were included in the multivariate logistic regression to determine independent predictors of postoperative complications. These variables included sex, type of diagnosis, indication for surgery, and bilateral lung involvement.

In the final multivariate model, only lung cancer diagnosis was significantly associated with reduced odds of postoperative complications. Patients with lung cancer had significantly lower odds of developing complications compared to other diagnoses (AOR = 0.065; 95% CI: 0.007–0.598; $p = 0.016$), suggesting a potentially more standardized surgical pathway or better preoperative optimization in cancer cases.

Other variables such as sex (AOR = 0.534; 95% CI: 0.097–2.923; $p = 0.469$) and bilateral lung involvement (AOR = 0.092; 95% CI: 0.002–3.538; $p = 0.200$) did not show statistically significant associations in the adjusted model. These results suggest that lung cancer patients were significantly less likely to develop postoperative complications. However, most other variables were not independently predictive, possibly due to small subgroup sizes or confounding factors.

Discussion

This five-year retrospective analysis evaluated the indications, types, and perioperative outcomes of pulmonary resections at Tikur Anbessa Specialized Hospital. Our study highlights the disease pattern, surgical indications, outcomes, and associated risk factors in a resource-limited setting. In our study, the patients were relatively young, with 35% under 35 years old, consistent with trends in low- and middle-income countries (LMICs), where infectious diseases affect younger populations disproportionately (15). The predominance of males (63%) and the high proportion of urban residents (63%) reflect similar demographic patterns reported in pulmonary surgery series from Ethiopia and other African countries (23, 27).

Lung cancer was the most common surgical indication (35%), followed by tuberculosis-related complications (21%). These findings align with global data showing that lung cancer remains the leading cause of cancer-related deaths (14, 19). In LMICs, infectious diseases remain prevalent. In our study, tuberculosis and its sequelae remained prominent indications for resection, which corresponds with WHO and Ethiopian Ministry of Health reports on TB's ongoing burden (16, 17, 18). This burden of malignancy and infectious pulmonary disease reflects a transitional epidemiological phase in Ethiopia, as previously described (21, 23).

The indications for surgery shifted over time. In the early years (2020–2022), benign conditions such as aspergilloma and bronchiectasis were the most common indications. However, starting in 2023, lung cancer became the dominant cause, representing 31% of all resections, increasing to 35% in 2024. This trend is parallel to national cancer trends in Ethiopia showing a rise in lung cancer cases (5), and aligns with other sub-Saharan African studies where late-stage cancer presentations are increasingly being managed surgically (14, 18). The rising cancer trend also reflects improvements in diagnostic capabilities and surgical access in urban centers like Addis Ababa (34).

Tuberculosis-related pathology was present in nearly half of all patients (49%), despite only 5% had active disease at the time of surgery. This is consistent with studies suggesting that many patients undergo surgery for TB sequelae such as destroyed lung or fibrosis, rather than active infection (20, 22). In our study, 13% of patients had received chemotherapy or radiotherapy,

indicating that a subset of lung cancer patients received multimodal care, as recommended for NSCLC (24).

Lobectomy (49%) was the most commonly performed operation, followed by pneumonectomy (30%). These findings are in line with current international standards, where lobectomy remains the gold standard for resectable NSCLC (24, 25). Opposite to high-income countries where minimally invasive approaches such as video-assisted thoracoscopic surgery (VATS) are increasingly adopted (26), all procedures in this study were performed via open thoracotomy, reflecting equipment and training limitations in Ethiopia (27, 28).

Intraoperative outcomes were generally favorable. In our study, only 6% of patients required intraoperative blood transfusion, and most procedures lasted more than three hours. Emergency surgery was rare (2%), and most procedures were elective and performed by experienced surgeons or fellows. These findings suggest careful patient selection and surgical planning, which may have contributed to the relatively low complication rate.

Postoperative complications occurred in 12% of patients, primarily pneumonia and surgical site infections. This complication rate is lower than some reports from other African centers (31), and may reflect improvements in perioperative care. While only 1% of patients experienced a fatal outcome within 30 days postoperatively. This mortality rate is favorable compared to historical African thoracic surgery data and highlights the potential for safe pulmonary surgery in resource-limited settings with proper systems in place (31, 32).

Multivariate analysis revealed that lung cancer diagnosis was significantly associated with reduced odds of postoperative complications (AOR = 0.065; $p = 0.016$). This finding is supported by literature suggesting that cancer patients often benefit from more structured perioperative pathways, earlier diagnosis, and standardized surgical protocols (8, 24). Other factors such as sex, bilateral lung involvement, and indication for surgery were not independently predictive of complications. These results differ from prior studies showing comorbidities and HIV infection to be significant risk factors (10, 30). The discrepancy may be due to the low number of HIV-positive patients in this study (3%), or underreporting of comorbidities (only 5% reported any), suggesting that larger sample sizes or prospective registries are needed to better assess these associations (33).

In our study, the postoperative recovery was generally smooth. Most patients (62%) were discharged within 8-14 days, and only 4% were readmitted within 30 days. Few patients experienced postoperative symptoms such as chest pain or shortness of breath, and 79% resumed normal activity after one month. The need for post-discharge interventions like chemotherapy or antibiotics (seen in 29% of patients) reflects ongoing care needs, mainly in cancer and infectious cases (12, 13).

Chest tube reinsertion was needed in only 3%, suggests satisfactory intraoperative technique and postoperative monitoring. Respiratory complications and oxygen support were limited, consistent with previous Ethiopian studies reporting good recovery in patients undergoing lung resections (28, 32).

The study also highlights several systemic challenges. Only 10% of patients had health insurance, and many came from rural areas with limited access to surgical care. These barriers echo broader concerns about surgical equity and resource distribution in Ethiopia, where specialized care is heavily concentrated in urban hospitals like TASH (34, 36). The lack of minimally invasive surgery and advanced postoperative support services further complicates outcomes (23, 27, 36).

This research shows the value of data-driven approaches in surgical planning and outcome monitoring. while this study demonstrates favorable outcomes, its retrospective nature and single-center scope limit generalizability. The absence of long-term survival and disease recurrence data further highlights the need for a national thoracic surgery registry to support quality improvement and policy development (35).

Limitation of the study

This study has several limitations that should be acknowledged:

1. **Retrospective Nature:** Being a retrospective cross-sectional study, the findings are based on existing medical records, which may be incomplete or lack critical information, especially on post-operative follow-up and complications. This may introduce information bias and limit the ability to assess long-term outcomes accurately.
2. **Single-Center Study:** The study is conducted solely at Tikur Anbessa Specialized Hospital, which may limit the generalizability of findings to other healthcare settings in Ethiopia, especially rural or less-equipped institutions.
3. **Limited Diagnostic and Surgical Resources:** The lack of advanced diagnostic tools (e.g., routine use of PET imaging) and minimally invasive surgical techniques (e.g., VATS) in the study setting may affect the types of cases managed surgically and the outcomes observed. This may not reflect best-case surgical outcomes achievable in higher-resource settings.
4. **Limited Control for Confounding Factors:** Although statistical methods are used to adjust for potential confounders, unmeasured variables (e.g., nutritional status, ART adherence in HIV patients, surgeon experience) may still influence peri-operative outcomes and limit the internal validity of the study.
5. **Short-Term Outcome Focus:** While the study assesses peri-operative outcomes within 30days post-surgery, long-term outcomes such as disease recurrence, quality of life, and pulmonary function recovery are beyond the scope due to lack of longitudinal data.

Conclusions and recommendations

This five-year retrospective study at Tikur Anbessa Specialized Hospital (TASH) provides a comprehensive overview of the indications, types, and peri-operative outcomes of pulmonary resections in a high TB/HIV burden, resource-limited setting. The findings reflect a dynamic shift in the surgical landscape, with lung cancer emerging as the leading indication for resection in recent years, overtaking traditionally dominant infectious causes such as tuberculosis-related complications and aspergilloma.

Lobectomy and pneumonectomy were the most frequently performed procedures, despite systemic limitations; including the lack of minimally invasive techniques and constrained postoperative care infrastructure, the overall surgical outcomes were favorable. The complication rate was low (12%), mortality was rare (1%), and most patients resumed normal function within a month. Notably, patients with lung cancer had significantly better postoperative outcomes, potentially reflecting earlier presentation, better optimization, and standardized surgical pathways.

The study underscores the evolving epidemiology of thoracic diseases in Ethiopia and the capacity of specialized centers like TASH to deliver safe pulmonary surgical care even in challenging environments. It also highlights critical gaps in access, insurance coverage, and technology, pointing to the need for strategic investment in surgical systems strengthening.

To sustain and enhance these outcomes, Ethiopia's thoracic surgery programs should prioritize the expansion of minimally invasive surgical capabilities, establish national surgical registries, and improve multidisciplinary coordination for oncologic care. Addressing inequities in referral pathways and financial protection mechanisms is also essential to ensure that all patients, regardless of geography or income, can benefit from life-saving pulmonary surgery.

Ultimately, this study contributes to the growing body of local evidence supporting safe, effective pulmonary resections in LMICs and offers a valuable framework for improving thoracic surgical services in similar high-burden, resource-limited settings.

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Annex

Questioners in English

Questionnaire ID code_____

Checklist as following with instruction:

Answer the questions by placing a “circle” on answer a corresponding to the question which is applicable to the patient.

Part: I Socio-Demographic Characteristics of patient treated with pulmonary resection TASH, Addis Ababa, Ethiopia.			
s. no	Question	Response	Skip to
101	Sex	A. Male B. Female	
102	age in years-----	A. <35 B. 35-44 C. 45-54 D. >55	
103	Ethnicity	A. Amara B. Oromo C. Tigre D. Somali E. Others_____	
104	marital status	A) Single B) Married C) Divorced D) Widowed	
105	Family size (Write in number-----)	A) <2 B) 3-5	

		c) >6	
106	Residency	A. Rural B. Urban	
107	Educational status	A. No formal education B. Primary school C. Secondary school D. Above Secondary school E. College/University	
108	Religion	A. Orthodox B. Muslim C. Protestant D. Others	
109	Occupation	A. Government B. Manual laborer C. House wife D. Merchant E. Farmer F. Private worker G. Retired H. Others, specify_____	
110	monthly income (in birr-----)	A. <5000 EBR B. 6000-10,000 EBR C. 11,000-15,000 EBR D. 16,000-20,000 EBR E. >21,000 EBR	
111	Does the patient have health insurance	A. Yes B. No C. No information	
Part II: Medical History of patients treated with pulmonary resection at TASH, Addis Ababa, Ethiopia.			

201	Has the patient been diagnosed with any of the following conditions? (Select all that apply)	A. Lung Cancer B. Tuberculosis C. Chronic Obstructive Pulmonary Disease (COPD) D. Asthma E. Emphysema F. Pneumonia G. Lung abscess H. None of the above Other, specify _____	
202	Has the patient been diagnosed with any of the following conditions? (Select all that apply)	A. Cardiovascular Disease B. Diabetes C. Hypertension D. None of the above Other, specify _____	
203	Has you been diagnosed with HIV?	A. No B. Yes C. Unknown If yes, please specify the number of years after diagnosis: _____ If yes _____ On ART a. Yes, specify duration in years _____ b. No	
204	Does the patient have a history of tuberculosis (TB)?	A. Yes B. No	

		If yes, please specify the type (active, past infection) and the year of diagnosis: _____	
205	Does the patient has history of TB treatment?	A. Yes B. No If yes, how many times _____	
206	Does the patient has history chemotherapy or radiotherapy?	A. Yes B. No If yes, specify the indication and frequency _____	
207	Does the patient have a history of smoking?	A. Yes B. No If Yes, how many pack-years? _____ (1 pack per day for 1 year is 1 pack-year)	
208	Does the patient have a family history of any of the following? (Select all that apply)	A. Lung Cancer B. Tuberculosis C. Asthma D. Chronic Obstructive Pulmonary Disease (COPD) E. None of the above	
209	Have the patient ever had any lung surgery before this one?	A. Yes B. No	
210	Have the patient ever undergone a biopsy or imaging for lung-related conditions (e.g., X-ray, CT scan, bronchoscopy)	A. Yes B. No	

Part III: Surgical Information of patient treated with pulmonary at TASH, Addis Ababa, Ethiopia

301	Indication for Surgery (Primary reason for the pulmonary resection)	A. Lung Cancer B. Tuberculosis C. Emphysema D. Chronic Obstructive Pulmonary Disease (COPD) E. Pulmonary Infections F. Benign Lung Disease Other: _____	
302	What type of pulmonary resection was performed?	A. Lobectomy (removal of one lobe) B. Pneumonectomy (removal of an entire lung) C. Segmentectomy (removal of a segment of the lung) D. Wedge Resection (removal of a small section) Other: _____	
303	Was there any involvement of both lungs in the disease process?	A. Yes B. No	
304	Which lung was affected?	A. Left lung B. Right lung C. Bilateral	
305	Was the surgery planned or emergent?	A. Planned (elective) B. Emergency	
306	Date of surgery:		
307	Surgeon's experience (number of procedures performed)	A. Senior Consultant B. Senior Fellow C. Junior Fellow	

308	Was the surgery performed as an open surgery or minimally invasive surgery (e.g., Video-Assisted Thoracic Surgery - VATS)	A. Open surgery B. Minimally invasive surgery	
309	Duration of Surgery (in hours):	A. < 1 hour B. 1–2 hours C. 2–3 hours D. > 3 hours	
310	Was there any need for blood transfusion during surgery?	A. Yes, if Yes, how many units? _____ B. No	
311	Any complications during or after surgery	A. Yes, specify _____ B. No	
Part IV: Post-Operative Information of patient treated with pulmonary at TASH, Addis Ababa, Ethiopia			
401	Post-operative Complications (Select all that apply)	A. Pneumonia B. Pulmonary Embolism C. Atelectasis (lung collapse) D. Wound Infection E. Bleeding F. Respiratory Failure G. None of the above	
402	Was there any need for blood transfusion after surgery?	A. Yes, how many units? _____ B. No	
403	Length of hospital stay (in days)	A. 1–3 days B. 4–7 days C. 8–14 days D. > 14 days	

404	Was chest tube inserted	A. Yes, how long did it stay insitu: _____	
		B. No	
405	Was chest tube re-inserted?	A. Yes, specify reason: _____	
		B. No	
406	Did the patient experience any post-operative breathing difficulties or need additional respiratory support?	A. Yes, specify: _____	
		B. No	
407	Was the patient on oxygen support?	A. Yes, how many liters? _____ how long? _____	
		B. No	
408	Was there any need for re-operation or prolonged intubation after surgery?	A. Yes, specify reason: _____	
		B. No	
409	Were there any long-term complications on follow-up visits?	A. Yes, specify: _____	
		B. No	
410	Did the patient die within 30 days of surgery?	A. Yes	
		B. No	
411	If alive, how long did it take for the patient to resume normal activities post-surgery?	A. < 1 week B. 1–2 weeks C. 3–4 weeks D. > 1 month	
Part V: Post-Surgical Follow-up and Outcomes of patient treated with pulmonary at TASH, Addis Ababa, Ethiopia.			
501	Has the patient attended follow-up consultations after your surgery?	A. Yes B. No If Yes, how many follow-up visits have you attended? _____	

502	Has the patient experienced any new symptoms since the surgery? (Select all that apply)	A. Chest pain B. Shortness of breath C. Cough D. Wheezing E. Weight loss F. Fatigue G. None of the above	
503	Did the patient require any additional treatments after discharge?	A. Yes B. No If Yes, specify: _____	
504	Have the patient experienced any re-admissions to the hospital within 30 days of discharge?	A) Yes B) No	

Final Comments

Please provide any additional information you believe is relevant to the patient's surgery and recovery:
