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ST. PAUL'S HOSPITAL MILLENNIUM MEDICAL COLLEGE

**SHORT TERM SURGICAL OUTCOMES AND ASSOCIATED FACTORS
AMONG PATIENTS WITH GASTRIC CANCER AT ST. PAUL'S
HOSPITAL MILLENNIUM MEDICAL COLLEGE:**

A RETROSPECTIVE STUDY

SCHOOL OF PUBLIC HEALTH

BY: DR. BETELHEM TADELE (MEDICAL INTERN)

MARCH 2026

ADDIS ABABA, ETHIOPIA

**ST. PAUL'S HOSPITAL MILLENNIUM MEDICAL COLLEGE
SCHOOL OF PUBLIC HEALTH**

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**A RESEARCH THESIS SUBMITTED TO THE SCHOOL OF PUBLIC
HEALTH, SPHMMC, IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE OF DOCTOR OF MEDICINE**

MARCH 2026

ADDIS ABABA, ETHIOPIA

DECLARATION

I, the undersigned student, declare that this research project is my original work in partial fulfillment of the requirement of the degree of **Doctor of Medicine, MD**. I also declare that it has never been presented in this or any other higher institution and that all resources and materials used in the research work have been duly acknowledged.

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March 27, 2026

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ADDIS ABABA, ETHIOPIA

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St. Paul's Hospital Millennium Medical College

Undergraduate study program

School of Public Health

Name of the principal investigator	Betelhem Tadele Eshetu (medical intern)
Full title of the research project	Short-term (90 days) surgical outcomes and associated factors among patients with Gastric Cancer at St. Paul's Hospital Millennium Medical College : A 5 year retrospective study
Duration of the project	9 months
Study area	SPHMMC
Total cost of the project	11,150 ETB
Source(s) of funding	Email: bethyteshetu@gmail.com +251991117306
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Acknowledgement

First of all, I would like to express my deepest gratitude to the Almighty God for letting me reach this day where I proudly took the privilege of preparing my thesis paper as per the requirement of completion of my degree.

I am sincerely thankful to St. Paul's Hospital Millennium Medical College for providing access to valuable data and for the institutional support that made this study possible. My heartfelt appreciation goes to the Department of Surgery, whose guidance and encouragement have been instrumental throughout the whole research process.

Special thanks to my academic advisors, **Dr. Genet Hailu** and **Dr. Fantu Lombamo** for their support, insightful feedback, and continuous mentorship. Your expertise and dedication have been a source of inspiration.

I also extend my appreciation to the medical records staff, nurses at surgical wards/OR, and all individuals who contributed directly or indirectly to the success of this research.

Finally, I am grateful to my family and dearest friends for their continuous encouragement and moral support throughout this journey.

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Abbreviations and acronyms

BP—Blood Pressure

BUN—Blood Urea Nitrogen

CI –Confidence Interval

CVD—Cardiovascular Disease

ECOG PS – Eastern Cooperative Oncology Group Performance Status

EGJ—Esophagogastric Junction

EMR—Electronic Medical Record

ERAS—Enhanced Recovery After Surgery

ETB—Ethiopian Birr

GC—Gastric cancer

GIST—Gastrointestinal Stromal Tumor

GJ—Gastrojejunostomy

H. pylori—Helicobacter Pylori

HR—Heart Rate

HTN—Hypertension

ICU —Intensive Care Unit

INR-International Normalized Ratio

LVI—Lymphovascular Invasion

OS —Overall Survival

PNI—Perineural Invasion

QoR-15K—Quality of Recovery-15 Korean version

RVI—Retroviral Infection

SCC —Squamous Cell Carcinoma

SPHMMC—St. Paul’s Hospital Millennium Medical College

SPH—School of Public Health

SPSS —Statistical Package for the Social Sciences

TB—Tuberculosis

TG —Total Gastrectomy

WHO —World Health Organization

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Abstract

Background: Gastric cancer is a major global health burden and an increasing concern in Ethiopia, where late presentation due to limited screening leads to high mortality and low 5-year survival (30–40%). Surgery remains the primary but high-risk treatment, significantly influencing patient outcomes. In Ethiopia, the burden of gastric cancer is rising, yet data on surgical outcomes remain limited.

Objectives: To assess short-term surgical outcomes and identify associated factors among gastric cancer patients at SPHMMC.

Methods: A single-center retrospective chart review was conducted from January 1, 2021 to August 31, 2025 G.C. among gastric cancer patients admitted to the surgical wards of St. Paul's Hospital, Addis Ababa, Ethiopia. All patients with operable disease who underwent surgery during this period were included (census). Data were extracted from medical records and pathology reports using a structured Google Form. Descriptive statistics summarized demographic and clinical variables, consequently bivariate and multivariable logistic regression analyses were performed using SPSS version 26.

Results: A substantial proportion of patients presented at a younger age and with advanced disease, with 34% aged ≤ 49 years and 77.6% diagnosed at stage II or higher. The most common symptoms were epigastric pain (84.4%) and weight loss (72.1%), while 21.1% had complications at presentation. Postoperative outcomes were significantly affected by comorbidity (AOR=2.72, 95% CI: 1.09-6.8, $p=0.032$), stage of cancer (AOR=2.67, 95% CI: 1.24-5.7, $p=0.012$), intention of surgery (AOR= 7.7, 95% CI: 2.6-22.8, $p=0.00$) and postoperative complications (AOR= 5.2, 95% CI: 1.1-24.3, $p=0.035$). Surgical site infection was the most frequent complication (19.2%), followed by pulmonary complications (8.9%) and hernia (4.5%). The overall postoperative morbidity and mortality rate was 37.8% and 17.9% respectively.

Conclusion: This study found that there is substantial rates of postoperative mortality and complications, compounded by comorbidities and advanced cancer stages. These findings highlight the urgent need for better early detection and more effective perioperative care to improve patient outcomes.

Keywords: Gastric cancer, factors, surgical outcomes, St. Paul's Hospital, Addis Ababa, Ethiopia

1. Introduction

1.1 Background

Cancer is a disease in which abnormal cells grow uncontrollably, ignore the normal rules that regulate cell division, and can spread (metastasize) to other parts of the body. Normally, the body's cells grow, divide, and die in an orderly way. Cancer develops when this balance is lost because of genetic mutations (changes in DNA) that damage genes controlling cell growth and death.

The exact causes of cancer are not fully understood, and often no single factor can be identified. However, existing evidence indicates that genetic alterations play a central role, and these changes are influenced by lifestyle habits such as tobacco use, unhealthy diet, and physical inactivity, as well as by environmental exposures including infections, carcinogens, and increased life expectancy (1,2). In low and middle-income countries, the burden of cancer is rising due to population growth, aging, and the growing adoption of lifestyle practices associated with higher cancer risk, such as smoking, sedentary behavior, and westernized diets (3,4). Despite this increasing burden, cancer remains a low priority in the health care agenda of Sub-Saharan Africa (5).

Currently, more than 50 million people are living within five years of a cancer diagnosis. According to GLOBOCAN 2022 estimates, there were nearly 20 million new cancer cases and 9.7 million cancer-related deaths worldwide (6,7). Cancer causes more deaths than AIDS, malaria, and tuberculosis combined, making it one of the leading causes of mortality, responsible for almost one in six deaths globally (8). The incidence of cancer is rising in developing countries such as Ethiopia, where preparedness for cancer control is limited, while it is declining in developed nations, largely due to the implementation of early detection and effective prevention strategies.

Gastric cancer is the second most common cause of cancer mortality worldwide in part because most patients are diagnosed with advanced, inoperable disease (9). But it is considered rare in sub-Saharan Africa despite the high prevalence of *H. Pylori*. There is a large variation in the incidence of GC in different geographical regions. While the incidence of GC is high in China, Japan, and Korea, it is relatively low in most of Europe, North America, and Africa (10).

Despite advances in treatment, nearly half of gastric cancer patients present with advanced disease beyond the loco regional stage at the time of diagnosis (11). Even among those with loco regional

tumors, only about 40–50% undergo potentially curative surgical resection (12). Early-stage gastric cancer is usually asymptomatic and is therefore rarely detected outside of organized screening programs (13). Population-based screening is not widely practiced globally; it is largely limited to high-incidence countries such as Japan and South Korea, where national screening programs have contributed to earlier detection and improved survival (14,15).

There is a great deal of variation in reported incidence and mortality among individual African countries. The highest prevalence of GC is found in a region comprising Rwanda, Burundi, Southwestern Uganda, and Eastern Kivu province of the Democratic Republic of Congo (16). In Ethiopia, available works in the literature place GC 9th among all cancers in incidence (17).

Gastric cancer remains a significant health problem worldwide and surgery is currently the only potentially curative treatment option. The surgery is generally considered to be high risk surgery and five-year survival rates are poor, therefore a continuous strive to improve outcomes for these patient is needed (18). However, in European and other Western countries, there are major differences in outcome between countries (19). A European clinical audit demonstrated considerable variation in 30-day postoperative mortality and resection rates, even after adjusting for case mix and hospital volume (20).

Similarly, an international benchmarking study confirmed significant disparities across countries, with Sweden reporting lower adjusted 30-day mortality after gastrectomy compared to the Netherlands (21). These findings highlight that surgical outcomes are influenced not only by patient factors, but also by health system capacity, surgical expertise, and national treatment strategies. Therefore, enhancing knowledge to improve the outcomes of gastric cancer treatment is critically important for advancing patient care and survival.

1.2 Statement of the problem

Gastric cancer remains a significant global health challenge, being one of the leading causes of cancer-related mortality worldwide. Surgery is the primary curative treatment modality; however, the short-term surgical outcomes—including postoperative complications, mortality, and recovery—vary widely based on patient, tumor, and treatment factors (18).

Despite definitive surgical management, many patients are discharged and scheduled for follow-up appointments, yet strict adherence to follow-up, particularly during the first postoperative month, is often limited. This early postoperative period is critical, as patients are at risk of developing a variety of complications due to the invasive nature of the surgery.

Assessment of patient factors such as comorbidities, nutritional status, ASA classification, and tumor stage at presentation is essential for predicting those at higher risk of adverse outcomes and for planning targeted interventions. However, in many public hospitals in Ethiopia, comprehensive postoperative follow-up is often constrained by high patient loads, limited resources, and inadequate facilities.

Despite advancements such as minimally invasive techniques and enhanced recovery protocols, there is limited data on the real-world short-term surgical outcomes of gastric cancer patients in sub-Saharan Africa, particularly at tertiary centers like St. Paul's Hospital in Ethiopia. Understanding these outcomes is critical for improving surgical care quality and patient prognosis in this setting (22).

Gastric Cancer is an aggressive malignancy whose management and early detection are challenging. There is no national or institutional guideline on GC in Ethiopia, and healthcare professionals use international guidelines. Moreover, no study was previously done on the surgical outcomes, histologic types, survival status, and associated factors in GC patients in SPHMMC, Ethiopia. This retrospective study over a five-year period aims to assess and analyze these short-term outcomes to identify gaps and inform clinical practice improvements.

1.3 Significance of the study

In Ethiopia, the burden of gastric cancer is rising, yet data on surgical outcomes remain limited. Given the aggressive nature of gastric cancer and the lack of data in the Ethiopian context, this study aims to understand these outcomes and their associated factors, at SPHMMC, a major referral center, that will provide valuable insights for improving clinical care and resource allocation.

Surgical care quality can be assessed using structure, process and outcome as metrics to further device improvement measures which will have impacts on post-operative care, appropriate resource use and quality of life.

Short-term surgical outcomes including postoperative complications, length of hospital stay, and 90-day mortality—are critical indicators of surgical quality and patient prognosis. Furthermore, collecting and analyzing procedure specific outcomes and institution related comparisons will help the health care system. This study aims at narrowing the gaps on data regarding outcomes of surgical treatment of GC in public hospitals with comparable disease burden and possibly identify major factors for procedure specific complications. By doing so, it will contribute in identifying high-risk groups, and inform policy-makers and clinicians on possible prevention and early detection strategies.

This study will also help inform improvements in surgical and perioperative practices, optimize patient care, and provide locally generated evidence to strengthen overall cancer management strategies in Ethiopia.

2. Literature review

2.1 Global Burden and Surgical Management of Gastric Cancer

Gastric cancer is a pressing global health challenge, ranking as the fifth most diagnosed cancer and the third most frequent cause of cancer-related death worldwide, accounting for over 770,000 deaths in 2020 (18,23). While its incidence is notably high in regions like East Asia, it is comparatively lower across much of Europe, North America, and Africa. However, the landscape in developing nations is evolving, with projections indicating a more than 20% increase in non-communicable diseases, including gastric cancer, in Africa between 2010 and 2020 (23).

Surgical resection remains the primary curative treatment for localized gastric cancer, focusing on complete tumor removal and adequate lymph node dissection (18). Standard surgical approaches include various types of gastrectomy (partial or total stomach removal) often combined with D2 lymphadenectomy, a more extensive lymph node dissection common in Asian practices, contributing to improved survival (18). Advancements in surgical care have significantly improved outcomes in high-income settings. These include enhanced preoperative risk assessment, the adoption of enhanced recovery after surgery protocols, and the increasing use of laparoscopic surgery, which offers benefits like reduced blood loss and shorter hospital stays.

In contrast, countries like Ethiopia face distinct challenges, where GC patients frequently present at advanced stages, often with metastatic disease, leading to poorer prognoses (18,23). Local studies indicate that only a minority of patients undergo surgical intervention, with curative intent gastrectomies performed in a small percentage of cases (10). These disparities highlight the critical need for improved early detection and enhanced surgical capacities in resource-limited settings (23).

2.2 Gastric Cancer in Low and Middle Income Countries

GC presents distinct epidemiological patterns and unique challenges within LMICs. While the global burden of gastric cancer remains significant, accounting for a high proportion of cancer-related deaths, its manifestation in LMICs often differs from high-income nations (18). For instance, studies in Ethiopia indicate GC is among the most frequently diagnosed cancers, though its ranking may differ in various reports (23, 10). A notable challenge is the prevalence of *H. pylori*

infection, a primary risk factor, which remains high in many LMICs, including Ethiopia (24). Other risk factors such as dietary habits and exposure to carcinogens also contribute to the unique epidemiological landscape (23).

The main difference lies in the comparison of disease presentation and stage at diagnosis between LMICs and high-income countries. In developed nations like Japan, gastric cancer is often diagnosed early, leading to better prognoses due to advanced screening and healthcare infrastructure (9). On the other hand, patients in LMICs, including Ethiopia, predominantly present in advanced stages, often with metastatic disease at initial diagnosis (23, 10). This late presentation is significantly influenced by patient and diagnostic delays, due to factors such as a lack of awareness, the search for traditional alternatives, economic hindrances, and misdiagnosis (23). Such delays mean that by the time patients seek medical attention, curative surgical options are frequently no longer feasible, leading to poorer outcomes (25).

The general challenges encountered in surgical care delivery further worsen the issue in resource-limited settings. These regions often face limitations in infrastructure, trained personnel, and access to essential medical technologies for effective diagnosis and treatment (18,23). In Ethiopia, for example, despite surgery being the mainstay of curative treatment, only a minority of gastric cancer patients undergo surgical intervention, and the proportion receiving curative intent gastrectomy is even smaller (25, 10). This highlights the broader systemic issues in providing comprehensive cancer care, including surgical management, in these environments (26). Overcoming these challenges needs a combination of efforts, including better systems for early detection, strengthening surgical services, and creating reliable pathways for ongoing patient follow-up.

2.3 A Comprehensive Review of Gastric Cancer in the Ethiopian Context

Gastric cancer presents a unique and challenging landscape within Ethiopia, significantly differing from patterns observed in high-income nations. Available literature indicates that GC is a prevalent malignancy in Ethiopia, with its incidence variably reported as the fifth or ninth most common cancer across different studies (9, 25, 10). This highlights a considerable burden on the healthcare system. A distinctive characteristic of GC in Ethiopia is the patient demographic: a significant

proportion of individuals are diagnosed at a younger age, often below 45 years, which contrasts with the typically older age of onset seen in developed countries (10).

Furthermore, patients in Ethiopia overwhelmingly present with advanced-stage disease, often with metastasis, severely impacting prognosis (10, 23). This late presentation is a key factor contributing to poor outcomes and is attributed to a complex interplay of patient- and system-related delays. Patient delays arise from a lack of awareness regarding the symptoms and risk factors, the common practice of seeking traditional medicine alternatives before conventional healthcare, and financial barriers to accessing timely medical attention (23). Misdiagnosis by healthcare professionals can further prolong the diagnostic process as well.

Studies have shown that the mean length of patient delay can be substantial, followed by significant diagnostic delays, ultimately leading to prolonged total delay between symptom onset and definitive treatment. For instance, one study found a mean patient delay of 106 days and a diagnosis delay of 318 days, with a total delay averaging over 467 days (23).

The surgical infrastructure and capacity for gastric cancer treatment in Ethiopia also pose significant limitations. Despite surgery being the mainstay of curative treatment, only a minority of gastric cancer patients undergo surgical intervention in Ethiopia, with curative intent gastrectomies performed in a small percentage of cases (25,10). These systemic challenges often necessitate palliative approaches, underscoring the urgent need for enhanced diagnostic capabilities and surgical training to improve resectability rates and overall patient survival (27). This points to constraints in specialized surgical expertise, equipment, and overall healthcare resources necessary for comprehensive cancer care, further contributing to the challenges in improving short-term surgical outcomes for gastric cancer patients in the country.

2.4 Overview of outcomes of surgery in gastric cancer

Postoperative complications following GC surgery remain a significant concern, impacting patient recovery, long-term survival, and healthcare burden globally. Common complications include anastomotic bleeding, gastric stasis, intestinal obstruction, and surgical site infections (26). There is a growing understanding that these complications not only affect short-term outcomes but also negatively influence long-term prognosis, leading to decreased overall survival and increased non-

cancer mortality. Consequently, the focus in postoperative management has broadened from immediate complication prevention to comprehensive long-term care, including addressing nutritional deficiencies (28). Advances in surgical techniques, enhanced recovery protocols, and the application of technologies like machine learning for predicting complications are emerging trends aimed at improving outcomes (27). Globally, higher surgical caseloads are often associated with improved results (29). In Ethiopia, data on postoperative complications in gastric cancer specifically is insufficient but it is emerging.

Short-term surgical outcomes include immediate postoperative events and recovery parameters, typically including post-operative morbidity, mortality, length of hospital stay and readmission rates. Key metrics include:

- **Postoperative morbidity:** This refers to complications arising soon after surgery. In a study from a tertiary teaching hospital in Addis Ababa, major morbidity was reported in 19.0% of patients who underwent surgery for gastric cancer (25). Reducing surgical morbidity is crucial not only for improving short-term recovery but also for enhancing long-term survival outcomes in patients undergoing surgery for gastric cancer.
- **Postoperative mortality:** This is a critical indicator, often measured as 30-day or in-hospital mortality and 90days postoperative mortality. The same study above reported a post-operative death rate of 12.8% (25). Another retrospective study in Addis Ababa indicated a postoperative mortality of 10.5% among patients who underwent surgery (10).
- **Length of hospital stay and readmission rates:** While these are standard metrics for short-term outcomes, specific data for gastric cancer patients in Ethiopia regarding these parameters were not explicitly detailed in the available literatures (25).

2.4.1 Factors affecting short-term outcomes of surgery in gastric cancer

Several factors can affect the short-term surgical outcomes for gastric cancer patients:

- **Patient-related factors:**
 - Age: Studies in Addis Ababa indicate a patient age range from 26 to 80 years, with a mean of 52.7 years (25). A significant percentage of patients were younger, with nearly a quarter (23.2%) below 45 years (10).

- Comorbidities and nutritional status are generally recognized as important, but specific data from the reviewed Ethiopian context were not detailed.

Gastric cancer patients are at a high risk for malnutrition and 30% to 38% of patients are reported to have > 10% weight loss in past six months (30). Malnutrition is associated with increased morbidity and mortality after gastric cancer surgery. Both malnourishment and weight loss are associated with poor clinical outcome after surgery (31).

Nutritional status plays a critical role in determining surgical outcomes for gastric cancer patients. For instance, a study showed that overweight patients [(BMI) > 25 kg/m²] are at an increased risk of complications. This showed increased complication rate (47.9% vs 35.8%). Obese patients especially had more anastomotic leakages (11.8% vs 5.4%) and wound infections (8.9% vs 4.7%). Several other studies have also shown the association between higher BMI and increased postoperative morbidity (32). This evidence highlights the importance of preoperative nutritional assessment and optimization as a key component of perioperative care in gastric cancer surgery.

- **Disease-related factors:**

- Tumor stage and location: A common challenge in Ethiopia, similar to other regions like Turkey, Iran, and Latin America, is late presentation with metastatic cancer, affecting approximately 51.2% of patients at presentation (23). Distal GC, involving the antrum and pylorus, are reported as the most prevalent in Addis Ababa (25).
- Histology: Gastric adenocarcinoma accounts for a large majority (85.1%) of cases (25).

- **Surgical factors:**

- Type of procedure: Distal subtotal gastrectomy is the commonest procedure done with curative intent, while bypass gastro-jejunostomy is often performed for palliation (25). Curative intent surgery was possible in 66% of patients in this study.
- Surgeon experience and facility volume: The quality of cancer surgery, particularly in terms of adequate lymph node dissection and margin status, is highlighted as an area that needs improvement in Africa, including Ethiopia.

Adequate lymph node dissection was achieved in less than a third of patients, and positive margins were noted in some cases, which is considered unacceptable for oncologic surgery (25). This suggests a need for better training and partnerships with international expertise.

- **Anesthetic and perioperative care practices:** While these are crucial for outcomes, specific details regarding their impact were not extensively covered in the provided excerpts. However, early oral feeding and optimized timing of oral diet have been shown to influence hospital stay (18).

2.4.2 Reported Short-term outcomes in Ethiopia

Data from a tertiary teaching hospital in Addis Ababa indicates a major postoperative morbidity rate of 19.0% and a mortality rate of 12.8% (25). This study considers these rates acceptable and comparable with results from other African countries. For instance, postoperative complication rates were 37.1% and mortality rates 18.1% in a retrospective review of cases in northwestern Tanzania. Similarly, a study in Nigeria, reported a postoperative complication rate of 27.7% and a mortality of 16.1%. The findings suggest that while complication and mortality rates are within the range reported in other African contexts, there is a clear need to improve the quality of oncologic surgery, particularly concerning lymph node retrieval and margin status (25).

2.5 Gaps in research and future directions

Existing research on short-term surgical outcomes for gastric cancer in Ethiopia is predominantly from a single major referral hospital in Addis Ababa, TASH (10,9). This limits a comprehensive understanding of outcomes across the country. In particular, there's a lack of up-to-date published data on these outcomes from St. Paul's Hospital, which makes it harder to identify areas for improvement and optimize patient care.

2.6 Conceptual framework

This conceptual framework serves as a foundational guide for this research on short term outcomes of surgery for gastric cancer at SPHMMC, Ethiopia. It was adopted by the researcher to guide the study, providing a structured basis for identifying key variables and understanding the complex relationships between them in analyzing postoperative outcomes.

In this framework, patient outcomes (postoperative complications, reoperation, death, or discharge improved) are affected by multiple interacting factors. Patient-related characteristics such as demographics, comorbidities, clinical status, and socioeconomic conditions—affect baseline risk and recovery capacity. Preoperative and intraoperative factors, including anesthesia type, blood loss, hypotension, transfusion, and duration of operation, directly impact surgical stress and immediate postoperative stability.

Tumor and oncologic characteristics, such as stage, size, and delays in diagnosis or treatment, reflect disease severity and influence both surgical complexity and prognosis. Surgical technique and intraoperative disease severity further determine the extent of intervention and risk of complications. Finally, peri- and early postoperative care processes, including timely antibiotics, VTE prophylaxis, and adherence to ERAS principles, play a critical role in modifying outcomes and promoting recovery.

By mapping out these relationships, the conceptual framework helps in identifying key variables that influence short-term surgical outcomes in gastric cancer for analysis and guide hypothesis testing.

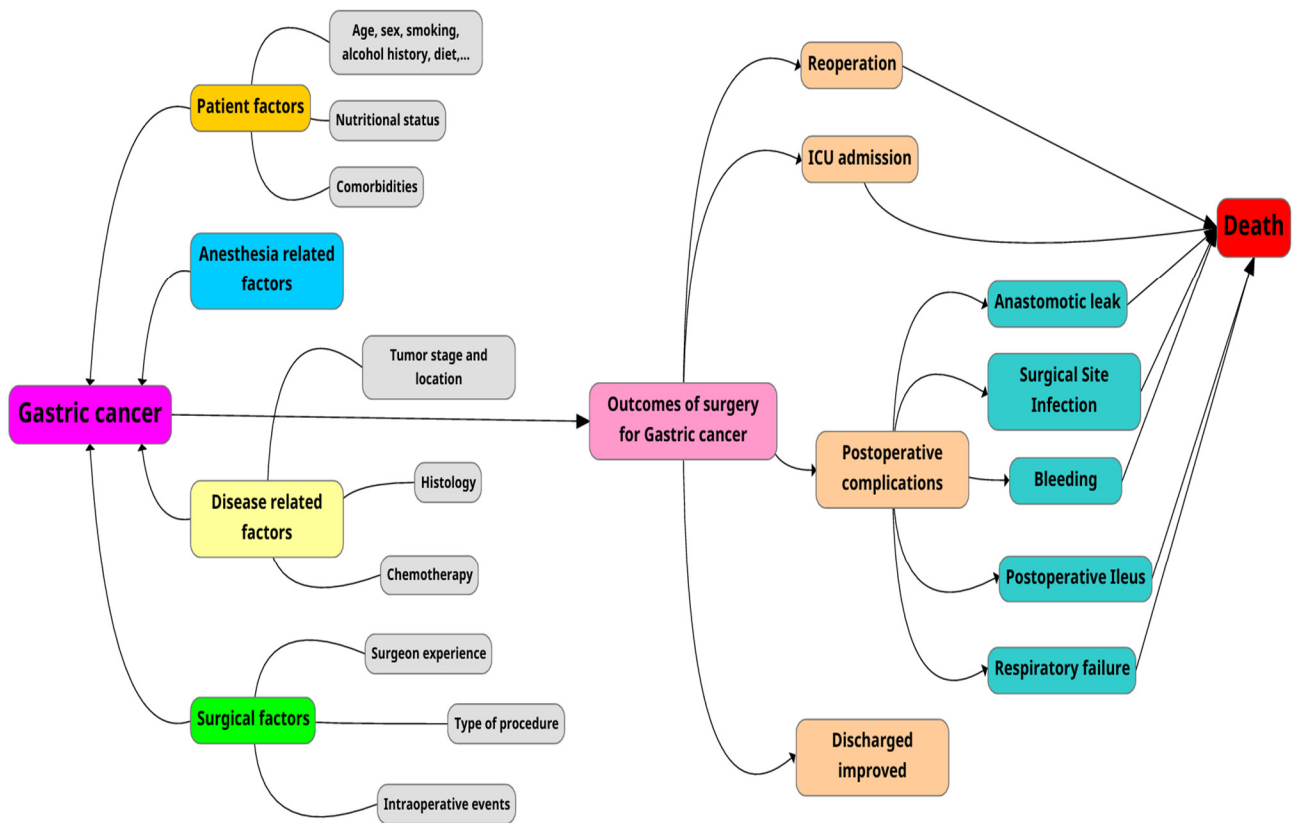


Figure 1: Conceptual framework

3. Objectives

3.1 General Objectives

- To assess the short-term surgical outcomes and associated factors among gastric cancer patients who underwent surgery at SPHMMC.

3.2 Specific Objectives

- To determine the short-term (90 days) surgical outcomes among gastric cancer patients at SPHMMC
- To identify factors associated with short-term surgical outcomes among gastric cancer patients at SPHMMC

4. Methods and materials

4.1 Study area and period

- The study was conducted at St. Paul's Hospital Millennium Medical College (SPHMMC), located in Addis Ababa, Ethiopia.
- Data was collected from patient records (both online on EMR and paper registries) documented in the Department of surgery from January 01, 2021, to August 31, 2025 G.C.

4.2 Study Design

- A hospital based retrospective chart review/study.

4.3 Population

4.3.1 Source Population

- All adult patients who were admitted at surgical wards of SPHMMC during the study period.

4.3.2 Study Population

- All patient records of adults (aged ≥ 18 years) who were diagnosed with gastric cancer, treated surgically, and admitted to the surgical wards of SPHMMC.

4.4 Eligibility criteria

4.4.1 Inclusion Criteria

- All patients aged ≥ 18 years with a histologic diagnosis of gastric cancer, and full clinical record on clinical stage and treatment given were included. Gastric cancers, not involving EGJ.
- Complete medical records available on EMR and/or on patient cards

4.4.2 Exclusion Criteria

- Incomplete medical records: patients registered but insufficient information or incomplete clinical records were excluded.

- Patients diagnosed elsewhere and referred only for treatment without diagnostic documentation.

4.5 Sample size determination and sampling technique

4.5.1 Sample size determination

All eligible patients with gastric cancer within the 5-year period who were found to have operable disease from pre-operative workup and operated at SPHMMC are included in the study (**census sampling**).

4.5.2 Sampling method and procedure

For a retrospective study assessing short-term surgical outcomes of gastric cancer patients, we used **census sampling** method due to the following reasons.

Rationale: Surgical volumes for gastric cancer are relatively low; therefore, including every eligible case (i) eliminates sampling error, (ii) maximizes statistical power and precision for estimating short-term outcomes, and (iii) improves representativeness of the defined study population. This approach also minimizes selection bias introduced by sampling.

Sample size considerations under census: Because all eligible cases are included, a formal sample size calculation is not required for selection. However, we reported the final cohort size and its achieved precision for the primary outcome (e.g., 95% CI around the 90-day complication rate).

Generalizability: Findings are generalizable to the population defined by the sampling frame (patients who underwent surgery for gastric cancer at SPHMMC during the study period).

4.6 Study variable

4.6.1 Dependent variables

- Short-term surgical outcomes were assessed using the following indicators within 90 days of surgery (or during the same hospital admission):
 - Occurrence of any postoperative complication (yes/no)
 - Unplanned ICU admission (yes/no)
 - Reoperation (yes/no)

- Postoperative mortality (death within 90 days or during admission) (yes/no)
- Discharge status (improved vs not improved/death)

4.6.2 Independent variables

a) Patient related factors:

These includes characteristics of individual patients that may influence outcomes. These include demographic (age, sex, residence, marital status,...), comorbidities (e.g. malnutrition, CVD, TB, RVI,..), occupation, lifestyle habits, clinical presentation, socioeconomic status, treatment adherence, and laboratory values (hemoglobin level, platelet count, INR, BUN/creatinine).

b) Preoperative and intraoperative:

These includes pre-op fasting duration (hours), pre-op transfusion (units), anesthesia type (general alone vs with epidural/nerve block), intraoperative hypotension (MAP <65 mmHg >10 min), intraoperative vasopressors used, intraoperative blood loss (ml; categories too), transfusion, and duration of operation (hours, minutes).

c) Tumor & oncologic characteristics (clinical):

These includes symptom duration before first presentation (weeks), time from first presentation to diagnosis, time from diagnosis to surgery (days), tumor location, clinical stage (by imaging/endoscopy), tumor size on imaging/endoscopy (cm), obstruction/bleeding/perforation at presentation, h. pylori status (if tested), and neoadjuvant therapy received.

d) Surgical technique & disease severity at surgery:

These includes surgical approach (open/laparoscopic/converted), type of gastrectomy (total/subtotal/proximal), extent of lymphadenectomy, reconstruction (Billroth I, Billroth II, Roux-En-Y), combined organ resection (e.g., spleen, pancreas, colon), intraoperative contamination/enterotomy, peritoneal contamination or ascites, surgeon seniority (consultant/resident with supervision) and case urgency (elective/urgent/emergency).

e) Peri- and early post-op care processes:

These includes the timing of prophylactic antibiotics (within 60 min of incision), VTE prophylaxis given, NG tube use beyond 24–48 h, early oral intake / mobilization per ERAS, and Post-op ICU admission planned vs unplanned.

4.7 Operational definitions

The following operational definitions are provided to ensure consistency and clarity in data collection and analysis procedures:

- **Gastric cancer patient:** Any patient with a histologically confirmed diagnosis of gastric cancer who underwent surgical intervention (curative or palliative) at SPHMMC during the study period
- **Comorbidity:** Any chronic medical illness diagnosed prior to surgery (e.g., hypertension, diabetes, HIV, TB, chronic liver/kidney disease, COPD)
- **ASA class:** American Society of Anesthesiologists physical status score (I–IV), recorded by anesthetist pre-op (Source: <https://uptodate.com>)
- **Tumor location:** Based on endoscopy or operative findings (proximal, body, distal).
- **Stage at presentation:** Patients were classified as follows:
 - Based on available imaging or intraoperative findings. (Source: *TNM staging of stomach cancer AJCC UICC 8th edition* <https://uptodate.com>)
 - Based on imaging and clinical findings (early/locally advanced/metastatic)
- **Type of surgery:** Subtotal gastrectomy, total gastrectomy, or palliative procedure (gastrojejunostomy, feeding jejunostomy, etc.).
- **Surgical approach:** Open vs laparoscopic.
- **Complete record:** A chart with full documentation of symptoms, investigations, management, and outcome (can be on EMR or patient card)
- **Short-term outcome:** Any outcome occurring within 90 days of surgery or during the same hospital admission (whichever is longer)
- **Postoperative complication:** Any deviation from the normal postoperative course, classified using the **Clavien-Dindo system**; Grade II or higher considered significant.

- **Surgical site infection (SSI):** Infection involving the incision or deep tissues within 90 days after surgery (*Source: CDC <https://www.cdc.gov/infection-control/hcp/surgical-site-infection/>*)
- **Anastomotic leak:** Clinical or radiological evidence of leakage of luminal contents from an anastomotic site.
- **Postoperative ileus:** Absence of passage of flatus/stool with abdominal distension and vomiting requiring nasogastric decompression beyond postoperative day.
- **Postoperative bleeding:** Drop in hemoglobin >2 g/dL or need for transfusion/reoperation due to bleeding (*Source: as used in many surgical studies*).
- **Pulmonary complication:** Occurrence of pneumonia, atelectasis, or respiratory failure requiring oxygen or ventilator support within 90 days.
- **Length of hospital stay:** Number of days from surgery to discharge. Categorized in this study as ≤ 7 days or > 7 days.
- **Unplanned ICU admission:** Admission to ICU postoperatively not scheduled preoperatively but required due to clinical deterioration.
- **Reoperation:** Any unplanned return to the operating room within 90 days of the index surgery.
- **90-day mortality:** Death from any cause within 90 days after surgery or during the index hospital admission.
- **Discharged improved:** The patient has been discharged from the hospital with stable vital signs, improvement of postoperative symptoms, and no immediate complications requiring further inpatient care.

5. Data collection tool, methods and procedures

A structured data extraction form was used to extract data from patient charts, pathology reports, and hospital registry. Variables include: age, sex, residence, occupation, smoking/alcohol history, dietary habits, H. pylori status, family history of cancer, cancer subtype, stage, and treatment modality.

Data was collected using a structured data extraction checklist developed based on literature and clinical relevance. This form was developed based on established surgical and oncologic guidelines, including the Clavien–Dindo classification, CDC definitions for surgical site infections, AJCC staging system, and ERAS perioperative care recommendations, as well as relevant literature on gastric cancer outcomes. This tool was designed to be completed by data collectors using an online Google Form questionnaire.

The checklist includes:

- Sociodemographic information
- Presenting symptoms
- Lab results
- Diagnosis and treatment interventions
- Patient outcomes

Two trained medical data collectors reviewed physical and electronic patient charts from the surgical wards. The tool was pre-tested on 10% of the sample in a non-study site to check clarity, consistency, and completeness, and modifications were made accordingly.

For the most part, data was extracted from online electronic medical records of patients, operative notes, anesthesia records, and discharge summaries. The principal investigator supervised the data collection and reviewed completed forms daily for accuracy and completeness.

The tool consists of four sections:

- (i) socio-demographic characteristics (age, sex, residence, occupation, insurance),

- (ii) clinical and comorbidity data (nutritional status, anemia, comorbid illnesses, ASA class, HIV status, tumor stage),
- (iii) perioperative and surgical details (type of surgery, surgical approach, operative time, blood loss, transfusion, urgency), and
- (iv) short-term surgical outcomes (postoperative complications based on *Clavien-Dindo* classification, SSI, anastomotic leak, ICU admission, length of stay, reoperation, and 90-day mortality).

5.1 Data quality control

Ensuring the reliability and accuracy of the collected data is key to the validity of this research.

The following measures were implemented throughout the research process:

1. **Standardized Data Collection Instruments:** Standardized survey instruments were utilized to promote consistency and uniformity in data collection procedures. This instrument (i.e., google form) was meticulously designed to capture relevant variables and outcomes aligned with the research objectives.
2. **Training:** Research team members involved in data collection were given an orientation/ training session. The session covered research ethics, how to access the EMR to obtain the required patient data and data collection techniques to ensure standardized data collection practices.
3. **Data Security and Confidentiality:** Adequate measures were implemented to ensure the confidentiality and privacy of participant data throughout the research process. Data was stored securely in password-protected google drive which only the principal investigator can access.

5.2 Data processing and analysis

- Data was entered and analyzed using SPSS version 26.
- Descriptive statistics was used to summarize demographic and clinical data.
- Categorical variables such as sex, comorbidities, type of surgery, and postoperative complications were presented using frequencies and percentages. Continuous variables such as age, operative time, blood loss, and length of hospital stay were summarized in tables.

- The prevalence of short-term surgical outcomes (e.g., overall complication rate, surgical site infection, anastomotic leak, 90-day mortality) was calculated and presented with 95% confidence intervals.
- Bivariate logistic regression was used for identifying individual/patient factors that might be associated with the outcome.
- Multivariable logistic regression method was used to analyze and identify independent predictors of an outcome while controlling for the effects of other variables. In this study, it was used to identify factors significantly affecting short term surgical outcomes in gastric cancer patients.
- Logistic regression assumptions were assessed prior to analysis. Independence of observations was ensured by study design, and the outcome variable was binary. Linearity between continuous predictors and the log odds of the outcome was checked using appropriate transformations where necessary.
- Model fitness was evaluated using the Hosmer–Lemeshow goodness-of-fit test, with a non-significant p-value indicating adequate fit. Multicollinearity among independent variables was assessed using Variance Inflation Factor (VIF), with VIF <10 considered acceptable.
- Results were presented using tables, graphs, and narrative summaries.

5.3 Ethical considerations

- Ethical approval was obtained from the Institutional Review Board of SPHMMC.
 - Approval for this study was obtained from the SPHMMC School of Public Health, the Academic & Research Director, and the Institutional Review Board under the letter (IRB Ref: PM 23/294), prior to enrollment.
- A formal letter was submitted to the medical service provost requesting the conduction of this research at the surgical wards of the hospital.
- Patient confidentiality was maintained by de-identifying all data.

5.4 Plan for dissemination of results

The study findings will be disseminated through academic and clinical channels to maximize reach and impact. Results will be presented at relevant national and international conferences (oral or poster presentations) to obtain peer feedback and encourage scholarly discussion. A full manuscript will be submitted to peer-reviewed medical journals, with additional submissions to specialty or regional journals where appropriate.

A concise plain-language summary will be prepared for clinicians, health program managers, and other stakeholders to facilitate translation into practice, and findings may be shared through institutional seminars, professional association newsletters, and targeted webinars. All dissemination will comply with ethical approvals, protect participant confidentiality, and clearly communicate study limitations to reduce risk of misinterpretation.

6. Results

6.1 Sociodemographic characteristics

A total of 194 gastric cancer cases were retrospectively identified; 38 were excluded due to incomplete records or not meeting inclusion criteria, yielding a final sample of 156 (response rate= 80.4%).

Of the study participants, 94 (60.3%) were male and 62 (39.7%) were female, yielding a male-to-female ratio of 1.5:1. The age of the patients ranged from 26 to 80 years, with a mean age of 55 years. 34% percent of the patients were younger than 45 years, while more than two-thirds (66%) were aged 45 years and above. A majority of the participants were from rural areas, accounting for 107 (68.5%) cases, whereas 49 (31.4%) were from urban settings. A sizable proportion of the study participants were married (96, 65.3%).

Blood group A and B were found to be the most prevalent blood groups accounting for 45.6% and 25.9% respectively. At presentation, 52 (33.4%) of the patients had one or more comorbidities (Table 1).

Table 1.0 Sociodemographic characteristics of gastric cancer patients operated at SPHMMC over the past 5 years (n=156)

	Category	Frequency (n=156)	Percent (%)
Sex	Male	94	60.3
	Female	62	39.7
Age	20-29	2	1.3
	30-39	21	13.5
	40-49	30	19.2
	50-59	37	23.7
	60-69	40	25.6
	>70	26	16.7
Region	Urban	49	31.4
	Rural	107	68.6
Marital status	Married	96	65.3
	Single	23	15.6
	Divorced	6	4.1
	Widow	4	2.7
	Unknown	27	17.3
Blood group	A	67	45.6
	B	38	25.9
	AB	7	4.8
	O	27	18.4
	Unknown	17	10.8
Comorbidity	No	104	66.7
	Yes	52	33.3

6.2 Clinical and Pathological Characteristics

The most common presenting symptom among the study participants was epigastric pain, reported by 124 patients (84.4%). This was followed by unintentional weight loss, which was seen in 106 patients (67.9 %).

Nausea and vomiting were also commonly observed, affecting 94 patients (63.9%), while anorexia was present in 66 patients (44.9%). Less frequently reported symptoms included early satiety in 43 patients (29.3%) and dysphagia in 28 patients (19.0%). Melena was reported by 11 patients (7.5%). Other symptoms included easy fatigability (2.7%) and other non-specific complaints (1.4%). (Table 2)

Table 2: Presenting symptoms of gastric cancer patients operated at SPHMMC over the past 5 years (n=156)

Chief complaint		Frequency (%)	Percent (%)
Unintentional weight loss	<5%	4	2.6
	5–10%	13	8.3
	>10%	89	57
	Total	106	67.9
Epigastric pain		124	84.4
Anorexia		66	44.9
Nausea and vomiting		94	63.9
Early satiety		43	29.3
Dysphagia		28	19.0
Melena		11	7.5
Easy fatigability		4	2.7
Others		2	1.4

Among the 156 gastric cancer patients included in the study, the **majority** had significant unintentional weight **loss**. More than half of the patients (89; 57%) reported weight loss greater

than 10% of their body weight. Overall, **67.9%** of the patients experienced some degree of unintentional weight loss.

Tumor location was predominantly in the distal stomach, with 95 (64.6%) cases involving the antrum and pylorus. Proximal gastric tumors (cardia and fundus) accounted for 26.5% of cases, while the remaining 8.8% were located in the body of the stomach.

Histopathology report showed 119 (76.3%) had adenocarcinoma, 33 (21.2%) had malignant gastrointestinal stromal tumor GIST, and 2 (1.2%) were neuroendocrine tumor. Majority (85.9%) of the surgeries conducted at the hospital were curative intent whereas the remaining were palliative (Table 3& 4).

Of the study participants, 120 (76.9%) were non-reactive for retroviral infection (RVI) at baseline during preoperative evaluation. 9 (5.8%) patients had a known RVI diagnosis and were already on HAART. For the remaining participants, provider-initiated testing and counselling (PITC) status was not documented in the electronic medical record (EMR). (Table 4)

Majority of the patients 84.6% had an ECOG performance status of 0–1, whereas 21 patients (13.5%) had an ECOG score of ≥ 2 ; performance status was unknown in 3 patients (1.9%).

More than half of the patients (88; 56.4%) reported symptom duration greater than six months prior to presentation, while 68 patients (43.6%) presented within six months of symptom onset.

Assessment of *H. pylori* status showed that 103 patients (66.0%) were *H. pylori*–negative, 13 patients (8.3%) were positive, while the status was unknown in 40 patients (25.6%). The majority of cases were managed as elective surgeries (146; 93.6%), with 10 patients (6.4%) requiring emergency intervention. (Table 4).

Based on *Lauren* classification, the diffuse subtype of GC was the most frequent, accounting for 72 patients (46.2%), followed by the intestinal subtype in 49 patients (31.4%). Mixed histology was rare (1.3%), while histologic subtype was not reported in 21.2% of cases.

Table 3: Clinical and Pathological Characteristics of gastric cancer patients operated at SPHMMC over the past 5 years (n=156)

	Category		Frequency (n=156)	Percent (%)
Histology	Adenocarcinoma		119	76.3
	GIST		33	21.2
	Neuroendocrine/carcinoid		2	1.3
	Others		2	1.2
Lauren subtype	Intestinal		49	31.4
	Diffuse		72	46.2
	Mixed		2	1.3
	Not reported		33	21.2
Intention of surgery	Curative intent		115	73.7
	Palliative intent	Feeding jejunostomy	11	7.1
		Exploration alone	24	15.4
		Bypass GJ	5	3.2
		Others	1	0.6
ECOG PS	0-1		132	84.6
	>or =2		21	13.5
	Unknown		3	1.9
Complications at presentation	Obstruction		19	12.2
	Bleeding		8	5.1
	Perforation		6	3.84
	None		123	78.8
Symptom duration at presentation	>6months		88	56.4
	<6months		68	43.6

Tumor location	Proximal:- cardia and fundus	41	26.3
	Body	13	8.3
	Distal:-antrum and pylorus	102	65.4
H. Pylori	Negative	103	66.0
	Positive	13	8.3
	Unknown	40	25.6
Case urgency	Elective	146	93.6
	Emergency	10	6.4
PICT Status	Reactive	9	5.8
	Non-reactive	120	76.9
	Unknown	27	17.3

Based on imaging findings (UGIE, CT of abdomen), 97 patients (62.2%) were found to have an early stage gastric cancer. The remaining were locally advanced and metastatic; 45 (28.8%) and 10 (6.4%) respectively. (Table 4).

Table 4: Clinical and pathologic stage of gastric cancer of gastric cancer patients operated at SPHMMC over the past 5 years (n=156)

		Frequency (n=156)	Percent (%)
Early		97	62.2
Locally advanced		45	28.8
Metastatic		10	6.4
Not documented		4	2.6
Stage of gastric cancer	I	13	8.3
	II	78	50
	III	43	27.6
	IV	-	-
	Unknown	22	14.1

The majority, 91 (58.3%), were underweight (BMI <18.5). About 58 participants (37.2%) had a normal BMI (18.5–24.9), while only a very small proportion, 2 (1.3%), were overweight (BMI 25–29.9). Additionally, 5 participants (3.2%) had unknown BMI status.

Table 5: Preoperative baseline investigations of gastric cancer patients operated at SPHMMC over the past 5 years (n=156)

		Frequency (n=156)	Percent (%)
Anemia	No	107	68.6
	Yes: (Hb <13 g/dL male; <12 g/dL female)	49	31.4
	Unknown	9	
Albumin	≥ 3.5 g/dL-Normal	58	37.2
	3.0–3.4 g/dL-Mild hypoalbuminemia	56	35.9
	2.5 – 2.9 g/dL-Moderate hypoalbuminemia	24	15.4
	< 2.5 g/dL-Severe hypoalbuminemia	18	11.5

The most commonly performed type of surgery in this study was subtotal (distal) gastrectomy, done in 87 patients (55.8%). Proximal gastrectomy was done in 21 patients (13.5%), and total gastrectomy in 8 patients (5.1%). In 12 (7.6%) patients, *Braun's anastomosis* was done. 3 patients were found to be unrespectable cancer intraoperatively.

Esophagogastrectomy procedures included Ivor-Lewis esophagogastrectomy in 4.5% and trans hiatal esophagogastrectomy in 1.9 % of patients. Other resections such as wedge resection were done in 5.8 %, while feeding gastrostomy was required in 6.4% of cases. Other procedures accounted for 2.6%.

Table 6: Type of surgery and LVI and PNI status of gastric cancer patients operated at SPHMMC over the past 5 years (n=156)

		Frequency (n=156)	Percent (%)
Total gastrectomy		8	5.1
Subtotal/Distal gastrectomy		87	55.8
Proximal gastrectomy		21	13.5
Near total gastrectomy		1	0.6
Wide local excision		6	3.8
Ivory lewis esophagogastrectomy		7	4.5
Trans hiatal esophagogastrectomy		3	1.9
Wedge resection		9	5.8
feeding gastrostomy		10	6.4
others		4	2.6
LNI and PNI status			
Lympho-vascular Invasion (LVI)	POS	27	17.3
	NEG	83	53.2
	Unknown	46	29.5
Perineural Invasion (PNI)	POS	13	8.3
	NEG	69	44.2
	Unknown	74	47.4

6.3 Clinical outcomes following surgery

Among the patients operated 21 patients had major morbidity with grade III and IV Clavien-Dindo complications (those who needed re-exploration or developed organ failure) and 28 patient died making operative mortality of **17.9%** but the rest of patients were discharged improved. 7 patients came back with recurrence during follow up— (Table 9).

Table 7: Clavien-Diindo grade of gastric cancer patients operated at SPHMMC over the past 5 years (n=156)

	Frequency (n=156)	Percent (%)
Class I	10	6.4
Class II	97	62.2
Class IIIA	18	11.5
Class IVA	3	1.92
Class V	28	17.94

The majority of patients (110; 70.5%) had a hospital length of stay of ≤ 7 days, while 46 patients (29.5%) stayed for more than 7 days.

Intraoperative events were uncommon, where 148 patients (94.9%) had uneventful hospital course. Intraoperative hypotension requiring vasopressors occurred in 6 patients (3.8%), and other intraoperative events such as (Enterotomy/Contamination) were reported in 2 patients (1.3%).

Most patients did not require intraoperative blood transfusion (144; 92.3%), while 12 patients (7.7%) received transfusions.

Table 8: Perioperative and intraoperative events of gastric cancer patients operated at SPHMMC over the past 5 years (n=156)

		Frequency (n=156)	Percent (%)
Length of hospital stay	≤7 days	110	70.5
	>7 days	46	29.5
	Total	156	100.0
Intraoperative events	None	148	94.9
	Hypotension requiring vasopressors	6	3.8
	Others	2	1.3
Combined organ resection	Yes (e.g. splenectomy, colectomy)	11	7.1
	No	133	85.3
	Unknown	12	7.7
Intraoperative transfusion	No	144	92.3
	Yes	12	7.7

Estimated blood loss was 300 mL or less in 78.8% of patients. Specifically, blood loss was 100 mL in 19.9%, 200 mL in 26.3%, and 300 mL in 32.7% of cases. Higher blood loss volumes of 400 mL and 500 mL were observed in 12.2% and 9.0% of patients, respectively.

Surgical site infection (SSI) occurred in 30 patients (19.2%). Of these, 17 patients (10.9%) developed superficial incisional SSI and 13 patients (8.3%) developed deep incisional SSI, whereas 126 patients (80.8%) had no SSI.

Generally, postoperative complications occurred in 59 patients (37.8%), while 97 patients (62.2%) experienced no documented complications. Unplanned ICU admission was required for 7 patients (4.5%), whereas the majority (95.5%) did not require unexpected critical care. Planned ICU admission was reported in 9 patients (5.8%).

Hospital readmission within 90 days occurred in 7 patients (4.5%), while 95.5% of patients were not readmitted during the follow-up period. (Table 9).

Table 9: 90 days' postoperative surgical outcomes in patients operated for gastric cancer at SPHMMC over the last 5 years

			Frequency (n=156)	Percent (%)
Postoperative outcome	Survived (discharged improved)		126	80.8
	Died		28	17.9
	Unknown or lost to follow up		6	3.8
Surgical site infection	No		126	80.8
	Yes	Superficial Incisional	17	10.9
		Deep incisional	13	8.3
Postoperative complications	No		97	62.2
	Yes	SSI	30	19.2
		Pulmonary (e.g. pneumonia, atelectasis, others)	14	8.9
		Hernia	9	5.8
		PTE	6	3.9
		Total	59	37.8
Recurrence	-		7	4.5
Unplanned ICU admission	No		149	95.5
	Yes		7	4.5
Planned ICU admission	No		147	94.2
	Yes		9	5.8
Readmission in 90days	No		149	95.5
	Yes		7	4.5

Postoperative chemotherapy was administered to 87 patients (55.8%), while 69 patients (44.2%) did not receive adjuvant treatment. Among those who received chemotherapy, **CAPOX** was the most commonly used regimen, given to 55 patients (35.3%), followed by FOLFOX in 28 patients (17.9%). Other chemotherapy regimens were used in 4 patients (2.6%).

Preoperatively, only 13 patients (8.3%) were given chemotherapy whereas the remaining were not. (Table 10).

Table 10: Chemotherapy before and after surgery

				Frequency (n=156)	Percent (%)
Neoadjuvant chemotherapy			No	143	91.6
			Yes	13	8.3
Postoperative chemotherapy	No			69	44.2
	Yes	Regimen	FOLFOX* ^a	28	17.9
			CAPEX* ^b	55	35.3
			Others	4	2.6

*a: FOLFOX= FOL – Folinic acid (leucovorin), F – 5-Fluorouracil (5-FU), OX – Oxaliplatin.

*b: CAPEX= CAP – Capecitabine, OX – Oxaliplatin

In some of the patients operated for GC, reconstruction techniques used have been recorded. Among these, Billroth II reconstruction technique was used most commonly, accounting for 10.3% or 16 cases, followed by Roux En Y reconstruction, accounting for 4.5% or 7 cases, and Billroth I reconstruction technique, accounting for 1.3% or 2 cases.

However, in nearly half of the cases, the type of reconstruction was not documented, accounting for 48.1% or 75 cases. Additionally, 35.9% or 56 cases have been recorded as "other" reconstruction techniques.

Table 11: Reconstruction and extent of lymphadenectomy of gastric cancer patients operated at SPHMMC over the past 5 years (n=156)

	Frequency (n=156)	Percent (%)
Bilroth I	2	1.3
Bilroth II	16	10.3
Roux en Y	7	4.5
Other	56	35.9
Unknown	75	48.1
<i>Extent of lymphadenectomy</i>		
D1 lymph node dissection	9	5.8
D1+ lymph node dissection	10	6.4
D2 lymph node dissection	29	18.6
Not recorded	108	69.2

In the majority of cases, documentation regarding whether lymphadenectomy was performed was unavailable (108 patients; 69.2%). Among the cases with recorded information, D2 lymph node dissection was the most frequently performed procedure, carried out in 29 patients (18.6%), followed by D1+ dissection in 10 patients (6.4%) and D1 dissection in 9 patients (5.8%).

Out of the 156 patients with gastric cancer, surgical margin status was free in 79 cases (50.6%). Positive resection margins were identified in 24 patients (15.4%). Margin status was not reported in 53 cases, accounting for 34% of the study population. (Table 12).

Table 12: Margin status of gastric cancer

	Frequency (n=156)	Percent (%)
Free	79	50.6
Positive	24	15.4
Not reported	53	34.0

Bivariate/Multivariate logistic regression of factors affecting the short term (90-days) surgical outcomes of patients with gastric cancer at SPHMMC over the past 5 years

Bivariate logistic regression analysis was done to assess factors associated with 90-day postoperative outcomes.

Table 13: Univariate/bivariate logistic regression of factors affecting short term surgical outcomes in gastric cancer patients at SPHMMC from 2001 to 2025 G.C. (n=156)

	Category	COR	P-value
Any comorbidity	Yes	6.340 (2.606-15.42)	.000
	No	1.00 (Ref)	
Any postoperative complication	Yes	4.808 (2.06-11.18)	.000
	No	1.00 (Ref)	
Surgical site infection	Yes	2.32 (1.15-4.67)	.018
	No	1.00 (Ref)	
STAGE of disease	I-IV	2.2 (1.28-3.7)	.004
T stage	T1-T4	0.99(.98-1.0)	.91
N stage	No-N3	1.0(.99-1.01)	.90
M stage	Mo-Mx	1.7 (.33-8.7)	.52
Type of surgery	-	1.180 (1.028-1.354)	.018
Case urgency	Emergency	7.2 (1.9-27.6)	.004
	Elective	1.00 (Ref)	
Length of hospital stay	>= 7days	3.86 (1.7-8.7)	.001
	< 7 days	1.00 (Ref)	
Unplanned post op ICU admission	Yes	5.5(1.37-22.2)	.016
	No	1.00 (Ref)	
Intraoperative events	Yes	2.97 (1.2-7.4)	.020
	No	1.00 (Ref)	
Clavien-Diando grade	-	1.8 (1.037-3.12)	.037
Serum Albumin	<3.5	1.52 (1.03-2.24)	0.03
	>3.5 (normal)	1.00 (Ref)	
Intention of surgery	Curative	5.8 (2.1-15.7)	0.01
	Palliative	1.00 (Ref)	
Extent of lymphadenectomy	D1-D2	1.1(0.6-1.7)	0.70
Duration of operation	>6hours	1.2 (0.81-1.7)	0.36
	<6hours	1.00 (Ref)	

Reconstruction	-	1.0 (0.99-1.01)	0.14
Lymphovascular Invasion	POS	0.993 (0.98-1.005)	.275
	NEG	1.00 (Ref)	
Perineural Invasion	POS	1.0 (0.99-1.01)	.892
	NEG	1.00 (Ref)	
Tumor location	-	0.994 (0.634-1.557)	.978

For instance, the bivariate logistic regression analysis demonstrated that patients with comorbidities had 6.3 times higher odds of experiencing poor postoperative outcomes compared to those without. Furthermore, in the multivariate analysis, the association remained statistically significant, with a Crude Odd Ratio (COR) of 6.3, confirming a strong relationship between comorbidity and postoperative outcome in this study.

Likewise, emergency surgery was associated with a markedly higher likelihood of poor outcome compared to elective surgery (Table 13).

Patients with unplanned postoperative ICU admission had significantly higher odds of poor outcomes (OR = 5.5, $p = 0.016$), as did those with intraoperative events (OR = 2.97, $p = 0.020$). Higher Clavien–Dindo grades were also associated with worse outcomes (OR = 1.8, $p = 0.037$). Additionally, palliative surgery was associated with poorer outcomes compared to curative intent (Table 13). Type of surgery also showed a significant association ($p = 0.018$).

Consequently, multivariate logistic regression analysis was done to identify independent predictors of the outcome. Variables entered into the model included surgical site infection, presence of comorbidities, symptom duration at presentation, intention of surgery, unplanned postoperative intensive care unit admission, postoperative complications, length of hospital stay, and disease stage.

All candidate independent variables were initially entered into the logistic regression model. A forward conditional variable selection method was applied to identify factors independently associated with the outcome. Variables were sequentially entered into the model based on their statistical contribution, and only variables demonstrating a **strong association ($p < 0.05$)** were retained in the final multivariable model. Adjusted odds ratios (AORs) with corresponding 95% confidence intervals were reported to quantify the strength of associations.

Table 14: Multivariate logistic regression of analysis of factors associated with 90-day postoperative outcomes of patients with gastric cancer at St. Pauls' Hospital (n=156)

	Category	AOR	95% CI	P- Value
Any comorbidity	Yes	2.721	(1.089-6.804)	.032
	No	1.00 (Ref)		
Intention of surgery	Palliative	7.69	(2.587- 22.85)	.000
	Curative	1.00 (Ref)		
Any postoperative complication	Yes	5.226	(1.1-24.36)	.035
	No	1.00 (Ref)		
Surgical Site Infection (SSI)	Yes	2.248	(1.03-4.8)	.040
	No	1.00 (Ref)		
STAGE	I to IV	2.668	(1.24-5.72)	.012

7. Discussion

7.1 Patient Demographics and Clinical Characteristics

The patient cohort in this study showed demographic characteristics largely consistent with existing literature from Ethiopia and other sub-Saharan African countries. The study cohort consisted of 156 patients, with a predominance of male participants ($n = 94$, 60.3%) compared to females ($n = 62$, 39.7%), yielding a male-to-female ratio of **1.5:1**. The age distribution peaked in the 60–69 age group (25.6%), followed closely by the 50–59 group (23.7%). In particular, a majority of the patients came from rural areas (68.6%) and were married (65.3%).

In this study, gastric cancer occurred more commonly in men than women (60.3% vs 39.7%; male-to-female ratio 1.5:1). This male predominance is consistent with international epidemiology, where gastric cancer incidence is generally higher among men across most world regions (33).

The mean age in this study was 55 years (range 26–80), and more than one-third of cases were diagnosed before 45 years of age. While gastric cancer is typically considered a disease of older adults globally, recent international literature increasingly recognizes a subset of *early-onset gastric cancer*, with several settings reporting stable or rising trends in younger adults particularly for non-cardia disease (25, 34).

The relatively high proportion of younger patients in our sample could indicate a greater contribution of early-life or persistent exposures (i.e., *Helicobacter pylori*), differences in population age structure, or delayed diagnosis leading to more symptomatic presentations at younger ages. (9) It may also suggest a larger share of diffuse-type histology in younger individuals, a pattern widely described in gastric cancer epidemiology, although histologic confirmation would be needed to support this interpretation (24).

Most patients in our study were from rural areas (66.7%). Internationally, rural residence is often linked with higher prevalence of established gastric cancer risks such as *H. pylori* infection, dietary salt exposure, and socioeconomic disadvantage, which can translate into higher risk and later stage at presentation. (35) At the same time, rural–urban differences observed in hospital-based studies can also reflect access pathways and referral dynamics rather than true population incidence. Therefore, while our findings are compatible with the broader international understanding that

social and environmental risk gradients matter in gastric cancer, population-based data would be required to determine whether the rural predominance reflects higher underlying incidence or differential access to diagnostic care (24).

However, the fact that majority of the patients are from rural areas may explain the lack of association between symptom duration at presentation and stage; this suggests that even when symptoms are caught early, barriers to access may result in advanced stages regardless of duration.

7.2 Nutritional status

Gastric cancer patients are at a high risk for malnutrition and more than 80% of patients in this study have unintentional weight loss in past six months. A misbalance between energy expenditure and nutritional supplementation is the fundamental physiologic derangement leading to cancer induced weight loss. Tumor related causes of malnutrition include early satiety and obstruction, but also tumor induced metabolic alterations. Malnutrition is associated with increased morbidity and mortality after gastric cancer surgery (36).

A considerable fraction of patients in our study presented with anemia (31.4%) and varying degrees of hypoalbuminemia, with 62.8% having mild to severe forms. These indicators of poor nutritional status underscore the advanced nature of the disease at presentation, which is a common challenge in low-resource settings and a known predictor of worse surgical outcomes (18).

Serum albumin is mainly an indicator of nutrition risk and systemic inflammation. In malignancy patients, a low albumin often reflects the combined effects of malnutrition, inflammation, and disease burden, and it correlates strongly with worse clinical outcomes. Severe hypoalbuminemia i.e., <2.5 g/dL, was strongly associated with increased 90-day postoperative mortality.

In this study, patients with hypoalbuminemia had 1.52 times higher odds of mortality, ($p=0.03$ in the bivariate logistic regression) compared to those with normal albumin levels. This finding shows the importance of nutritional status as a significant prognostic factor and suggests that aggressive preoperative nutritional optimization could potentially improve outcomes.

The majority of our patients had locally advanced (28.8%) or metastatic (6.4%) disease, with 62.2% in early stages and 2.6% undocumented. This aligns with observations that diagnostic delays in low-resource settings often lead to advanced disease presentation (37).

In our study, the majority, 91 (58.3%), were underweight (BMI <18.5), indicating a high prevalence of undernutrition in the study population. It is highly important to thoroughly screen patients for malnutrition as interventions can be done to preoperatively improve nutritional status and subsequently surgical outcome. Both malnourishment and weight loss are associated with poor clinical outcome after surgery. (38) It is important to provide nutritional support in patients with gastric cancer in order to reduce postoperative complications and increase long-term quality of life.

7.3 Quality of Surgery and surgeons' expertise

Quality of surgery in gastric cancer shows how effectively and safely a surgical procedure achieves optimal oncologic outcomes while minimizing complications. High-quality surgery is primarily defined by complete tumor removal with negative margins (R0 resection) and adequate lymph node dissection, typically at least a D1+ or D2 lymphadenectomy, with retrieval of ≥ 15 lymph nodes for accurate staging.

Equally important is adherence to standardized surgical techniques, including proper tumor handling, avoidance of spillage, and appropriate reconstruction. Surgeon expertise and hospital volume significantly influence outcomes; high-volume centers are associated with lower morbidity and mortality (39).

In this study, assessment of the type of surgery revealed that subtotal gastrectomy was the most common procedure performed. Regarding lymphadenectomy, D2 dissection was performed in only 18.6% of cases, with D1 or D1+ accounting for a small proportion, and lymph node dissection extent not recorded in a significant 69.2% of patients. This suggests a potential gap in adherence to optimal oncological standards, as adequate lymph node dissection is crucial for accurate staging and prognosis in gastric cancer.

Similarly, adequate lymph node dissection was achieved in less than a third of patients in the study at TASH, concluding that while morbidity and mortality might be acceptable, the quality of cancer surgery, particularly in terms of lymph node retrieval and margin status, was suboptimal (10). Our study also found that surgical margin status was free in 50.6% of cases, with positive margins in 15.4%, and not reported in 34%. These findings collectively point to a need for improved surgical training and standardized oncological procedures in the region.

The success of gastric cancer surgery is closely linked to the surgeon's expertise, as experienced specialists not only perform technically demanding resections and lymphadenectomies with precision, but also integrate nutritional support and multidisciplinary care to improve survival, reduce complications, and enhance patients' quality of life.

A systematic review and meta-analysis found that *higher surgeon volume was associated with lower 30-day mortality* after gastrectomy, and high-volume centers showed better survival outcomes overall, supporting the argument that experience and systems of care matter, not only patient factors. (39)

In this study, we found that all gastric surgeries were performed under the supervision of a senior specialist, assisted by senior resident physicians. Experienced gastric cancer surgeons are more likely to deliver key technical and oncologic standards, including safer reconstruction, fewer technical complications, and more consistent adequate lymphadenectomy and staging quality, which influences adjuvant treatment decisions and survival.

7.4 Perioperative care practices and reconstruction techniques

Estimated blood loss was 300 mL or less in 78.8% of patients. Specifically, blood loss was 100 mL in 19.9%, 200 mL in 26.3%, and 300 mL in 32.7% of cases. Higher blood loss volumes of 400 mL and 500 mL were observed in 12.2% and 9.0% of patients, respectively.

The observed estimated blood loss (EBL) in gastric cancer surgery, with 78.8% of patients experiencing ≤ 300 mL, reflects a generally favorable perioperative management. This is particularly noteworthy given that global benchmarks often consider $EBL < 200$ mL as optimal for early-stage gastric cancer, while $EBL > 400$ mL can significantly impact long-term survival

(40). The breakdown of EBL (19.9% at 100 mL, 26.3% at 200 mL, 32.7% at 300 mL) suggests a majority of cases are managed within acceptable limits.

However, the 21.2% of patients with higher EBL indicates a subset of cases with more challenging surgical conditions. In the African context, where late presentation and advanced disease stages are common, leading to more complex surgeries and potentially higher blood loss (41), achieving $EBL \leq 300$ mL in nearly 80% of patients is commendable. This outcome suggests adherence to good surgical practices, although the higher EBL in a fifth of patients might still correlate with advanced tumor characteristics or anatomical complexities, consistent with challenges in resource-limited settings.

In this study, reconstruction techniques used have been recorded in few patients. Among these, Billroth II reconstruction technique was used most commonly, accounting for 10.3%, followed by Roux En Y reconstruction, accounting for 4.5%, and Billroth I reconstruction technique, accounting for 1.3%. However, in majority of the cases, the type of reconstruction was not documented, accounting for 48.1%.

Roux-en-Y is the accepted standard technique for re-constructing bowel continuity after total gastrectomy. Billroth I and II reconstruction after distal gastrectomy have been the standard for a long time but are associated with increased rates of reflux symptoms and esophagitis (42). Roux-en-Y reconstruction as an alternative after distal gastrectomy has been thoroughly investigated. Studies have shown beneficial outcomes in terms of less reflux symptoms and less gastric remnant gastritis. (43,44) These findings persist in long-term follow-up. (45) However, patients did not differ in terms of quality of life. (46) Morbidity and mortality were similar between Billroth I and Roux-en-Y technique, but the latter was associated with longer length-of-stay and discontinuance of food intake (47).

7.5 Chemotherapy in gastric cancer

Gastric cancer is often diagnosed in locally advanced or metastatic stage and, therefore, has a poor prognosis. Systemic chemotherapy is recommended for patients with stage II or III disease as neoadjuvant or perioperative treatment and for patients with stage IV as a single-modality

treatment. In the latter case, only 10% of the patients survive longer than 2 years. Unlike with other tumor entities, such as colon and ovarian cancer, in which multimodality approaches are frequently used for select patients in stage IV, patients with metastatic gastric cancer generally receive only palliative chemotherapy. (48)

In our study, postoperative chemotherapy was administered to 87 patients (55.8%). Among those who received chemotherapy, CAPOX was the most commonly used regimen, given to 55 patients (35.3%), followed by FOLFOX in 28 patients (17.9%). Other chemotherapy regimens were used in 4 patients (2.6%). Preoperatively, only 13 patients (8.3%) were given chemotherapy whereas the remaining were not.

In the management of locally advanced gastric cancer (LAGC), the fluoropyrimidine-oxaliplatin doublets FOLFOX (5-fluorouracil, leucovorin, and oxaliplatin) and CAPEOX (capecitabine and oxaliplatin) serve as foundational systemic therapies in both perioperative and postoperative settings. Traditionally, adjuvant (postoperative) chemotherapy with CAPEOX was established as a standard of care, particularly in Asian populations, following the CLASSIC trial which demonstrated significant improvements in disease-free survival (DFS) and overall survival (OS) after D2 gastrectomy. (49) However, clinical practice has increasingly shifted toward a perioperative approach: comprising both preoperative (neoadjuvant) and postoperative phases to facilitate tumor downstaging, increase R0 resection rates, and early eradication of micrometastases (50).

While the triplet FLOT (fluorouracil, leucovorin, oxaliplatin, and docetaxel) is currently the preferred perioperative regimen in Western guidelines (NCCN, ESMO) due to superior survival outcomes shown in the FLOT4 trial, FOLFOX and CAPEOX remain critical "Other Recommended" alternatives for patients who are unable to tolerate the toxicity of docetaxel or in regions where docetaxel is not standard. (51,52) Recent evidence, including real-world data from 2025, suggests that perioperative FOLFOX/CAPEOX significantly improves 4-year OS compared to postoperative administration alone (78% vs 51% in some cohorts) (53).

Furthermore, the choice between FOLFOX and CAPEOX is often dictated by logistical factors and patient preference; CAPEOX offers the convenience of oral capecitabine, while FOLFOX utilizes an infusion pump but avoids the hand-foot syndrome more commonly associated with

capecitabine. In the adjuvant setting, current 2025–2026 guidelines also suggest that three months of CAPOX may be non-inferior to the conventional six-month course in specific patient subgroups, potentially reducing oxaliplatin-induced neurotoxicity without compromising oncologic outcomes. (54) Ultimately, FOLFOX and CAPEOX provide a balanced efficacy-to-toxicity profile that underpins modern multimodal gastric cancer treatment strategies.

Chemotherapy is an important component of gastric cancer management in Ethiopia, mainly used in advanced or metastatic disease and as adjuvant or palliative therapy. Studies at major centers such as Tikur Anbessa Specialized Hospital shows that commonly used regimens include cisplatin-based combinations, particularly cisplatin with paclitaxel or 5-fluorouracil (5-FU). However, the current practice is challenged by late-stage presentation, with a large proportion of patients diagnosed at stage IV, limiting curative treatment options (55).

Chemotherapy is therefore often palliative, aiming to improve survival and symptom control. Some regimens, such as paclitaxel-based combinations, have shown survival benefit in local studies discussed above. Despite its role, several limitations exist, including low treatment adherence (around 42.6%), toxicity (e.g., high rates of neutropenia), and significant malnutrition among patients, which affect treatment outcomes (56).

Overall, chemotherapy practice in Ethiopia follows global principles but is constrained by resource limitations, late diagnosis, and treatment-related challenges, highlighting the need for improved early detection and supportive care.

7.6 Post-operative care and follow ups

Enhanced recovery after surgery (ERAS) programs have been developed and implemented with great success in colorectal surgery (57). All recommendations by ERAS society for colonic surgery can potentially be implemented in gastric cancer patients, i.e., early removal of urinary catheter, prevention of postoperative ileus, postoperative analgesia, and early mobilization and resumption of normal diet (58).

A study from South Korea revealed that the ERAS program significantly improved early recovery, as measured using the QoR-15K score, after minimally invasive gastric cancer surgery. The ERAS

program also improved postoperative pain control, reduced postoperative opioid consumption, and enhanced the recovery of gastrointestinal function. These improvements are likely attributable to the use of multimodal opioid-sparing analgesia and a shortened perioperative fasting period, both of which contribute to reduced postoperative pain and accelerated gastrointestinal recovery. Furthermore, it significantly decreased the length of hospital stay without any associated adverse outcomes (59).

Our study demonstrated that nearly all patients (150, 96.2%) had follow-up within the first three months after surgery (Table 11). During these visits, patients underwent blood workups, physical examinations, and appropriate imaging studies to monitor for recurrence and postoperative complications. This high early follow-up rate reflects good adherence to postoperative surveillance practices in the hospital, which is crucial for timely detection of complications and disease recurrence.

Follow-up after gastric cancer surgery is essential for early detection of recurrence, management of postoperative complications, and monitoring nutritional status. Most recurrences occur within the first 2–3 years, supporting closer surveillance during this period. Follow-up also facilitates timely initiation of adjuvant therapy and improves symptom control and quality of life.

7.7 Pre and postoperative complications in Gastric cancer

Preoperative complications in gastric cancer patients are a significant concern globally, often influencing treatment strategies and patient outcomes.

In our study, 21.2% of the patients were found to have complications preoperatively, with specific incidences of 12.2% for obstruction, 3.8% for perforation, and 5.1% for bleeding. Comparatively, Gastric outlet obstruction (GOO), for instance, is reported globally to range from 10-25% in advanced gastric cancer cases, aligning with the 23.2% found in another Ethiopian studies (10).

Conversely, gastric perforation, typically a rare complication with global incidences often less than 1% (60), presents a higher rate of 3.8% at St. Paul Hospital. This elevated rate could be indicative of delayed diagnosis or advanced disease stages, which are common in resource-limited settings in Africa. Preoperative bleeding (melena), reported at 5.1% in this study, falls within the global

range of 5-15% for advanced cases, and is comparable to the 12% found in another Ethiopian study (10).

The overall high preoperative complication rate at St. Paul Hospital, particularly the elevated perforation rate, indicates the challenges associated with late-stage presentations of gastric cancer in African healthcare settings, where patients often seek medical attention when complications are already manifest.

On the contrary, postoperative complications occurred in 37.8% of patients in our study. This is within the range reported by other African studies. For instance, a study in Tanzania reported postoperative complication rates of 37.1%, and one in Nigeria, reported 27.7% (10). The most common complications observed in our study were surgical site infections. SSI was observed in 19.2% of our patients, with 10.9% superficial and 8.3% deep incisional SSIs. The next most observed were pulmonary complications such as atelectasis and pneumonia (8.9%), followed by hernia (4.5%).

Out of a total of 156 patients, 7 (4.5%) developed incisional hernia, while 2 (2.6%) had other types (namely Para umbilical and hiatal hernia). Overall, postoperative hernias accounted for 9 cases (5.8%), indicating that although relatively uncommon, hernia formation remains a notable postoperative complication requiring attention during follow-up.

Unplanned ICU admission was required for 4.5% of patients, and hospital readmission within 90 days occurred in 4.5%. The majority of patients (70.5%) had a hospital length of stay of ≤ 7 days. These complication rates, particularly SSI, indicate areas where adherence to perioperative care protocols need to be improved.

A national clinical audit on abdominal surgery in Ethiopia (2019–2024) reported an overall postoperative complication rate of 9.0% and a 30-day mortality rate of 1.50% for all abdominal surgeries, noting that cancer is a significant risk factor for complications (61). More specifically for gastric cancer, a study from a tertiary teaching hospital in Addis Ababa (2020) reported a postoperative morbidity rate of 19% and a mortality rate of 12.8% (25).

Another study indicated a prevalence of postoperative complications of 39.2% in a tertiary hospital setting (62). Ethiopian patients undergoing abdominal surgery tend to be younger, yet face relatively high complication and mortality rates (61). These figures highlight the need for further efforts in improving surgical care, patient selection, and postoperative management strategies in Ethiopia to mitigate these adverse outcomes.

Postoperative complications of the patients were classified according to **Clavien-Dindo Classification**. According to this classification, 49 (31.4%) patients with score of III and above were grouped as the major complication group, and 107 (68.6%) patients who did not develop complications or scored I or II according to Clavien-Dindo were grouped as without major complications.

The finding that 31.4% of gastric cancer patients experienced major complications (Clavien-Dindo grade III and above) is a significant observation when compared to global and African surgical outcomes. Globally, major complication rates after gastrectomy for gastric cancer in high-volume centers typically range from 10-15% (63) (64), although overall complication rates can be higher, ranging from 11% to 46% (65). A large prospective study also highlighted that low-to-middle income countries often face higher mortality and complication rates (66).

In the African context, while specific Clavien-Dindo grade III+ rates for gastric cancer are less frequently reported, general postoperative complication rates for gastric cancer can be around 27.7% (67), and other major abdominal surgeries in Ethiopia have shown complication rates as high as 60.6% (68). The observed 31.4% major complication rate, therefore, appears higher than many reported global benchmarks from developed settings but aligns with the challenges often encountered in African healthcare systems, where late presentation and advanced disease stages contribute to increased surgical morbidity and more severe postoperative outcomes.

7.8 Predictors of Gastric Cancer Mortality

The 90-day postoperative mortality rate in our study was 17.9%. This figure is comparable to mortality rates reported in other sub-Saharan African contexts, which range between 13.8% and 18.1% (40). A postoperative mortality rate of 10.5% was reported at TASH (10). Another study in Mali reported a postoperative death rate of 23.77% (69). These regional comparisons suggest that

despite localized efforts, surgical mortality for gastric cancer remains a significant concern in the region.

Factors including age, sex, ECOG, histopathology, pathologic grading, stage, comorbidity, and metastasis site, surgical treatment modality, chemotherapy, and regimen change contribute to mortality.

Our study identified several factors significantly associated with adverse 90-day postoperative outcomes. In multivariate logistic regression analysis, the presence of comorbidity (AOR = 2.72, 95% CI: 1.089-6.8, $p = 0.032$), intention of surgery (palliative vs. curative) (AOR = 7.69, 95% CI: 2.58–22.85, $p < 0.000$), presence of postoperative complications (AOR = 5.226, 95% CI: 1.1–24.36, $p = 0.035$), and higher disease stage (AOR = 2.67, 95% CI: 1.25–5.72, $p = 0.012$) were independently associated with increased odds of poor outcomes.

Most patients are in the 50–70 age group, and the strong association between stage and clinical factors suggests that late-stage presentation significantly impacts outcomes among gastric cancer patients at SPHMMC.

Patients with any comorbidity had significantly increased odds of the adverse 90-day postoperative outcome compared to those without comorbidity (AOR = 2.721; 95% CI: 1.089–6.804; $p = 0.032$). This indicates that, after controlling for other variables in the model, the odds of experiencing an adverse 90-day postoperative outcome were approximately 2.72 times higher for patients with any comorbidity compared to those without. The 95% confidence interval, which does not include 1, further supports the statistical significance of this finding.

This finding suggests that the presence of comorbidities is an important *independent risk factor* for poorer 90-day postoperative outcomes in this patient population. These findings are consistent with global literature.

Studies have highlighted comorbidity as a critical factor influencing postoperative outcomes (70), with poor nutritional status (e.g., low albumin levels) being particularly impactful (71). The intention of surgery, reflecting disease extent and resectability, is a well-established prognostic indicator; palliative procedures are inherently associated with worse outcomes due to advanced

disease (72). The strong association between postoperative complications and adverse outcomes is clear, as complications directly contribute to morbidity and mortality. Factors like unplanned ICU admission and advanced disease stage are also widely recognized as predictors of poor prognosis (73).

Case urgency also played a significant role in the univariate analysis with the outcomes of patients included in the study. Emergency surgical cases showed a markedly higher odds of adverse outcomes (COR: 7.2, 95% CI: 1.9-27.6,) when compared to elective cases, which served as the reference group (COR: 1.00). This further underscores the impact of patient presentation on prognosis.

Although length of hospital stay, LNI and PNI were significant in bivariate analysis, they did not retain significance in the adjusted multivariate model in our study, suggesting these might act as confounding factors rather than independent predictors. Conversely, external studies have indicated that prolonged hospital stay, intraoperative events, and unplanned postoperative ICU admission can increase the risk of adverse outcomes.

Our study showed that LVI was positive in 17.3% (n=27) of cases, while PNI was present in 8.3% (n=13). Notably, a significant portion of the data remains "Unknown" (29.5% for LVI and 47.4% for PNI), which likely reflects challenges in standardized pathological reporting or poor documentation by healthcare staff.

In clinical oncology, LVI and PNI are established markers of tumor aggressiveness. LVI indicates that malignant cells have penetrated the lymphatic or blood vessels, facilitating systemic dissemination and lymph node metastasis. PNI represents the invasion of malignant cells into the space surrounding nerves, which often serves as a low-resistance pathway for tumor spread.

Globally, the presence of LVI and PNI is strongly correlated with advanced TNM staging and is an independent predictor of poor postoperative survival. Studies consistently show that patients positive for these markers have significantly higher mortality rates. Global meta-analyses indicate that PNI-positive patients may have a 5-year survival rate as low as 6.4%, compared to nearly 30% in PNI-negative cases (74, 75).

The LVI (17.3%) and PNI (8.3%) positivity rates in this finding are relatively lower than some global averages (where PNI can range from 6.8% to 75.6%) (76). This discrepancy might be attributed to the high "Unknown" or not documented data in this study.

However, when present, these markers are critical in predicting postoperative mortality. In African cohorts, where specialized oncology care and adjuvant therapies may be less accessible, the presence of LVI/PNI often signals a "high-risk" status that necessitates more aggressive surgical margins and closer postoperative surveillance.

Both LVI and PNI are pivotal in predicting short-term and long-term mortality in gastric cancer patients. Postoperatively, these markers are associated with a higher likelihood of local recurrence and distant metastasis. Multivariate analyses confirm that LVI and PNI are independent risk factors for mortality (77). The 17.3% LVI-positive group likely has a significantly higher risk for postoperative death compared to the negative group, particularly if they do not receive intensive follow-up or adjuvant treatment.

7.9 Comparative Summary of Key Outcomes

To further illustrate the findings in a broader context, the table below provides a comparative summary of key outcomes from this study with selected regional and global benchmarks.

Table 15: Summary of key findings of the research

Characteristics	SPHMMC Study (Ethiopia)	Other African Studies	High-Income Countries (e.g., South Korea, Japan, USA)
Male Predominance	59.9%	Generally observed ⁽⁸⁴⁾	Varies, but often less pronounced than in Africa ⁽⁸⁵⁾
Mean Age (years)	55	Often younger than Western ⁽⁸⁴⁾	Generally older (e.g., 60-70s) ⁽⁸⁶⁾
Rural Residence	66.7%	Common	Less relevant for comparison ⁽⁸⁶⁾
Late Stage at Presentation	High (6.4% metastatic)	High ⁽⁸⁴⁾	Significantly lower due to screening programs
Operative Mortality	17.9%	Up to 16.1% ⁽⁸⁴⁾	1-5% ⁽⁸⁶⁾
Postoperative Complications	37.8%	Varies, often high	10-20% ⁽⁸⁶⁾
D2 Lymphadenectomy Rate	18.6% (documented)	Low/Undocumented	Standard of care (routinely >90%)
Positive Resection Margins	15.4%	Varies, often higher	<5% ⁽⁸⁶⁾
Hypoalbuminemia	62.8%	High	Lower, with aggressive nutritional support ⁽⁸⁷⁾

8. Strength and limitation of the study

8.1 Strengths of the study

- ✚ The study assessed the short term (90-days) surgical outcomes of gastric cancer patients in SPHMMC, Addis Ababa, Ethiopia by using census technique to include all cases operated over the past 5 years (reasonable sample size, increases the generalizability of the study result).
- ✚ The data collection was done strictly by prepared online google form questionnaires' and was done in two phases: one was by adequately trained data collectors, second phase by the principal investigator. (reliability and accuracy of data)
- ✚ The study utilized standard clinical classifications (e.g., TNM staging, Clavien–Diendo classification), improving the comparability of results with other studies.
- ✚ The gathered data is still eligible for further analysis.

8.2 Limitations of the study

- The findings are based on retrospective review of electronic medical records, and incomplete documentation was a recurring challenge. Important clinical and operative details such as the extent of lymphadenectomy, reconstruction techniques, selected investigation results, and PICT status were not consistently recorded. These gaps in documentation may have resulted in misclassification of some variables and may have limited the accuracy of certain analyses.
- **Missing** data restricted the inclusion of some clinically relevant variables in multivariable analyses, potentially limiting full adjustment for confounding factors. Missing data were handled by performing a complete-case analysis, excluding records with incomplete variables from multivariable models.
- Postoperative follow-up information was not uniformly available for all patients. Some individuals did not have documented follow-up notes in the EMR, particularly after hospital discharge. This may have led to under-reporting of postoperative complications, readmissions, or other outcomes occurring later in the postoperative period.

Despite these limitations, the study reflects real-world clinical practice and provides useful insight into the short-term surgical outcomes of gastric cancer patients in this setting. The results highlight the importance of improved documentation practices and structured follow-up systems. Future prospective studies with standardized operative reporting and systematic follow-up would help address these gaps and strengthen the evidence base.

9. Conclusion

The findings from SPHMMC demonstrate that while short-term surgical outcomes for gastric cancer are comparable to other regional centers in sub-Saharan Africa, there are other key areas where surgical care in tertiary hospitals need improvement i.e., the use of sterile techniques to reduce burden of surgical site infections, standardize perioperative care protocols, early detection/diagnosis of cancer and increasing health awareness of the public. There is also a need for ensuring comprehensive oncological surgical training, particularly regarding lymphadenectomy and margin assessment.

The advanced stage of disease at presentation, in addition to patient comorbidities, contributes substantially to adverse outcomes. Therefore, to truly understand the scope of this challenge and guide effective strategies for improving gastric cancer care in Ethiopia, future research should involve longer studies and consistent data collection.

10. Recommendations

For Healthcare Professionals

- **Preoperative Patient care:** Implement standardized preoperative nutritional screening and intervention protocols to address prevalent nutritional deficiencies, such as anemia (31.4%) and hypoalbuminemia (62.8%), which are key for reducing postoperative risks (80)(81). Emphasize attention on comorbidity management due to its strong association with adverse outcomes.
- **Surgical Quality and Standardization:** Provide advanced training in aseptic instrumentation, oncological gastrectomy, particularly focusing on D2 lymphadenectomy, given its current low rate (18.6%). Ensure stricter adherence to surgical documentation protocols, especially regarding lymph node dissection and margin status.
- **Perioperative Care:** Implement ERAS protocols to reduce the observed 37.8% postoperative complication rate and improve overall patient recovery.

For Policymakers

- **Early Detection and Screening:** Support the implementation of public health campaigns for early symptom awareness and invest in exploring cost-effective gastric cancer screening methods suitable for low-resource regions.
- **Resource allocation:** Allocate resources for advanced oncological gastrectomy training and the establishment of perioperative care infrastructure

For Patients/the public

- **Symptom Awareness:** Be aware of early gastric cancer symptoms, such as epigastric pain and unintentional weight loss, and seek timely medical attention.
- **General/Preoperative Health:** Actively participate in preoperative nutritional screening and intervention programs, and manage existing comorbidities as advised by healthcare providers to optimize health before surgery.

For Community Workers

- **Public Health Education:** Engage in public health campaigns to raise awareness about early gastric cancer symptoms and the importance of timely medical consultation, especially given the advanced disease presentation and younger age of patients observed in this study.
- **Support and Advocacy:** Support initiatives aimed at improving access to healthcare and nutritional resources within the community to help address prevalent deficiencies like anemia and hypoalbuminemia.

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12. Annexes

Annex I: Information sheet

Title of the Research Project: Assessment of the short term surgical outcomes of patients with gastric cancer at SPHMMC (5-year retrospective study)

Name of Principal Investigator: Betelhem Tadele Eshetu

Name of the institution: Saint Paul's Hospital Millennium Medical College (SPHMMC)

Introduction

This information sheet is prepared to inform study team members and relevant stakeholders about the purpose and procedures of this retrospective study. The study aims to review the short term surgical outcomes of patients with gastric cancer at SPHMMC.

Purpose of the Research Project

To assess the short term surgical outcomes of patients with gastric cancer at SPHMMC (5-year retrospective study), providing data that could improve patient care and hospital management strategies.

Procedure

This study involves reviewing medical records of patients diagnosed with gastric cancer at SPHMMC in the past 5 years. No direct patient contact or interviews will be conducted as it is a retrospective chart review.

Risk and /or discomfort

Since the study is based on retrospective record review, there are no direct risks or discomforts to patients.

Benefits of being in the study

The findings will contribute to a better understanding of the short term surgical outcomes of patients with GC in this setting, which may inform clinical practice and resource allocation to improve patient care.

Confidentiality and privacy

All data will be handled confidentially, and patient identifiers will be removed during data collection to ensure privacy. Data will be securely stored and used only for research purposes.

Incentives/payments

There are no incentives or payments involved as this is a record review study.

Right to refusal or withdraw

Since the study uses existing medical records, individual patient consent is not required, but confidentiality will be strictly maintained.

Contacts

For any questions about the study, please contact:

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Annex II: Data Extraction Form

Title: Assessment of Short-Term Surgical Outcomes of Patients with Gastric Cancer in Ethiopia:
A retrospective study from Jan 2021 to Aug 31, 2025

Use this checklist to collect data from each chart anonymously (no patient names or MRNs)

Data sources:

☐ Chart ☐ EMR ☐ Anesthesia record ☐ Pathology report ☐ Discharge summary ☐ ICU record

Date of admission to surgical ward: ____ / ____ / 20__

Instructions: Extract data from the medical record only. Do not leave blanks—use coded options; if unknown, mark 99 = Unknown. For numeric fields, write the value and circle the category if applicable. Timeframe for outcomes is within 90 days post-operation or during index admission (whichever is longer).

Section I. Socio-Demographic Characteristics

1. Card number/MRN: _____
2. Age (years): _____
3. Sex: ☐ Male (1) ☐ Female (2)
4. Marital Status: ☐ Married (1) ☐ Single (2) ☐ Widowed (3) ☐ Divorced (4)
5. Residence: ☐ Urban (1) ☐ Rural (2)
6. Region/Zone: _____
7. Occupation: ☐ Farmer (1) ☐ Self-employed (2) ☐ Employed (3) ☐ Unemployed (4) ☐ Other (5, specify): _____

8. Health insurance: ☐ CBHI (1) ☐ Private (2) ☐ None (3) ☐ Other (4, specify): _____

9. Blood group: ☐ A (1) ☐ B (2) ☐ AB (3) ☐ O (4)

Section II. Clinical & Comorbidity Data (Pre-operative)

Anthropometry & Nutrition

8. Height (m): _____

9. Weight (kg): _____

10. BMI (kg/m²): _____

Category: ☐ <18.5 Underweight (1) ☐ 18.5–24.9 Normal (2) ☐ 25–29.9 Overweight (3) ☐ ≥30 Obese (4) ☐ Not recorded (98)

11. MUAC (cm): _____ ☐ Not recorded (98)

12. Unintentional weight loss in last 6 months: ☐ <5% (1) ☐ 5–10% (2) ☐ >10% (3) ☐ Not recorded (98)

13. Main presenting symptom: (Tick all that apply)

☐ epigastric pain (1) ☐ anorexia (2) ☐ nausea and vomiting (3) ☐ early satiety (4) ☐ weight loss (5) ☐ dysphagia (6) ☐ melena (7) ☐ others: specify: _____ (8)

Hematologic & Biochemistry

14. Hemoglobin (g/dL): _____

Anemia: ☐ No (0) ☐ Yes (1) (Hb <13 g/dL male; <12 g/dL female)

15. Creatinine (mg/dL): _____ ☐ Not recorded (98)

Comorbidities (tick all that apply; if none, mark 0)

16. Hypertension: ☐ No (0) ☐ Yes (1)

17. Diabetes mellitus: ☐ No (0) ☐ Yes (1)

HbA1c (if available): _____% (98 = Not recorded)

18. Coronary artery disease/Heart failure: ☐ No (0) ☐ Yes (1)

19. Chronic respiratory disease (COPD/Asthma): ☐ No (0) ☐ Yes (1)

20. Chronic kidney disease: ☐ No (0) ☐ Yes (1)

21. Chronic liver disease/Hepatitis: ☐ No (0) ☐ Yes (1)

22. Tuberculosis (past or active): ☐ No (0) ☐ Yes (1)

23. HIV status: ☐ Negative (0) ☐ Positive (1) ☐ Unknown (99)

On ART? ☐ No (0) ☐ Yes (1) ☐ N/A (97)

24. Alcohol use: ☐ None (0) ☐ Moderate (1) ☐ Harmful (2) ☐ Unknown (99)

25. Smoking: ☐ Never (0) ☐ Former (1) ☐ Current (2) ☐ Unknown (99)

26. ASA class (I–IV): ☐ I (1) ☐ II (2) ☐ III (3) ☐ IV (4) ☐ Not recorded (98)

Tumor/Oncology (Pre-op/Clinical)

27. Symptom duration before first presentation: ☐ ≥ 6 months ☐ < 6 months ☐ (99=Unknown)

28. Time from diagnosis to surgery (days): _____ (99=Unknown)

29. ECOG PS at diagnosis: ☐ 0-1 (1) ☐ >2 (2) ☐ unknown (99)

30. Tumor location:

☐ Proximal (1)-cardia and fundus

☐ Whole stomach (4)

☐ Body (2)

☐ Unknown (99)

☐ Distal (3)-antrum and pylorus

31. Clinical stage (if documented): ☐ Early (1) ☐ Locally advanced (2) ☐ Metastatic (3) ☐ Not documented (98)

32. Complications at presentation: ☐ Obstruction (1) ☐ Bleeding (2) ☐ Perforation (3) ☐ None (0) ☐ Unknown (99)

33. H. pylori status: ☐ Positive (1) ☐ Negative (0) ☐ Not tested (98)

34. Neoadjuvant therapy before surgery: ☐ No (0) ☐ Yes (1) → Regimen (text): _____
☐ Unknown (99)

Section III. Perioperative & Surgical Details (Index Operation)

34. Date of surgery: ____/____/20__

35. Case urgency: ☐ Elective (1) ☐ Emergency (2)

36. Surgical approach: ☐ Open (1) ☐ Laparoscopic (2) ☐ Converted to open (3)

37. Type of procedure:

a) curative intent: ☐ yes (1) ☐ no (2)

☐ Total gastrectomy (1)

☐ Proximal gastrectomy (3)

☐ Subtotal/Distal gastrectomy (2)

☐ Near total gastrectomy

☐ Wide local excision

☐ Trans hiatal esophagogastrectomy

☐ Ivory lewis esophagogastrectomy

b) palliative intent ☐ yes (1) ☐ no (2)

☐ Bypass GJ (1)

☐ Exploration alone (4)

☐ Wide local excision (2)

☐ Other palliative (5, specify): _____

☐ Feeding jejunostomy (3)

38. Lymphadenectomy extent: ☐ D1 (1) ☐ D1+ (2) ☐ D2 (3) ☐ Not applicable/Not recorded (98)

39. Reconstruction:

☐ Billroth I (1) ☐ Billroth II (2) ☐ Roux-en-Y (3) ☐ Other (4) ☐ N/A (97)

40. Combined organ resection (e.g., spleen/pancreas/colon): ☐ No (0) ☐ Yes (1) → Specify:

41. Operative time (minutes): _____

42. Estimated blood loss (mL): _____

43. Intraoperative transfusion: ☐ No (0) ☐ Yes (1) → Units: ____

44. Intraoperative events: ☐ None (0) ☐ Hypotension requiring vasopressors (1) ☐ Enterotomy/Contamination (2) ☐ Other (3, specify): _____

45. Planned postoperative ICU admission: ☐ No (0) ☐ Yes (1)

46. ERAS/prophylaxis adherence (if documented):

Antibiotic within 60 min of incision: ☐ No (0) ☐ Yes (1) ☐ Not recorded (98)

VTE prophylaxis given: ☐ No (0) ☐ Yes (1) ☐ Not recorded (98)

Section IV. Short-Term Surgical Outcomes (within 90 days or index admission)

48. Any postoperative complication (deviation from expected course): ☐ No (0) ☐ Yes (1)

49. Clavien-Dindo grade (highest): ☐ I (1) ☐ II (2) ☐ IIIa (3) ☐ IIIb (4) ☐ IVa (5) ☐ IVb (6)
☐ V (7) ☐ Not classified (98)

50. Surgical Site Infection (SSI) (CDC): ☐ No (0) ☐ Superficial incisional (1) ☐ Deep incisional (2) ☐ Organ/space (3) ☐ Unknown (99)

51. Anastomotic leak: ☐ No (0) ☐ Yes (1) ☐ Not applicable (97) ☐ Unknown (99)

Diagnostic basis: ☐ Clinical (1) ☐ Imaging (2) ☐ Intra-op/re-op (3)

52. Postoperative ileus (NG decompression > POD3): ☐ No (0) ☐ Yes (1) ☐ Unknown (99)

53. Postoperative bleeding (Hb drop >2 g/dL or transfusion/re-op): ☐ No (0) ☐ Yes (1)

54. Pulmonary complication (pneumonia/atelectasis/resp. failure): ☐ No (0) ☐ Yes (1)

55. Unplanned ICU admission: ☐ No (0) ☐ Yes (1)

56. Reoperation (within 30 days): ☐ No (0) ☐ Yes (1) → Indication: _____

57. Length of hospital stay (days): _____

Category: ☐ ≤7 (1) ☐ >7 (2)

58. 30-day mortality (or in-hospital if stay >30 days): ☐ Survived (0) ☐ Died (1)

Date of death: ____/____/20__ (if applicable)

59. Readmission within 30/90 days: ☐ No (0) ☐ Yes (1) ☐ Unknown (99) → Reason:

Section V. Pathology

60. Histology: ☐ Adenocarcinoma (1) ☐ GIST (2) ☐ Neuroendocrine/carcinoid (3) ☐ Other: specify _____

61. Lauren subtype: ☐ Intestinal (1) ☐ Diffuse (2) ☐ Mixed (3) ☐ Not reported (98)

62. T stage: ☐ T1 (1) ☐ T2 (2) ☐ T3 (3) ☐ T4 (4) ☐ Not reported (98)

63. N stage: ☐ N0 (0) ☐ N1 (1) ☐ N2 (2) ☐ N3 (3) ☐ Not reported (98)

64. Margin status: ☐ R0 (1) ☐ R1 (2) ☐ R2 (3) ☐ Not reported (98)

65. Number of lymph nodes examined: _____

Number positive: _____

Completeness & Notes

66. Data completeness check (core fields complete): ☐ Yes ☐ No → If no, list missing fields:

Coding Summary:

- Missing/Not recorded = 98; Unknown = 99; Not applicable = 97.
- Outcomes window = 90 days post-op or index admission.

Quick Reference: Clavien–Dindo (highest grade within 30 days)

I: Deviation without pharmacologic/surgical intervention.

II: Pharmacologic treatment (e.g., antibiotics, transfusion, TPN).

IIIa/IIIb: Intervention with anesthesia (IIIb = general anesthesia).

IVa/IVb: Life-threatening, ICU; single vs multi-organ failure.

V: Death