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St. Paul's Hospital Millennium Medical College

Incidence and Predictors of Surgical Site Infections following Open Urologic Surgeries at Tikur Anbesa Specialized Hospital, Ethiopia: A Retrospective Cohort Study

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Abbreviations and Acronyms

Abbreviation	Meaning	Abbreviation	Meaning
AAU	Addis Ababa University	**min**	Minute
AMR	Antimicrobial Resistance	**mL**	Milliliter
aOR	Adjusted Odds Ratio	**OR**	Operating Room
ARR	Adjusted Risk Ratio	**Ref**	Reference Category
ASA	American Society of Anesthesiologists	**RR**	Risk Ratio
BMI	Body Mass Index	**SD**	Standard Deviation
CDC	Centers for Disease Control and Prevention	**SPHMMC**	St. Paul's Hospital Millennium Medical College
CI	Confidence Interval	**SPHMMC-ERC**	SPHMMC - Ethical Review Committee
cOR	Crude Odds Ratio	**SSI**	Surgical Site Infection
CRR	Crude Risk Ratio	**Stata**	Data Analysis and Statistical Software
g/dL	Grams per deciliter	**TASH**	Tikur Anbessa Specialized Hospital
HAI	Hospital-Acquired Infection	**TURP**	Transurethral Resection of the Prostate
HMIS	Hospital Management Information System	**USA**	United States of America
IPC	Infection Prevention and Control	**UTI**	Urinary Tract Infection(s)
IRB	Institutional Review Board	**VIF**	Variance Inflation Factor
		WHO	World Health Organization

ABSTRACT

Background: Surgical site infections (SSIs) are among the most frequent healthcare-associated infections worldwide, driving up morbidity, extending hospitalizations, and inflating treatment costs. Open urologic surgeries carry varying and distinct infection hazards because they regularly involve exposure to the genitourinary system and the potential handling of colonized urine. Despite this high-risk profile, there is an acute shortage of localized, department-specific epidemiology detailing the exact magnitude and independent drivers of SSIs in specialized urology wards within East Africa and Ethiopia.

Objective: To determine the cumulative incidence and identify the independent predictors of surgical site infections (SSIs) among patients undergoing open urologic surgeries at Tikur Anbessa Specialized Hospital (TASH) in Addis Ababa, Ethiopia, from April 1, 2024, to April 1, 2026.

Methods: A hospital-based retrospective cohort study was conducted at Tikur Anbessa Specialized Hospital (TASH). Electronic medical records of 337 eligible patients who underwent open urologic surgical procedures between April 1, 2024, and April 1, 2026, were systematically reviewed. Data were collected using a structured data abstraction form developed in Google Forms, exported to Microsoft Excel for cleaning, and analyzed using Stata version 17. Descriptive statistics were used to summarize participants' characteristics and study variables. The primary outcome was a documented diagnosis of surgical site infection within 30 days after surgery based on the standard CDC criteria. Bivariable and multivariable modified Poisson regression analyses with robust variance estimation were performed to identify predictors of surgical site infection. Crude risk ratios (CRR) and adjusted risk ratios (ARR) with 95% confidence intervals (CI) were used to measure the strength of associations. Variables with a **p-value <0.05** in the multivariable analysis were considered statistically significant.

Results: Medical records of 337 eligible patients were analyzed. The 30-day cumulative incidence of surgical site infection was **14.2%** (95% CI: 10.5%–18.0%). Independent predictors of surgical site infection were preoperative urinary tract infection (ARR = 1.91; 95% CI: 1.13–3.22), lower urinary tract surgery (ARR = 2.10; 95% CI: 1.20–3.70), ASA Class III (ARR = 2.42; 95% CI: 1.13–5.19), and preoperative hospital stay >3 days (ARR = 2.48; 95% CI: 1.10–5.59).

Conclusion: The incidence of surgical site infection following open urologic surgery at Tikur Anbessa Specialized Hospital was considerable. Preoperative urinary tract infection, lower urinary tract surgery, and ASA Class III status were identified as independent predictors of surgical site infection. Strengthening preoperative patient optimization and implementing targeted infection prevention strategies for high-risk patients may help reduce the occurrence of surgical site infections and improve surgical outcomes.

Keywords: Surgical Site Infection; Open Urologic Surgery; Predictors; Retrospective Cohort; Tikur Anbessa Specialized Hospital; Ethiopia.

1. Introduction

1.1. Background

Surgical site infection (SSI) is one of the most common healthcare-associated infections and remains a major cause of postoperative morbidity and mortality worldwide(1). According to the Centers for Disease Control and Prevention (CDC), an SSI is an infection occurring at or near the surgical incision within 30 days after surgery, or within 90 days if an implant is inserted (2). Surgical site infections are classified into superficial incisional, deep incisional, and organ/space infections based on the anatomical depth of involvement. This classification is widely used for surveillance, diagnosis, and comparison of SSI rates across healthcare settings(2).

Surgical site infections are associated with prolonged hospitalization, increased healthcare costs, readmissions, reoperations, and, in severe cases, death. Although many SSIs are preventable through adherence to evidence-based infection prevention and control (IPC) measures, they continue to affect millions of surgical patients worldwide each year(3). Recognizing their substantial clinical and economic burden, the World Health Organization (WHO) and the CDC have developed evidence-based guidelines recommending interventions such as appropriate surgical antibiotic prophylaxis, hand hygiene, skin antisepsis, glycemic control, maintenance of normothermia, and continuous surveillance to reduce the occurrence of SSIs. However, implementation of these strategies remains challenging in many low- and middle-income countries because of limited resources and health system constraints(1,3,4).

The burden of SSI varies considerably across regions. In high-income countries, the incidence generally ranges from 2% to 5%, whereas studies from sub-Saharan Africa have reported rates exceeding 15% (5,6). This disparity has been attributed to inadequate operating room infrastructure, limited infection prevention resources, delayed presentation of patients, and a high volume of emergency and complex surgical procedures. Ethiopia faces similar challenges, and surgical site infections continue to be an important cause of postoperative complications(5,7).

Patients undergoing urologic surgery are particularly vulnerable to SSIs because many procedures involve entry into the urinary tract, making the surgical wound clean-contaminated or contaminated. Open urologic procedures such as nephrectomy, prostatectomy, and cystectomy

are generally associated with a higher risk of infection than minimally invasive procedures. Furthermore, urologic patients are often older and have multiple comorbidities, which may further increase their susceptibility to postoperative infections (8,9).

The occurrence of SSI following urologic surgery is influenced by a combination of patient-related and procedure-related factors. Patient-related factors reported in previous studies include diabetes mellitus, obesity, smoking, advanced age, higher American Society of Anesthesiologists (ASA) physical status, and preoperative urinary tract infection (UTI). Procedure-related factors such as the type of surgery, prolonged operative time, wound classification, blood loss, prolonged preoperative hospital stay, and drain use have also been associated with an increased risk of SSI(3,10,11). In particular, untreated preoperative UTI may contaminate the surgical field during urinary tract manipulation and increase the likelihood of postoperative wound infection(6,11,12).

Studies conducted in urology departments have reported considerable variation in SSI incidence, ranging from 0.7% to 22.9%, depending on the type and complexity of the surgical procedure(6,8,12). Most previous studies have focused on individual procedures such as radical cystectomy or suprapubic transvesical prostatectomy, demonstrating that the risk of SSI differs across surgical procedures(13–17). Although these studies have improved understanding of SSI in specific settings, evidence remains limited regarding the overall incidence and predictors of SSI among patients undergoing various open urologic surgeries, particularly in resource-limited settings(18).

In Ethiopia, evidence on SSIs in specialized surgical disciplines remains limited. A national systematic review and meta-analysis reported an overall SSI prevalence of 12.3%; however, it did not specifically evaluate patients undergoing open urologic surgery(5). Other Ethiopian studies have primarily focused on bacterial isolates, antimicrobial resistance patterns, or general surgical populations rather than identifying predictors of SSI in urologic surgery (19,20). Consequently, evidence describing the epidemiology of SSI following open urologic surgery is scarce.

Tikur Anbessa Specialized Hospital is the largest tertiary referral and teaching hospital in Ethiopia and performs a high volume of complex open urologic procedures. Despite this, no retrospective cohort study has comprehensively assessed the cumulative incidence and independent predictors of SSI among patients undergoing open urologic surgeries at this institution(15,21). Generating local evidence is essential for identifying high-risk patients and informing targeted infection prevention strategies. Therefore, this study aimed to determine the cumulative incidence and identify the independent predictors of surgical site infections among patients undergoing open urologic surgeries at Tikur Anbessa Specialized Hospital between April 1, 2024, and April 1, 2026.

1.2. Statement of the Problem

Surgical site infection (SSI) remains one of the most common healthcare-associated infections and continues to be a major cause of preventable postoperative morbidity and mortality worldwide (3,22). Despite advances in surgical techniques and infection prevention, SSI incidence in high-income countries generally ranges from 2% to 5%, whereas substantially higher rates have been reported in low- and middle-income countries, particularly in sub-Saharan Africa, where the incidence frequently exceeds 15%(5,6). Patients undergoing urologic surgery are at particularly high risk because many procedures involve entry into the urinary tract, resulting in clean-contaminated wounds. Studies conducted in Tanzania and the Republic of the Congo have reported SSI incidences ranging from 13.8% to 22.9% following open urologic surgery (6,12). In Ethiopia, a national systematic review and meta-analysis also identified SSI as a major postoperative complication, although evidence specific to urologic surgery remains limited(5).

Surgical site infection has substantial health, social, and economic consequences. It prolongs hospital stay, increases the risk of readmission, reoperation, antimicrobial use, and mortality, and places a considerable financial burden on patients, families, and healthcare systems(3,22–24). Previous studies have identified several independent predictors of SSI, including preoperative urinary tract infection, diabetes mellitus, obesity, higher American Society of Anesthesiologists

(ASA) physical status, prolonged preoperative hospital stay, contaminated wound classification, prolonged operative duration, and increased blood loss (3,8,10,11).

The World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC) recommend evidence-based infection prevention strategies, including appropriate surgical antimicrobial prophylaxis, hand hygiene, skin antisepsis, maintenance of normothermia, perioperative glycaemic control, and continuous SSI surveillance (1,4). Nevertheless, implementing these recommendations remains challenging in many resource-limited settings because of inadequate infection prevention infrastructure, limited surveillance systems, shortages of trained personnel, and inconsistent adherence to recommended practices (3,5,22).

In Ethiopia, most published studies on surgical site infection have focused on general surgery, obstetric, or orthopedic procedures, with limited attention to open urologic surgery. Recent Ethiopian studies have mainly described bacterial profiles and antimicrobial resistance patterns rather than the incidence and predictors of SSI following urologic surgery (7,19,20). To date, no retrospective cohort study has comprehensively evaluated the cumulative incidence and independent predictors of SSI among patients undergoing open urologic surgeries at Tikur Anbessa Specialized Hospital. This evidence gap limits the development of context-specific infection prevention strategies for this high-risk population. Therefore, this study was conducted to determine the cumulative incidence and identify the independent predictors of surgical site infection among patients undergoing open urologic surgeries at Tikur Anbessa Specialized Hospital.

1.3. Significance of the Study

This study will contribute new evidence on the burden and determinants of surgical site infection among patients undergoing open urologic surgeries in Ethiopia. Specifically, it will provide the first institution-specific estimate of the 30-day cumulative incidence of SSI and identify independent predictors among patients treated at Tikur Anbessa Specialized Hospital, the largest tertiary referral center for urologic care in the country.

The findings will add to the existing evidence by generating procedure-specific data from a specialized surgical field that has been poorly studied in Ethiopia and other resource-limited

settings. Identification of modifiable risk factors associated with SSI will help clinicians recognize high-risk patients, improve perioperative decision-making, and develop targeted infection prevention and control strategies.

Furthermore, the study will provide baseline information that can support the establishment of SSI surveillance systems, evaluation of current infection prevention practices, and future quality improvement interventions at TASH and similar healthcare facilities. The findings may also serve as a reference for future researchers conducting studies on postoperative infections in urologic surgery and contribute to the development of context-specific evidence-based strategies to improve surgical outcomes.

2. Literature Review

2.1 Definition and Classification of Surgical Site Infections (SSI)

Surgical site infection (SSI) is one of the most common healthcare-associated infections (HAIs) and remains a major indicator of the quality and safety of surgical care worldwide (3). To standardize surveillance and facilitate comparisons across healthcare settings, the Centers for Disease Control and Prevention (CDC), through the National Healthcare Safety Network (NHSN), has established internationally accepted definitions and diagnostic criteria for SSI(1) According to the current CDC/NHSN guideline, an SSI is an infection related to an operative procedure that occurs within 30 days after surgery or within 90 days for selected NHSN operative procedures involving implants (1). These standardized criteria distinguish SSIs from other postoperative infections and ensure consistency in surveillance, clinical practice, and research.

According to the CDC/NHSN surveillance criteria, an SSI is diagnosed when one or more of the following conditions are present (1):

- Purulent drainage from the superficial incision, deep incision, or organ/space.
- Isolation of microorganisms from an aseptically obtained specimen of fluid or tissue collected from the incision or organ/space.
- Evidence of infection identified during direct examination, reoperation, histopathological examination, or radiological imaging.
- Diagnosis of SSI by the attending surgeon or physician based on the CDC/NHSN surveillance criteria.

The CDC classifies surgical site infections into three categories according to the anatomical depth of tissue involvement.

1. **Superficial Incisional SSI:** Infection involving only the skin and subcutaneous tissue of the surgical incision.

2. **Deep Incisional SSI:** Infection involving the deeper soft tissues of the incision, including the fascia and muscle layers.
3. **Organ/Space SSI:** Infection involving any organ or anatomical space that was opened or manipulated during the surgical procedure, excluding the incision itself. In urologic surgery, organ/space SSI may involve the urinary tract, retroperitoneum, pelvis, or other operative sites.

This standardized classification is widely used in epidemiological surveillance, clinical practice, and research because it facilitates accurate diagnosis, comparison of SSI rates across healthcare institutions, and evaluation of infection prevention and control interventions (1,3,4).

2.2 Magnitude of Surgical Site Infection

Despite considerable advances in surgical techniques and perioperative care, surgical site infection (SSI) continues to impose a substantial burden on healthcare systems worldwide. It remains a leading cause of postoperative morbidity, prolonged hospital stay, readmission, reoperation, increased healthcare costs, and preventable mortality (3,22). Although the incidence of SSI has declined in high-income countries through effective infection prevention and surveillance programmes, the burden remains disproportionately high in low- and middle-income countries, where limited resources, inadequate infection prevention practices, and weak surveillance systems continue to hinder effective control(1,4).

Globally, the incidence of SSI varies according to the type of surgery, healthcare setting, and patient characteristics. In high-income countries, SSI rates generally range from 2% to 5%**,** whereas studies from LMICs, particularly those conducted in sub-Saharan Africa, have reported incidences exceeding 15% (3,5). This variation reflects differences in surgical complexity, infection prevention practices, perioperative care, and post-discharge surveillance (4,22).

Within urologic surgery, the incidence of SSI differs according to the type and complexity of the procedure. Minimally invasive procedures such as laparoscopic and robotic surgery generally have lower infection rates because of smaller incisions, reduced tissue trauma, and shorter hospital stays(25–27). In contrast, open urologic procedures remain at greater risk because they frequently involve prolonged operative time, extensive tissue dissection, urinary tract

manipulation, and the use of urinary catheters (28). Previous studies have reported SSI incidences ranging from 0.7% to 22.9% following urologic surgery, with the highest rates observed after major open procedures such as radical cystectomy, radical prostatectomy, and nephrectomy (6,8,11,12).

In sub-Saharan Africa, studies specifically evaluating urologic surgery have also demonstrated a substantial burden of SSI. A prospective cohort study conducted in Tanzania reported an SSI incidence of approximately 22% among patients undergoing urologic surgery, while a study from the Republic of the Congo reported an incidence of 22.9% following open urologic procedures (6). These findings indicate that SSI remains a significant challenge in resource-limited settings and highlight the importance of generating locally relevant evidence to guide prevention strategies.

In Ethiopia, SSI remains one of the most common postoperative complications. A systematic review and meta-analysis reported a pooled SSI prevalence of 12.3% among postoperative patients, demonstrating a considerable burden of postoperative infections. Similarly, a recent systematic review and meta-analysis among women undergoing cesarean delivery reported a pooled SSI incidence of 12.3%, which is comparable with the overall postoperative SSI burden(5,29). Despite the available evidence, most Ethiopian studies have focused on general surgery, obstetric, orthopedic, or mixed surgical populations, with limited evidence from specialized surgical fields such as urology(5,29). Consequently, the incidence and predictors of SSI following open urologic surgery in Ethiopia remain poorly understood.

Despite Tikur Anbessa Specialized Hospital being Ethiopia's largest tertiary referral center for complex urologic surgery, no published retrospective cohort study has comprehensively evaluated the incidence of SSI following open urologic procedures. Generating institution-specific evidence is therefore essential to quantify the local burden of SSI and support the development of targeted infection prevention strategies aimed at improving surgical outcomes in this high-risk patient population.

2.3 Predictors of Surgical Site Infection

The occurrence of surgical site infection is influenced by multiple interacting factors related to the patient, surgical procedure, and perioperative care. Identification of these predictors is essential because many SSI risk factors are modifiable and can guide targeted prevention strategies. Previous studies and systematic reviews have categorized SSI predictors into three major domains: patient-related factors, procedure-related factors, and perioperative factors (1,4).

2.3.1 Patient-related Predictors

Patient-related factors substantially influence the risk of surgical site infection (SSI) by affecting host immunity, tissue oxygenation, and wound healing. Diabetes mellitus is one of the most consistently identified predictors of SSI, as hyperglycemia impairs neutrophil function, reduces tissue perfusion, delays collagen synthesis, and compromises wound healing. Consequently, perioperative glycemic optimization is strongly recommended to reduce postoperative infectious complications (4,5,30,31).

Preoperative urinary tract infection (UTI) is a particularly important predictor in urologic surgery because microorganisms present in infected urine can contaminate the operative field during urinary tract manipulation(32). Current evidence and international urological guidelines recommend routine screening and treatment of bacteriuria before elective urologic procedures to minimize postoperative SSI and other infectious complications (9,33).

Preoperative anemia is another important modifiable risk factor for SSI. Reduced hemoglobin concentration compromises tissue oxygen delivery, impairs collagen synthesis and leukocyte function, and delays wound healing, thereby increasing susceptibility to postoperative infection. Early identification and optimization of anemia are therefore recommended as part of perioperative risk reduction strategies (4,5,31). Other patient-related factors, including advanced age, obesity, smoking, chronic comorbidities (such as cardiovascular disease and chronic kidney disease), and a higher American Society of Anesthesiologists (ASA) physical status classification, have also been consistently associated with an increased risk of SSI. These factors reflect impaired physiological reserve, altered immune response, and reduced tissue healing

capacity and should be considered during preoperative risk assessment and optimization (30,31,34).

2.3.3 Perioperative-related Predictors

Perioperative management practices are important determinants of surgical site infection (SSI) because they directly influence microbial contamination and the patient's ability to resist infection. Prolonged preoperative hospital stay is a well-established risk factor for SSI, primarily due to increased exposure to healthcare-associated pathogens, including multidrug-resistant organisms, before surgery(30,34).

Appropriate surgical antimicrobial prophylaxis is one of the most effective interventions for preventing SSI. Current international guidelines recommend administering an appropriate antibiotic within 60 minutes before surgical incision (or within 120 minutes for agents requiring longer infusion times) to ensure adequate tissue concentrations during surgery. Prolonged postoperative antibiotic prophylaxis is not recommended because it does not further reduce SSI risk and contributes to antimicrobial resistance (4,28).

Other evidence-based perioperative measures, including appropriate preoperative skin preparation, strict adherence to aseptic surgical techniques, effective sterilization of surgical instruments, maintenance of operating room sterility, and standardized postoperative wound care, are essential components of comprehensive SSI prevention programs (4).

2.4 Surgical Site Infection Burden and Microbiology in Ethiopia

Surgical site infection remains one of the most common healthcare-associated infections in Ethiopia and continues to impose a substantial burden on patients and the healthcare system.

Despite the growing body of evidence, most Ethiopian studies have focused on general surgery, obstetric surgery, orthopedic surgery, or mixed surgical populations. Evidence on SSI following open urologic surgery remains limited, despite the unique infection risks associated with urinary tract manipulation, clean-contaminated procedures, urinary catheterization, and prolonged operative duration. This lack of specialty-specific evidence underscores the need for studies evaluating SSI among patients undergoing open urologic surgery in Ethiopia(28).

The microbiology of SSI following urologic surgery is largely influenced by urinary tract flora. Gram-negative bacteria, particularly *Escherichia coli* and *Klebsiella pneumoniae*, are among the most frequently isolated pathogens, although Gram-positive organisms such as *Staphylococcus aureus* also contribute to postoperative infections (28). In Ethiopia, recent studies have demonstrated increasing antimicrobial resistance among uropathogens, including resistance to third-generation cephalosporins and fluoroquinolones, emphasizing the importance of culture-guided therapy and antimicrobial stewardship in patients undergoing urologic procedures (19).

The emergence of antimicrobial-resistant organisms presents an additional challenge to SSI prevention and treatment by reducing the effectiveness of empirical antimicrobial therapy, prolonging hospital stay, increasing healthcare costs, and worsening postoperative outcomes. Therefore, locally generated evidence on the incidence, predictors, and microbiological profile of SSI following open urologic surgery is essential to inform infection prevention strategies and optimize antimicrobial stewardship in Ethiopia.

2.5 Knowledge Gap and Rationale for the Study

Although SSI has been widely studied globally, evidence specific to open urologic surgeries remains limited, particularly in low- and middle-income countries. Existing Ethiopian studies have mainly focused on mixed surgical populations, making it difficult to determine the specific burden and predictors of SSI among urologic patients (5,18).

Open urologic procedures have unique infection risks due to urinary tract manipulation, clean-contaminated wounds, prolonged operative time, and frequent use of catheters and drains(28). However, local data regarding SSI incidence and specialty-specific predictors, including preoperative UTI, type of surgery, ASA classification, and perioperative factors, remain scarce.

Tikur Anbessa Specialized Hospital is the largest tertiary referral center in Ethiopia and performs a high volume of complex open urologic surgeries. Despite this, institution-specific evidence on SSI among these patients is limited. Therefore, this study was conducted to determine the cumulative incidence and identify independent predictors of SSI following open urologic surgeries at TASH. The findings will provide baseline evidence to guide targeted infection prevention strategies and improve perioperative surgical care in Ethiopia.

2.6 Conceptual Framework

The conceptual framework was developed based on findings from the reviewed literature, previous studies on surgical site infections, and established SSI risk-factor models (3,4). The framework was constructed by identifying factors consistently reported to influence SSI occurrence and categorizing them into major domains, including patient-related, procedure-related, and perioperative factors.

Patient-related factors, including age, sex, comorbidities, anemia, ASA classification, and preoperative urinary tract infection, may influence SSI development through their effects on immune response, tissue oxygenation, and wound healing. Procedure-related factors, such as type of surgery, wound classification, operative duration, blood loss, and drain use, may increase infection risk through greater tissue injury, bacterial contamination, and prolonged exposure of the surgical site. Perioperative factors, including preoperative hospital stay and antibiotic prophylaxis, may further modify the risk of SSI development (1,3,4).

Based on these relationships, the conceptual framework illustrates the hypothesized pathway through which independent variables influence the dependent variable, surgical site infection, among patients undergoing open urologic surgeries at Tikur Anbessa Specialized Hospital (Figure 1).

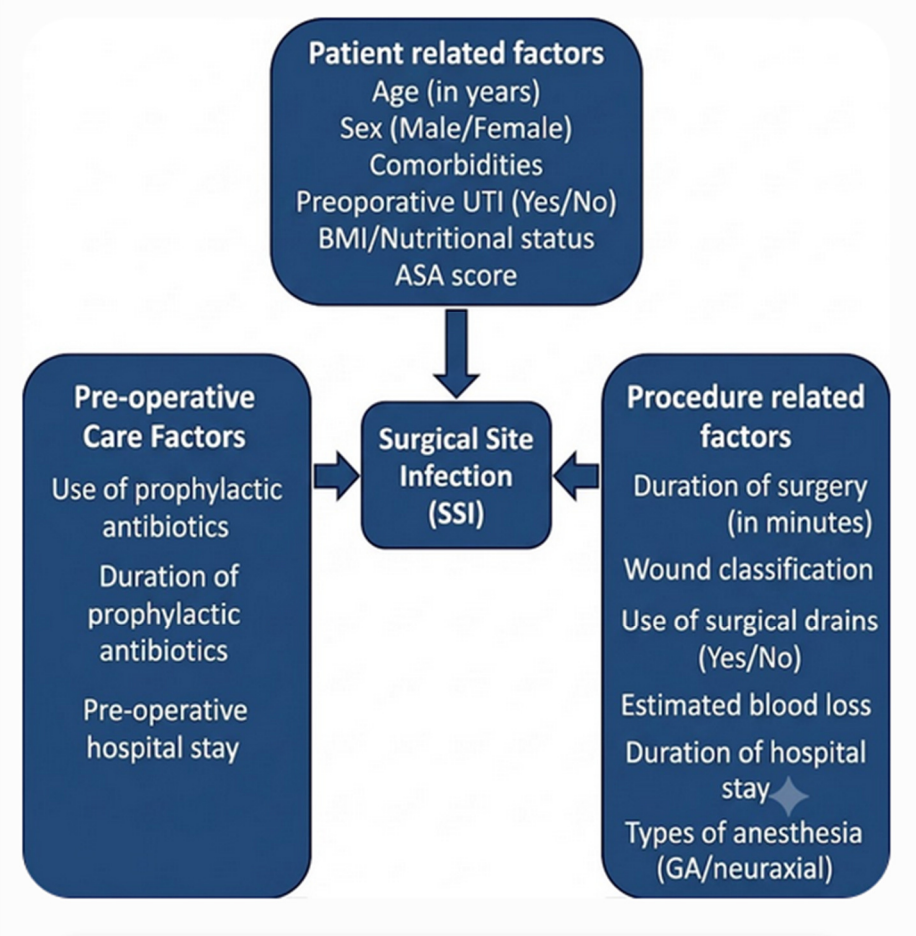


Figure 1 Conceptual framework on predictors of surgical site infection

3. Objectives

3.1 General Objective

To determine the cumulative incidence and identify independent predictors of surgical site infections among patients undergoing open urologic surgeries at Tikur Anbessa Specialized Hospital, Ethiopia, during the period from April 1, 2024, to April 1, 2026

3.2 Specific Objectives

1. To determine the incidence of surgical site infections following open urologic surgeries at Tikur Anbesa Specialized Hospital.
2. To identify predictors of surgical site infections.

4. Methods and materials

4.1 study setting and period

The study was conducted at Tikur Anbessa Specialized Hospital (TASH), located in Addis Ababa, Ethiopia. TASH is the country's largest tertiary referral and teaching hospital under the College of Health Sciences, Addis Ababa University, serving approximately half a million patients annually and having a bed capacity of about 700, including approximately 120 surgical beds. As one of the two major urology centers in Ethiopia, the hospital provides comprehensive specialized urological care and performs a high volume of complex open urologic procedures, including prostatectomy, nephrectomy, urethroplasty, and cystectomy. The Department of Urology at TASH is one of the largest urology units in the country, managing a substantial surgical and outpatient caseload. On average, the department performs approximately 60 elective urologic procedures per month, of which nearly 36 are open surgeries. The outpatient clinic records more than 45 patient visits daily, with male patients accounting for an average of 27 visits per day (23). The study involved a retrospective review of medical records of all eligible patients who underwent open urologic surgery at the Department of Urology between April 1, 2024, and April 1, 2026. Data were extracted retrospectively from electronic medical records during January and February 2026.

4.2 Study Design

A hospital-based retrospective cohort study design was employed. This approach is highly appropriate as it facilitates both the determination of the surgical site infection (SSI) incidence and the robust identification of predictor variables among patients who have already undergone open urologic surgeries.

4.3 Source and Study Population

4.3.1 Source Population

The source population comprised all patients who underwent open urologic surgical procedures at Tikur Anbessa Specialized Hospital, Addis Ababa, Ethiopia.

4.3.2 Study Population

The study population consisted of all eligible patients from the source population who underwent open urologic surgeries at Tikur Anbessa Specialized Hospital between April 1, 2024, and April 1, 2026, and whose medical records contained the required information for data abstraction.

4.4 Eligibility Criteria

Patients of all ages who underwent any open urologic procedure at Tikur Anbessa Specialized Hospital during the study period (April 1, 2024, to April 1, 2026) were included in the study. Patients with incomplete electronic medical records regarding the primary outcome variable (surgical site infection status) or important predictor variables, including preoperative urinary tract infection, ASA classification, type of urologic surgery, preoperative hospital stay, wound classification, and duration of surgery, were excluded.

In addition, patients with a documented surgical site infection prior to the index operation were excluded to ensure that only postoperative infections attributable to the current surgery were captured. Furthermore, patients who underwent emergency surgical procedures were excluded because emergency surgeries have different perioperative conditions and risk profiles that may influence SSI occurrence and confound the assessment of predictors.

4.5 Sample Size Determination

For objective one

The required sample size as calculated using the formula for estimating a single population proportion, necessary for determining the incidence of Surgical Site Infections (SSI):

$$n = \frac{Z^2 \cdot P \cdot (1 - P)}{E^2}$$

The calculation utilized a 95% confidence level ($Z = 1.96$), an anticipated SSI proportion (P) of 0.229 based on the study by Atipo et al. (2019), and a desired margin of error (E) of 0.05.

Substituting these values:

$$n = \frac{(1.96)^2 \cdot 0.229 \cdot (1 - 0.229)}{(0.05)^2} \approx 271.38$$

This yielded a minimum sample size of 272 participants. Since the study was based on retrospective data abstraction from electronic medical records, a 10% was added to compensate for possible incomplete records and missing information, the final sample size was adjusted: N adjusted = 272 / 0.90 = 302.22

The final target sample size for this study is 303 patients.

For objective two

To identify factors associated with the development of surgical site infections, the sample size was cross-checked using the formula for comparing two independent proportions. Calculations were based on various effect sizes reported in the literature to ensure the study can detect associations across a range of clinical variables beyond just the strongest predictors.

Associated Factor	Effect Size (OR/aOR)	Proportion in Exposed (p1)	Proportion in Unexposed (p2)	Calculated Sample Size (n)	Source
Contaminated Wound Class	24.99 (aOR)	53.00%	5.10%	25	6
Pre-operative UTI	9.73 (aOR)	59.10%	10.10%	46	6
Catheterization	3.03 (cOR)	33.80%	14.40%	142	6
Duration of Surgery (>90 mins)	2.40 (cOR)	26.00%	12.70%	238	6

Table 1 Sample Size Calculation Summary for Associated Factors

The final study size is driven by the most statistically demanding objective. Since the primary incidence objective requires a sample of 272 (unadjusted) and the most conservative association (Duration of Surgery) requires 238, the adjusted total of 303 patients is considered highly powered and sufficient to address all study objectives.

4.6 Sampling Technique

Patients were identified from the Hospital Management Information System (HMIS) registry of Tikur Anbessa Specialized Hospital. The registry was reviewed to identify all patients who underwent elective open urologic surgeries during the study period (April 1, 2024, to April 1, 2026). A total of 382 patients were identified from the surgical registry. Their electronic medical records were then reviewed using the predefined eligibility criteria.

Among the identified patients, 337 fulfilled the eligibility criteria and had complete information regarding the SSI outcome and selected predictor variables; therefore, they were included in the final analysis. The remaining 45 patients were excluded due to incomplete medical records or failure to meet the eligibility criteria. Since the number of eligible participants exceeded the calculated minimum sample size (303), all eligible patients were included using a universal sampling technique (census method) figure (2).

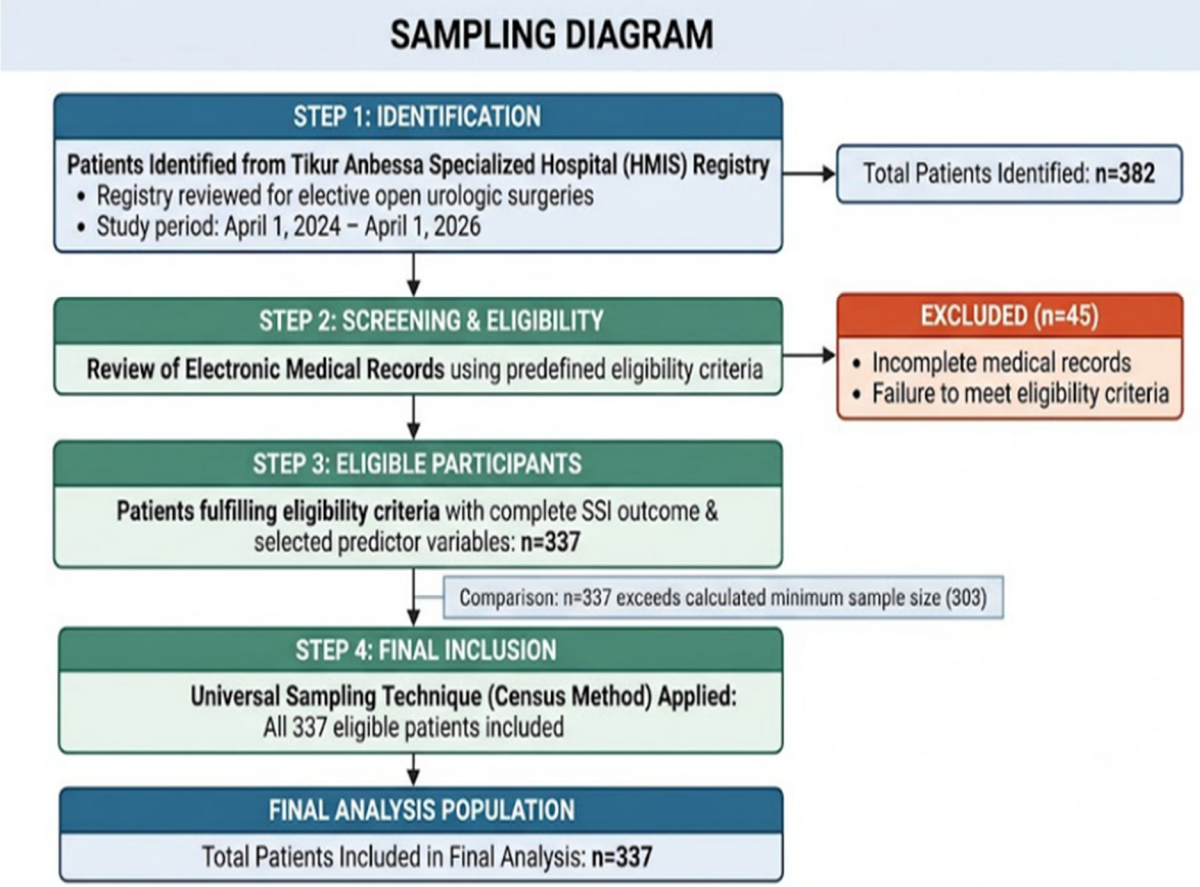


Figure 2- Study participant selection flow diagram

4.7 Data Collection

The study data were systematically abstracted from electronic medical records using a structured data abstraction form developed on the Google Forms platform. The tool was developed based on the study objectives, relevant literature, and standard SSI surveillance criteria, including CDC SSI definitions. It covered socio-demographic characteristics, preoperative factors (including preoperative urinary tract infection), intraoperative variables (such as wound classification and duration of surgery), and postoperative outcomes, including SSI occurrence within 30 days and available microbiological findings. The validity of the tool was ensured through expert review by the principal investigator and supervisors, while reliability was enhanced through pre-testing on approximately 5% of records at Black Lion Specialized Hospital, standardized variable definitions, and necessary modifications based on the findings.

Three data collectors with clinical backgrounds and experience in reviewing surgical records were recruited and trained by the principal investigator on the study objectives, variables, ethical considerations, electronic medical record navigation, SSI identification, and use of the Google Forms data entry system. Eligible open urologic surgery patients were identified sequentially from operating room logbooks, and relevant information was extracted from their electronic medical records using the structured tool. The principal investigator closely supervised the data collection process, performed routine quality checks, and ensured completeness and accuracy of the extracted data, particularly SSI outcome assessment based on 30-day postoperative documentation.

4.8 Variables

4.8.1 Dependent Variable

The dependent variable of this study was **surgical site infection (SSI) status**, recorded as a dichotomous variable (Yes/No). SSI was defined as a documented infection occurring within 30 days after the index surgery based on CDC SSI criteria.

4.8.2 Independent Variables

The independent variables were categorized into patient-related, clinical, preoperative, and procedure-related factors.

Patient-related factors:
Age (continuous variable in years) and sex (male/female).

Clinical status factors:
Comorbidities, preoperative anemia, and preoperative urinary tract infection (UTI), recorded as dichotomous variables (Yes/No). The American Society of Anesthesiologists (ASA) physical status classification was recorded according to its original classification system (I–V).

Preoperative care factors:
Use of prophylactic antibiotics (Yes/No), duration of antibiotic administration (<24 hours, 24–48 hours, or >48 hours), and preoperative hospital stay (continuous variable in days).

Procedure-related factors:

Type of urologic surgery, wound classification, duration of surgery (minutes), estimated blood loss (milliliters), use of surgical drains (Yes/No), type of anesthesia (general or neuraxial), and total hospital stay (days).

4.9 Operational definitions

Surgical Site Infection (SSI) a patient's outcome is recorded as "Yes" (SSI) if the medical chart confirms infection within 30 days post-operation based on either: The attending surgeon's explicit diagnosis in the progress notes; or Clinical signs meeting any of the CDC criteria for Superficial Incisional, Deep Incisional, or Organ/Space SSI(2).

Pre-operative UTI a variable recorded as "Yes" if, before the date of surgery and without documented treatment, the patient's record shows any of the following: A formal clinical diagnosis of UTI; A positive urine culture; or Urinalysis results indicating infection, specifically a positive leukocyte esterase or nitrite test, or a report of many white blood cells(35).

Anemia: a dichotomous variable and will be recorded as "Yes" if the patient's pre-operative hemoglobin level is below the World Health Organization (WHO) thresholds of 13.0 g/dL for men, 12.0 g/dL for non-pregnant women, and 11.0 g/dL for pregnant women ,otherwise, it will be recorded as "No"(36).

Wound Classification -This categorical variable (Clean, Clean–Contaminated, Contaminated, or Dirty) is assigned by the data collector for each case by reviewing the type of urologic procedure performed and applying the CDC Wound Classification guidelines to ensure consistent and standardized rating across all patients(1).

4.10 Data Quality Assurance

Data quality assurance was ensured through several rigorous procedures. First, the digital data extraction tool developed on Google Forms was pre-tested on 30 patient records that were not included in the main study to assess clarity, flow, completeness, and feasibility. Based on the pre-test findings, modifications were made, including clarification of variable definitions, revision of unclear questions/items, adjustment of response options, and improvement of the

sequence and organization of sections to facilitate accurate data abstraction. All data collectors received comprehensive training on the study objectives, standardized data extraction procedures, and proper use of the digital data collection platform. During the data collection process, close supervision was carried out to ensure adherence to the study protocol. Daily checks for completeness and consistency of the collected data were performed, and necessary corrections were made before the final dataset was exported for analysis.

4.11 Data Processing and Analysis

Data collected through Google Forms were checked for completeness and consistency before being exported to Stata version 17 for analysis. Descriptive statistics were used to summarize the socio-demographic and clinical characteristics of the study population. Frequencies and percentages were used for categorical variables, while means with standard deviations were used for continuous variables. The cumulative incidence of SSI was calculated as the proportion of patients who developed SSI within 30 days after surgery and was reported with a 95% confidence interval.

A modified Poisson regression model with robust variance estimation was used to identify independent predictors of surgical site infection. This method was selected because the outcome variable (SSI) was binary, and the incidence of SSI was relatively common (>10%), making odds ratios from logistic regression potentially overestimate the association. Modified Poisson regression provides a direct estimate of risk ratios, which are more appropriate and easier to interpret in cohort studies.

The analysis was performed in two stages. Initially, bivariable modified Poisson regression was conducted to assess the association between each independent variable and SSI. Variables with a p-value <0.25 were entered into the multivariable model to control for potential confounding. The final multivariable model was used to identify independent predictors of SSI, and results were presented as crude risk ratios (CRR) and adjusted risk ratios (ARR) with 95% confidence intervals (CI). Variables with a p-value <0.05 were considered statistically significant.

The assumptions of the modified Poisson regression model were assessed before interpretation of the results. The binary nature of the outcome and independence of observations were ensured by the study design, as each patient contributed only one observation. The linearity assumption for continuous variables was assessed by evaluating their functional relationship with the outcome. Multicollinearity among independent variables was assessed using the variance inflation factor (VIF); the mean VIF was 1.16, indicating no significant multicollinearity among predictors. Robust variance estimation was applied to address possible violation of the Poisson variance assumption and to provide valid standard errors for the binary outcome. The overall model fitness was assessed using the Wald chi-square test, which demonstrated that the predictors included in the final model significantly explained variation in SSI occurrence (Wald $\chi^2(11) = 68.44$, $p < 0.001$).

4.12 Ethical Considerations

Ethical clearance was obtained from the Institutional Review Board (IRB) of St. Paul's Hospital Millennium Medical College, with protocol number SPHMMC-ERC-714/26, prior to data collection. As the study involved a retrospective review of existing patient medical records, a waiver of informed consent was granted by the IRB. All patient data were fully anonymized to ensure confidentiality and protection of privacy throughout the study. The data were stored on a password-protected computer accessible only to the principal investigator, and no identifiable information was included in the dataset. Furthermore, all electronic files were securely stored and protected, and the information was not shared with any third party, ensuring strict confidentiality during and after the completion of the study.

4.13 Dissemination of findings

The dissemination of study results will primarily fulfill the requirements for the Master's Degree in Public Health at the St. Paul's Hospital Millennium Medical College (SPHMMC) School of Public Health. The complete thesis will be submitted to the School, and the final results will be presented during the scheduled defense seminar for faculty review. Beyond this academic fulfillment, the key findings—including the calculated SSI incidence and the identified independent predictors—will be immediately shared with local clinical stakeholders through

targeted presentations. This dissemination involves providing formal feedback to the AAU Urology Department and the hospital's Infection Prevention and Control Committee and Hospital Management at TASH (Tikur Anbessa Specialized Hospital) to directly inform local changes in surgical prophylaxis and patient care protocols. Furthermore, the manuscript detailing the research will be prepared for submission to a peer-reviewed journal.

5: RESULTS

5.1 Socio-demographic and Preoperative Clinical Characteristics of the Study Cohort

A total of 337 patients who underwent open urologic surgery were included in the study. The mean age of the patients was 46.4 ± 18.0 years**,** with an age range of 13–86 years. Patients aged 18–44 years accounted for 142 (42.1%) of the study population. Males constituted 266 (78.9%) of the cohort. Comorbid medical conditions were documented in 80 (23.7%) patients. Preoperative anemia was present in 69 (20.5%) patients, while 64 (19.0%) had a documented preoperative urinary tract infection. Most patients were classified as ASA Class I (203, 60.2%). A preoperative hospital stay of ≤3 days was recorded in 192 (57.0%) patients (Table 2).

Table 2 Socio-demographic and preoperative clinical characteristics (N = 337)

Characteristics	Categories	Frequency	Percentage (%)
Age (years)	<18	11	3.3
	18–44	142	42.1
	45–64	116	34.4
	≥65	68	20.2
Sex	Male	266	78.9
	Female	71	21.1
Pre-operative anemia	Yes	69	20.5
	No	268	79.5
Pre-operative UTI	Yes	64	19
	No	273	81
Preoperative hospital stay	>3 days	192	43

	≤3 days	145	57
ASA score	I	203	60.2
	II	123	36.5
	III	11	3.3
Comorbidity	Yes	80	23.7
	No	257	76.3

5.2 Intraoperative and Perioperative Clinical Characteristics of the Study Cohort

Of the 337 patients included in the study, 195 (57.9%) underwent lower urinary tract surgery. The duration of surgery was more than 180 minutes in 164 (48.7%) patients. Blood loss of less than 500 mL was recorded in 289 (85.8%) patients. Most procedures were classified as clean-contaminated wounds (291, 86.4%). General anesthesia was used in 189 (56.0%) patients. Surgical drains were placed in 95 (28.2%) patients, and 246 (73.0%) received postoperative antibiotics for more than 48 hours (Table 3).

Table 3 Socio-demographic and preoperative clinical characteristics (N = 337)

Characteristics	Categories	Frequency	Percentage (%)
Site of surgery	Upper urinary tract	142	42.1
	Lower urinary tract	195	57.9
Duration of surgery (min)	<90	21	6.2
	90–180	152	45.1
	>180	164	48.7
Blood loss (mL)	<500	289	85.8
	500–1000	38	11.3
	>1000	10	3
Wound classification	Clean	37	11
	Clean-contaminated	291	86.4

	Dirty/contaminated	9	2.7
Drain use	Yes	95	28.2
	No	242	71.8
Type of anesthesia	General	189	56
	Spinal/Regional/Local	148	44
Postoperative antibiotics duration	≤24 hr	34	10.1
	25–48 hr	57	16.9
	>48 hr	246	73

5.3 Incidence of Surgical Site Infection

Among the 337 patients who underwent open urologic surgery, 48 developed surgical site infection, yielding a 30-day cumulative incidence of 14.2% (95% CI: 10.5%–18.0%).

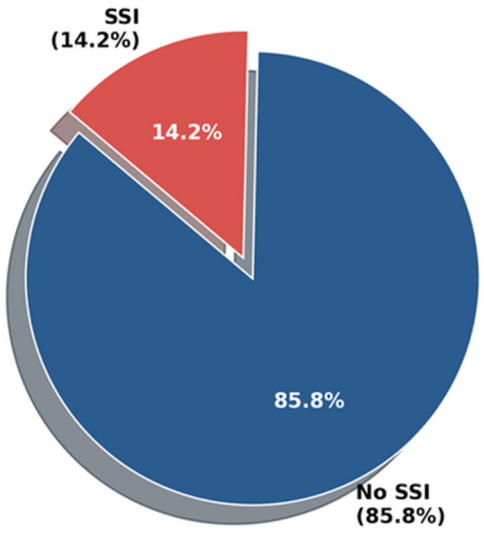


Figure 3 Proportion of patients with and without surgical site infection

Of the 48 patients who developed SSI, 29 (60.4%) had superficial incisional SSI, 11 (22.9%) had deep incisional SSI, and 8 (16.7%) had organ/space SSI (Figure 4).

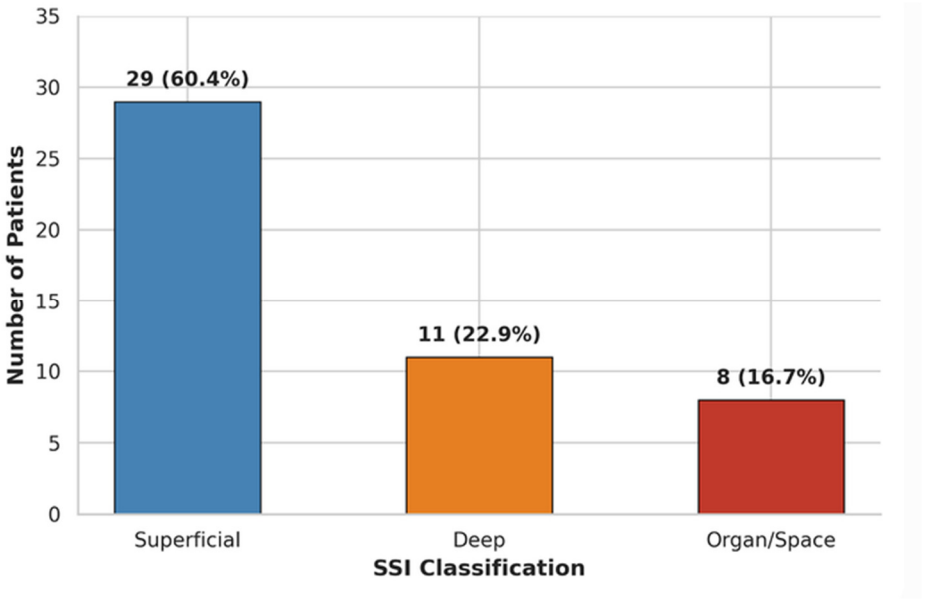


Figure 4 Distribution of surgical site infections by type

5.4. Predictors of Surgical Site Infection

A bivariable Poisson regression analysis was performed to assess factors associated with surgical site infection. Variables with a p-value ≤0.25 in the bivariable analysis and those considered clinically relevant were included in the multivariable Poisson regression model. In the bivariable analysis, preoperative urinary tract infection, preoperative anemia, preoperative hospital stay, ASA classification, site of surgery, wound classification, and intraoperative blood loss were associated with surgical site infection (Table 4).

In the multivariable analysis, preoperative urinary tract infection, preoperative hospital stay greater than three days, lower urinary tract surgery, and ASA Class III remained independently associated with surgical site infection Patients with preoperative urinary tract infection had a higher risk of developing SSI (ARR = 1.91; 95% CI: 1.13–3.22; p = 0.015). Similarly, a preoperative hospital stay of more than three days was associated with an increased risk of SSI (ARR = 2.48; 95% CI: 1.10–5.59; p = 0.028). Furthermore, patients who underwent lower urinary tract surgery had a higher risk of SSI compared with those who underwent upper urinary

tract surgery (ARR = 2.06; 95% CI: 1.16–3.67; p = 0.014). Likewise, ASA Class III was associated with an increased risk of SSI compared with ASA Class I (ARR = 2.42; 95% CI: 1.13–5.19; p = 0.023) (Table 4).

Table 4 Socio-demographic and Clinical Characteristics Associated with Surgical Site Infection (N=337)

Predictor Variable	Category	SSI Developed (n=48)	No SSI (n=289)	Crude RR (95% CI)	Adjusted RR (95% CI)	p-value (Multivariable)
Pre-op Anemia	No	30(11.2%)	238(88.8%)	1.0 (Reference)	1.0 (Reference)	
	Yes	18(26.1%)	51(73.9%)	2.3 (1.4–3.9)	1.7 (1.0–2.9)	0.077
Pre-op UTI	No	29(10.6%)	244(89.4%)	1.0 (Reference)	1.0 (Ref)	
	Yes	**19**(29.7%)	**45(70.3%)**	**2.8 (1.7–4.7)**	**1.9 (1.1–3.2)**	**0.015**
Surgical Site	Upper tract	15(10.6%)	127(89.4%)	1.0 (Reference)	1.0 (Ref)	
	Lower tract	**33**(16.9%)	**162(83.1%)**	**1.6 (0.9–2.8)**	**2.1 (1.2–3.7)**	**0.014**
Wound Class	Clean	4(10.8%)	33(89.2%)	1.0 (Reference)	1.0 (Ref)	
	Clean-contaminated	39(13.4%)	252(86.6%)	1.2 (0.5–3.3)	1.2 (0.5–3.0)	0.746
	Dirty/Contaminated	5(55.6%)	4(44.4%)	5.1 (1.7–15.4)	2.2 (0.7–7.0)	0.172
Drain Use	No	8(8.4%)	87(91.6%)	1.0 (Reference)	1.0 (Ref)	
	Yes	40(16.5%)	202(83.5%)	2.0 (1.0–4.0)	1.5 (0.7–3.1)	0.263
ASA Class	I	21(8.4%)	182(9%1.6)	1.0 (Ref)	1.0 (Ref)	

	II	21(17.1%)	102(82.9%)	1.7 (0.9–2.9)	1.2 (0.7–2.0)	0.619
	III	**5** (45.5%)	**6(54.5%)**	**5.3 (2.7–10.4)**	**2.4 (1.1–5.2)**	**0.023**
Pre-op Hospital Stay	≤3 days	8(5.5%)	137(94.5%)	1.0 (Reference)	1.0 (Ref)	
	>3 days	**40**(20.8%)	**152(79.2%)**	**3.8 (1.8–7.8)**	**2.5 (1.1–5.6)**	**0.028**
Estimated Blood Loss	<500 mL	34(11.8%)	255(88.2%)	1.0 (Reference)	1.0 (Reference)	
	500–1000 mL	12(316)	26(68.4%)	2.7 (1.5–4.7)	1.6 (0.9–3.0)	0.11
	>1000 mL	2(20.0)	8(80.0%)	1.7 (0.5–6.1)	1.1 (0.4–3.1)	0.867

CI = Confidence Interval; RR = Risk ratio; SSI = Surgical site infection; UTI= Urinary tract infection; ASA= American society of anesthesiologist

5.5 Postoperative Outcomes and Microbiological Profiles Among SSI Patients

Among the 48 patients who developed SSI, 26 (54.2%) were diagnosed between postoperative days 8 and 14, while 21 (43.8%) were diagnosed after postoperative day 14. Microbiological cultures were not performed in 38 (79.2%) patients. Among the cultured specimens, Escherichia coli was isolated in 3 cases, Klebsiella pneumoniae in 2 cases, Acinetobacter species in 1 case, and Staphylococcus aureus in 1 case. Readmission was required in 10 (20.8%) patients, 3 (6.3%) underwent re-operation, and 1 (2.1%) patient died. Overall, 44 (91.7%) patients improved and were discharged following (Table 5).

Table 5 Postoperative outcomes among SSI patients (n = 48)

Variable	Category	Frequency	Percentage (%)
Time of SSI diagnosis	<7 days	1	2.1
	8–14 days	26	54.2

	>14 days	21	43.8
Microbiology	Gram-negative bacteria	6	12.5
	Gram-positive (*S. aureus*)	1	2.1
	No growth	3	6.3
	Culture not done	38	79.2
Readmission	Yes	10	20.8
	No	38	79.2
Clinical outcome	Improved/discharged	44	91.7
	Re-operation	3	6.3
	Death	1	2.1

5.6 Comparison of Total Postoperative Hospital Stay by Infection Status

An independent samples t-test was performed to compare the mean total postoperative hospital stay between patients who developed surgical site infection (SSI) and those who did not. Patients without SSI had a mean postoperative hospital stay of 8.78 ± 5.06 days (95% CI: 8.19–9.36), whereas patients who developed SSI had a mean postoperative hospital stay of 14.23 ± 6.76 days (95% CI: 12.31–16.15). The mean difference in postoperative hospital stay between the two groups was 5.45 days. This difference was statistically significant ($t(335) = -6.56$, $p < 0.001$) (Table 6).

Table 6 Comparison of hospital stays by SSI status

SSI Status	**Mean hospital stay (days)**	**SD**	**95% CI**
No SSI (n = 289)	8.78	5.06	8.19–9.36
SSI (n = 48)	14.23	6.76	12.31–16.15
Metric	**Value**		
Mean difference	5.45 days		
t-value	-6.56		
Degree of freedom	335		
p-value	<0.001		

6. DISCUSSION

This study assessed the incidence and predictors of surgical site infection (SSI) among patients undergoing open urologic surgery at Tikur Anbessa Specialized Hospital. The 30-day cumulative incidence of SSI was 14.2%. Preoperative urinary tract infection (UTI), preoperative hospital stay of more than three days, lower urinary tract surgery, and ASA Class III were independently associated with SSI. In addition, patients who developed SSI experienced a longer postoperative hospital stay than those who did not. Taken together, these findings suggest that SSI following open urologic surgery is influenced by a combination of preoperative infection, duration of hospital exposure, type of surgical procedure, and the patient's underlying physical condition.

The incidence observed in this study indicates that SSI remains an important postoperative problem among patients undergoing open urologic surgery in this setting. It is within the range reported from resource-limited settings and is consistent with the substantial burden of SSI reported in Ethiopia (5,7) However, the incidence was higher than that reported in several urologic studies from high-income settings(10,13). This difference may reflect variations in patient characteristics, surgical case mix, perioperative care, infection-prevention practices, and postoperative surveillance. The predominance of open procedures in the present study may also contribute to the higher incidence, as minimally invasive urologic procedures have generally been associated with lower SSI rates (25,26). In contrast, the incidence observed in this study was lower than that reported in some African settings, including studies from Brazzaville and Tanzania (6,12). Such variation between settings highlights the influence of differences in surgical populations, SSI definitions, perioperative practices, and surveillance methods.

In the Ethiopian context, the observed incidence was slightly higher than the pooled SSI estimate reported by the study done in 2020(5). However, this comparison should be interpreted cautiously because the systematic review included different surgical specialties, whereas the present study focused specifically on open urologic surgery. Urologic procedures frequently involve manipulation of the urinary tract and may be performed in clean-contaminated or contaminated surgical fields depending on the procedure and the patient's urinary condition (33). The higher incidence observed in this study may therefore partly reflect the characteristics of the surgical population rather than a difference in the overall quality of surgical care. This also

emphasizes the value of procedure-specific surveillance, particularly in settings where SSI surveillance systems remain limited. Previous work from Ethiopia has demonstrated that differences in surveillance strategies can substantially affect the detection and estimation of SSI burden (18)

The distribution of SSI in this study was predominantly superficial, followed by deep incisional and organ/space infections. This pattern is consistent with the established classification of SSI and with findings reported in urologic surgical populations (1,10). Although superficial infections are generally easier to recognize and manage, deep and organ/space infections may have greater clinical consequences because they can involve deeper tissues or anatomical spaces and may require prolonged antimicrobial treatment, drainage, or additional surgery. In urologic surgery, infection involving the pelvis, retroperitoneum, or perinephric region can be particularly challenging because of the anatomical relationship with the urinary tract. Therefore, the lower proportion of deep and organ/space infections should not be interpreted as indicating a minor clinical burden.

Preoperative UTI emerged as an important independent predictor of SSI. This finding is consistent with previous evidence from urologic surgery. It is known that bacteria present in preoperative urinary infections could contaminate the surgical field and subsequently contribute to SSI(32). Similar associations have also been reported among patients undergoing urologic procedures in other settings (10,12). The association is biologically plausible because manipulation of an infected urinary tract can provide an opportunity for endogenous bacteria to contaminate the operative field. This may be particularly relevant in open procedures in which the urinary tract is directly exposed during surgery.

However, preoperative UTI should not be viewed in isolation. Patients with urinary infection may also have urinary obstruction, stones, malignancy, indwelling urinary devices, or other conditions that increase both surgical complexity and infection risk. Therefore, some of the observed association may reflect the broader clinical condition of these patients. Nevertheless, the consistency of this finding with previous urologic literature supports the importance of identifying and appropriately managing urinary infection before elective urologic surgery. This is particularly relevant in settings where antimicrobial resistance may limit the effectiveness of

empirical treatment. Recent Ethiopian evidence has demonstrated substantial antimicrobial resistance among organisms causing surgical site infections (20), reinforcing the importance of appropriate antimicrobial selection rather than relying solely on routine prophylaxis.

Similarly, a preoperative hospital stay of more than three days was independently associated with SSI. This finding is consistent with previous studies identifying prolonged preoperative hospitalization as a risk factor for postoperative infection (12,30). Prolonged hospitalization may increase exposure to healthcare-associated microorganisms, including antimicrobial-resistant organisms. It may also indicate greater underlying illness, prolonged clinical optimization, or a more complicated disease process. Thus, the observed association may reflect both increased exposure to the hospital environment and the clinical characteristics of patients requiring longer hospitalization.

The finding nevertheless has practical implications because unnecessary preoperative hospitalization represents a potentially modifiable component of perioperative care. Where clinically feasible, investigations and optimization can be completed before admission, and avoidable delays before surgery can be minimized. This approach is consistent with the broader principle that SSI prevention begins before the operation and requires attention to the patient's condition as well as the operative environment (4). At the same time, prolonged hospitalization may sometimes be necessary for patients with complicated urologic conditions; therefore, the objective should not be to shorten admission indiscriminately but to avoid unnecessary hospital exposure.

Furthermore, the type of urologic surgery was independently associated with SSI. Patients undergoing lower urinary tract procedures had a higher risk of infection than those undergoing upper urinary tract procedures. Similar differences according to the type of urologic procedure have been reported in previous studies(10,14). Several factors may explain this finding. Lower urinary tract procedures commonly involve the bladder, urethra, or pelvic structures and are performed closer to the perineal microbial flora. They may also require urinary catheterization, suprapubic drainage, or other forms of urinary diversion, creating additional opportunities for bacterial colonization. In contrast, many upper urinary tract procedures are performed through

operative fields that are relatively less exposed to the microbial flora of the lower urinary tract and perineum.

However, anatomical location should not be considered the sole explanation. Lower urinary tract procedures may differ from upper tract procedures in their complexity, duration, degree of contamination, use of drains, and need for urinary instrumentation. Therefore, the observed association may represent the combined effect of several procedural characteristics. Clinically, the finding may nevertheless help identify patients who require particular attention during perioperative management, including careful assessment of urinary infection, appropriate antimicrobial prophylaxis, meticulous operative technique, and adequate postoperative surveillance.

Likewise, ASA Class III was independently associated with SSI, whereas ASA Class II was not significantly associated with infection after adjustment. This finding is consistent with previous evidence showing that greater systemic illness and higher ASA classification are associated with an increased risk of postoperative infection (12,30). Patients with substantial systemic disease may have impaired immune responses, reduced tissue perfusion, poorer nutritional reserve, or delayed wound healing, making them more vulnerable to postoperative infection. However, ASA classification is a broad measure of physical status rather than a specific biological mechanism. The finding should therefore be interpreted as indicating increased vulnerability among patients with greater systemic disease rather than suggesting that ASA classification itself directly causes SSI. It nevertheless supports careful preoperative optimization and closer postoperative monitoring of patients with significant comorbidity.

Several variables that were associated with SSI during bivariable analysis, including preoperative anemia, wound classification, and surgical drain use, did not retain statistical significance after adjustment. This difference suggests that their crude associations may have been influenced by other patient or procedural characteristics. For example, anemia may be more common among patients with advanced malignancy, chronic disease, or prolonged hospitalization, which may themselves be related to greater systemic illness and surgical complexity. Similarly, wound classification is closely related to the nature of the urologic procedure and the degree of contamination, while drains are more commonly used in complex or extensive operations. Their

loss of statistical significance after adjustment therefore suggests that these variables may partly reflect the underlying complexity of the patient or procedure rather than acting as independent predictors in this cohort. However, the absence of an independent association should not be interpreted as evidence that these factors have no clinical relevance.

An important observation in this study was that most SSIs were diagnosed after the first postoperative week. This finding has implications for postoperative surveillance because assessment limited to the immediate postoperative period may fail to identify infections that become clinically apparent later. Deep incisional and organ/space infections may take longer to manifest because infection develops within deeper tissues or anatomical spaces before producing obvious clinical signs (1,3). The timing may also have been influenced by the relatively prolonged use of postoperative antibiotics observed in this cohort. However, the present study cannot establish that prolonged antibiotic administration caused delayed presentation. The delayed diagnosis may also reflect the natural progression of deeper infections or differences in post-discharge follow-up. Therefore, the finding primarily emphasizes the importance of surveillance beyond the immediate postoperative period.

The relatively prolonged use of postoperative antibiotics in this cohort also deserves consideration. Although antibiotics may temporarily suppress bacterial growth, extending prophylaxis beyond the recommended period does not necessarily prevent SSI and may increase antimicrobial exposure and the risk of resistance. Evidence from urologic surgery has suggested that shorter prophylactic courses may be sufficient, while current urologic antimicrobial prophylaxis recommendations emphasize procedure-specific selection and appropriate duration (8,9). Therefore, the relatively high SSI incidence observed despite widespread antibiotic use suggests that antimicrobial prophylaxis alone is unlikely to be sufficient for SSI prevention. Attention should also be directed toward preoperative infection control, operative technique, appropriate patient preparation, and postoperative surveillance.

The clinical consequences of SSI were also important. Patients who developed SSI had a longer postoperative hospital stay than those without infection. This finding is consistent with evidence showing that SSI increases healthcare utilization, treatment requirements, and costs (22,23). In a tertiary public hospital, prolonged hospitalization can increase bed occupancy, antimicrobial use,

nursing requirements, and overall workload. The need for readmission or additional surgery further increases the burden on both patients and the health system. Therefore, preventing SSI has implications beyond reducing wound complications; it may also improve the efficiency of surgical services and reduce avoidable use of limited hospital resources.

Overall, the findings indicate that SSI following open urologic surgery at Tikur Anbessa Specialized Hospital is associated with a combination of potentially modifiable preoperative factors and characteristics reflecting the patient's underlying condition and the type of procedure performed. Preoperative UTI and prolonged hospitalization identify areas in which perioperative practice may be improved, while lower urinary tract surgery and higher ASA class may help identify patients who require closer attention and surveillance. These findings support a multifaceted approach to SSI prevention rather than reliance on antimicrobial prophylaxis alone. Strengthening preoperative urinary assessment, minimizing avoidable hospital exposure, optimizing patients with significant systemic disease, applying procedure-appropriate infection-prevention measures, and extending postoperative surveillance may help reduce the burden of SSI following open urologic surgery.

7. Strength and Limitation of the study

7.1. Strengths of the Study

This study possesses several distinct methodological strengths. The utilization of a universal sampling strategy ensured the consecutive inclusion of all eligible patients who underwent open urological surgery during the specified study window, thereby minimizing potential selection bias. In addition, this investigation provides critical baseline local evidence on surgical site infections within open urological cohorts, addressing a pronounced data scarcity in the Ethiopian surgical literature. Furthermore, the institutional positioning of Tikur Anbessa Specialized Hospital as the premier national referral center facilitated the recruitment of a highly diverse clinical population presenting with advanced and complex urological pathologies. Mechanistically, the application of modified Poisson regression with robust variance estimators further allowed accurate estimation of risk ratios rather than the typical overestimations associated with traditional logistic frameworks in high-incidence scenarios.

7.2. Limitation of the Study

This study have some limitations. First, its retrospective design relied on existing medical records, resulting in missing or incompletely documented data and limiting assessment of potentially important variables such as BMI, nutritional status, smoking status, and some intraoperative factors. Second, although urinalysis, urine culture, and clinical documentation of UTI within 30 days before surgery were available, the retrospective nature of the data limited our ability to verify whether patients with preoperative UTI received appropriate targeted treatment before surgery. Third, because Tikur Anbessa Specialized Hospital is a national referral center, some patients may have sought treatment for mild or delayed SSI at other healthcare facilities after discharge. This may have resulted in underestimation of the true 30-day SSI incidence. Fourth, the single-center design may limit the generalizability of the findings to other hospitals or healthcare settings. Finally, because of the observational retrospective design, the observed associations should not be interpreted as causal relationships.

8. Conclusion

This study found a 30-day cumulative incidence of surgical site infection of 14.2% among patients undergoing open urological surgery at Tikur Anbessa Specialized Hospital. Preoperative urinary tract infection, preoperative hospital stay of more than three days, lower urinary tract surgery, and ASA Class III were independently associated with an increased risk of surgical site infection. Patients who developed surgical site infection also had a longer postoperative hospital stay than those without infection.

These findings indicate that surgical site infection remains an important postoperative problem among patients undergoing open urological surgery at the study hospital. The identified predictors highlight the importance of appropriate preoperative assessment and optimization, minimizing unnecessary preoperative hospitalization, careful management of preoperative urinary tract infection, and closer attention to patients undergoing lower urinary tract procedures and those with greater systemic illness. The increased postoperative hospital stay among patients with SSI further demonstrates the clinical and healthcare burden associated with these infections.

9. Recommendations

Based on the findings of this study, the following recommendations are directed to the relevant stakeholders:

9.1. For the TASH Department of Urology

The Department of Urology should strengthen preoperative assessment and management of urinary tract infection before elective open urologic surgery. Patients with suspected or documented preoperative UTI should undergo appropriate clinical and laboratory assessment and receive appropriate treatment before surgery whenever clinically feasible.

The department should also review the causes of prolonged preoperative hospitalization and minimize avoidable delays before surgery. Particular attention should be given to patients undergoing lower urinary tract procedures and those with higher ASA physical status, as these groups had a higher risk of SSI in this study. Postoperative surveillance should also extend beyond the immediate postoperative period to facilitate early recognition of infections that become apparent after discharge.

9.2. For the TASH Infection Prevention and Control Committee and Hospital Administration

The Infection Prevention and Control Committee should strengthen SSI surveillance following open urologic surgery, including appropriate follow-up after discharge, because a substantial proportion of infections in this study were identified after the first postoperative week.

The hospital should also strengthen adherence to evidence-based perioperative infection-prevention measures and antimicrobial stewardship. Antibiotic prophylaxis should be selected and administered according to the type of urologic procedure and local antimicrobial susceptibility patterns, while unnecessary prolonged postoperative antibiotic use should be avoided.

9.3. For the Federal Ministry of Health and Researchers

The findings support strengthening postoperative SSI surveillance and surgical infection-prevention programs in Ethiopian hospitals, particularly for procedures with a higher observed risk of infection. Further multicenter prospective studies are recommended to confirm these predictors across different hospitals and to evaluate potentially important factors that could not be adequately assessed in this retrospective study, including nutritional status, BMI, smoking, and detailed intraoperative factors.

In general the main recommendation is to strengthen preoperative optimization, particularly identification and appropriate management of preoperative UTI and reduction of avoidable prolonged preoperative hospitalization**.** This is prioritized because both preoperative UTI and hospitalization exceeding three days were independently associated with SSI in this study and represent potentially modifiable factors that can be addressed before surgery.

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Annex

Data extraction form

Predictors and incidence of Surgical Site Infection (SSI)

Study Title: incidence and predictors of Surgical Site Infection Following Open Urologic Surgeries at Black Lion Referral Hospital

Date of Abstraction	Data Abstractor ID
DD/MM/YYYY	No.

Part 1: Patient-Related Factors (Pre-operative Risk)

Variable	Value to Record (Continuous/Specific)	Categorical Value for Analysis (Check One)
1. Age (in years)	Record exact age:	
2. Sex		□ Male □ Female
3. Pre-operative Anemia		□ Yes □ No
4. Preoperative UTI (within 30 days)		□ Yes □ No
5. Pre-operative Hospital Stay (days)	Record exact days:	
6. ASA Score		□ I □ II □ III □ IV □ V
7. Comorbidities (Check all that apply)	□ DM □ HTN □ CKD □ None	Others (Specify):

Part 2: Procedure-Related Factors (Intra-operative)

Variable	Value to Record (Continuous/Specific)	Categorical Value for Analysis (Check One)
8. Kind of Urological Surgery	Check one: □ Radical cystectomy □ Radical prostatectomy □ Open nephrectomy □ Open pyeloplasty / ureterolithotomy	Others (Specify):
9. Type of Surgery		□ Elective □ Emergency

10. Duration of Surgery (minutes)	Record exact minutes:	
11. Estimated Blood Loss (EBL) (mL)	Record exact EBL:	
12. Wound Classification		□ Clean □ Clean-Contaminated □ Contaminated □ Dirty
13. Use of Surgical Drains		□ Yes □ No
14. Types of anesthesia		□GA □neuraxial

Part 3: Perioperative Care Factors

Variable	Value to Record (Continuous/Specific)	Categorical Value for Analysis (Check One)
15. Use of Prophylactic Antibiotics		□ Yes □ No
16. Duration of Prophylactic Antibiotics (Post-op)	Record total hours post-op:	□≤24 hrs□25–48 hrs□>48 hrs
17. Total Hospital Stay (days)	Record exact days:	

Part 4: Outcome Variable (Surgical Site Infection - SSI)

Variable	Answer	Classification Details
18. SSI Developed within 30 days of surgery?	□ Yes □ No	→ If No, skip to Question 27
19. Interval of SSI Diagnosis (If Yes)	Check one: □ In the first 7 days □7–14 days□14–21 days□21–30 days	
20. Classification of SSI (If Yes)	Check one: □ Superficial Incisional □ Deep Incisional □ Organ/Space	
21. Causative Organism(s)	Specify organism(s):	Or check: □ Negative □ Not Done
22. Readmission due to SSI	□ Yes □ No	
23. Outcome	□ Discharged □ Death	If Death, was it SSI-related? □ Yes □ No

Declaration

I, the undersigned researcher, hereby declare that I have accessed and utilized the required data solely for the purpose of the research study entitled **"Predictors and Prevalence of Surgical Site Infection Following Open Urologic Surgeries at Tikur Anbessa Specialized Hospital (TASH)."**

I affirm that all patient-related data have been handled with strict confidentiality and used only for this research purpose. No identifiable patient information has been disclosed, shared, or used beyond the scope of the approved study. The study has been conducted in accordance with the approved research protocol, institutional regulations, and ethical principles governing medical and clinical research.

I take full responsibility for maintaining data security, protecting patient privacy, and ensuring compliance with all ethical standards throughout the entire research process.

Researcher Name: Habte Gebremichael
Signature: _____
Date: June, 2026

Advisor Name: Yoseph Worku, MD, MPH, MBA
Signature: _____
Date: June, 2026