Surgical Case Patterns and WHO AWaRe Antibiotic Utilization: A Retrospective Hospital-Based Study from South India

Dr. N. Junior Sundresh, M.S., FRCS., FACS., Ph.D.[1], Sowmini M.[2], Mahisha N.[2]

[1]Medical Superintendent & Professor, Department of General Surgery, Government Cuddalore Medical College and Hospital, Annamalai Nagar, Chidambaram, Tamil Nadu, India.

[2]Pharm.D, Department of Pharmacy, Annamalai University, Annamalai Nagar, Chidambaram, Tamil Nadu, India.

ABSTRACT:

Background: *Surgical pathology contributes significantly to the healthcare burden in low- and middle-income countries (LMICs), where delayed presentation, metabolic comorbidities, and limited diagnostic support complicate perioperative management. The WHO AWaRe framework allows standardized evaluation of antimicrobial use patterns and stewardship performance.*

Methods: *This retrospective review included 40 adult surgical inpatients admitted consecutively to a tertiary government hospital in Tamil Nadu, India. Demographic characteristics, clinical presentation, diagnostic investigations, operative or conservative management, and inpatient antimicrobial therapy were collected from medical records. Antibiotics were categorized according to WHO AWaRe 2023 guidelines.*

Results: *The cohort was predominantly male (92.5%) with a mean age of 41.4 ± 12.8 years. Soft-tissue infections (30%), abdominal wall hernias (22.5%), and gastrointestinal emergencies (20%) were the most common diagnoses. Surgical intervention was required in 85% of patients. Watch-category antibiotics accounted for 68% of prescriptions, with cefotaxime administered to 90% of patients. Access agents constituted 32%, largely metronidazole (52.5%). The resulting Access-to-Watch ratio was 0.47, below the WHO benchmark of ≥0.60. No surgical-site infections, complications, readmissions, or in-hospital mortality were observed.*

Conclusion: *Antibiotic prescribing in this surgical cohort showed heavy reliance on Watch-category agents despite favourable clinical outcomes. Strengthened microbiology capacity and AWaRe-aligned stewardship protocols are needed to optimize antimicrobial use in resource-limited surgical settings.*

Keywords: *Surgical epidemiology; General surgery; Soft-tissue infections; Hernia; Antimicrobial stewardship; WHO AWaRe classification; Antibiotic utilization; Low- and middle-income countries*

INTRODUCTION:

Surgical diseases account for a substantial share of global morbidity, yet their epidemiology in low- and middle-income countries (LMICs) remains under-documented. Limitations in diagnostic capacity, perioperative optimization, and antimicrobial decision-support frequently shape surgical care pathways in these settings (1-3). General surgery units manage a wide spectrum of conditions, including acute abdominal emergencies, soft-tissue infections, abdominal wall hernias, and complications arising from chronic illnesses such as diabetes mellitus (4, 5). The composition of surgical caseloads, combined with delayed presentation and disease severity, influences operative risk, antibiotic decision-making, and resource utilization across LMIC hospitals (2, 6, 7). However, granular descriptions of real-world surgical cohorts from resource-constrained institutions remain scarce, limiting the ability to benchmark outcomes and identify opportunities for targeted stewardship improvement (8, 9). Across developing health systems, surgical departments commonly encounter a mix of elective and emergency conditions. Abdominal wall hernias persist as a leading indication for elective general surgery globally, driven by anatomical susceptibilities, occupational strain, and delays in accessing timely repair (4). Conversely, gastrointestinal emergencies such as perforated viscus, obstruction, and acute appendicitis continue to contribute substantially to surgical morbidity and typically necessitate urgent evaluation and operative intervention (5, 6, 10). Soft-tissue infections and diabetic foot disease pose additional challenges, especially where chronic disease management systems remain overburdened (11-13). Poor glycaemic control, neuropathy, and peripheral vascular disease accelerate tissue breakdown and infection progression, often resulting in the need for surgical debridement or amputation (11, 12, 14). Parallel to these clinical demands, antimicrobial resistance (AMR) has emerged as a critical global threat. Empirical perioperative antibiotic use particularly in settings with limited microbiological support creates selection pressures that drive resistance within surgical wards (7, 8). To address global disparities in antibiotic utilization, the World Health Organization introduced the AWaRe classification, which groups antimicrobials into Access, Watch, and Reserve categories (15, 16). WHO recommends that at least 60% of national antibiotic consumption derive from Access agents, with deviations from this threshold indicating potential overuse of broad-spectrum or Watch-category antibiotics (8, 15). Assessing surgical prescribing patterns through the AWaRe framework provides a structured lens for evaluating antimicrobial stewardship in routine practice. Although multi-country point-prevalence surveys describe global AWaRe trends, hospital-level analyses focused specifically on surgical departments—particularly within LMICs—are still limited (17) hospital-level analyses especially from LMIC surgical departments remain limited. Variability in diagnostic access, clinician preference, infection severity, and resource constraints contributes to heterogeneity in prescribing practices (8, 9). Yet detailed descriptions of demographics, comorbidities, operative decisions, and postoperative outcomes in resource-limited surgical settings remain scarce.

Accordingly, this study sought to characterize surgical disease patterns, resource use, antimicrobial prescribing aligned with the AWaRe framework, and short-term outcomes among patients admitted to a tertiary-care general surgery department (2, 3, 9, 15). Furthermore, few studies simultaneously evaluate demographics, comorbidities, operative decisions, and short-term outcomes within the same surgical population. To address these evidence gaps, the present study aimed to characterize surgical case patterns, resource utilization, AWaRe-aligned antimicrobial use, and early clinical outcomes among inpatients admitted to a tertiary-care general surgery department in South India. The findings provide locally relevant insights that may support stewardship interventions, enhance perioperative care, and strengthen health-system preparedness within LMIC settings.

METHODS:

Study Design and Setting

A retrospective observational study was conducted in the Department of General Surgery at Government Cuddalore Medical College and Hospital, a 1,250-bed tertiary-care teaching institution in Tamil Nadu, India. The hospital provides round-the-clock emergency and elective surgical services to a predominantly rural and semi-urban population.

Study Population

The study included all adult patients (≥18 years) admitted consecutively under the General Surgery service during the study period. Patients with incomplete medical records, pediatric patients, and individuals transferred before completion of treatment were excluded.

Data Collection

Data were retrieved from inpatient case sheets and records. Variables extracted included:

- demographic characteristics,
- risk factors (smoking use and alcohol use),
- comorbidities,
- presenting complaints and clinical diagnosis,
- laboratory investigations,
- radiological imaging reports,
- operative findings and procedures carried out,
- antibiotic prescriptions with dose and route,
- clinical outcomes at discharge.

Treatment decisions were recorded as operative or conservative, and postoperative outcomes were documented.

Antibiotic Classification

All antibiotics prescribed during the hospital stay were classified according to the 2023 WHO AWaRe (Access–Watch–Reserve) framework. Each antibiotic course was categorized independently. Combination regimens contributed counts to each included AWaRe category. The Access-to-Watch ratio was calculated and benchmarked against the WHO recommendation of ≥0.60.

Outcome Measures

Primary outcomes included:

- pattern of antibiotic utilization by AWaRe category,
- proportion receiving combination therapy.

Secondary outcomes included:

- type and frequency of surgical procedures,
- postoperative complications,
- surgical-site infections,
- readmissions,
- in-hospital mortality, and
- length of hospital stays.

Statistical Analysis

Data were compiled in Microsoft Excel and analysed using descriptive statistics. Categorical variables were expressed as frequencies and percentages. Continuous variables were reported using mean, median, and range. Graphical summaries including bar charts, pie charts, and histograms were generated to depict diagnosis profiles, AWaRe antibiotic distribution, and hospital-stay patterns.

Ethical considerations and confidentiality

Permission to access anonymized patient records was obtained from the institutional authorities. Because the study used retrospective de-identified data, individual consent was not required under institutional guidelines.

All records were handled confidentially. Each patient was assigned a unique study code unrelated to hospital registration numbers. Data were stored in password-protected electronic files accessible only to the research investigators. No personal identifiers are presented in this manuscript.

Data integrity and record preservation

All extracted data were cross-verified by two independent reviewers to ensure accuracy. The compiled dataset and related documents will be maintained securely in the Department of General Surgery for academic reference and institutional auditing.

RESULT:

A total of 40 adult surgical inpatients were included. The cohort was predominantly male, with a broad range of surgical conditions and significant variability in comorbidities, laboratory abnormalities, antibiotic utilization, and surgical interventions.

Demographic and Clinical Characteristics

Patients had a mean age of 41.4 ± 12.8 years (range 14–63 years), and 92.5% were male. smoking and alcohol use were reported in 42.5% and 47.5% of patients, respectively. The most common comorbidity was type 2 diabetes mellitus (30%), followed by hypertension (17.5%).

Table 1 Patient Demographic and Clinical Profile (n = 40)

Baseline demographic characteristics, lifestyle habits, and comorbidities.

Parameter	Value
Mean age (years)	41.4 ± 12.8 (14–63)
Male	37 (92.5%)
Female	3 (7.5%)
Married	33 (82.5%)
Smoking use	17 (42.5%)
Alcohol use	19 (47.5%)
Type 2 diabetes mellitus	12 (30%)
Hypertension	7 (17.5%)
Coronary artery disease	3 (7.5%)
Chronic kidney disease	1 (2.5%)
≥2 chronic conditions	1 (2.5%)

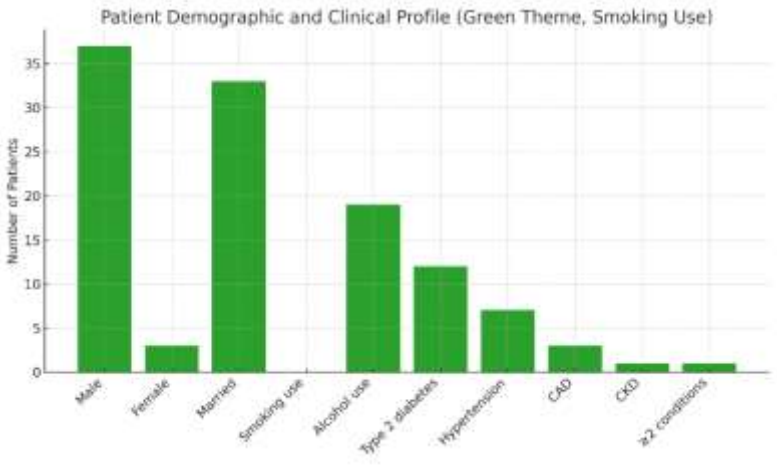

Figure 2 Demographic and Clinical Profile of Surgical Inpatients.

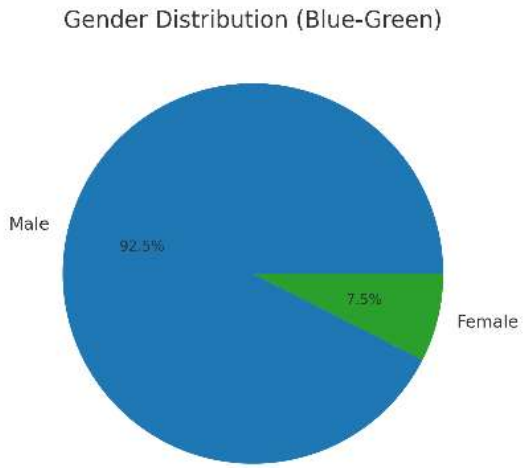

Figure 1 Gender Distribution of the Study

Distribution of Surgical Diagnoses

The most common diagnostic categories were soft-tissue infections (30%), abdominal wall hernias (22.5%), and gastrointestinal emergencies (20%). Diabetic foot complications and genitourinary conditions contributed smaller proportions.

Table 2 Distribution of Final Surgical Diagnoses (n = 40)

Diagnostic categories and condition frequency.

Category	Diagnosis	n (%)
Abdominal wall	Inguinal hernia	6 (15%)
	Umbilical hernia	3 (7.5%)
Gastrointestinal emergencies	Perforated viscus	5 (12.5%)

	Acute appendicitis	2 (5%)
	Acute pancreatitis	1 (2.5%)
Anorectal	Fistula-in-ano	2 (5%)
	Chronic fissure	1 (2.5%)
	Hemorrhoids	2 (5%)
Soft-tissue	Abscess	5 (12.5%)
	Lipoma	3 (7.5%)
	Cellulitis	4 (10%)
Diabetic foot	Ulcers	2 (5%)
Genitourinary	Balanitis / Epididymo-orchitis	2 (5%)
	Hydrocele	1 (2.5%)
Breast	Breast lump	2 (5%)

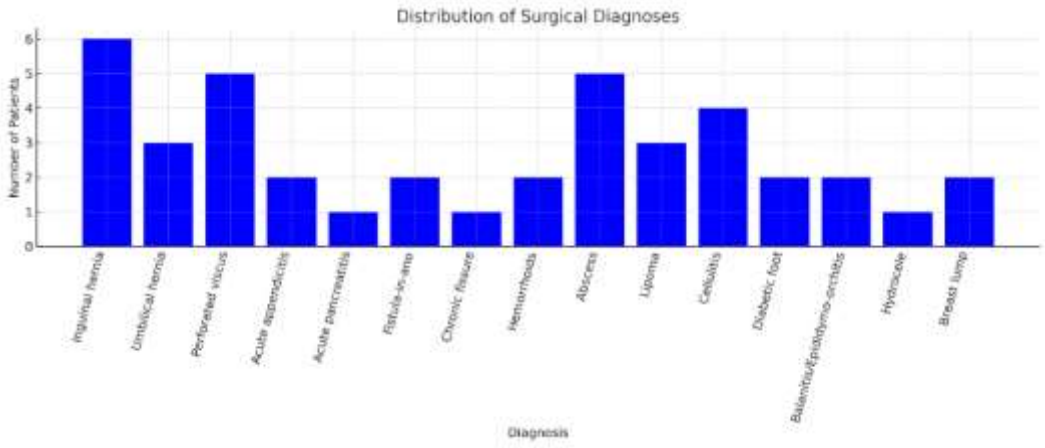

Figure 3 Distribution of Surgical Diagnoses

Laboratory Findings

Anemia was identified in 37.5%, leukocytosis in 32.5%, and elevated admission glucose in 30% of patients. Renal function abnormalities were uncommon.

Table 3 Admission Laboratory Values (n = 40)

Mean values, ranges, and proportion of abnormal findings.

Parameter	Mean ± SD	Range	Abnormal (%)
Hemoglobin (g/dL)	12.2 ± 1.7	7.7–14.3	37.5 (low)
WBC (/mm³)	10,428 ± 4,156	6,100–21,000	32.5 (high)
Platelets (lakhs/mm³)	2.66 ± 0.71	1.85–4.90	Normal
RBS (mg/dL)	111 ± 42	68–245	30 (high)
Serum creatinine (mg/dL)	1.12 ± 0.34	0.7–2.0	12.5 (high)
Sodium (mmol/L)	138.6 ± 3.1	132–145	Normal
Potassium (mmol/L)	4.0 ± 0.41	3.4–5.2	Normal

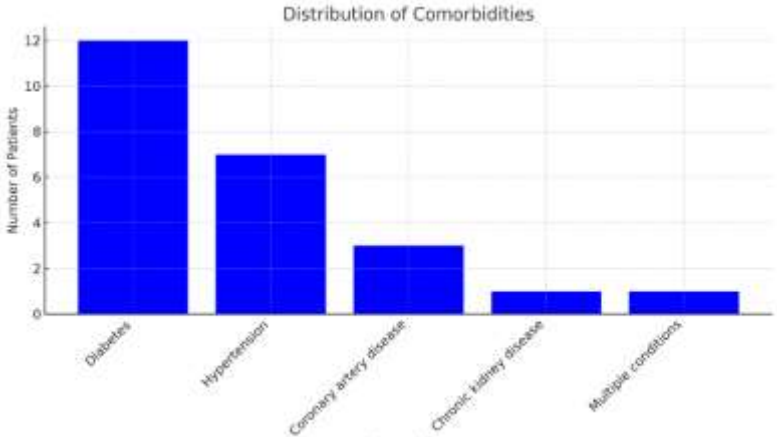

Figure 4 Distribution of Comorbidities

Imaging Studies

Ultrasonography was performed in 67.5% of cases; CT abdomen was used selectively for suspected perforation, appendicitis, pancreatitis, or deep-space abscess.

Surgical and Conservative Management

Overall, 34 patients (85%) underwent operative management, while six (15%) were managed non-operatively. Hernia repairs, abscess drainage, excision procedures, and anorectal surgeries comprised the bulk of interventions.

Table 4 Treatment Approaches and Surgical Procedures (n = 40)

Distribution of emergency, elective, and soft-tissue procedures.

Category	Procedure	n (%)
Emergency surgeries	Laparotomy ± patch repair	5 (12.5%)
	Emergency appendicectomy	2 (5%)
Elective hernia repairs	Meshplasty / Hernioplasty	6 (15%)
	Herniorrhaphy	2 (5%)
Soft-tissue operations	Incision & drainage	5 (12.5%)
	Excision with biopsy	6 (15%)
Anorectal surgeries	Fistulectomy	2 (5%)
	Lateral sphincterotomy	1 (2.5%)
	Hemorrhoidectomy	2 (5%)
Limb surgeries	Ray amputation	2 (5%)
Other	Circumcision	1 (2.5%)
Conservative treatment	Non-operative	6 (15%)

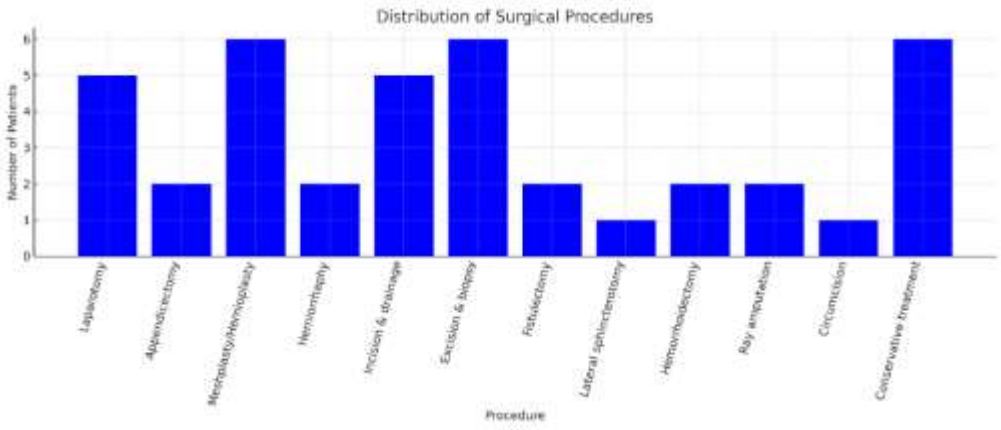

Figure 5 Distribution of Surgical Procedures

Antibiotic Utilization (WHO AWaRe)

Watch-group antibiotics were used extensively (68%), dominated by cefotaxime (90%). Access antibiotics accounted for 32%, mainly metronidazole (52.5%). No Reserve-category antibiotics were prescribed.

Table 5 Antibiotic Usage Categorized by WHO AWaRe (n = 40)

Distribution of antibiotics by AWaRe category and route.

AWaRe Category	Antibiotic	Route	n (%)
Watch	Cefotaxime	IV	36 (90%)
	Gentamicin	IV	10 (25%)
	Ciprofloxacin	IV	6 (15%)
	Cefixime	PO	2 (5%)
	Cephalexin	PO	1 (2.5%)
Access	Metronidazole	IV	21 (52.5%)
Reserve	—	—	0 (0%)

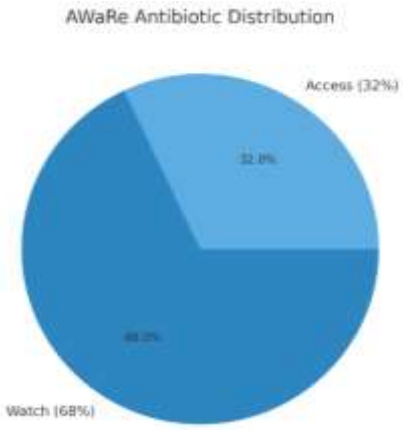

Figure 7 AWaRe Antibiotic Distribution

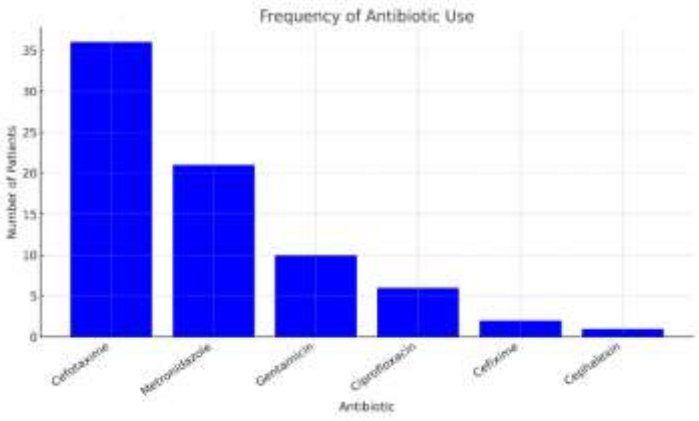

Figure 6 Frequency of Antibiotic Use

Length of Hospital Stay and Outcomes

The mean length of stay was 8.4 ± 3.6 days, with the highest proportion admitted for 6–10 days. No postoperative complications, SSIs, readmissions, or mortality were observed.

Table 6 Length of Hospital Stay and Clinical Outcomes (n = 40)

Distribution of hospitalization duration and outcomes.

Parameter	Value
Mean LOS	8.4 ± 3.6 days
Median LOS	7 days
LOS range	3–14 days
LOS 3–5 days	10 (25%)
LOS 6–10 days	17 (42.5%)
LOS 11–14 days	13 (32.5%)
Surgical complications	0%
Surgical-site infections	0%
Readmissions	0%
In-hospital mortality	0%
Symptom resolution	100%

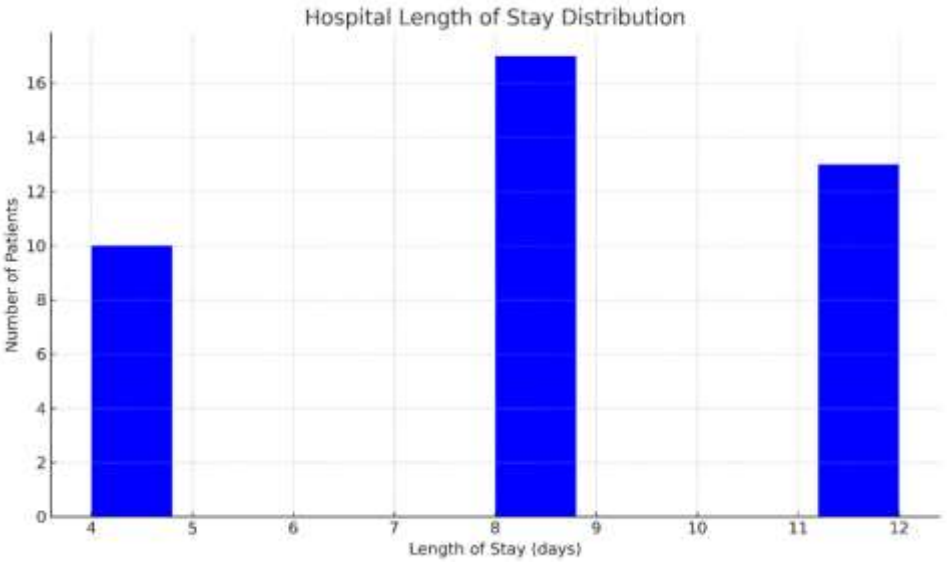

Figure 8 Hospital Length-of-Stay Distribution

DISCUSSION:

This retrospective analysis provides a detailed examination of surgical disease patterns, antibiotic utilization, and short-term clinical outcomes within a tertiary-care teaching hospital in South India. The findings highlight the considerable burden of surgical morbidity in low- and middle-income countries (LMICs), where structural constraints in early diagnosis, perioperative optimization, and antimicrobial stewardship continue to shape patient

trajectories. These observations align with global assessments describing surgery as an under-recognized contributor to morbidity in resource-constrained settings (1-3). The demographic pattern of our cohort exclusively male, relatively young, and with high rates of lifestyle-associated risk factors mirrors trends reported in LMIC surgical units, where occupational strain, smoking, and alcohol consumption significantly influence surgical case mix (1, 4). Metabolic disease, particularly type 2 diabetes mellitus (T2DM), played a central role in disease severity and treatment complexity. Diabetes is known to heighten susceptibility to soft-tissue infections, impair wound healing, and increase the likelihood of requiring limb-preserving or amputative surgery (11-13). The two cases of diabetic foot requiring ray amputation in our cohort fall in line with global reports identifying diabetic foot ulcers as a major and recurrent cause of limb infection (11, 12). The diagnostic distribution observed in this study dominated by abdominal wall hernias, gastrointestinal emergencies, soft-tissue infections, and anorectal disease is consistent with international epidemiological patterns. Hernias remain among the most common indications for elective surgery worldwide and frequently present in LMICs due to delayed access to primary and preventive care (4). The gastrointestinal emergencies observed, particularly perforated viscus and acute appendicitis, represent high-acuity conditions with significant risk of morbidity and mortality if untreated. These conditions follow well-established pathophysiological trajectories described in global surgical literature (5, 6, 10). Perforated peptic ulcer and hollow viscus perforation, in particular, are associated with high rates of sepsis, prolonged hospitalization, and increased need for broad-spectrum antimicrobial therapy (5, 6). Soft-tissue infections were commonly encountered and ranged from cellulitis to abscesses, requiring incision, drainage, and antibiotic therapy. The treatment approaches align with established guidelines for skin and soft-tissue infection management (14). These diagnoses often overlapped with uncontrolled diabetes, reinforcing the syndemic nature of metabolic disease and surgical infection.

Antibiotic prescription patterns in this cohort show a distinct predominance of WHO Watch-category agents, especially cefotaxime. While this trend is characteristic of LMIC surgical units, it also underscores the tension between clinical necessity and stewardship principles. Broad-spectrum antibiotics are frequently required for perforation, deep soft-tissue infection, and diabetic foot disease, aligning with consensus guidelines for intra-abdominal infection management (6) and surgical prophylaxis (7). However, overreliance on Watch antibiotics reflected in an Access-to-Watch ratio below WHO's recommended threshold of ≥ 0.60 indicates a stewardship gap requiring ongoing system-level attention (8, 15).

Global studies have shown that AWaRe compliance varies widely across hospitals and countries, with LMIC institutions frequently demonstrating higher Watch usage due to limited microbiology support, delayed presentations, and supply chain constraints (9, 17). Our findings reinforce these observations: the absence of Reserve antibiotic use suggests that although resistance pressures exist, the bacterial profiles in this cohort were manageable with first- and second-line therapy. Strengthening stewardship programs and diagnostic capacity including culture facilities, rapid diagnostics, and clear de-escalation pathways could help optimize antibiotic use (8). Despite resource limitations, short-term outcomes were uniformly positive: no postoperative infections, no complications, no readmissions, and zero mortality. Such results

speak to the effectiveness of structured perioperative care, timely surgical intervention, and clinician expertise in emergency and elective settings. Enhanced recovery pathways emphasizing pain control, early mobilization, and optimized metabolic management have been shown to improve outcomes in surgical populations, and their principles likely contributed to favorable recovery in this cohort (18). Length of stay averaged 9.1 days, longer than typical durations reported in high-income countries but consistent with LMIC patterns, where disease severity, comorbidities, and sociocultural discharge barriers prolong hospitalization (2, 3). Patients with perforation and diabetic foot disease exhibited the longest stays, reflecting the higher physiological burden and the need for extended postoperative monitoring.

The study's strengths lie in its comprehensive chart-based data capture, evaluation of both operative and antimicrobial practices, and integration of WHO AWaRe metrics into surgical audit processes. However, several limitations must be acknowledged. The small sample size limits generalizability, and the exclusively male cohort prevents sex-specific comparisons. The single-center design may not reflect regional variation. Additionally, the lack of culture data restricts analysis of pathogen-specific antibiotic appropriateness a common constraint in LMIC hospitals (8, 9).

Nevertheless, this study adds meaningful insight to global surgical literature. As the global surgery movement continues to emphasize equitable access to safe surgical care, high-quality evaluations of real-world surgical populations become essential. Effective integration of antimicrobial stewardship within surgical systems is a crucial component of preventing resistance escalation and ensuring sustainable surgical capacity (8, 15). By positioning general surgery units as central actors in managing complex infection profiles and guiding antimicrobial decision-making, the present study reinforces their pivotal role in advancing antibiotic stewardship within resource-limited health systems. The predominance of soft-tissue infections, abdominal wall hernias, and gastrointestinal emergencies alongside substantial rates of metabolic comorbidities such as diabetes highlights the intersecting clinical and public-health challenges faced by surgical departments. The marked reliance on Watch-category antibiotics, particularly cefotaxime, coupled with a low Access-to-Watch ratio, further underscores systemic stewardship gaps shaped by limited diagnostic microbiology support. Despite these constraints, the absence of postoperative complications, surgical-site infections, readmissions, or mortality demonstrates the department's capacity to deliver effective care under operational limitations. In summary, the findings reveal a dual landscape of high-volume elective conditions and high-acuity emergencies, accentuated by infection-prone comorbidities and constrained investigative capacity. These results emphasize the need for integrated surgical, metabolic, and antimicrobial-stewardship strategies tailored to LMIC settings. Future multi-center evaluations incorporating microbiological diagnostics, antibiotic-resistance surveillance, and AWaRe-based prescribing protocols will be essential for refining context-specific guidelines, improving stewardship performance, and strengthening the resilience of surgical services within the broader global Antimicrobial Resistance (AMR) agenda.

CONCLUSION:

This study provides a detailed overview of the surgical case profile, treatment patterns, and antimicrobial utilization in a tertiary-care government hospital in South India. Abdominal wall hernias, soft-tissue infections, and gastrointestinal emergencies formed the major burden of surgical admissions, frequently compounded by metabolic comorbidities such as diabetes mellitus. Although surgical intervention was required in most patients, the absence of postoperative complications, surgical-site infections, readmissions, or mortality demonstrates effective clinical management within a resource-limited context. However, antibiotic utilization was heavily skewed toward Watch-category agents particularly cefotaxime resulting in an Access-to-Watch ratio below WHO stewardship recommendations. These findings highlight a persistent dependency on broad-spectrum agents and underscore the limitations posed by inadequate microbiological diagnostic support.

Overall, the study emphasizes the dual need to strengthen both surgical care delivery and antimicrobial stewardship in LMIC settings. Integrating evidence-based prescribing practices with improved diagnostic capabilities will be essential to ensure rational antibiotic use without compromising clinical outcomes.

FUTURE SCOPE

Future research should build upon these findings by incorporating multi-center studies with larger sample sizes to validate surgical case patterns, antibiotic utilization trends, and stewardship indicators across different healthcare settings. Strengthening routine microbiological cultures and resistance profiling will enable more targeted therapy and reduce dependence on empirical Watch-group antibiotics. Evaluating the impact of AWaRe-based stewardship interventions such as standardized surgical prophylaxis protocols, antibiotic time-outs, and de-escalation strategies will be essential for improving prescribing practices. Integrating metabolic disease management, particularly optimized diabetes control, may further decrease the burden of infection-related surgical admissions. Digital surveillance systems capable of real-time tracking of antibiotic use, resistance patterns, and postoperative outcomes would enhance monitoring capabilities. Additionally, capacity-building initiatives aimed at clinicians, nurses, and pharmacists can reinforce antimicrobial stewardship awareness and promote sustained behavioural change. Addressing these domains collectively will support the development of context-sensitive guidelines, strengthen health-system preparedness, and align surgical antibiotic practices with global efforts to reduce antimicrobial resistance.

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