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Assessing the Knowledge, Attitude, and Practices of Surgical Residents Regarding Surgical Antimicrobial Prophylaxis at Tikur Anbessa Specialized Hospital, Ethiopia

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Acronyms and abbreviations

- **AMR:** Antimicrobial Resistance
- **ASHP:** American Society of Health-System Pharmacists
- **ASP**: Antimicrobial Stewardship Program
- **ETB**: Ethiopian Birr
- **G.C:** Gregorian Calendar
- **KAP:** Knowledge, Attitudes, and Practices
- **LMICs**: Low- and Middle-Income Countries
- **PI**: Principal Investigator
- **SAP:** Surgical Antimicrobial Prophylaxis
- **SPSS**: Statistical Package for Social Sciences version 27
- **SSI:** Surgical Site Infection
- **TASH:** Tikur Anbessa Specialized Hospital
- **WHO:** World Health Organization

Abstract

Background: Inappropriate use of surgical antimicrobial prophylaxis (SAP) contributes significantly to surgical site infections and antimicrobial resistance in developing countries. At Tikur Anbessa Specialized Hospital (TASH), Ethiopia's largest pediatric referral center, the quality of SAP for children is a significant concern. The knowledge, attitudes, and practices of surgical residents regarding pediatric SAP have not been systematically studied.

Objective: This study aimed to assess the knowledge, attitudes, and practices of surgical residents regarding pediatric surgical antimicrobial prophylaxis at TASH and to identify barriers and facilitators to appropriate SAP use.

Methods: An institution-based cross-sectional study was conducted from September to December 2025 at TASH. A census approach was used, inviting all eligible surgical residents who operate on pediatric patients across five surgical departments. Data were collected using a structured, self-administered questionnaire. Knowledge, attitude, and practice were assessed using composite scores and dichotomized at the sample mean. Descriptive statistics, chi-square tests, and binary logistic regression were performed using SPSS version 27.

Results: Eighty-nine surgical residents participated in the study, representing a response rate of 76.7%. The mean knowledge score was 4.6 out of 9, with 50.6% classified as having good knowledge. The mean attitude score was 34.6 out of 45, with 47.2% demonstrating favorable attitudes. The mean practice score was 3.3 out of 5, with 46.1% reporting good practice. Single-dose sufficiency (94.4%) and vancomycin for MRSA coverage (89.9%) were the most correctly answered knowledge items, while first-line agent identification (38.2%) and penicillin allergy alternatives (38.2%) were the weakest. Senior residency status was independently associated with good knowledge (adjusted odds ratio 5.49, $p = 0.001$). The most frequently reported barrier was lack of clear hospital guidelines (66.3%), and the most endorsed facilitator was availability of clear SAP guidelines (80.9%).

Conclusion: Approximately half of surgical residents at TASH demonstrated adequate knowledge, favorable attitudes, and good practices regarding pediatric SAP. However, substantial gaps remain, particularly in knowledge of appropriate antibiotic selection and timing. The convergence of lack of guidelines as both the primary barrier and the most desired facilitator indicates a clear need for development and implementation of standardized, pediatric-specific SAP protocols at TASH. Educational programs targeting identified

knowledge gaps, establishment of audit and feedback systems, and integration within an antimicrobial stewardship program are recommended to improve SAP practices and reduce surgical site infections.

Keywords: Surgical antimicrobial prophylaxis, knowledge-practice gap, pediatric surgery, antimicrobial resistance, Ethiopia

1. Introduction

1.1. Background

Surgical site infections (SSIs) have emerged as important global health care problems that contribute significantly to postoperative complications, longer hospital stay, and mortality [6]. Internationally, the prevalence of SSIs has been reported as between 0.5% and 15% of all surgical interventions, however, the prevalence is much higher in LMICs [6,8]. In pediatric surgery, SSIs remains one of the commonest complications that leads to increased hospitalization periods and cost, as illustrated by reported prevalence rates as high as 23% in Nigeria [2].

Surgical Antimicrobial Prophylaxis is an important part of preventing Surgical Site Infections. Surgical Antimicrobial Prophylaxis can really help reduce the chances of getting Surgical Site Infections by much, as 50 percent if we use Surgical Antimicrobial Prophylaxis correctly [7,8]. As per the best practice guidelines, surgical antimicrobial prophylaxis refers to a one-time administration of an appropriate antibiotic dose 60 minutes before skin incision (120 minutes if vancomycin is used), dose dependent on the body mass index (BMI) of children, re-administration during prolonged procedures and blood loss, and cessation within 24 hours of surgery [10,11,12]. The objective would be to maintain adequate drug concentrations within the tissues throughout the procedure without increasing the chances of toxicity, C. difficile infection, or AMR by using an antimicrobial with the most limited spectrum of action and the shortest possible duration of treatment [8,12,14].

The use of SAP in children must be approached carefully because of the physiological and pharmacokinetic considerations of this population, such as their less developed immune system, higher body water content, and different drug elimination capacities [11,13]. However, despite these differences, the general principles of proper timing and indications remain the same as in adults; however, precise calculations based on weight are required, usually based on adult data due to lack of pediatric clinical trials [11,12,13]. In resource-constrained nations like Ethiopia, a recent meta-analysis found a pooled incidence of SSI of 25.2% [6].

The deviation from the guidelines above has been noted in the clinical practice in Ethiopia. For example, although the national clinical protocol recommends short-term SAP, studies from Tikur Anbessa Specialized Hospital (TASH) demonstrate that only 50 percent of

patients are treated according to the protocol, with more than 40 percent of patients being administered antibiotics for an extensive period after their surgeries. Such treatment does not contribute to a decrease in SSIs, but increases the risk of AMR [7,8,9].

The Tikur Anbessa Specialized Hospital is the largest academic referral center in Ethiopia for pediatric surgery. However, as a result of qualitative analysis of its practices, a lack of a protocol for SAP use was identified. This factor contributed to numerous inconsistencies during the process. The order and administration of prophylactic medication have often been made by surgical residents, who do not have enough experience or instructions, which lead to numerous deviations from international guidelines concerning the type, timing, dosage, and duration of antibiotics used [7,8,9,10].

Since surgical residents are the key providers who actually implement the SAP orders in the hospitals, it follows that their level of knowledge, attitude, and practices forms the core determinant of care quality [11,12,13]. Nonetheless, for TASH, there is no available information about the knowledge, attitudes, and practices of such key providers concerning pediatric SAP. Such knowledge is critical for the design of measures that would help in ensuring proper interventions such as education and other strategies to fight AMR. It is with this aim that the current study seeks to systematically examine the KAP of surgical residents at TASH.

1.2. Statement of the problem

Although there are international guidelines to guide the use of SAP, its practice often diverges from recommendations resulting in inappropriate antibiotic use and increase in AMR [10,12,14]. In particular, extended SAP still persists in pediatrics despite lack of evidence that proves any benefit in its use [11,12]. At Tikur Anbessa Specialized Hospital (TASH) which is the principal referral hospital in Ethiopia for pediatric surgeries, the surgical residents are mostly responsible for requesting for SAP orders. The main determinants of their prescription practices their knowledge, attitudes and practices (KAP) concerning SAP have not yet been assessed. Therefore, the underlying reasons for non-compliance with SAP guidelines at TASH are not known, making it impossible to design interventions aimed at correcting such a practice [8,9]. For this reason, this study attempts to bridge this critical knowledge gap by assessing the KAP of surgical residents at TASH [11,12].

1.3. Significance of the study

The significance of this study cannot be underestimated since it will be the first systematic analysis of the KAP of surgical residents on pediatric SAP at TASH, thus providing the necessary evidence and accurately quantifying the differences between international guidelines and current practices [11,12]. The obtained data will be used to create interventions aimed at solving identified problems. Such interventions will include the development of a specific protocol for pediatric SAP, organizing educational courses for surgical residents, and setting up an audit and feedback system within an ASP [8,9,12]. All mentioned interventions are expected to contribute to improving patient safety and surgical outcomes by reducing the risk of surgical site infections and unnecessary antibiotic use in a highly vulnerable group [2,6,14]. Additionally, the study results will provide an example of intervention development that can be applied in other Ethiopian hospitals with the aim of reducing antimicrobial resistance in surgical wards throughout the country.

2. Literature review

Many studies carried out in high-income countries as well as low-resource environments show the suboptimal application of surgical antimicrobial prophylaxis guidelines, where considerable differences exist between the recommended and performed practices [10, 12].

A study conducted in Austria was aimed at evaluating the surgeons' knowledge, attitudes, and practice regarding the use of antiseptic agents to decolonize patients before surgery and minimize their risk of developing SSIs. It found that 65% of surgeons used different protocols of antiseptic decolonization ranging from selective decolonization for the carriage of S. aureus bacteria to universal decolonization of all patients. The most common antiseptics were octenidine and mupirocin; rarely chlorhexidine was combined with other agents. Only 50% claimed to be well-informed on this issue [16].

In a study performed in India, the knowledge, attitude, and practice of SAP were evaluated among consultants and residents working in several specialties in surgery. Even though most participants were familiar with international guidelines, there was poor compliance with the recommended practices. Only 35.9% were familiar with the right type of SAP, and only 42.4% were aware of the proper duration of its use. Some of the important factors hindering guideline adherence were the hierarchy of decision-making, doubtfulness and over-cautiousness, lack of antimicrobial drugs, patients' features, and absence of locally tailored guidelines [14].

In another study carried out in Sudan on surgical doctors, knowledge, attitude, and practice of preoperative SAP were assessed. Most respondents did not have adequate knowledge regarding preoperative SAP (only 12.5%), although all of them were aware of the necessity of creating local and national guidelines. There was no good adherence to recommended practices.

Another study in Egypt examined the extent of compliance with SAP guidelines using a mixed methodology approach. The findings indicated that the overall adherence was low; 62.5% were found to have selected correct antibiotics, while 38.2% and 6.1% respectively had correctly done pre-incision antibiotic administration and administered single dose or ≤24 hours of therapy [10].

In Ethiopia, another study done at Jimma University Medical Centre involved assessment of knowledge, attitude, and practice of medical practitioners from surgery department on SAP. Although 75.4% exhibited good knowledge about SAP, their attitude (82%) and practice (57.6%) were found to be poor in terms of adherence to evidence-based guidelines. However, all the study participants agreed that local and national SAP guidelines as well as hospital antimicrobial stewardship program is required. The conclusion drawn was that although there was sufficient knowledge about SAP, attitude and practice needed intervention.

3. Objectives

3.1. General objective

To assess the knowledge, attitude, practice levels of surgical antimicrobial prophylaxis among surgical residents collaborating with the Pediatrics and Child Health Department at Tikur Anbessa Specialized Hospital, Addis Ababa.

3.2. Specific objectives

1. To quantify the level of knowledge of surgical residents on standard SAP guidelines in pediatric patients.

2. To evaluate the attitudes of surgical residents towards the importance and application of SAP in pediatrics patients.

3. To measure the practice levels and associated factors of SAP compliance among surgical residents in pediatric patients.

4. Methods

4.1 Study Design and Period

An institutional based cross-sectional study carried out from September to December 2025 at Tikur Anbessa Specialized Hospital (TASH), Addis Ababa, Ethiopia. The KAP (Knowledge, Attitude, and Practice) model was applied to assess the status of the knowledge, attitudes, and self-reported practices of SAP among surgical residents performing operations on pediatric patients.

4.2 Study Setting

TASH is the biggest teaching hospital and the country's national referral hospital, linked to the College of Health Sciences, Addis Ababa University. This tertiary pediatric surgical facility offers specialized pediatric surgery training and education programs. There are five surgical departments that perform surgeries on pediatric patients together with the Department of Pediatrics and Child Health: Pediatric Surgery, Neurosurgery, Orthopedic Surgery, Ear-Nose-Throat Surgery, and General Surgery. At the time of the study, 116 surgical residents from these five departments were doing rotations at the pediatric surgical ward.

4.3 Source Population

The source population comprised all surgical residents who operate on pediatric patients under the pediatric surgical ward at TASH. All individuals who were present at the time of data collection and agreed to participate in the study constituted the sample group. Individuals on maternity, annual, or medical leave and those not willing to participate formed the excluded population.

4.4 Sample Size Determination

Given that the population from which sampling was done was finite and relatively small (N = 116), a census method was used and all eligible and willing participants were included. Therefore formal sample size calculation was not used.

4.5 Sampling Method

A census approach was employed. All the eligible surgical residents from each of the five departments were solicited to take part during the period of data gathering. Out of the 116 surgical residents working in the five surgical departments, 89 of them consented to take part

in the study for a participation rate of 76.7%. There were 27 other residents who could not participate because of being on leave or being away in other hospitals.

4.6 Study Variables

4.6.1 Dependent Variables

Three composite outcome variables were assessed, each dichotomized using the sample mean as the cutoff:

- **Knowledge** (good vs. poor):This is a binary composite score based on 9 knowledge questions (scale: 0-9). Those with a score greater than or equal to the sample mean scored for good knowledge.
- **Attitude** (favorable vs. unfavorable): Likert-based composite score derived from 9 attitude items (range 9–45, after reverse coding). Participants scoring at or above the sample mean were classified as having a favorable attitude.
- **Practice** (good vs. poor): Binary composite score derived from 5 self-reported practice items (range 0–5). Participants scoring at or above the sample mean were classified as having good practice.

A sensitivity analysis using Bloom's modified cutoff points (good ≥80%, moderate 60–79%, poor <60% of the maximum obtainable score) was performed for each domain to assess the robustness of the mean-based classification.

4.6.2 Independent Variables

Independent variables included age (categorized as 25–34 years vs. 35–44 years), sex (male vs. female), year of residency (first through fifth, dichotomized as senior [≥3rd year] vs. junior [1st–2nd year] for regression modeling), primary surgical specialty (pediatric surgery, neurosurgery, orthopedic surgery, ENT surgery, general surgery), and prior receipt of formal training or orientation on SAP (yes vs. no).

4.7 Data Collection Tool

Data were collected using a structured, self-administered questionnaire adapted from previously validated instruments used in SAP-KAP research [4, 14] and contextualized for the pediatric surgical setting at TASH. The questionnaire comprised five sections:

Section A — Sociodemographic and professional information (6 items): Age, gender, year of residency, main surgical specialty, prior SAP training, and source of SAP training.

Section B — Knowledge assessment (9 items): Each item evaluated a specific area of knowledge based on international guidelines (ASHP 2013, WHO 2018, AHA 2021). The questions asked concerned the surgical procedure that most required SAP (clean-contaminated), optimal time for SAP delivery (less than 60 minutes prior to incision), optimal duration of SAP (24 hours maximum), first choice for SAP (cefazolin), criterion for re-administration (greater than 2 drug half-lives), single dose sufficient for the vast majority of surgical procedures, second choice of SAP for penicillin allergy (clindamycin), infective endocarditis prevention (amoxicillin), and antimicrobial choice for methicillin-resistant Staphylococcus aureus (MRSA) prophylaxis (vancomycin).

Section C — Attitude assessment (9 items): Attitudes were evaluated using a 5-point Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree). Six questions were directly scored, where agreement indicated more positive attitude: need for SAP guidelines, efficacy of SAP, concern about resistance to antibiotics, use of guidelines, confidence in own SAP knowledge, and awareness that long-term prophylaxis increases the risk of developing Clostridioides difficile.

Section D — Practice assessment (5 items): Self-reported clinical practices were assessed dichotomously (1 = guideline-concordant, 0 = guideline-discordant). Items covered: ordering SAP within 60 minutes before incision, re-dosing for prolonged surgery or major hemorrhage, discontinuation within 24 hours (the item "Do you continue prophylactic antibiotics for more than 24 hours?" was inversely coded, such that "No" = correct), administration of SAP for non-perforated appendectomy, and antibiotic selection based on institutional guidelines. Items were summed (range 0–5).

Section E — Barriers and facilitators (2 items): Respondents selected all applicable barriers (from 7 predefined options: lack of clear guidelines, limited drug availability, inadequate training, fear of SSI, senior surgeons' influence, high workload, family pressure) and facilitators (from 6 options: clear guidelines, regular training, reliable supply, senior support, audit with feedback, patient education) to appropriate SAP use.

The questionnaire was pilot-tested among five residents not included in the final analysis, and minor modifications were made to improve clarity of items K5 (re-dosing criterion) and P3 (duration item phrasing).

4.8 Data Collection Procedure

Printed questionnaires were hand-delivered to eligible surgical residents during their duty shifts and departmental sessions. The principal investigator (B.M.) was available during distribution to clarify procedural questions without influencing responses. The completed questionnaires were submitted in an envelope. All 89 questionnaires were completed, leaving no missing information in knowledge, attitudes, and practices variables.

4.9 Data Processing and Management

The completed questionnaire was analyzed based on its completion, coding, and entry in the database. The dataset was then exported to IBM SPSS Statistics version 27 for analysis.

4.10 Statistical Analysis

The statistical analysis proceeded through the following stages:

4.10.1 Descriptive Statistics

Sociodemographic characteristics were summarized as frequencies and percentages. Composite scores for each KAP domain were described using means, standard deviations, medians, interquartile ranges, and ranges. Item-level frequencies and percentages were computed for all knowledge and practice items; item-level means and standard deviations were computed for attitude items.

4.10.2 Score Classification

The primary classification method used the sample mean as the cutoff for each domain, following established KAP methodology [4]: scores at or above the mean were classified as good/favorable and those below as poor/unfavorable. As a sensitivity analysis, Bloom's modified cutoff was applied, classifying scores as good (≥80% of maximum), moderate (60–79%), or poor (<60%).

4.10.3 Reliability Assessment

Internal consistency reliability was assessed by Cronbach’s Alpha for all three domains. The attitude scale reliability was estimated twice: first based only on 6 directly scored items; secondly based on the entire 9-item attitude scale, where 3 items were scored in the opposite

direction since item-total correlation analysis showed that these items had negative/negative zero correlation with the central concept.

4.10.4 Normality Testing

The Shapiro-Wilk test was used to examine whether the distributions of composite score values of each of the three domains could be characterized as normally distributed. As a result, none of the distributions met normality criteria ($p < 0.05$)

4.10.5 Bivariate Analysis

Associations between each independent variable and the dichotomized KAP outcomes were tested using Pearson's chi-square test for 2 × k contingency tables. Fisher's exact test was used in place of χ^2 test whenever the smallest expected frequency was less than 5. Crude odds ratio (COR) with 95% CI was determined for 2x2 table to provide an idea about the strength of association between each pair of variables.

In addition to that, continuous domain scores were tested for group differences through Mann-Whitney U test (in case of binary variables) and Kruskal-Wallis H test (in case of polytomous variables) due to the non-normal distribution of scores.

Finally, a less stringent cutoff point of p-value ≤ 0.25 was set for variable selection into the multivariate model based on Hosmer and Lemeshow's recommendations not to prematurely exclude important predictors from the model.

4.10.6 Multivariate Analysis

Binary logistic regression was performed separately for each KAP outcome (good knowledge, favorable attitude, good practice). Predictor candidates that satisfied the criterion of p-value < 0.25 for bivariate analysis were selected into the multivariable regression model simultaneously using the forced entry technique. The maximum number of predictors was limited according to the events-per-variable principle, which states that at least 10 events should be present for each predictor. Considering the presence of 41–44 events in the minority outcome group, only four predictors can be accommodated. However, three predictors were included for simplicity: being in a senior residency year (≥ 3rd year vs. 1st–2nd year), having SAP training (yes vs. no), and gender (male vs. female).

The variable "residency year" was not entered as a five-category variable, but dichotomized based on a third-year cutoff due to the limitation of the EPV approach, which does not allow for the inclusion of predictors consuming more than two degrees of freedom.

The model's adequacy was assessed using the Likelihood Ratio Test, Nagelkerke R^2, the Hosmer-Lemeshow Goodness of Fit Test (where a p value above 0.05 means good fit), and the overall accuracy rate of the model. The adjusted odds ratios (AOR) with 95% confidence interval and p values from the Wald test were given for each variable. The statistical significance level for all tests was set at $p < 0.05$ (two-tailed).

4.10.7 Barriers and Facilitators

Frequencies and percentages of each barrier and facilitator were computed from the multiple-response item. No inferential testing was performed on these descriptive items.

4.11 Operational Definitions

- **Good knowledge:** The total knowledge score was equal to or greater than the sample mean (≥5.36 out of 9 points), demonstrating good awareness of SAP, which was consistent with ASHP/WHO recommendations.
- **Poor knowledge:** The total knowledge score was less than the sample mean (<5.36 out of 9 points).
- **Favorable attitude:** The total attitude score was equal to or higher than the sample mean (≥34.55 out of 45 points), showing a favorable attitude towards evidence-based SAP.
- **Unfavorable attitude:** The total attitude score was lower than the sample mean (<34.55 out of 45 points).
- **Good practice:** The total practice score was equal to or higher than the sample mean (≥3.28 out of 5 points).
- **Poor practice:** The total practice score was lower than the sample mean (<3.28 out of 5 points).
- **Senior resident:** A resident who has completed three, four, or five years of residency.
- **Surgical antimicrobial prophylaxis (SAP):** An antibiotic administered before surgery in order to prevent surgical-site infections rather than treating a preexisting infection.

- **Prolonged surgical procedure:** A surgical procedure taking more time than the institution-specific threshold for that particular surgery (usually >120 minutes for day-case procedures according to the Italian Society of Pediatric Surgery).

- **Major hemorrhage (pediatric)**: Blood loss exceeding 40 mL/kg over 24 hours; transfusion of ≥50% of total blood volume within 3 hours; transfusion of ≥100% of total blood volume within 24 hours; or bleeding with clinical signs of hypovolemic shock unlikely to be controlled.

4.12 Ethical Considerations

Ethical clearance was obtained from the Department of Pediatrics and Child Health, College of Health Sciences, Addis Ababa University. Permission to conduct the study was additionally obtained from the hospital administration. Written informed consent was obtained from each participating resident prior to data collection. Participation was entirely voluntary, with no penalty for non-participation. The questionnaire was anonymous and no names or personal identifiers were recorded and all data were kept confidential. The study involved no physical or psychological harm to participants.

5. Results

5.1 Sociodemographic Characteristics

A total of 89 surgical residents participated in the study, yielding a response rate of 76.7%. The majority were aged 25 to 34 years (85; 95.5%) and male (60; 67.4%). Third-year residents constituted the largest group (33; 37.1%), followed by second-year (23; 25.8%) and fourth-year residents (19; 21.3%). Pediatric surgery was the most represented specialty (30; 33.7%), followed by neurosurgery (22; 24.7%). Nearly two thirds of respondents (58; 65.2%) had not received any formal training on surgical antimicrobial prophylaxis.

Table 1. Sociodemographic characteristics of surgical residents at TASH, 2025 (n = 89).

Variable	Category	n	%
Age group	25–34 years	85	95.5
	35–44 years	4	4.5
Sex	Male	60	67.4
	Female	29	32.6
Year of residency	First	9	10.1
	Second	23	25.8
	Third	33	37.1
	Fourth	19	21.3
	Fifth	5	5.6
Surgical specialty	Pediatric surgery	30	33.7
	Neurosurgery	22	24.7
	Orthopedic surgery	14	15.7
	ENT surgery	12	13.5
	General surgery	11	12.4
SAP training received	Yes	31	34.8

	No	58	65.2

SAP = surgical antimicrobial prophylaxis; TASH = Tikur Anbessa Specialized Hospital; ENT = ear, nose, and throat.

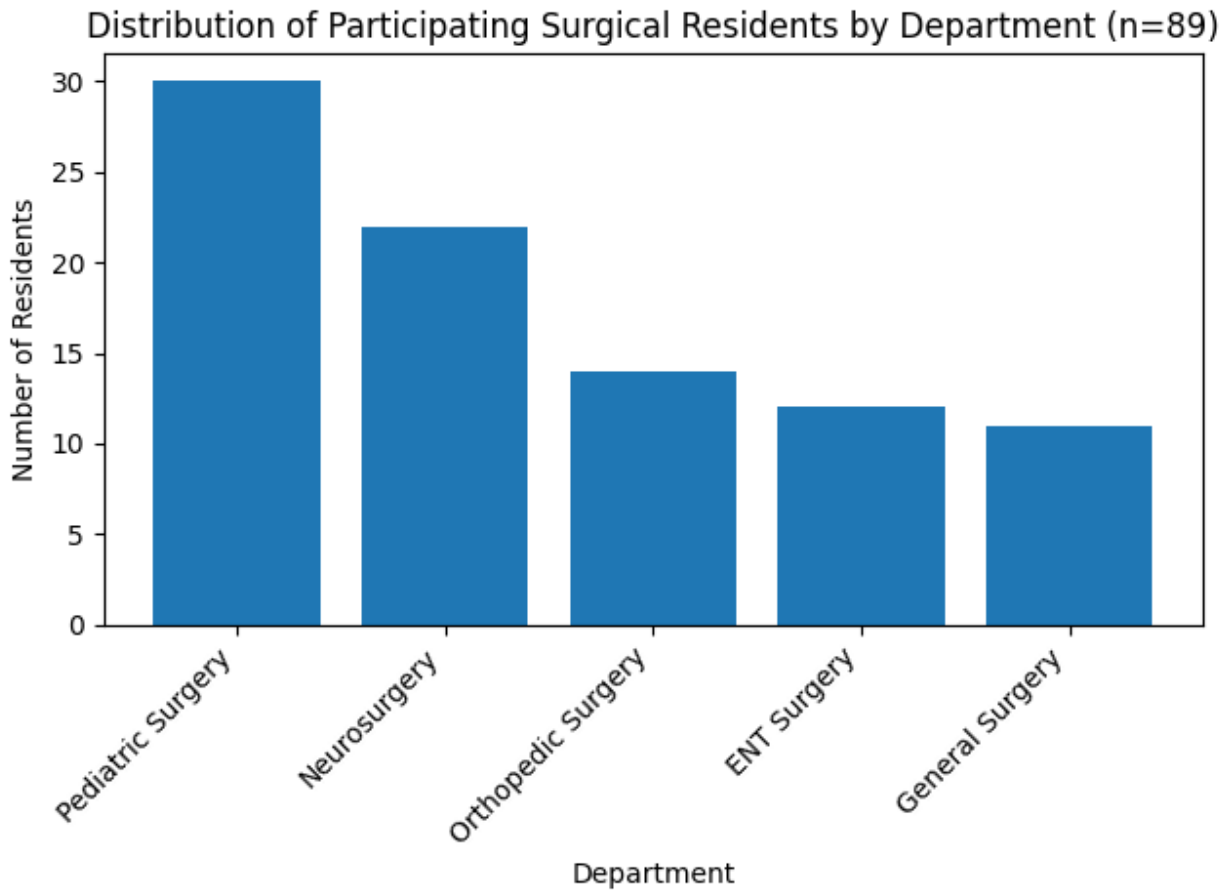


Figure 1: Distribution of participating surgical residents by department (n=89).

5.2 Knowledge, Attitude, and Practice Scores

All three domain scores deviated significantly from normality (Shapiro-Wilk $p < 0.001$ for each), and non-parametric methods were therefore used for group comparisons.

The mean knowledge score was 5.4 out of 9 (SD 1.7), corresponding to 59.6%. Using the mean-based cutoff, 45 residents (50.6%) were classified as having good knowledge. The items with the highest correct response rates were single-dose sufficiency (84/89; 94.4%) and vancomycin for MRSA coverage (80/89; 89.9%). The lowest correct response rates were observed for first-line agent identification (cefazolin; 34/89; 38.2%) and penicillin-allergy alternative (clindamycin; 34/89; 38.2%).

The mean attitude score was 34.6 out of 45 (SD 4.5), corresponding to 76.8%. Forty-two residents (47.2%) were classified as having a favorable attitude. The strongest agreement was observed for the need for a standardized SAP guideline (mean 4.6, SD 0.9), whereas the lowest favorability was noted for cost-effectiveness perceptions of prolonged prophylaxis (mean 3.1, SD 1.3, reverse-coded).

The mean practice score was 3.3 out of 5 (SD 1.1), corresponding to 65.6%. Forty-one residents (46.1%) demonstrated good practice. Ordering SAP within 60 minutes before incision was the most commonly reported correct practice (73/89; 82.0%), while choosing the antibiotic based on institutional guidelines was the least adhered to (48/89; 53.9%).

Table 2. Distribution of KAP scores among surgical residents (n = 89).

Domain (range)	Mean ± SD	Median (IQR)	Mean %	Good/Favorable†	Poor/Unfavorable†
Knowledge (0–9)	5.4 ± 1.7	6 (4–6)	59.6	45 (50.6)	44 (49.4)
Attitude (9–45)	34.6 ± 4.5	34 (32–38)	76.8	42 (47.2)	47 (52.8)
Practice (0–5)	3.3 ± 1.1	3 (3–4)	65.6	41 (46.1)	48 (53.9)

† *Classified using mean score as cutoff; values are n (%). IQR = interquartile range; SD = standard deviation.*

Table 3. Item-level knowledge of surgical antimicrobial prophylaxis (n = 89).

Item	Correct answer	n	%
K1. Surgery type requiring SAP	Clean-contaminated	49	55.1
K2. Optimal timing of administration	Within 60 min before incision	40	44.9
K3. Recommended duration	≤24 hours	71	79.8
K4. First-line antibiotic agent	Cefazolin	34	38.2
K5. Criterion for intraoperative re-dosing	Exceeds 2 half-lives	43	48.3

K6. Single-dose sufficiency for most procedures	Yes	84	94.4
K7. Alternative in penicillin allergy	Clindamycin	34	38.2
K8. IE prophylaxis agent	Amoxicillin	42	47.2
K9. Agent for MRSA coverage	Vancomycin	80	89.9

SAP = surgical antimicrobial prophylaxis; IE = infective endocarditis; MRSA = methicillin-resistant Staphylococcus aureus. Correct answers are based on ASHP 2013, WHO 2018, and AHA 2021 guidelines.

5.3 Internal Consistency

Cronbach's alpha for the knowledge scale (9 items) was 0.411, reflecting the heterogeneous content domains assessed (timing, drug selection, re-dosing, allergy management, and special prophylaxis). The attitude scale achieved good internal consistency when restricted to the 6 directly scored items (alpha = 0.833); three reverse-coded items (A5, A7, A9) were excluded from the reliability estimate because they showed negative or near-zero corrected item-total correlations, indicating they measured constructs distinct from the core attitudinal dimension. The practice scale (5 items) yielded an alpha of 0.194, consistent with the broad range of clinical scenarios captured.

5.4 Factors Associated with Knowledge, Attitude, and Practice

In bivariate analysis, good knowledge was significantly associated with year of residency (chi-square = 15.66, df = 4, p = 0.004) and surgical specialty (chi-square = 11.46, df = 4, p = 0.022). Fourth-year residents had the highest proportion of good knowledge (16/19; 84.2%), compared with first-year residents (2/9; 22.2%). Residents who had received SAP training were less likely to have good knowledge than those who had not (10/31, 32.3% vs 35/58, 60.3%; chi-square = 6.38, p = 0.012).

Favorable attitude was significantly associated with sex (chi-square = 4.51, p = 0.034), year of residency (chi-square = 9.72, df = 4, p = 0.045), and surgical specialty (chi-square = 14.64, df = 4, p = 0.006). All fifth-year residents (5/5) demonstrated a favorable attitude, whereas no ENT surgery residents (0/12) did. Males had a higher proportion of favorable attitude than females (33/60, 55.0% vs 9/29, 31.0%).

No individual sociodemographic variable reached statistical significance at the 0.05 level for practice. However, sex (p = 0.231), age (Fisher's exact p = 0.121), year of residency (p =

0.152), specialty (p = 0.242), and SAP training (p = 0.097) all met the liberal screening threshold of p < 0.25 and were considered as candidate predictors for the multivariate model.

Table 4. Bivariate analysis of factors associated with knowledge level (n = 89).

Variable	Category	Good, n (%)	Poor, n (%)	χ^2	p value
Sex	Male	30 (50.0)	30 (50.0)		
	Female	15 (51.7)	14 (48.3)	0.02	0.879
Age group	25–34 years	44 (51.8)	41 (48.2)		
	35–44 years	1 (25.0)	3 (75.0)	1.10	0.295
Year of residency	First	2 (22.2)	7 (77.8)		
	Second	7 (30.4)	16 (69.6)		
	Third	18 (54.5)	15 (45.5)		
	Fourth	16 (84.2)	3 (15.8)		
	Fifth	2 (40.0)	3 (60.0)	15.66	0.004
Specialty	Pediatric surgery	18 (60.0)	12 (40.0)		
	Neurosurgery	7 (31.8)	15 (68.2)		
	Orthopedic surgery	4 (28.6)	10 (71.4)		
	ENT surgery	7 (58.3)	5 (41.7)		
	General surgery	9 (81.8)	2 (18.2)	11.46	0.022
SAP training	Yes	10 (32.3)	21 (67.7)		
	No	35 (60.3)	23 (39.7)	6.38	0.012

Pearson chi-square test used throughout. Degrees of freedom: 1 for dichotomous variables, 4 for polytomous variables. Good knowledge defined as score at or above sample mean (5.36/9). SAP = surgical antimicrobial prophylaxis.

Table 5. Bivariate analysis of factors associated with attitude level (n = 89).

Variable	Category	Favorable, n (%)	Unfavorable, n (%)	χ^2	p value
Sex	Male	33 (55.0)	27 (45.0)		
	Female	9 (31.0)	20 (69.0)	4.51	0.034
Age group	25–34 years	42 (49.4)	43 (50.6)		
	35–44 years	0 (0.0)	4 (100.0)	3.74	0.053
Year of residency	First	4 (44.4)	5 (55.6)		
	Second	9 (39.1)	14 (60.9)		
	Third	12 (36.4)	21 (63.6)		
	Fourth	12 (63.2)	7 (36.8)		
	Fifth	5 (100.0)	0 (0.0)	9.72	0.045
Specialty	Pediatric surgery	16 (53.3)	14 (46.7)		
	Neurosurgery	10 (45.5)	12 (54.5)		
	Orthopedic surgery	8 (57.1)	6 (42.9)		
	ENT surgery	0 (0.0)	12 (100.0)		
	General surgery	8 (72.7)	3 (27.3)	14.64	0.006
SAP training	Yes	17 (54.8)	14 (45.2)		
	No	25 (43.1)	33 (56.9)	1.12	0.291

Favorable attitude defined as score at or above sample mean (34.55/45). SAP = surgical antimicrobial prophylaxis.

Table 6. Bivariate analysis of factors associated with practice level (n = 89).

Variable	Category	Good, n (%)	Poor, n (%)	χ^2	p value
Sex	Male	25 (41.7)	35 (58.3)		
	Female	16 (55.2)	13 (44.8)	1.44	0.231
Age group	25–34 years	41 (48.2)	44 (51.8)		
	35–44 years	0 (0.0)	4 (100.0)	3.58	0.121*
Year of residency	First	4 (44.4)	5 (55.6)		
	Second	11 (47.8)	12 (52.2)		
	Third	19 (57.6)	14 (42.4)		
	Fourth	7 (36.8)	12 (63.2)		
	Fifth	0 (0.0)	5 (100.0)	6.72	0.152
Specialty	Pediatric surgery	13 (43.3)	17 (56.7)		
	Neurosurgery	10 (45.5)	12 (54.5)		
	Orthopedic surgery	7 (50.0)	7 (50.0)		
	ENT surgery	3 (25.0)	9 (75.0)		
	General surgery	8 (72.7)	3 (27.3)	5.47	0.242
SAP training	Yes	18 (58.1)	13 (41.9)		
	No	23 (39.7)	35 (60.3)	2.76	0.097

*Good practice defined as score at or above sample mean (3.28/5). *Fisher's exact test used (expected cell count <5). SAP = surgical antimicrobial prophylaxis.*

5.5 Multivariate Logistic Regression

Variables that met the screening criterion ($p < 0.25$) in bivariate analysis were entered into binary logistic regression models. Given the sample size of 89, the events-per-variable rule (minimum 10 events per predictor) permitted a maximum of four predictors; three were

retained for parsimony: senior residency status (third year or above), prior SAP training, and sex.

For knowledge, the model was statistically significant (omnibus chi-square = 18.61, df = 3, p < 0.001; Nagelkerke R-squared = 0.252; Hosmer-Lemeshow p = 0.377; classification accuracy 66.3%). Senior residency was the strongest independent predictor, with an adjusted odds ratio of 5.49 (95% CI 1.97 to 15.33, p = 0.001). Receipt of SAP training was independently associated with lower odds of good knowledge (AOR 0.23, 95% CI 0.08 to 0.66, p = 0.006), a finding attributable to confounding by indication (residents who recognized their knowledge gaps were more likely to have received or sought training). Sex was not significantly associated with knowledge after adjustment (AOR 1.61, 95% CI 0.57 to 4.53, p = 0.370).

For attitude, the overall model did not reach statistical significance at the 0.05 level (omnibus chi-square = 6.48, df = 3, p = 0.091; Nagelkerke R-squared = 0.094; Hosmer-Lemeshow p = 0.078; classification accuracy 58.4%). Male sex was the only individual predictor reaching significance (AOR 2.79, 95% CI 1.05 to 7.41, p = 0.039). Neither senior residency (AOR 1.75, 95% CI 0.70 to 4.37, p = 0.231) nor SAP training (AOR 1.33, 95% CI 0.53 to 3.33, p = 0.546) was independently associated with attitude.

For practice, the overall model was not statistically significant (omnibus chi-square = 5.46, df = 3, p = 0.141; Nagelkerke R-squared = 0.079; Hosmer-Lemeshow p = 0.223; classification accuracy 59.6%). SAP training approached significance (AOR 2.54, 95% CI 1.00 to 6.46, p = 0.051). Male sex (AOR 0.45, 95% CI 0.17 to 1.18, p = 0.106) and senior residency (AOR 0.85, 95% CI 0.35 to 2.11, p = 0.734) were not independently associated with practice.

Table 7. Multivariate binary logistic regression: factors independently associated with KAP outcomes.

Outcome	**Predictor**	**B**	**AOR (95% CI)**	**p value**	
Knowledge					
(n = 89)	Senior residency (≥3rd year)	1.704	5.49 (1.97–15.33)	0.001	**
	SAP training (Yes)	−1.456	0.23 (0.08–	0.006	**

			0.66)		
	Male sex	0.474	1.61 (0.57–4.53)	0.370	
Attitude					
(n = 89)	Senior residency (≥3rd year)	0.559	1.75 (0.70–4.37)	0.231	
	SAP training (Yes)	0.283	1.33 (0.53–3.33)	0.546	
	Male sex	1.028	2.79 (1.05–7.41)	0.039	*
Practice					
(n = 89)	Senior residency (≥3rd year)	−0.157	0.85 (0.35–2.11)	0.734	
	SAP training (Yes)	0.931	2.54 (1.00–6.46)	0.051	
	Male sex	−0.788	0.45 (0.17–1.18)	0.106	

*AOR = adjusted odds ratio; CI = confidence interval; B = regression coefficient. Reference categories: junior residency (1st–2nd year), no SAP training, female sex. *p < 0.05; **p < 0.01. Knowledge model: omnibus p < 0.001, Nagelkerke R^2 = 0.252, Hosmer-Lemeshow p = 0.377, classification accuracy 66.3%. Attitude model: omnibus p = 0.091, Nagelkerke R^2 = 0.094, H-L p = 0.078, accuracy 58.4%. Practice model: omnibus p = 0.141, Nagelkerke R^2 = 0.079, H-L p = 0.223, accuracy 59.6%.*

5.6 Non-parametric Score Comparisons

Continuous knowledge scores differed significantly across residency years (Kruskal-Wallis H = 27.31, df = 4, p < 0.001) but not across specialties (H = 5.34, p = 0.255), sex (Mann-Whitney U = 799, p = 0.526), or training status (U = 686, p = 0.062). Continuous attitude scores differed significantly by sex (U = 601.5, p = 0.018), residency year (H = 10.77, p = 0.029), and specialty (H = 11.09, p = 0.026), but not by training (U = 790, p = 0.345).

Continuous practice scores differed significantly by specialty only (H = 10.73, p = 0.030), without significant differences by sex (U = 769, p = 0.359), training (U = 770.5, p = 0.251), or residency year (H = 5.45, p = 0.244).

5.7 Self-reported Barriers and Facilitators

The most frequently reported barrier to appropriate SAP was lack of clear hospital guidelines or protocols (59/89; 66.3%), followed by limited drug availability or stock-outs (44/89; 49.4%) and inadequate training (38/89; 42.7%). Fear of surgical site infection prompting extended antibiotic use was reported by 35 residents (39.3%), and influence of senior surgeons' prescribing habits by 34 (38.2%). High workload (15/89; 16.9%) and family pressure (3/89; 3.4%) were less commonly cited.

The most endorsed facilitator was availability of clear SAP guidelines and protocols (72/89; 80.9%), followed by regular training and continuing medical education (54/89; 60.7%) and reliable antibiotic supply chains (48/89; 53.9%). Routine audit with feedback (30/89; 33.7%), senior surgeon or pharmacist support (26/89; 29.2%), and patient or parent education (16/89; 18.0%) were also endorsed.

Table 8. Self-reported barriers and facilitators to appropriate SAP (n = 89).

Item	n	%
BARRIERS		
Lack of clear hospital guidelines/protocols	59	66.3
Limited drug availability/stock-outs	44	49.4
Inadequate training on SAP	38	42.7
Fear of SSI prompting extended use	35	39.3
Senior surgeons' prescribing influence	34	38.2
High workload/time constraints	15	16.9
Family pressure for extended prophylaxis	3	3.4
FACILITATORS		
Clear SAP guidelines and protocols	72	80.9

Regular training and CME	54	60.7
Reliable antibiotic supply	48	53.9
Routine audit with feedback	30	33.7
Senior surgeon/pharmacist support	26	29.2
Patient/parent education	16	18.0

Multiple responses permitted. SAP = surgical antimicrobial prophylaxis; SSI = surgical site infection; CME = continuing medical education.

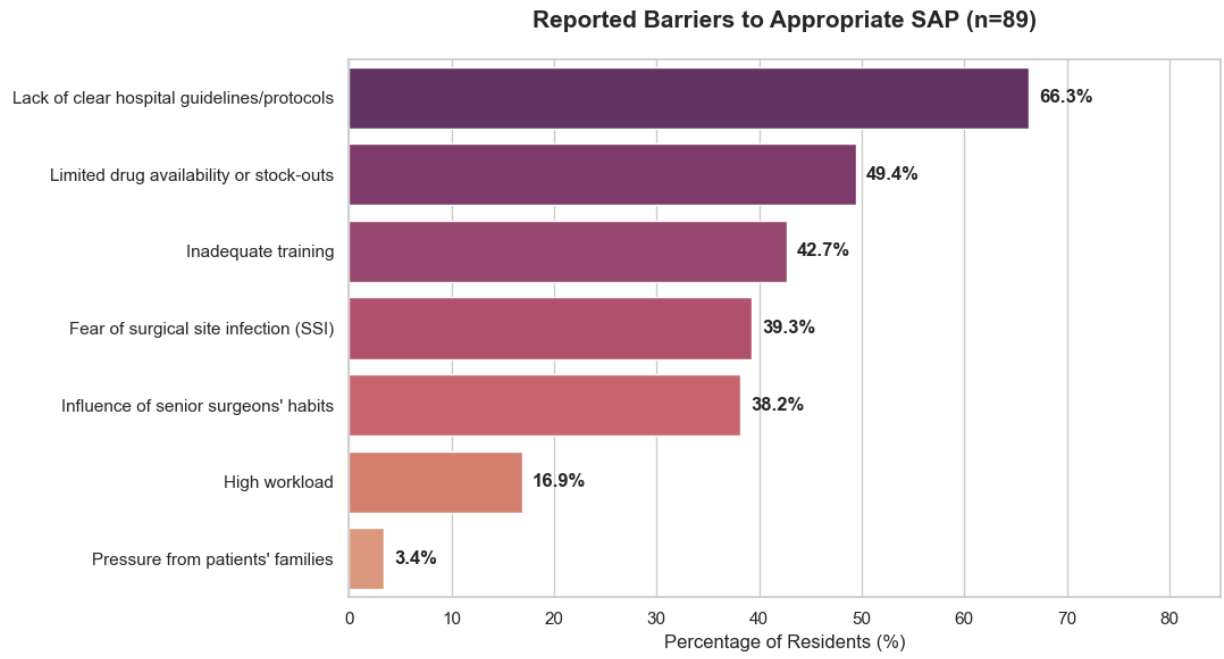


Figure 2: Key barriers hindering the appropriate use of surgical antimicrobial prophylaxis.

6. Discussion

This study represents the first systematic assessment of knowledge, attitude, and practice regarding surgical antimicrobial prophylaxis among surgical residents operating on pediatric patients at Tikur Anbessa Specialized Hospital. The findings reveal a convergent pattern: approximately half of residents were classified as having good knowledge (50.6%), favorable attitude (47.2%), and good practice (46.1%), indicating that substantial gaps in all three domains coexist at Ethiopia's largest pediatric surgical referral center. These results have direct implications for the design of targeted educational and stewardship interventions.

6.1 Knowledge

The mean knowledge score of 59.6% places TASH surgical residents in an intermediate position within the wider SAP-KAP literature. This figure is considerably lower than the 75.4% good knowledge reported among surgical staff at Jimma University Medical Center [4], a finding that may reflect differences in study population composition, the Jimma cohort included attending physicians and medical staff alongside residents, potentially inflating the knowledge estimate through inclusion of more experienced practitioners. Conversely, the TASH knowledge level substantially exceeds the 12.5% adequate knowledge reported among surgical doctors in Sudan [15], where the absence of any structured residency training program and more severe resource constraints likely depressed performance. The intermediate position of TASH residents is consistent with the institution's status as an academic referral center that provides some degree of postgraduate training exposure but lacks a formalized SAP education curriculum.

Item-level analysis provides more actionable insight than the composite score. The exceptionally high correct response rates for single-dose sufficiency (94.4%) and vancomycin for MRSA coverage (89.9%) suggest that these concepts have been effectively absorbed through clinical exposure and represent knowledge domains that do not require additional educational investment. In contrast, identification of cefazolin as the first-line SAP agent (38.2%) and clindamycin as the penicillin-allergy alternative (38.2%) were the two weakest items. The cefazolin finding warrants particular contextual interpretation. Although cefazolin is the guideline-recommended first-line agent per ASHP 2013 and WHO 2018 [4], it is not available through the Ethiopian Pharmaceutical Supply Service, and 60.7% of residents selected ceftriaxone instead. This selection pattern likely reflects a pragmatic adaptation to local formulary constraints rather than pure ignorance of guidelines a distinction with important implications for intervention design. This mirrors the broader Ethiopian experience

documented by Afework et al., who found that clinical practice at Ethiopian academic medical centers frequently deviates from international protocols due to supply-chain limitations rather than knowledge deficits alone [3]. Similarly, the Egyptian study by Abdel-Aziz et al. identified limited antibiotic availability as a key barrier to guideline adherence, with correct antibiotic selection achieved in only 62.5% of cases [10].

The finding that only 44.9% of residents correctly identified the 60-minute pre-incision timing window is concerning, as timing is arguably the single most impactful SAP parameter and one that is entirely within the prescriber's control regardless of drug availability. This figure is comparable to the 38.2% timely pre-incision administration reported in the Egyptian study [10] and aligns with the broader pattern identified in a mixed-methods study from that setting, where workflow inefficiencies and knowledge gaps jointly contributed to timing failures [10]. The relatively better performance on duration knowledge (79.8% correctly identified ≤24 hours) suggests that the concept of limiting prophylaxis duration has penetrated clinical teaching more effectively than timing precision, though self-reported practice data (40.4% continuing beyond 24 hours) indicate that knowledge of the 24-hour rule does not reliably translate into behavior which is a knowledge-practice gap that warrants attention.

6.2 Attitude

The mean attitude score of 76.8% and the observation that 47.2% of residents held favorable attitudes is notable in that it represents a markedly better attitudinal profile than the 82% poor attitude reported at Jimma [4]. This divergence may be partly explained by differences in attitude scale construction and scoring thresholds between the two studies, but it may also reflect genuine institutional differences — TASH residents, operating in a larger academic environment with greater exposure to international literature and visiting faculty, may have internalized the rationale for SAP more fully even if their practice does not consistently reflect it.

The strongest attitudinal endorsement was for the perceived need for a standardized SAP guideline (mean 4.60/5.0), and this is concordant with findings from Sudan, where 98–100% of surgical doctors recognized the need for local and national guidelines [15]. This near-universal recognition of a guideline gap, replicated across markedly different settings, reinforces that residents are aware of the structural deficit and would likely be receptive to protocol-based interventions. However, the relatively low self-reported confidence in

personal SAP knowledge (mean 3.35/5.0) is telling: it indicates that residents recognize their own knowledge limitations, which may paradoxically create a window of educational opportunity if harnessed through structured training. The Italian study by Pelullo et al. similarly found that only half of surgeons felt sufficiently informed about perioperative prophylaxis, concluding that subjective knowledge gaps are a consistent finding across settings and training levels [13].

The finding that ENT surgery residents demonstrated uniformly unfavorable attitudes (0/12 classified as favorable) stands out and may reflect specialty-specific culture: ENT procedures at TASH are typically shorter and classified as clean, potentially leading residents to perceive SAP as less relevant to their surgical practice. This specialty-dependent attitudinal variation aligns with the observation by Khan et al. that attitudes toward SAP are shaped not only by individual knowledge but also by the prevailing norms and perceived infection risk within specific surgical disciplines [5].

Male sex emerged as the only independent predictor of favorable attitude in the multivariate model (AOR 2.79, $p = 0.039$), though the overall attitude model did not achieve statistical significance. This sex-based difference is not prominently reported in the comparative literature and should be interpreted cautiously given the modest model explanatory power (Nagelkerke $R^2 = 0.094$) and the marginal Hosmer-Lemeshow fit ($p = 0.078$). Possible explanations include differential patterns of clinical assertiveness, self-selection into surgical specialties with stronger SAP cultures, or residual confounding by unmeasured variables such as prior clinical rotations outside surgery.

6.3 Practice

The mean practice score of 65.6% and the classification of 46.1% of residents as having good practice indicate that more than half of residents report at least one guideline-discordant behavior. The most commonly reported correct practice is ordering SAP within 60 minutes before incision (82.0%) which is encouraging, though the discrepancy between practice self-report (82.0%) and knowledge of the timing rule (44.9%) suggests that some residents adhere to timing protocols through institutional habit or operating room workflow rather than explicit knowledge of the underlying guideline, a finding that has implications for the durability of correct behavior in the absence of structured protocols.

The weakest practice item which is guideline-based antibiotic selection (53.9%) directly mirrors the knowledge deficit on first-line agent identification and is consistent with the

barrier most frequently endorsed by residents themselves: the absence of clear hospital guidelines or protocols (66.3%). This convergence between a knowledge gap, a practice deficit, and a self-identified barrier on the same domain (antibiotic choice) represents a particularly actionable finding. The Indian study by Ali et al. reported a similarly low rate of correct SAP choice (35.9%) and identified unavailability of antimicrobial agents and lack of locally adapted guidelines as key drivers [14]. At TASH, the supply-chain constraint (cefazolin unavailability forcing ceftriaxone substitution) and the absence of a written institutional protocol operate synergistically: without a protocol that explicitly endorses ceftriaxone as an acceptable local alternative, residents are left to make ad hoc choices that may or may not align with evidence.

The observation that 40.4% of residents reported continuing prophylaxis beyond 24 hours is consistent with data from TASH's own orthopedic surgery unit, where Argaw et al. found that over 40% of patients received extended postoperative antibiotics [7]. This pattern has been qualitatively explored by Steeman et al., who identified fear of SSI as a primary driver of prolonged prophylaxis among Ethiopian surgeons, a finding corroborated in the present study, where 39.3% of residents endorsed this fear as a barrier [8]. The persistence of this behavior despite adequate knowledge of the 24-hour rule (79.8%) underscores that knowledge alone is insufficient to change deeply ingrained prescribing habits, particularly when hierarchical clinical cultures allow senior surgeons' preferences to override evidence-based practice [9].

No sociodemographic variable independently predicted good practice in the multivariate model, and the overall model failed to achieve statistical significance (omnibus $p = 0.141$). This null finding suggests that practice behavior at TASH may be more strongly shaped by systemic and institutional factors like protocol availability, drug supply, operating room workflow, and senior surgeon culture rather than by individual-level characteristics, a conclusion supported by the qualitative ethnographic work of Alemkere et al. on the etiquette of antibiotic decision-making in Ethiopian surgical settings [9].

6.4 The Training Paradox

One of the most striking findings was the inverse association between prior SAP training and good knowledge (AOR 0.23, $p = 0.006$): residents who had received training had 77% lower adjusted odds of good knowledge compared with those who had not. This finding, though counterintuitive, is most parsimoniously explained by confounding by indication inherent to

the cross-sectional design. Residents who recognized their own knowledge deficiencies or whose supervisors identified gaps in their SAP competence were more likely the ones directed to or self-selecting into available training opportunities. The training itself may have been insufficient in content, duration, or pedagogical approach to close the knowledge gap. This interpretation is supported by the low self-reported confidence in SAP knowledge (mean 3.35/5.0) and by the fact that SAP training at TASH is not standardized: it varies in format from informal ward-based teaching to intermittent didactic sessions, with no structured curriculum or competency assessment.

Notably, SAP training showed the opposite directional effect for practice (AOR 2.54, p = 0.051), approaching significance as a predictor of good practice. This divergence in training associated with worse knowledge but better practice may indicate that whatever training is provided focuses more on procedural behavior (when to order, how long to continue) than on the pharmacological and guideline-based rationale (which drug, why cefazolin, allergy alternatives). A similar dissociation between knowledge and practice has been documented at Jimma, where despite 75.4% good knowledge, 57.6% showed poor practice [4], suggesting that the knowledge-practice interface in SAP is a consistent challenge across Ethiopian training institutions.

6.5 Barriers and Facilitators

The barrier and facilitator profiles were internally coherent and externally consistent. The most endorsed barrier include lack of clear guidelines (66.3%), which is directly mirrored the most endorsed facilitator, availability of clear guidelines (80.9%) that confirms that residents both recognize the institutional void and articulate what they need to fill it. This convergence is not unique to TASH: the need for locally adapted guidelines was identified as a priority in studies from Sudan [15], Egypt [10, 14], and the prior Ethiopian study at Jimma [4], forming a remarkably consistent finding across the developing-country SAP literature.

Limited drug availability (49.4%) ranked as the second most common barrier, corroborating the cefazolin problem identified in the knowledge analysis and the broader supply-chain challenges documented across Ethiopian surgical settings [3, 7]. The influence of senior surgeons' habits (38.2%) aligns with the hierarchical prescribing culture described by Alemkere et al. [9] and the observation in the Indian study that hierarchical decision-making was among the foremost barriers to guideline compliance [14]. That family pressure was

rarely cited (3.4%) is contextually expected in a setting where antibiotic decision-making is physician-driven and family involvement in perioperative prescribing is minimal.

6.6 Strengths and Limitations

This study has several strengths. It is the first to assess SAP-related KAP specifically among surgical residents operating on pediatric patients at TASH, providing baseline data for a population that has never been systematically evaluated.

Several limitations should be acknowledged. First, the cross-sectional design precludes causal inference; the inverse training-knowledge association, in particular, cannot be interpreted as evidence that training worsens knowledge. A prospective or quasi-experimental design would be required to establish the effect of training. Second, all practice data are self-reported and therefore subject to social desirability bias, likely overestimating guideline-concordant behavior. Chart audit or direct observation studies would provide more objective practice data. Third, the sample size of 89, while adequate for descriptive analysis and sufficient to detect large bivariate effects, limited the multivariate models to three predictors and may have been underpowered to detect small-to-moderate effects, particularly for the practice and attitude models, which did not reach overall statistical significance. Fourth, the cefazolin knowledge item presents an interpretive challenge: scoring ceftriaxone as incorrect penalizes residents who may be making a locally rational choice in the absence of cefazolin, and the true knowledge gap on this item may be smaller than the 38.2% correct response suggests. Fifth, the low Cronbach's alpha values for the knowledge (0.411) and practice (0.194) scales indicate that these instruments assess heterogeneous content domains rather than a single latent construct; while this is typical of comprehensive KAP instruments and does not invalidate the composite scores, it does limit the psychometric interpretation of the summed scores as reflections of a unitary ability. Finally, the study was conducted at a single tertiary academic center, and findings may not generalize to district or regional hospitals where training infrastructure, drug availability, and surgical complexity differ substantially.

7. Conclusion and Recommendations

This study demonstrates that approximately half of surgical residents at TASH exhibit suboptimal knowledge, unfavorable attitudes, and guideline-discordant practices regarding surgical antimicrobial prophylaxis in pediatric patients, with the most critical deficits concentrated in first-line agent identification, optimal timing precision, and antibiotic selection methodology. Senior residency was the strongest predictor of good knowledge, while no individual-level factor independently predicted good practice, a finding that implicates systemic and institutional determinants rather than individual competence as the primary drivers of SAP non-adherence. The near-universal endorsement of guideline availability as both the top barrier and the top facilitator provides a clear mandate for intervention.

Three immediate, evidence-informed actions are warranted. First, TASH should develop and disseminate a pediatric-specific SAP protocol that explicitly addresses the local formulary reality, including ceftriaxone as an endorsed alternative where cefazolin is unavailable, and integrating this protocol into the operating room workflow through pre-incision checklists and order sets. Second, a structured SAP educational module should be incorporated into the surgical residency curriculum, with emphasis on the weakest knowledge domains identified (timing, drug selection, allergy alternatives, re-dosing criteria), delivered longitudinally across training years rather than as a single orientation, and including competency assessment to close the knowledge-practice gap. Third, a prospective audit-and-feedback system should be established to monitor SAP prescribing against the newly developed protocol, providing residents and departments with regular performance data which is an intervention that one third of residents already endorsed as a desired facilitator. These actions, taken together, would position TASH as a model for antimicrobial stewardship in pediatric surgical settings across Ethiopia and provide the infrastructure necessary to reduce surgical site infections and combat antimicrobial resistance in this vulnerable population.

8. References

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9. Annexes:

Annex I: Consent Form

Addis Ababa University, College of Health Sciences, School of Medicine

This questionnaire is developed to assess the knowledge, attitude, and practices of surgical residents regarding surgical antimicrobial prophylaxis at Tikur Anbessa Specialized Hospital (TASH).

My name is Bezawit Mulat , a final year pediatrics and child health Resident. I am conducting this research as part of the requirements for pediatrics and child health specialty program at Addis Ababa University.

Data will be collected from surgical residents working in the Pediatrics and Child Health Department. I will ask you some questions that are very relevant to this study.

All information you provide, including any identifiers, will be kept confidential. Your name or any other personal identifiers will not be included in the study. Participation in this study will involve no harm to you.

You have the right not to participate or not to answer any question you are uncomfortable with. However, your willingness to answer all the questions is highly appreciated.

Would you like to participate in this study by responding to this questionnaire? Yes, _____ No, _____

Date: _____

Annex II: Data collection questionnaire

Section A: Socio-Demographic & Professional Information

1. Age: _____ years
2. Sex: ( ) Male ( ) Female ( )
3. Year of Residency: ( ) 1st ( ) 2nd ( ) 3rd ( ) 4th ( ) 5th ( ) Other: ____
4. Primary Surgical Specialty: (e.g., Pediatric Surgery, General Surgery, Orthopedics, ENT, Neurosurgery (____)

5. SAP Training: Have you received formal training/orientation on surgical antibiotic prophylaxis? (A) Yes (B) No
6. If yes to #5, please specify the source or type of training: _____

Section B: Knowledge Assessment

Circle the best answer

1. According to guidelines, prophylactic antibiotics should be given within 60 minutes before skin incision. (True / False)
2. Prophylactic antibiotics should generally be continued for 5 days after pediatric surgery. (True / False)
3. Which antibiotic is generally recommended as first-line SAP for pediatric abdominal surgery?

    (A) Cefazolin

    (B) Amoxicillin/clavulanate

    (C) Vancomycin

    (D) Ceftriaxone

4. If a surgery lasts longer than 4 hours, an additional dose of the initial prophylactic antibiotic should be given. (True / False)
5. A single intravenous dose of prophylactic antibiotic is usually sufficient for most pediatric surgeries. (True / False)
6. When after surgery should prophylactic antibiotics ideally be discontinued?

    (A) Immediately after closing the wound

    (B) Within 24 hours

    (C) 3 days

    (D) 5 days

Section C: Attitudes (Circle one for each statement)

Scale: 1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

1. SAP is effective in preventing surgical site infections in children.

    (1) Strongly Disagree

    (2) Disagree

    (3) Neutral

    (4) Agree

    (5) Strongly Agree

2. I am concerned about antibiotic resistance in my pediatric patients.

    (1) Strongly Disagree

    (2) Disagree

    (3) Neutral

    (4) Agree

    (5) Strongly Agree

3. Hospital guidelines on SAP are helpful in my practice.

    (1) Strongly Disagree

    (2) Disagree

    (3) Neutral

    (4) Agree

    (5) Strongly Agree

4. I feel pressured by patients' families to prescribe antibiotics in surgery.

    (1) Strongly Disagree

    (2) Disagree

    (3) Neutral

    (4) Agree

    (5) Strongly Agree

5. I feel confident in my knowledge about when and how to use SAP.

    (1) Strongly Disagree

    (2) Disagree

    (3) Neutral

    (4) Agree

    (5) Strongly Agree

6. I feel pressured by seniors to prescribe antibiotics in surgery.

    (1) Strongly Disagree

    (2) Disagree

    (3) Neutral

    (4) Agree

    (5) Strongly Agree

Section D: Self-Reported Practices

1. Do you routinely order SAP to be administered within 1 hour before skin incision? ( ) Yes ( ) No

2. If a surgery lasts longer than 4 hours, do you re-dose the prophylactic antibiotic? ( ) Yes ( ) No
3. Do you continue prophylactic antibiotics for more than 24 hours after surgery? ( ) Yes ( ) No
4. Would you give SAP in on-perforated Appendectomy:? ( ) Yes ( ) No
5. How do you usually choose the antibiotic for SAP in pediatric cases? (select one)

    (A) Follow hospital/department protocol or guideline

    (B) Based on attending surgeon's recommendation

    (C) Based on antibiotics available in pharmacy

    (D) My own experience or habit

Section E: Barriers and Facilitators

1. What challenges (barriers) do you face in following recommended SAP practices?

    ☐ Lack of clear hospital guidelines/protocols on SAP

    ☐ Limited availability or frequent stock-outs of recommended antibiotics

    ☐ Inadequate training or knowledge about SAP

    ☐ High workload or time constraints in practice

    ☐ Fear of surgical site infections leading to extended antibiotic use

    ☐ Pressure from patients' families to use antibiotics

    ☐ Influence of senior surgeons' or colleagues' habits

    ☐ Other (please specify): _____

2. Other barriers/challenges (please describe):

3. What factors do you think would facilitate proper SAP use?

   - ☐ Availability of clear SAP guidelines and protocols
   - ☐ Regular training and continuing education on SAP
   - ☐ Reliable supply of appropriate antibiotics
   - ☐ Support and guidance from senior surgeons or pharmacists
   - ☐ Routine monitoring/audit of antibiotic use with feedback
   - ☐ Patient/parent education about antibiotic use
   - ☐ Other (please specify): _____

4. How could the use of SAP in pediatric surgery be improved at our hospital?