Appropriateness of surgical antimicrobial prophylaxis in a teaching hospital in Ghana: findings and implications

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Received 22 July 2022; accepted 6 September 2022

Background: Surgical site infections (SSIs) are among the most common infections seen in hospitalized patients in low- and middle-income countries (LMICs), accounting for up to 60% of hospital-acquired infections. Surgical antimicrobial prophylaxis (SAP) has shown to be an effective intervention for reducing SSIs and their impact. There are concerns of inappropriate use of SAP in Ghana and therefore our audit in this teaching hospital.

Methods: A retrospective cross sectional clinical audit of medical records of patients undergoing surgery over a 5 month duration from January to May 2021 in Ho Teaching Hospital. A data collection form was designed to collect key information including the age and gender of patients, type and duration of surgery, choice and duration of SAP. The collected data was assessed for the proportion of SAP compliance with Ghana Standard Treatment Guidelines (STGs) and any association with various patient, surgical wound and drug characteristics.

Results: Of the 597 medical records assessed, the mean age of patients was 35.6 ± 12.2 years with 86.8% (n=518) female. Overall SAP compliance with the STG was 2.5% (n=15). SAP compliance due to appropriate choice of antimicrobials was 67.0% (n=400) and duration at 8.7% (n=52). SAP compliance was predicted by duration of SAP (P<0.000) and postoperative hospitalization duration (P=0.005).

Conclusions: SAP compliance rate was suboptimal, principally due to a longer duration of prescription. Quality improvement measures such as education of front-line staff on guideline compliance, coupled with clinical audit and regular updates, are urgently needed to combat inappropriate prescribing and rising resistance rates.

Introduction

Surgical antimicrobial prophylaxis (SAP) is the use of antimicrobials to prevent surgical site infections (SSIs) where there is no pre-operative decolonization or treatment of established infections. 1,2 This is important as SSIs are among the most common infections seen in hospitalized patients in low- and middle-income countries (LMICs), accounting for up to 60% of hospital-acquired infections. 3-11 SSIs increase morbidity, mortality and costs, especially among African countries; consequently, clinical practice should use a variety of approaches to prevent them. 12-14 The global incidence of SSIs is estimated to be between 3% and 50% depending on the surgery and country, with typically appreciably higher rates among LMICs. 5,15-17 In Africa, studies have suggested that the overall incidence of SSIs is up to 14.8% for all types of surgery. 3,15

Hand-scrubbing and preparing the skin with antiseptics along with coated sutures, postoperative wound care strategies such as negative-pressure wound dressing, and wound protector devices are among the principal methods used to reduce SSIs. 13,18-20 In addition to these interventions is the administration of SAP, which
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Table 1. Socio-demographic and clinical characteristics of patients including nature of surgery and SAP

| Variable                                      | Categories                      | Frequency (n) | Percentages (%) |
|------------------------------------------------|---------------------------------|---------------|-----------------|
| Mean age [± SD] years (n=597)                  |                                 | 35.6 ± 12.2   |                 |
| Age range (years) (n=597)                      | 20 and below                    | 41            | 6.9             |
|                                                | 21–40                           | 419           | 70.2            |
|                                                | 41–60                           | 106           | 17.8            |
|                                                | 61 and above                    | 31            | 5.2             |
| Gender (n=597)                                 | Male                            | 79            | 13.2            |
|                                                | Female                          | 518           | 86.8            |
| Patient residence (n=597)                      | Urban                           | 269           | 45.1            |
|                                                | Rural                           | 328           | 54.9            |
| Type of surgery (n=597)                        | Elective                        | 277           | 46.4            |
|                                                | Emergency                       | 320           | 53.6            |
| Duration of surgery overall [± SD] hours (n=597)| less than 1 hour                | 160           | 26.4            |
|                                                | 1–2 hours                       | 412           | 68.1            |
|                                                | 3 hours and above               | 33            | 5.5             |
| Type of surgical procedure (n=597)             | Gastrointestinal                | 86            | 14.4            |
|                                                | Gynaecology                     | 418           | 70.0            |
|                                                | Orthopaedics                    | 24            | 4.0             |
|                                                | Urology                         | 14            | 2.4             |
|                                                | Others                          | 55            | 9.2             |
| Name of surgery performed (n=597)              | Caesarean section               | 366           | 61.3            |
|                                                | Herniorrhaphy                   | 42            | 7.0             |
|                                                | Excision biopsy                 | 33            | 5.5             |
|                                                | Myomectomy                      | 33            | 5.5             |
|                                                | Exploratory laparotomy          | 32            | 5.4             |
|                                                | Open reduction                  | 21            | 3.5             |
|                                                | Thyroidectomy                   | 12            | 2.0             |
|                                                | Others                          | 58            | 9.7             |
| Surgical wound class (n=597)                   | Clean                           | 57            | 9.6             |
|                                                | Clean-contaminated              | 482           | 80.7            |
|                                                | Contaminated                    | 58            | 9.7             |
| Presence of comorbid disease (n=597)           | Yes                             | 104           | 17.4            |
|                                                | No                              | 493           | 82.6            |
| Overall duration of SAP [± SD] days (n=597)     |                                 | 6.9 ± 2.1     |                 |
| Duration of SAP IV [± SD] days (n=597)          |                                 | 1.1 ± 0.3     |                 |
| Duration of SAP oral [± SD] days (n=536)        |                                 | 6.5 ± 1.0     |                 |
| Duration of postoperative hospitalization [± SD]days (n=597) |   | 2.9 ± 2.7     |                 |
| SAP compliance with STGs (n=597)                | Yes                             | 15            | 2.5             |
|                                                | No                              | 582           | 197.5           |
| SAP choice appropriateness (n=597)              | Yes                             | 400           | 67.0            |
|                                                | No                              | 197           | 33.0            |
| SAP prescription duration appropriateness (n=597)| Yes                            | 52            | 8.7             |
|                                                | No                              | 545           | 91.3            |

Boldened values are mean and standard deviation figures for the variables above.

is typically viewed as the single most effective activity to reduce subsequent SSIs and their implications. However, there are concerns across Africa, including Ghana, and other LMICs that antimicrobial prophylaxis is typically extended beyond postsurgery and often beyond 24 hours (Table S1 available as Supplementary data at JAC Online). This is an issue as extending SAP has been shown to increase morbidity, adverse reactions and costs as well as increasing antimicrobial resistance (AMR). Currently, Sub-Saharan Africa already has the highest AMR morbidity and mortality rates globally, with associated considerable cost implications, and with rates set to rise still further unless addressed.

Appropriate use of SAP, generally administered as a single dose within 60 minutes prior to the first incision, appreciably reduces the rate of SSIs without increasing AMR and costs.
are not sufficiently clean and aseptic techniques are not being followed. Overcrowding in hospitals, poor knowledge about antimicrobials among attending doctors as well as concerns with malnutrition and patient expectations are additional reasons for the extension of SAP.41–43

Published studies have shown that a range of interventions can successfully reduce extended prophylaxis among LMICs (Table S2). Successful activities include education of all key stakeholders, instigation of agreed antimicrobial protocols with subsequent audit of activities, as well as computer-assisted programmes centered around antimicrobial stewardship programmes (ASPs), can limit the extent of prolonged SAP.5,10,16 However, ASPs can be more difficult to implement in LMICs due to issues of available personnel and costs.37,38 This, however, is beginning to change with ASPs successfully being instigated across Africa39,40 in line with the goals of National Action Plans (NAP) across Africa to reduce AMR.42

The Ghana Standard Treatment Guidelines (STGs) on SAP recommends that a single parenteral dose of a combination of antimicrobials, which are mostly cefuroxime and metronidazole, be administered for general surgeries and single antimicrobial, typically metronidazole, for gynaecological surgeries.43 There is, however, evidence of high usage of antimicrobials for inpatients in this hospital, which was observed following a previous point prevalence survey.44 These concerns necessitated this study to assess SAP appropriateness among patients undergoing general and gynaecological surgery in this hospital and, if needed, seek ways to address concerns raised. This builds on successful training activities and other ASP interventions regarding antimicrobial prescribing currently ongoing within this hospital.44 These are part of general quality improvement measures designed to improve on antimicrobial use in this teaching hospital, which is in line with the Ghana NAP for AMR.42

Methods

Study design

A retrospective cross-sectional clinical audit of medical records of patients undergoing surgery over a 5-month duration from January to May 2021 in Ho Teaching Hospital (HTH) was conducted.

Figure 1. Pattern of surgical antimicrobial prophylaxis prescribed.

Study site and population

HTH in the Ho Municipality, regional capital city of Volta Region, was the study site. This is the only teaching hospital in this region serving a population of approximately 1.2 million and is a 306-bed tertiary facility with departments including obstetrics and gynaecology, surgery, emergency and public health with approximately 1200 staff.45 The surgical unit, where the audit was performed, is staffed with six general surgeons, six obstetric and gynaecological surgeons, four orthopaedic surgeon and three urological surgeons.

Data collection

Data from all medical records of patients who accessed general or gynaecological surgery from 1st January 2021 to 30th June 2021 were extracted from the facilities’ electronic patient databases.

Medical records with incomplete data, patients given antimicrobials for therapeutic use, non-surgical prophylaxis use and dirty procedures according to the Centre for Disease Control and Prevention surgical wound classification system46 were excluded along with paediatric patients (less than 18 years) as well as patients who underwent any surgical procedure other than general or gynaecological surgeries including orthopaedic and urological surgery. Duplications were avoided by ensuring that any repeated medical record numbers within the study period were reconciled with the previous number and the data merged.

The data collection form was adopted from previous publications.47–49 It included socio-demographic characteristics, type and duration of surgery, presence of comorbidities (which included any disorder identified in a patient other the disorder being managed for the surgical intervention), and type of surgical wound, as well as SAP information, e.g., the name of the antimicrobial prescribed, appropriateness of SAP based on the choice and duration of antimicrobial use, and overall compliance of SAP (based on both the choice and duration of the SAP prescribed) with Ghana STGs46,48. The duration of any SAP included both initial intravenous antimicrobials given peri-operatively as well as any subsequent switching to oral antimicrobials, which is usually prescribed to reduce possible complications, hasten discharge and conserve costs.50,51 This approach was chosen because compliance to guidelines is seen as a key quality improvement measure across Africa and wider.46,47,52–54

Compliance of SAP with the Ghana STGs was based on a combination of actual prescribing against the suggested choice, frequency and duration of antimicrobial.46 We could not access the actual timing of administration of the first antimicrobial for SAP from the patients’ medical records; consequently, this did not form part of the compliance decision.

Data were extracted from the medical records of patients onto the data collection form (Table S3) by a team of pharmacists with infectious disease training (IAS & EYD). These pharmacists also assessed the appropriateness of SAP on the basis of the agreed criteria.

Data analysis

Data collected were entered into Microsoft Excel sheet and imported into Stata v.14 for statistical analysis. The analyses undertaken included descriptive statistics as well as bivariate and multivariate analyses to determine key factors associated with compliance of SAP with Ghana STG. The factors were based on the categories of collected data. A P value <0.05 was considered significant.

Ethical consideration

Ethical clearance for this study was obtained from the ethical review committee of the University of Health and Allied Science (UHAS-REC A.2) [26] 21–22 while administrative approval was obtained from the Management of the Hospital.
Results

Of the 597 medical records assessed, the mean age of patients was 35.6±12.2 years with 86.8% (n=518) being female and 54.9% (n=328) coming from urban settlements (Table 1).

More than half (53.6%) of the surgeries performed were for emergency reasons, mostly lasting between 1 and 2 hours (68.1%, n=412). Moreover, 70.0% (n=418) of the surgeries conducted were for gynaecological purposes especially caesarean sections (61.3%, n=366). The study revealed that 80.7% (n=482) of the surgical wounds were clean-contaminated, with almost no comorbid diseases recorded during surgery. An overall mean duration of SAP of 6.9±2.1 days was observed, comprising a mean duration of intravenous SAP at 1.1±0.3 days and oral SAP at 6.5±1.0 days (Table 1).

The most common SAP prescribed was a combination cefuroxime and metronidazole (56.1%, n=335) (Figure 1). Overall SAP compliance with Ghana STG was 2.5% (n=15). SAP compliance due to the appropriate choice of antimicrobials was 67.0% (n=400), with compliance to the duration of SAP only 8.7% (n=52).

The bivariate analysis showed an association between SAP compliance with age ranges (P=0.003), the presence of comorbid diseases (P=0.032), type of surgical procedure (P<0.000), surgical wound class (P=0.020), SAP duration appropriateness (P<0.000) and postoperative hospitalization duration (P=0.005) (Table 2). SAP compliance was independently predicted by SAP duration appropriateness (P<0.000) and postoperative hospitalization duration (P=0.005) as per the multivariate analysis (Table 3).

Discussion

The observed prolonged overall duration of SAP of 6.9 (SD 2.1) days is similar to that observed in a number of African

Table 2. Bivariate analysis of the association between SAP compliance with STG and socio-demographic and clinical characteristics of patient

| Variables                        | Categories                      | Compliance with STG | Fisher's exact test |
|----------------------------------|---------------------------------|---------------------|---------------------|
|                                  |                                 | Yes, n (%)          | No, n (%)           | P value  |
| Age ranges                       | 20 and below                    | 3 (7.3)             | 38 (92.7)           | 0.003    |
|                                  | 21–40                           | 5 (1.2)             | 414 (98.8)          |          |
|                                  | 41–60                           | 4 (3.8)             | 102 (96.2)          |          |
|                                  | 61 and above                    | 3 (9.7)             | 28 (90.3)           |          |
| Gender                           | Male                            | 3 (3.8)             | 76 (96.2)           | 0.434    |
|                                  | Female                          | 12 (2.3)            | 506 (97.7)          |          |
| Type of surgery                  | Elective                        | 6 (2.3)             | 271 (97.8)          | 0.794    |
|                                  | Emergency                       | 9 (2.8)             | 311 (97.2)          |          |
| Residence                        | Urban                           | 7 (2.6)             | 262 (97.4)          | 1.000    |
|                                  | Rural                           | 8 (2.4)             | 320 (97.6)          |          |
| Presence of Comorbid disease     | Yes                             | 6 (5.7)             | 98 (94.3)           | 0.032    |
|                                  | No                              | 9 (1.8)             | 484 (98.2)          |          |
| Duration of surgery              | <1 hour                         | 2 (1.3)             | 155 (98.7)          | 0.394    |
|                                  | 1–2 hours                       | 13 (3.2)            | 394 (96.8)          |          |
|                                  | 3 hours and >                   | 0 (0)               | 33 (100)            |          |
| Type of surgical procedure       | GI                              | 6 (7.0)             | 80 (93.0)           | 0.000    |
|                                  | Gynaecology                     | 3 (0.7)             | 415 (99.3)          |          |
|                                  | Orthopaedics                    | 3 (12.5)            | 21 (87.5)           |          |
|                                  | Urology                         | 1 (7.1)             | 13 (92.9)           |          |
|                                  | Others                          | 2 (3.6)             | 53 (96.4)           |          |
| Surgical wound Class            | Clean                           | 3 (5.3)             | 54 (94.7)           | 0.020    |
|                                  | Clean-Contaminated              | 8 (1.7)             | 474 (98.3)          |          |
|                                  | Contaminated                    | 4 (6.9)             | 54 (93.1)           |          |
| SAP choice appropriateness      | Yes                             | 3 (3.8)             | 76 (96.2)           | 0.783    |
|                                  | No                              | 12 (2.3)            | 506 (97.7)          |          |
| SAP duration appropriateness    | Yes                             | 6 (2.3)             | 271 (97.8)          | 0.000    |
|                                  | No                              | 9 (2.8)             | 311 (97.2)          |          |
| Postoperative hospitalization duration | 1 day and below              | 3 (1.7)             | 184 (98.3)          | 0.005    |
|                                  | 2–5 days                        | 6 (1.8)             | 333 (98.2)          |          |
|                                  | 6–9 days                        | 3 (5.7)             | 50 (94.3)           |          |
|                                  | Above 9 days                    | 3 (16.7)            | 15 (83.3)           |          |

Emboldened P values are those that are below the significance level of 0.005. Independent variables with P-values boldened showed statistically significant association with SAP compliance using Ghana STG from Fisher's exact test.
There have been a number of interventions that have effectively reduced SAP duration, and increase appropriate selection of antimicrobials, through compliance to STG and local guidelines, with some also reducing SSI rates, among African countries (Table S2).11,17,68–71 Some of these interventions, which the antimicrobial stewardship team in this hospital in Ghana can take forward as future quality improvement projects, include education and training and conducting leadership programmes for frontline staff. These interventions can be implemented either alone or in combination with other approaches including regular audit and feedback meetings with the entire clinical team, dose optimization and the use of prior authorization for restricted antimicrobials.61–63 We will now consider some of these approaches with the surgical teams to improve SAP use in HTH in future quality improvement projects.

We are aware of a number of limitations with our study. First, our study was limited by the short duration of clinical audit which may differ from SAP use in the entire year. We were also unable to assess the timing of the first dose of SAP administration, which has been shown to be an important determinant of the effectiveness of SAP in preventing SSIs. This was due to limited availability of such data from the electronic medical records. The study was also limited by the exclusion of other surgical procedures including orthopaedic and urological surgeries. The investigators also did not validate the data collection tool, however, this was based on previous publications. Despite these concerns, we believe that our findings provide baseline quality gap information in this hospital and wider, which can be built on by subsequent audits and prospective interventional studies.

### Conclusion

There was poor compliance of SAP prescription with local guidelines mainly due to prolonged duration (>1 day) of antimicrobial prescribing. The most common SAP prescribed was a combination of cefuroxime and metronidazole, which were used mostly for gynaecological procedures, with caesarean section being the most prominent indication. Instigation of ASPs including the education and training of front-line clinical teams to promote compliance with SAP in STG and local guidelines, coupled with regular clinical audit with feedback meetings among the team members, will help improve future antimicrobial use to combat rising AMR rates.

### Funding

The study was self-funded by investigators.

### Transparency declarations

None to declare.

### Supplementary material

Table S1–S3 are available as Supplementary data at JAC Online.
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