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

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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),[3,4] accounting for up to 60% of hospital-acquired infections.[5–11] 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

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)		**1.8±0.5**	
Duration of surgery (*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.[4,21] However, there are concerns across Africa, including Ghana, and other LMICs that antimicrobial prophylaxis is typically extended beyond post-surgery and often beyond 24 hours (Table S1 available as Supplementary data at *JAC* Online).[4,22–24] This is an issue as extending SAP has been shown to increase morbidity, adverse reactions and costs as well as increasing antimicrobial resistance (AMR).[4,22,25–27] 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.[28–30]

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.[21,22,31,32] However, SAP is often extended due to concerns that hospitals

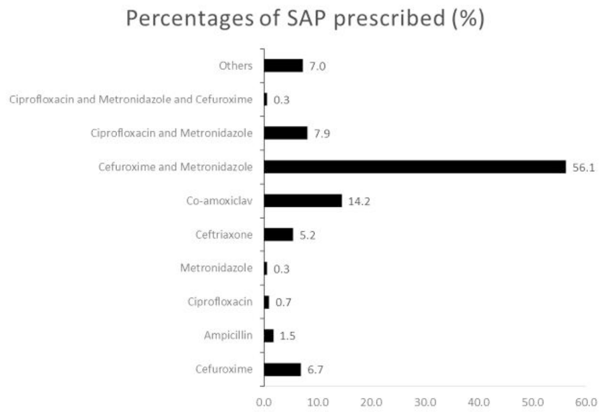

Figure 1. Pattern of surgical antimicrobial prophylaxis prescribed.

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.[17,22,33–35]

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 centred around antimicrobial stewardship programmes (ASPs), can limit the extent of prolonged SAP.[5,10,36] 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 Africa[29,39–41] 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.[23] 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.

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 system[46] 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 adapted 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 by 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 STGs[34,43] 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.[24,47,52–54]

Compliance of SAP with the Ghana STG was based on a combination of actual prescribing against the suggested choice, frequency and duration of antimicrobial.[43] 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.

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 Yes, *n* (%)	Compliance with STG No, *n* (%)	Fisher's exact test *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.

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 3. Multivariate analysis of the predictors of SAP compliance with STG and socio-demographic and clinical characteristics of patient

Independent variables	aOR	95% CI	*P* value
Age ranges			0.475
20 years and below (*r*)	1		
21–40 years	0.101	0.014–0.709	
41–60 years	0.118	0.017–0.814	
Above 60 years	0.131	0.132–1.297	
Presence of comorbid diseases			0.270
Yes	2.861	0.712–11.506	
No (r)	1		
Type of surgical procedure			0.255
Gastrointestinal (*r*)	1		
Gynaecological	0.169	0.025–1.113	
Orthopaedics	0.616	0.090–4.193	
Urological	0.411	0.015–10.815	
Others	0.020	0.000–0.865	
Class of surgical wound			0.532
Clean-contaminated	1		
Clean	3.647	0.149–88.809	
Contaminated	0.516	0.081–3.253	
SAP duration appropriateness			**0.000***
Yes	21.860	4.791–99.747	
No (*r*)	1		
Postoperative hospitalization duration			**0.005***
1 day and below (*r*)	1		
2–5 days	1.241	0.236–6.528	
6–9 days	5.461	0.727–41.018	
Above 9 days	11.221	1.347–93.409	

Independent variables with *P*-values boldened showed statistically significant association with SAP compliance using Ghana STG from Fisher's exact test.

countries (Table S1).[2,40,53,55–62] While there was reasonably rapid switching from IV to oral antimicrobials after an average of 1.1 days (SD 1.1), the overall length of prophylaxis was considerably longer than currently recommended due to the completion of a full oral course of prescribed antimicrobials.[1,4,32] This is a concern as extending SAP has been shown to increase AMR rates, adverse reactions, the extent of *Clostridioides difficile* infections and costs.[4,21,26,63]

While there was reasonable compliance to the Ghana STG based on the choice of antimicrobial prescription (67.0%—Table 1), overall compliance to the guidelines was low (2.5%). Similar patterns of antimicrobial prescribing for SAP comprising cephalosporins and metronidazole alone or in combination were seen in other African countries.[2,46,56,63,64] This low compliance to SAP guidelines concerning antimicrobial prescribing, particularly with respect to the length of SAP, observed in this hospital in Ghana has also been seen among other African countries.[2,65–67] However, the poor compliance observed in this study was mainly predicted by the prolonged duration of SAP and postoperative hospitalization (Table 3). This has also been observed in similar studies in many African countries.[31–46]

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 front-line 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.

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Transparency declarations

None to declare.

Supplementary material

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

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