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Authors

Enriquez, Kayla
Raouf, Saned
Shakpeh, John
et al.

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BMJ Open Surgical antimicrobial prophylaxis among surgical patients: results from a retrospective observational study at a public hospital in Liberia

Kayla Enriquez ¹, Saned Raouf,¹ John Shakpeh,² Michelle Niescierenko,^{3,4} Finda Mayah-Toto⁵

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¹Department of Emergency Medicine, University of California San Francisco, San Francisco, California, USA

²Nursing Department, Redemption Hospital, Monrovia, Liberia

³Harvard Medical School, Boston, Massachusetts, USA

⁴Department of Pediatrics and Emergency Medicine, Harvard Medical School, Boston, Massachusetts, USA

⁵Infection Prevention and Control, Redemption Hospital, Monrovia, Liberia

Correspondence to

Dr Kayla Enriquez;
kayla.enriquez@ucsf.edu

ABSTRACT

Background Surgical antibiotic prophylaxis (SAP) is one of the most effective measures to prevent surgical site infections (SSIs). According to WHO SAP guidelines, SAP requires appropriate indication for administration and delivery of the antimicrobial agent to the operative site through intravenous administration within 60–120 min before the initial surgical incision is made. In Liberia, it is unknown how surgeons practice and there has been anecdotal observation of antibiotic overuse.

Objective To elucidate baseline SAP compliance, particularly appropriate SAP use based on wound class and time of antibiotic administration.

Methods An observational, cross-sectional study was conducted from November to December 2017. One-day training was provided on SAP/SSI to 24 health workers by the Ministry of Health and WHO. Following this training, surgical cases (general surgery and obstetrics and gynaecology (OB/GYN) underwent chart review with focus on time of SAP administration and appropriate SAP based on Centers for Disease Control and Prevention (CDC) wound classification.

Results A total of 143 charts were reviewed. Twenty-nine (20.3%) cases showed appropriate prophylaxis through administrations of antibiotics 120 min before surgical incision, resulting in SAP compliance. One hundred and fourteen cases (79.7%) showed SAP noncompliance with timing of antibiotic administration. Of the OB/Gyn cases, 109 wounds were classified as Class I (clean) and one wound was classified as Class III (contaminated). For General Surgical cases, 32 wounds were classified as Class I and one as Class III. Of the 109 Class I OB/Gyn surgeries, 24 (22%) were appropriately given antibiotics based on the CDC wound guidelines while 78% were non-compliant with recommendations. Of the 32 Class I General surgery cases, 4 (12.5%) were compliant with antibiotics guidelines while 28 (87.5%) were not.

Conclusion Compliance with SAP is low. More studies need to be done to explore the contributing factors to this. Implementing mechanisms to achieve proper use of SAP is needed.

INTRODUCTION

The WHO has identified surgical site infections (SSIs) as a particular problem

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ A 1 day training of nurses, surgeons, and obstetricians on surgical antibiotic prophylaxis (SAP) use was conducted prior to the 2 month retrospective chart review to optimise provider prescribing patterns based on Centers for Disease Control and Prevention and WHO guidelines.
- ⇒ Use of the hospital operating theatre ledger to identify patients to include in the study likely did not capture all patients undergoing surgical procedures given not all patients were recorded in the ledger or not all charts recorded were able to be collected.
- ⇒ Only information on wound classification and antibiotic administration were collected with no further information on patient demographics or physician qualifications.
- ⇒ Wound classification and antibiotic administration timing was determined based on documentation in the chart which is not always reliable due to no standard documentation template.
- ⇒ Specifics on antibiotic class and dose were not collected thus we were unable to comment on appropriateness of antibiotic use.

worldwide.¹ Patients who develop SSIs are up to 60% more likely to spend time in an intensive care unit, have a high readmission rate, and are twice as likely to die than are patients without an SSI.² Healthcare costs are substantially increased for patients who develop SSIs.² The risk of SSIs in developing countries is strikingly higher than in high income countries for the equivalent surgical procedure, with a pooled SSI incidence in low-income and middle-income countries (LMIC) of 11.8 per 100 surgical patients undergoing surgical procedures and 5.6 per 100 surgical procedures. SSIs are the most frequent hospital-acquired infection (HAI) reported hospital-wide in LMICs.¹

Surgical antibiotic prophylaxis (SAP) is an effective management strategy to prevent SSI. SAP reduces the burden of micro-organisms

at the surgical site and cost-effectively reduces the rate of SSI and hospital length of stay.³ The use of antibiotics has been shown to decrease SSI by 39%.³ Successful SAP reires administration of antibiotics before the surgical procedure with the aim of preventing SSIs. This does not include preoperative treatment of established wound infections. In 2016, the WHO offered guidelines on SAP to prevent SSIs; however, globally, there is substantial variability in the use of SAP.^{2,4} The selection of antibiotics for SSIs is often based on wound classification, the normal floral distribution of the site to be operated on, and local antibiotic resistance patterns.⁵ Most guidelines recommend the administration of SAP within 60–120 min before the first incision.^{1,3} Studies have shown that the risk of SSI increases five-fold when antibiotics are administered more than 120 min prior to the first incision and almost doubled when antibiotics are administered after the first incision.⁵ Moreover, most guidelines recommend no SAP for clean wounds (Centers for Disease Control and Prevention (CDC) class I) and to discontinue SAP within 24 hours after surgery, except prolonged or specific surgical procedures such as cardiac surgery.⁶ Despite these recommendations, studies continue to show inappropriate SAP compliance. Antibiotic choice, timing and duration were the commonly reported misuses of SAP.⁷

To date, limited research and guidelines have been conducted and developed on SAP use in sub-Saharan Africa.⁴ In Mwita *et al*, it was found that the timing of the initiation of antibiotics, antibiotic selection and duration of antibiotic prophylaxis perioperatively were not according to the published guidelines with a majority of patients being administered antibiotics for a mean duration of 5 days postoperatively.^{3,5} Studies by Afriyie *et al* showed that despite SAP recommendations for abx duration being no longer than 24 hours, two hospitals in Ghana showed prophylaxis lasting >1 day in 70% of case.⁸ In Liberia, preventative measures against SSIs are not standard and currently do not follow recommendations put forth by the WHO. Little data exist to determine baseline SAP use, and SSI surveillance and monitoring are currently not being practised in Liberia. There has also been anecdotal observation of poor antibiotic stewardship, which could lead to increase in SSI and antibiotic resistance. Due to varying limitations in laboratory and microbiology infrastructure throughout sub-Saharan Africa, it is challenging to explore these anecdotal observations around antibiotic stewardship. This study attempts to assess baseline SAP practice in a tertiary referral hospital in Liberia and use the findings to guide future activities, research, and guideline development in Liberia to improve SAP use.

METHODS

Redemption Hospital, one of the largest public hospitals in Monrovia, is composed of 100–299 beds^{7,9} and two surgical theatres⁹ and provides services to an estimated 400 000+ patients.⁷ With no prior data coming out of

Liberia regarding SAP and no formal training in SSI prevention, SAP use or appropriate antibiotic use, the Liberian Ministry of Health and Social Welfare (MOH) in collaboration with the WHO offered healthcare workers at Redemption Hospital a 1-day training on SAP use. Participants included nurses, surgeons and obstetricians. The SAP training used didactic training modules developed by the MOH and WHO.¹ Following the training, a retrospective chart review of all patients undergoing general surgery and obstetrical surgery was conducted over a 2-month period between November and December 2017.

Study design

An observational, cross-sectional study was conducted via a 2 month retrospective chart review. The surgical theatre ledger for Redemption Hospital was used to identify all patients who underwent general surgical or obstetrical/gynaecological procedures during the study period. All patients undergoing a surgical procedure that were entered in the ledger were included in the study. Two data points from the patients' medical chart were extracted to evaluate for SAP compliance: wound classification and antibiotic timing around surgical procedure. No additional patient information was collected including identifying factors and patient demographics.

Wound classification and surgical antibiotic prophylaxis timing

Wounds were classified postoperatively based on documentation in the chart using the CDC Surgical Wound Classification, as defined in [table 1](#). SAP appropriateness was evaluated with regard to compliance with WHO guidelines.¹ Compliance in this study was defined as appropriate administration of SAP based on CDC surgical wound classification and timing of administration. These guidelines recommend that SAP should be given to patients with clean wounds that contain a prosthetic (class I+prosthetic), clean-contaminated surgery (class II) and contaminated surgery (class III). SAP is not recommended for clean surgeries without prosthetics or implants. [Table 1](#) includes all four classes of wounds and their definitions.¹⁰ The aforementioned guidelines were chosen based on them being taught during the preceding SAP training.

While SAP dosing can depend on pharmacokinetics, antibiotic type and wound type, we used the WHO recommended SAP administration time of up to 120 min before incision.¹ Data regarding wound classification, antibiotic choice and time of administration of SAP were input into a password-secured Microsoft Excel document for data analysis.

Patient and public involvement

Retrospective chart review was conducted with no patient identifying information or demographics collected. Patients were not involved in the development of the

Table 1 CDC surgical wound classification, reprinted from Mangram *et al*¹⁰

Wound classification	Description
Class I/clean	An uninfected operative wound in which no inflammation is encountered and the respiratory, alimentary, genital or uninfected urinary tract is not entered. In addition, clean wounds are primarily closed and, if necessary, drain with closed drainage. Operative incisional wounds that follow non-penetration (blunt) trauma should be included in this category if they meet the criteria.
Class II/clean-contaminated	An operative wound in which the respiratory alimentary, genital or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, operations involving the biliary tract appendix, vagina and oropharynx are included in this category, provided no evidence of infection or major break in technique is encountered.
Class III/contaminated	Open fresh, accidental wounds. In addition, operation with major breaks in sterile technique or gross spillage from the gastrointestinal tract, and incisions in which acute, non-purulent inflammation is encountered are included in this category.
Class IV/dirty-Infected	Old traumatic wounds with retained devitalised tissue and those that involve existing clinical infection or perforate viscera.

CDC, Centers for Disease Control and Prevention.

research question and outcome measures and treatment received was not affected by the study.

RESULTS

A total of 143 charts of patients who had undergone general surgery and obstetrical and gynaecological surgeries were reviewed. Clean (class I) wounds and contaminated (class III) wounds constituted 98.6% (141 patients) and 1.4% (2 patients) of surgical procedures,

respectively. There were no characteristics of class II or class IV wounds in any patient chart.

Overall compliance with SAP based on both wound classification and timing of antibiotic administration was not achieved in any surgical case. As shown in [figure 1](#), 29 (20.3%) of the 143 cases followed appropriate prophylaxis through administrations of antibiotics ≤ 120 min before surgical incision. One hundred and fourteen cases (79.7%) of the 143 had inappropriate timing of antibiotics prophylaxis. Of these cases, 38 of the 114 cases (33.3%) were given antibiotics after surgery rather than before surgical incision, while the remaining 76 of the 114 cases (66.6%) were given antibiotics more than 120 min prior to surgery.

Of all class I wounds regardless of type of surgery (n=141), 113 (80.2%) inappropriately received prophylaxis based on wound classification recommendations. When class I wounds are further stratified by surgical subspecialty: 24 of the 109 obstetrical/gynaecological surgeries (22.0%) were appropriately given antibiotics based on wound classification guidelines, while the remaining 85 (78.0%) were non-compliant ([figure 2A](#)). Of the 32 class I general surgery cases, 4 of the 32 cases (12.5%) were appropriately given antibiotics based on wound classification guidelines, while the remaining 28 (87.5%) other patients received SAP inappropriately based on wound classification guidelines ([figure 2B](#)). Of the class III wounds (n=2), the one contaminated obstetrical/gynaecological surgery was compliant with antibiotic prophylaxis, while the one general surgery wound was found to be non-compliant with antibiotics guidelines. No class II or class IV wounds were identified in the study.

DISCUSSION

SSIs are the most common cause of HAI resulting in significant morbidity and mortality, extended duration of hospital stay, an increase in antibiotic resistance and an increased burden on otherwise fragile healthcare systems.¹¹ The WHO guidelines on SAP are not always

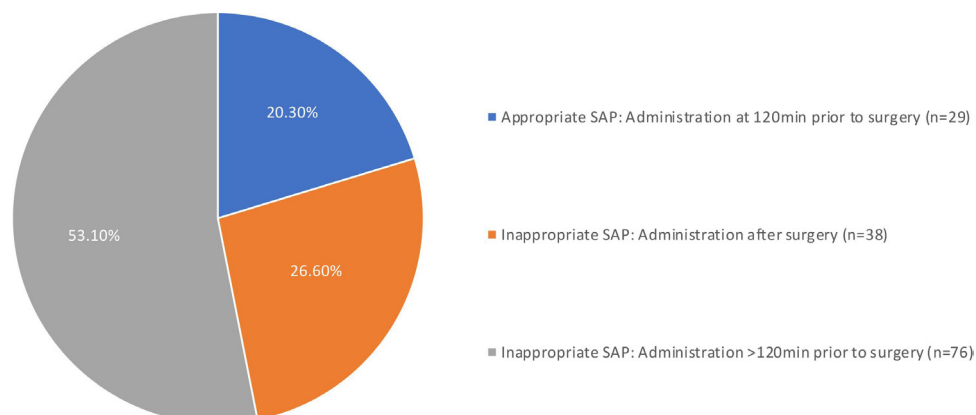


Figure 1 SAP timing compliance (n=143). SAP, surgical antibiotic prophylaxis.

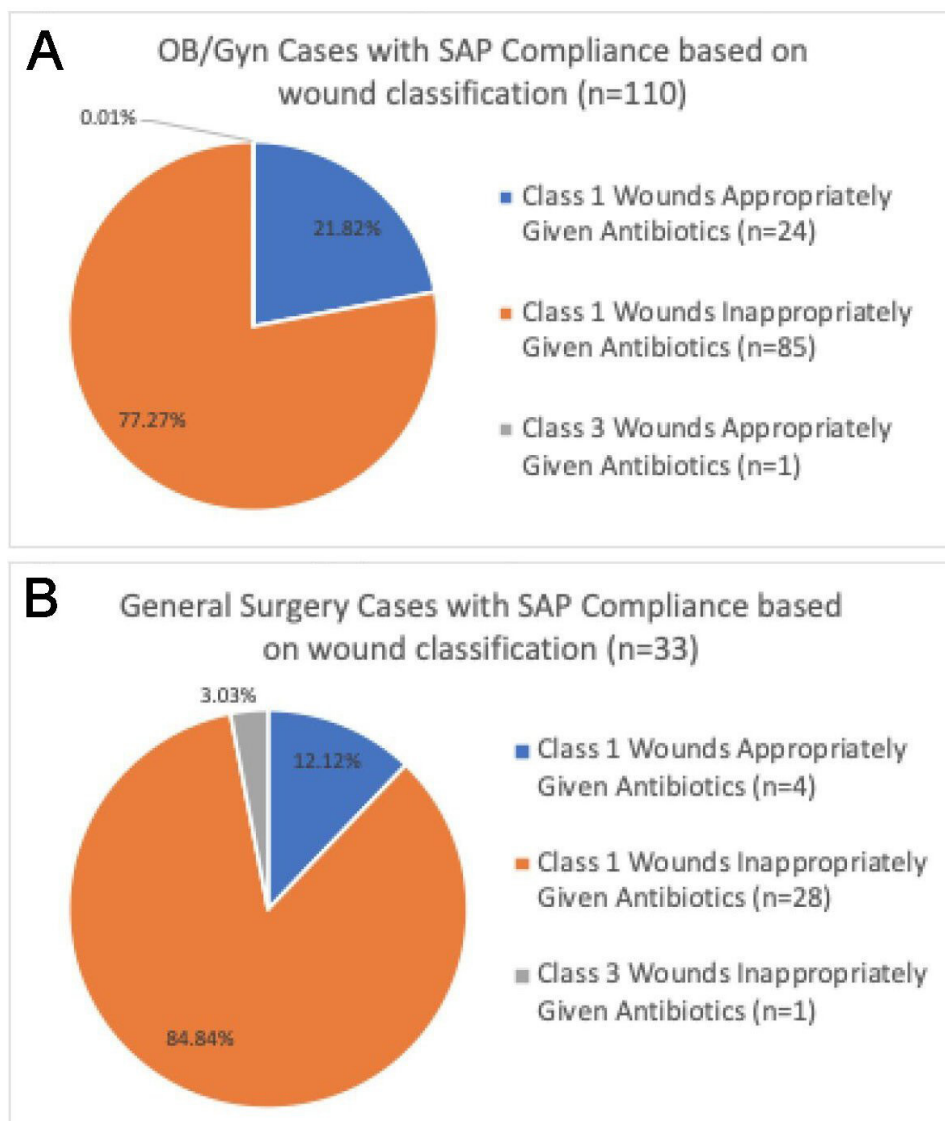


Figure 2 (A) OB/GYN case compliance with SAP based on wound classification. (B) General surgery case compliance with SAP based on wound classification. OB/GYN, obstetrics and gynaecology; SAP, surgical antibiotic prophylaxis.

adhered to and local guidelines are not always available or followed. Studies reported low compliance with recommended timing of SAP and patients being given antibiotics for long periods postoperatively or when they were not indicated.¹² Non-compliance with WHO guidelines has been attributed to lack of knowledge regarding spectrum of antibiotic activity and of optimal timing of antibiotic prophylaxis.

This study aimed to study SAP practices in a large tertiary referral centre in Monrovia, Liberia. To our knowledge, the results from this study are the first to delineate current SAP practice in Liberia, with these findings being a baseline for future studies. This study showed SAP non-compliance in all studied variables in both OB/GYN and general surgical cases compared with WHO guidelines, CDC guidelines and evidence-based practice for SSI prevention.

These findings are similar to those in recent studies out of other sub-Saharan countries looking at SAP

compliance, particularly antibiotic choice and timing of administration. In a study out of an Ethiopian referral centre, only 8.48% of patients who received SAP received it between 0 min and 120 min before surgery.¹³ Similarly, a large study in a rural referral hospital in Uganda showed widespread inappropriate prescribing of perioperative antibiotics and prolonged postoperative use among OB/GYN and general surgical patients.⁶ However, one major difference in our study was the high number of class I wounds that received SAP with no indication. The study from Ethiopia showed that only 5.4% of wounds that received SAP were not indicated, and a study by Bunduki *et al* out of the Democratic Republic of Congo studying SAP compliance in a teaching hospital reported only 1.9% of wounds receiving non-indicated SAP.^{13 14} It is important to understand causes of non-compliance within their local contexts. A scoping review of evidence on the duration of SAP and related incidence of SSI in LMICs highlighted staff education as a key element of building

evidence-based infection surveillance and control skills in LMICs.¹² An audit of SAP in Nigeria suggested that poor knowledge regarding the spectrum of antibiotic activity may lead to inappropriate prescribing, and an implementation study in Kenya found limited awareness of national policy documents, poor access to appropriate medicines and lack of awareness of the potential for cost savings.¹²

In Liberia, our findings can potentially be explained by difficulty with sterility practices at Redemption Hospital and overall hospital and community cleanliness as experienced anecdotally. Given many hospitals in Liberia face challenges with equipment, electricity and infrastructure, sterilisation procedures are often affected, and previously sterilised equipment is often incorrectly stored, thus risking contamination of equipment. Moreover, infection prevention and control guidelines and protocols were not widely implemented and practised until the Ebola epidemic of 2014–2016.¹⁴ As a result, many surgical specialties give SAP to patients regardless of wound classification and prolonged antibiotic courses postoperatively due to concern for wound contamination both in the hospital and in the community.⁹ Improved SAP at Redemption Hospital would need to encompass further educational initiatives around antibiotic stewardship, SAP guidelines and wound classification. Implementation of standard documentation and stop gaps when prescribing antibiotics would be key in decreasing inappropriate SAP. Additionally, improvement in infrastructure, water supply, electricity and supply chain would improve antibiotic prescribing practices.

The need for implementation of standardised, evidence-based practices to prevent SSI and future surveillance of SSI in Liberia is key to improving overall patient outcomes, healthcare delivery and healthcare system cost efficiency. Various studies have focused on the effects of antibiostewardship interventions as a means to address these gaps.¹⁵ A study out of Kenya showed that a locally developed SAP policy resulted in improved antibiotic stewardship leading to decreased need for intravenous antibiotics and improved cost efficiency.³ As reported in Mwita *et al*, Saied *et al* reported improved timing of the first dose of antibiotics from 6.7% to 38.7%, and Brink *et al* showed that antibiotic selection consistent with guidelines can be achieved with up to 95.9% of patients receiving appropriate SAP.⁵ Nonetheless, other studies shed light on local challenges in improving implementation and development of SAP guidelines. Ozgun *et al* (as reported in Mwita *et al*) instigated several measures including analysing key concerns regarding SAP with individual surgical teams; however, compliance to agreed guidelines decreased post intervention, with patients receiving prolonged SAP increasing from 34% of patients to 52%. This was mainly attributed to surgeons' comfort level at the time with prolonged administration.⁵

Limitations

This study has many limitations. First, the hospital operating theatre ledger was used to identify patients

undergoing surgical procedures and charts were then collected in medical records. This method of chart collection likely missed patients due to them not being entered in the ledger or the chart not being able to be found. Second, wound classification and antibiotic administration timing was determined based on documentation in the chart. This method of classifying wounds was not ideal, given documentation of wound characteristics often lacked and interpretation of wound class was dependent on the data collectors' SAP training and familiarity with CDC and WHO wound classification guidelines. Charting is often not standardised and exact documentation of timing on antibiotic distribution can sometimes not be reliable. Additionally, specifics on antibiotic class and dose were not collected. This information would have been helpful in determining appropriateness of antibiotic use. Third, no patient demographics were collected during the chart review. The lack of this information does not allow for various factors such as age and comorbidities, which can contribute to the antibiotic prescribing patterns of healthcare providers, be taken into account. Lastly, other limitations are secondary to resource constraints. For example, lack of sterilisation techniques and unavailability of culture microbiology makes it difficult to study antimicrobial susceptibility patterns in SSI to ascertain appropriate antibiotic choice and eventually develop effective local guidelines. Moreover, the pattern of antibiotic use, while not studied, depends on local availability, and data are lacking at the pharmacy level. Nonetheless, these data open the opportunity to improve current practices and antibiotic stewardship.

CONCLUSION

This study found significant misuse of SAP and diversion from current WHO guidelines. There was a substantial overuse of SAP for class I (clean) wounds and improper timing of SAP with the majority of antibiotics given after surgery. Future studies to understand antibiotic regimens, SSI incidence, and physician attitudes and knowledge around SAP are needed. Additionally, microscopy and information on bacterial sensitivities are crucial for antibiotic stewardship. Nonetheless, interventions must include local context and address strongly held beliefs.

Contributors KE: guarantor of all work, coprincipal investigator for the project, study design and implementation plan, data analysis, literature review, manuscript writing. SR: literature review and manuscript writing. JS: Redemption Hospital liaison, study design and implementation plan. MN: study design, data analysis. FM-T: coprincipal investigator for project, study design and implementation plan, data collection, data analysis and abstract writing.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, conduct, reporting or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Approval for research was obtained from the chief medical officer and administrative board of directors at Redemption Hospital. Given this



research collected no patient demographics or identifying factors, it was deemed ethically appropriate and no further approval was sought from the University of Liberia-Pacific Institute for Research and Evaluation Institutional Review Board (UL-PIRE-IRB). Patient consent was waived, given no patient information was collected.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article.

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ORCID iD

Kayla Enriquez <http://orcid.org/0000-0002-4186-0045>

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