ORIGINAL RESEARCH

Hospital-acquired infections in patients with surgical infections at a tertiary hospital in Kigali, Rwanda: A prospective observational study

Thierry Cyuzuzo[1], Jean Bosco Katabogama[1], Vital Muvunyi[1], Christophe Mpirimbanyi[2], Christian Urimubabo[1,2], Jennifer Rickard[1,3,4]

[1]College of Medicine and Health Sciences, University of Rwanda, Kigali, Rwanda
[2]Department of Surgery, Kibagabaga District Hospital, Kibagabaga, Rwanda
[3]Department of Surgery, University Teaching Hospital of Kigali, Kigali, Rwanda
[4]Department of Surgery, University of Minnesota, Minneapolis, Minnesota

Correspondence: Dr Thierry Cyuzuzo (cyuzutsi95@gmail.com)

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Abstract

Introduction
Hospital-acquired infections (HAIs) account for a substantial burden on healthcare systems, with surgical site infections being the most common. Limited data exist on HAIs in low-resource settings, particularly device-associated HAIs. This study aimed to characterize the incidence and different types of HAIs among patients with surgical infections in Kigali, Rwanda.

Methods
We conducted a prospective, observational study on all patients with surgical infections admitted to a tertiary referral hospital in Kigali. Patient demographics, clinical features, and outcomes, including HAIs, were analysed. Data on devices associated with HAIs, such as the use of Foley catheters, intubation outside of the operating theatre, and central lines, were also gathered. The incidence and types of HAIs were determined.

Results
Over 14 months, 124 patients were admitted and underwent surgery for surgical infections. Appendicitis (n=24, 19%), soft tissue infection (n=27, 22%), and abscesses (n=26, 21%) were the most common diagnoses. Seventy-three patients (59%) had comorbidities. Sixteen (13%) required postoperative admission to the intensive care unit. The perioperative mortality rate was 10% (n=13). Thirty-two patients (25%) developed HAIs. Urinary tract infections were seen in 2 patients (2%), and 1 patient developed pneumonia. In total, 30 patients (24%) had SSIs, with 15 (12%) experiencing superficial SSIs, 18 (15%) with deep SSIs, and 16 (13%) with organ-space SSIs. There were no instances of catheter-associated urinary tract infections, ventilator-associated pneumonia, or central line–associated bloodstream infections.

Conclusions
The incidence of HAIs among patients with surgical infections was high, with surgical site infections being the most prevalent. Minimizing device exposure is crucial for reducing the risk of other device-related HAIs.

Keywords: hospital-acquired infections, surgical site infections, infection control, Rwanda

Introduction

Globally, surgical conditions represent 30% of the disease burden, and infection is among the most common indications for surgery in low- and middle-income countries (LMICs).[1],[2] LMICs bear a disproportionate burden of emergency surgical conditions but have inadequate capacities to address these challenges.[3],[4] Delays in surgical care leading to infections and primary infections requiring surgical intervention are common scenarios in LMICs.[5],[6] Patients who experience surgical infections face long hospitalizations, prohibitive healthcare-related costs, and high mortality rates.[7],[8] Hospital-acquired infections (HAIs) impose a significant burden on healthcare systems, with surgical site infections (SSIs) being the most

Table 1. Demographics and clinical features of patients with surgical infections at the time of hospital admission (N=124)

Variable	Value
Age, years (median, IQR)	35 (24-52)
Gender, n (%)	
Male	85 (69)
Female	39 (31)
Province, n (%)	
Kigali	45 (36)
North	32 (26)
South	31 (25)
West	14 (11)
East	1 (1)
Other	1 (1)
Insurance, n (%)	
Community based health insurance	102 (82)
Other insurance	15 (12)
None	7 (6)
Transferred from another hospital within 30 days, n (%)	108 (87)
Antibiotics within the past 30 days, n (%)	32 (26)
Comorbidities, n (%)	
Diabetes	8 (6)
Gastritis	12 (10)
Hypertension	4 (3)
Alcohol	46 (37)
Human immunodeficiency virus	3 (2)
Other[a]	6 (5)
None	51 (41)
Symptom duration, days (median, IQR*)	7 (3-14)
Diagnosis, n (%)	
Appendicitis	24 (19)
Soft tissue infection	27 (22)
Intestinal obstruction	15 (12)
Abscess	26 (21)
Peptic ulcer disease perforation	20 (16)
Typhoid	10 (8)
Trauma	2 (2)
Antibiotics, n (%)	
Any	118 (97)
Metronidazole	103 (83)
Ceftriaxone	71 (57)
Cefotaxime	34 (27)
Cloxacillin	17 (14)
Ciprofloxacin	10 (8)
Augmentin	1 (1)
Erythromycin	1 (1)
Doxycycline	1 (1)
ASA physical status class, n (%)	
I	37 (34)
II	45 (41)
III	25 (23)
IV	3 (3)

Continued

ASA, American Society of Anesthesiologists; IQR, interquartile range

[a]Other comorbidities: smoking (n=2), mental/psychiatric disorder (n=2), hepatitis C (n=1), urethral stricture (n=1)

common HAI worldwide. The World Health Organization estimates that the prevalence of SSIs in LMICs is double the average reported in high-income countries.[8]-[11]

Rwanda, a small landlocked country with a high population density and approximately 14.4 million inhabitants,[12] experienced a devastating genocide in 1994, which decimated its healthcare infrastructure and workforce. In the aftermath, the Rwandan government embarked on healthcare system reforms aimed at rebuilding and providing high-quality, affordable, and accessible healthcare services.[13] The current healthcare system in Rwanda is structured such that patients initially seek care at the nearest health centre before being referred to a district hospital, then to a provincial hospital, and ultimately to a referral hospital.[14] As of 2018 (when the study reported herein was conducted), Rwanda had about 60 surgeons, primarily stationed in provincial and referral hospitals.[15]

To date, data on HAIs in Rwanda are scarce. Previous studies at the University Teaching Hospital of Kigali (Centre Hospitalier Universitaire de Kigali, CHUK) have indicated an SSI incidence of 10%.[16],[17] This study aimed to characterize HAIs in patients with surgical infections in Kigali, Rwanda, hypothesizing that SSIs would be the most prevalent type of HAI.

Table 2. Operative and microbiological characteristics of patients with surgical infections at the time of hospital admission (N=124)

Variable	Value
Primary surgeon, n (%)	
Consultant	64 (53)
Senior resident	50 (41)
Junior resident	7 (6)
Operating theatre start time, n (%)	
Weekday	58 (47)
Weeknight	22 (18)
Weekend	44 (35)
Operative duration, minutes (median, IQR)	85 (4-135)
Procedure, n (%)	
Laparotomy	28 (23)
Abscess drainage	29 (23)
Appendectomy	18 (15)
Gastric repair	18 (15)
Bowel resection	15 (12)
Debridement/disarticulation	14 (11)
Bowel anastomosis	6 (5)
Stoma	11 (9)
Primary bowel repair	8 (6)
Adhesiolysis	5 (4)
Pathogen isolated, n	56
Escherichia coli	38
Klebsiella spp.	13
Pseudomonas spp.	4
Proteus spp.	4
Other Enterobacteriaceae	2
Acinetobacter spp.	2
ESBL positive, n/N (%)	24/51 (47)

IQR, interquartile range; ESBL, extended-spectrum beta-lactamase

Methods

The study was conducted over a period of 14 months (August 2018-October 2019) at CHUK, a referral hospital in Kigali that serves a catchment area of 6 million people.[11] It has a capacity of 560 beds, with 25% allocated to the surgical department. Surgeons and surgery residents manage a significant burden of emergency cases, with 70% of general surgery cases classified as urgent or emergency procedures.[18],[19] Most emergency operations are performed in a single operating theatre, and all operations adhere to standard aseptic protocols.

This was a subset analysis from a study evaluating surgical infections in acute-care surgery patients.[17] Surgical infections encompassed patients with infections at the time of hospital admission, as well as any patient who developed an infection during hospitalization. The initial study considered diagnoses such as appendicitis, typhoid intestinal perforation, abscess, and soft tissue infection as surgical infections. We included peptic ulcer disease (PUD), trauma, and complicated intestinal obstruction if these diagnoses were associated with gangrenous bowel, perforation, inflammatory fluid, or more than 12 hours of contamination from a perforated bowel. Patients who did not undergo surgery or who did not have a microbiology sample collected at the time of surgery were excluded. Patients were followed for the duration of their hospital stays and contacted at 30 postoperative days for follow-up. In this subset analysis, we specifically evaluated all acute-care surgery patients with any of the following surgical infections at the time of admission: appendicitis, typhoid intestinal perforation, abscess, soft tissue infection, PUD, trauma, or complicated intestinal obstruction (Figure 1).

Each patient with a surgical infection had at least 1 microbiology specimen collected at the time of surgery. These specimens were processed in the hospital laboratory to identify pathogens and resistance patterns using the Kirby–Bauer culture and sensitivity methods in accordance with CLSI (Clinical and Laboratory Standards Institute) standards.[20]

Data were collected on patients' demographic information, clinical features, complications, and outcomes. Complications included unplanned reoperation, cardiac arrest, venous thromboembolism, prolonged ventilation, bedsores, and malnutrition, based on the clinical assessment of the treating clinician.

HAIs were defined as any infection not present at the time of hospital admission but identified after 48 hours of hospital admission. Pneumonia and urinary tract infection (UTI) were defined based on the clinical assessment of the treating clinician. Device-associated HAIs were defined according to the Centers for Disease Control and Prevention definitions. Catheter-associated UTI (CAUTI) was defined based on the presence of a Foley catheter and a positive urine culture. Ventilator-associated pneumonia (VAP) was defined based on an endotracheally intubated patient with mechanical ventilation and a positive tracheal aspirate. Central line–associated bloodstream infection (CLABSI) was defined based on the presence of a central line and positive blood cultures. SSIs were defined according to the Centers for Disease Control and Prevention definitions.[21] SSIs were classified as superficial, deep, or organ-space. Deep SSIs included all cases of fascial dehiscence or evisceration. Organ-space SSIs included all intra-abdominal abscesses and all cases of anastomotic leakage.

Statistical analysis

Data were collected using paper-based forms and entered

Table 3. Clinical outcomes in patients with surgical infections at the time of hospital admission (N=124)

Variable	Value
In-hospital complications, n (%)	
None	79 (64)
Unplanned reoperation	26 (21)
Death	13 (10)
Unplanned reintubation	10 (8)
Cardiac arrest	11 (9)
Mechanical ventilation >48 h	12 (10)
Bedsores	4 (3)
Malnutrition	4 (3)
Venous thromboembolism	1 (1)
Hospital-acquired infections, n (%)	
Urinary tract infection	2 (2)
Catheter-associated urinary tract infection	0
Pneumonia	1 (1)
Ventilator-associated pneumonia	0
Central line–associated bloodstream infection	0
Any surgical site infection	30 (24)
Superficial surgical site infection	15 (12)
Deep surgical site infection	18 (15)
Organ space surgical site infection	16 (13)
Length of stay, days (median, IQR) (n=129)	8 (6-18)

IQR, interquartile range

into a REDCap (Research Electronic Data Capture; Vanderbilt University, Nashville, TN, USA) database.[22] Data were analysed using Stata 13 (StataCorp, College Station, TX, USA). Categorical results were evaluated as frequencies and percentages. Continuous data were evaluated as medians and interquartile ranges (IQRs). The primary outcome was the incidence and type of HAIs. Secondary outcomes included SSIs, in-hospital mortality, and 30-day mortality.

Ethical approval and informed consent

Ethical clearance was obtained from the University of Rwanda College of Medicine and Health Sciences Institutional Review Board (Ref: No 333/CMHS IRB/2017), the CHUK Ethics Committee (Ref: EC/CHUK/484/2017), and the University of Minnesota Institutional Review Board (Ref: STUDY00001252). All patients provided informed consent. Patients had the ability to agree to study participation while deferring postdischarge follow-up phone calls.

Results

Over a period of 14 months, 191 acute-care surgery patients with infections were enrolled in the study.[17] Of these, 124 patients had 1 of the following surgical infection diagnoses and were included in the subset analysis: appendicitis (n=24, 19%), typhoid intestinal perforation (n=10, 8%), abscess (n=26, 21%), soft tissue infection (n=27, 22%), PUD (n=20, 16%), trauma (n=2, 2%), or complicated intestinal obstruction (n=15, 12%). Among the patients with intestinal obstruction, 9 presented with gangrenous bowels, 3 with perforation, 3 with purulence or abscess, and 8 with turbid or inflammatory fluid. Of the 20 patients who presented with PUD, 11 had purulence or abscess. Three patients with PUD perforation presented within 24 hours of symptom onset, and the remainder presented with more than 2 days of symptoms.

Demographic and clinical characteristics of patients in this subset analysis are presented in Table 1. The majority of patients (n=85, 69%) were male, and 45 (36%) were from Kigali. The median age of the patients was 35 years (IQR, 24-52). Overall, 46 patients (38%) had no comorbidities, 5 had diabetes, 4 had HIV, and 52 (43%) were alcohol drinkers. The most commonly prescribed antibiotics were metronidazole (n=103, 83%) and third-generation cephalosporins (ceftriaxone, n=71, 57%; cefotaxime, n=34, 27%). Most patients were classified as ASA (American Society of Anesthesiologists) physical status class I (n=37, 34%) or II (n=45, 41%).

Operative details are presented in Table 2. The majority of operations (n=64, 53%) were performed by consultant surgeons. The most commonly performed procedures were abscess drainage (n=29, 23%), exploratory laparotomy (n=28, 23%), appendectomy (n=18, 15%), gastric repair (n=18, 15%), and bowel resection (n=15, 12%). Pathogens were isolated from 56 specimens, with *Escherichia coli* (n=38) and *Klebsiella* spp. (n=13) being the most common isolates. Overall, 24 of 51 isolates (47%) were ESBL (extended-spectrum beta-lactamase)–positive. Postoperatively, 16 patients (13%) were admitted to the intensive care unit (Table 3). In total, 45 patients (36%) developed complications, and 26 patients (21%) underwent unplanned reoperations. The median length of hospital stay was 8 days (IQR, 6-18). The majority of patients (n=106, 86%) were discharged home, whereas 4 patients (3%) were referred back to the district hospital, and 13 patients (11%) died in hospital. At 30 days, 81 patients (66%) were alive, and 15 patients (12%) had died. Thirty-day follow-up information was not available for 26 patients (21%).

Thirty-two patients (26%) developed HAIs. The most common HAI was SSI (n=30, 24%), with 15 patients (12%) having superficial SSIs, 18 (15%) with deep SSIs, and 16 (13%) with organ-space SSIs. Two patients (2%) developed UTIs. A majority of patients (n=81, 65%) had in situ Foley catheters, but no CAUTIs were detected. One patient developed pneumonia. Twelve patients (10%) required mechanical ventilation, but none of these patients developed VAP. Four patients (3%) had central lines placed, but there were no cases of CLABSI. Table 4 shows the breakdown of different HAIs by diagnosis.

Table 4. Hospital-acquired infections by diagnosis (N=124)

Infection type	Total (n=124)	Skin and soft tissue infection (n=27)	Abscess (n=26)	Appendicitis (n=24)	Peptic ulcer disease (n=20)	Complicated intestinal obstruction (n=15)	Typhoid intestinal perforation (n=10)	Trauma (n=2)
Any surgical site infection	30 (24)	5 (19)	2 (8)	5 (21)	8 (40)	3 (20)	5 (50)	2 (100)
Superficial	15 (12)	5 (19)	1 (4)	1 (4)	3 (15)	0	3 (30)	2 (100)
Deep	18 (15)	0	0	3 (13)	5 (25)	3 (20)	5 (50)	2 (100)
Organ space	16 (13)	0	1 (4)	4 (17)	5 (25)	1 (7)	4 (40)	1 (50)
Any urinary tract infection	2 (2)	0	0	0	0	1 (7)	1 (10)	0
Catheter-associated urinary tract infection	0	0	0	0	0	0	0	0
Any pneumonia	1 (1)	1 (4)	0	0	0	0	0	0
Ventilator-associated pneumonia	0	0	0	0	0	0	0	0
Central line–associated bloodstream infection	0	0	0	0	0	0	0	0

Values are n (%) or 0.

Discussion

HAIs among surgical patients are a major health concern that needs further attention in Rwanda. In this study of patients with surgical infections at the time of hospital admission in Rwanda, the overall rate of HAI was 25%, with the majority being SSIs. This was similar to reports from the World Health Organization, which found that up to one-third of patients in LMICs undergoing surgery develop SSIs.[23]

The SSI rate in this study was similar to those of other studies in LMICs investigating patients with contaminated or infected wounds.[24] Patients with surgical infections are expected to be at high risk of developing SSIs as they present with infections at the time of admission. Our study sample included patients with conditions not commonly thought to be infections (such as trauma and intestinal obstruction), as these patients presented with advanced disease leading to infections (infected wounds, gangrenous bowels). The common use of broad-spectrum antibiotics in this population may mitigate the development of SSIs but may also contribute to the development of antibiotic resistance.[17]

No device-related HAIs, such as CAUTI, VAP, and CLABSI, were detected in this study. One factor that may contribute to a relatively low rate of HAIs is the overall low use of invasive devices. Most patients had Foley catheters, but only 10% of patients were intubated, and only 3% had central lines. This low rate of device usage contributes to low rates of these HAIs. However, there is an opportunity to further reduce risk by avoiding the use of Foley catheters when possible.

The diagnostic criteria for HAIs such as CAUTI, VAP, and CLABSI included a positive culture result. This may have affected the ability to detect these infections in our low-resource setting. In such contexts, providers may be less likely to test for infections because of the cost burden on patients and the perception that culture results come too late to influence outcomes. In this setting, culture and sensitivity testing was used rather than molecular testing, which may have further decreased the sensitivity of the testing conducted.

Limitations

This study's findings provide important data regarding HAIs in surgical patients presenting to a tertiary referral hospital in Rwanda with infections at the time of hospital admission. This study was limited by its single-centre design; nevertheless, it has provided novel information regarding HAIs in the region. Another limitation was reliance on clinical diagnosis for pneumonia, which could have introduced reporting bias dependent on chart documentation. Owing to the prospective data and sample collection, we were uniquely positioned to isolate and detect pathogens at the time of admission. The hospital laboratory is capable of performing culture and sensitivity testing for bacterial pathogens. However, advanced laboratory techniques, such as molecular testing or polymerase chain reaction testing, could broaden the breadth and scope of pathogens tested.

Conclusions

HAIs are common among patients with surgical infections, with SSIs being the most common HAI in this setting. Efforts to prevent SSIs should be targeted towards high-risk individuals. Minimizing device exposure limits the risk of some HAIs.

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References

1. Mpirimbanyi C, Abahuje E, Hirwa AD, et al. Defining the three delays in referral of surgical emergencies from district hospitals to University Teaching Hospital of Kigali, Rwanda. *World J Surg*. 2019;43(8):1871-1879. doi:10.1007/s00268-019-04991-3 [View Article] [PubMed]
2. Shrime MG, Dare A, Alkire BC, Meara JG. A global country-level comparison of the financial burden of surgery. *Br J Surg*. 2016;103(11):1453-1461. doi:10.1002/bjs.10249 [View Article] [PubMed]
3. Stewart B, Khanduri P, McCord C, et al. Global disease burden of conditions requiring emergency surgery. *Br J Surg*. 2014;101(1):e9-e22. doi:10.1002/bjs.9329 [View Article] [PubMed]
4. Weiser TG, Regenbogen SE, Thompson KD, et al. An estimation of the global volume of surgery: a modelling strategy based on available data. *Lancet*. 2008;372(9633):139-144. doi:10.1016/S0140-6736(08)60878-8 [View Article] [PubMed]
5. Kakembo N, Grabski DF, Fitzgerald TN, et al. Burden of surgical infections in a tertiary-care pediatric surgery service in Uganda. *Surg Infect (Larchmt)*. 2020;21(2):130-135. doi:10.1089/sur.2019.045 [View Article] [PubMed]
6. Henry M, Poyser T, Bampoe S. The surgical epidemic. *Br J Hosp Med (Lond)*. 2017;78(11):612-615. doi:10.12968/hmed.2017.78.11.612 [View Article] [PubMed]
7. Ban KA, Minei JP, Laronga C, et al. American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update. *J Am Coll Surg*. 2017;224(1):59-74. doi:10.1016/j.jamcollsurg.2016.10.029 [View Article] [PubMed]
8. Ademuyiwa AO, Hardy P, Runigamugabo E, et al; NIHR Global Research Health Unit on Global Surgery. Reducing surgical site infections in low-income and middle-income countries (FALCON): a pragmatic, multicentre, stratified, randomised controlled trial. *Lancet*. 2021;398(10312):1687-1699. doi:10.1016/S0140-6736(21)01548-8 [View Article] [PubMed]
9. Monahan M, Jowett S, Pinkney T, et al. Surgical site infection and costs in low- and middle-income countries: a systematic review of the economic burden. *PLoS One*. 2020;15(6):e0232960. doi:10.1371/journal.pone.0232960 [View Article] [PubMed]
10. Allegranzi B, Aiken AM, Zeynep Kubilay N, et al. A multimodal infection control and patient safety intervention to reduce surgical site infections in Africa: a multicentre, before-after, cohort study. *Lancet Infect Dis*. 2018;18(5):507-515. doi:10.1016/S1473-3099(18)30107-5 [View Article] [PubMed]
11. Shiferaw WS, Aynalem YA, Akalu TY, Petrucka PM. Surgical site infection and its associated factors in Ethiopia: a systematic review and meta-analysis. *BMC Surg*. 2020;20(1):107. doi:10.1186/s12893-020-00764-1 PMID:32423397 [View Article] [PubMed]
12. Total population by country. World Population Review. https://worldpopulationreview.com/
13. Ministry of Health of Rwanda, Society for Family Health Rwanda and Abbott launch pioneering model of primary health care service delivery. Abbott Newsroom. 9 September 2019. https://abbott.mediaroom.com/2019-09-09-Ministry-of-Health-of-Rwanda-Society-for-Family-Health-Rwanda-and-Abbott-Launch-Pioneering-Model-of-Primary-Health-Care-Service-Delivery-in-Rwanda
14. Rwanda Ministry of Health. *Fourth Health Sector Strategic Plan July 2018-June 2024*. Republic of Rwanda Ministry of Health; 2018. https://extranet.who.int/countryplanningcycles/planning-cycle-files/fourth-health-sector-strategic-plan-2018-2024
15. Rwanda Ministry of Health. *National Surgical, Obstetrics, and Anesthesia Plan 2018-2024*. 2018. Republic of Rwanda Ministry of Health; 2018. https://www.moh.gov.rw/fileadmin/user_upload/Moh/Publications/Strategic_Plan/NSOAP_Rwanda-_Approved1.pdf
16. Mukagendaneza MJ, Munyaneza E, Muhawenayo E, et al. Incidence, root causes, and outcomes of surgical site infections in a tertiary care hospital in Rwanda: a prospective observational cohort study. *Patient Saf Surg*. 2019;13(1):10. doi:10.1186/s13037-019-0190-8 [View Article] [PubMed]
17. Muvunyi V, Mpirimbanyi C, Katabogama JB, et al. Community- and hospital-acquired infections in surgical patients at a tertiary referral hospital in Rwanda. *World J Surg*. 2020;44(10):3290-3298. doi:10.1007/s00268-020-05634-8 [View Article] [PubMed]
18. Rickard JL, Ntakiyiruta G, Chu KM. Identifying gaps in the surgical training curriculum in Rwanda through evaluation of operative activity at a teaching hospital. *J Surg Educ*. 2015;72(4):e73-e81. doi:10.1016/j.jsurg.2015.01.013 [View Article] [PubMed]
19. Rickard JL, Ntakiyiruta G, Chu KM. Associations with perioperative mortality rate at a major referral hospital in Rwanda. *World J Surg*. 2016;40(4):784-790. doi:10.1007/s00268-015-3308-x [View Article] [PubMed]
20. Hudzicki J. Kirby-Bauer disk diffusion susceptibility test protocol. American Society for Microbiology. 8 December 2009. https://asm.org/protocols/kirby-bauer-disk-diffusion-susceptibility-test-pro
21. Petroze RT, Byiringiro JC, Kyamanywa P, Ntakiyiruta G, Calland JF, Sawyer RG. Infectious outcomes assessment for health system strengthening in low-resource settings: the novel use of a trauma registry in Rwanda. *Surg Infect (Larchmt)*. 2014;15(4):382-386. doi:10.1089/sur.2013.146 [View Article] [PubMed]
22. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009;42(2):377-381. doi:10.1016/j.jbi.2008.08.010 [View Article] [PubMed]
23. Allegranzi B, Bischoff P, Kubilay Z, et al. *Global Guidelines for the Prevention of Surgical Site Infection*. 2nd ed. World Health Organization; 2018. https://www.ncbi.nlm.nih.gov/books/NBK536404/
24. Bhangu A, Ademuyiwa AO, Aguilera ML, et al; GlobalSurg Collaborative. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: a prospective, international, multicentre cohort study. *Lancet Infect Dis*. 2018;18(5):516-525. doi:10.1016/S1473-3099(18)30101-4 [View Article] [PubMed]

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