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Surgical Antibiotic Prophylaxis Used in A University Clinics Hospital and Antibiotic Costs: A 3-year Survey

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ABSTRACT

Background: Surgical Site Infections (SSIs) represent one of the most common post-operative complications and are the third most prevalent nosocomial infections.
Objective: The objective of this study was to analyze the conditions of using antibiotics in surgery at the University Clinics of Lubumbashi.
Methods: A retrospective study was conducted, collecting data from medical registers over a 3-year period, from 2017 to 2019. Parameters have been analyzed according to the European Centre for Disease Prevention and Control (ECDC), National Institute for Health and Care Excellence (NICE) and World Health Organization (WHO) guidelines.
Results: Shortcomings in registered data and the application of exclusion criteria allowed to include only 256 of the 977 retrospective procedures recorded during this period, with around 50% of the cases in 2019. A little more than half of them concerned men with a sex ratio of 1.28. Among these patients, 66% were aged between 16 and 40 years. Of these, 37.1% underwent visceral surgery. Over 38.7% of patients were hospitalized for more than 30 days, with 4.3% staying over 4 months. After the surgery, metronidazole 1.5 g, ceftriaxone 1 g and cefotaxime 1 g were the most used (89%) antibiotics followed by amoxicillin 1 g, all mainly parenterally. In 38,7% of cases, a series of other antibiotics were used in combination over a long period (7 days). A 32.8% rate of surgical site infection was recorded, with antibiotic-related costs of around 62,311 ± 30,417 CDF (31 ± 15 €). A comparison of the characteristics of patients with and without infections showed a significant influence of the sex and type of surgery. Men were 4.7 times more likely to develop a surgical site infection than women, and orthopedic surgery had a higher risk of infection than other surgeries.
Conclusion: These retrospective data suggest that the use of antibiotics before and after surgery at the University Clinics of Lubumbashi does not meet accepted standards (ECDC, NICE and WHO guidelines) and would not be efficient for their intended purpose.

Introduction

It is estimated that, all over the world, over 5 billion people lack access to safe surgical and anesthesia care. Annually, 313 million procedures are undertaken worldwide [1] with approximately 4.2 million people dying within 30 days of surgery. Of these deaths, 50% occur in developing countries.[2] This accounts for 7.7%[3] of all global deaths, the fourth largest contributor of death after ischemic heart disease, COVID-19 and stroke.[4,5] It is estimated that 143 million surgical procedures are needed yearly in low-income and middle-income countries.[1] In addition, the number of deaths within 30 day of surgery and surgical site infections is higher than the combined total of deaths from all causes related to HIV, malaria, and tuberculosis (2.97 million deaths).[3] Internationally, surgical site infection (SSI) rates are estimated to range from 1.9%[6] to 40% of surgeries.[7,8] Furthermore, the majority of antibiotics prescribed each year are for surgery.[9–11] It appears that the use of

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Table 1
International recommendations for surgical antibiotic prophylaxis (SAP) for certain surgeries.

Types of surgery	SAP indication	Molecule	Dose	Route of administration	Time of administration	Number of administrations	SAP duration
Cardiac	Always	Cefazolin (+ Vancomycin 15 mg/kg if MRSA)	2 g	Intra venous (IV)	15-60 min before incision	3 or 4 if prolonged surgery or blood loss ≥ 1.5 L	24–48 h
Gastro enterologic	Always	Cefazolin + Metronidazole (+ Vancomycin 15 mg/kg if MRSA)	2 g + 1.5 g	IV	15-60 min	3 or 4 if prolonged surgery or blood loss ≥ 1.5 L	24 h
Orthopedic	Always	Cefazolin (+ Vancomycin 15 mg/kg if MRSA)	2 g	IV	15-60 min before incision	3/24 h	24–48 h if fitting prosthesis
Urinary tract	Always	- Cefuroxime or - Ciprofloxacin	- 1.5 g - 400 mg (or 500 mg)	IV (Oral)	10-60 min before incision (1-2 h before incision)	1 or 2	24 h
Visceral	Not always	-Cefazolin -Amoxicillin-clavulanic acid (+ Vancomycin 15 mg/kg if MRSA)	2 g/ 200 mg	IV	10-60 min before incision	3 if necessary	24–48 h

surgical antibiotic prophylaxis (SAP) constitutes a significant issue with regard to the development of SSI, antibiotic resistance, prolonged hospital stays and the overall cost of healthcare.[12–14] This situation deserves special attention to secure surgical patients by putting them in the best conditions, particularly r the implementation of effective surgical antibiotic prophylaxis. Indeed, the appropriate administration of antibiotic prophylaxis is known as an important strategy to reduce the incidence of postoperative infections. In the absence of Congolese standards, the guidelines of ECDC, NICE and WHO were used in this study. At present, no study has been carried out in the health facilities of Lubumbashi to understand the practices of antibiotic prophylaxis in surgery and the impact on the occurrence of surgical site infections. This study aimed to analyze surgical antibiotic prophylaxis, its influence on the occurrence of surgical site infections and antibiotic cost at the University Clinics of Lubumbashi.

Material and Methods

Study Design

A retrospective, analytical and descriptive study was performed at the University Clinics of Lubumbashi in Democratic Republic of Congo (DR Congo). This health facility, with a capacity of 217 beds, is divided into 9 pavilions. It was built in 1919 for care, research and the training of medical science students. As the only university clinic in the city and one of the best health facilities, it has a very high level of attendance, with an average daily attendance of approximately 30 patients. The hospital provides a range of medical care, including a surgical service

Data Collection and Inclusion Criteria

The study was conducted by collecting data from medical registries over a period of three years, from January 2017 to December 2019.

The inclusion criteria were patients undergoing any type of surgery, with the exclusion of patients already infected but untreated and those under antibiotic therapy prior to surgery. All surgical information of the patients included in this study was collected after their hospitalization period.

The observation parameters were extracted from the patient files, i.e. the admission forms, operation forms and/or anesthesia forms, which were coded by the investigator in an Excel© sheet. Data missing in the patient records were replaced by an empty cell in the Excel file. These data were considered unreported and were excluded during the analysis to avoid bias.

Data Analysis

Data were analyzed according to the ECDC, NICE, and WHO guidelines for each SAP. The data collected included patient's data [age, weight, sex, allergy status to penicillin (if known)]. Additionally, the data set comprised qualitative and quantitative information pertaining to the following domains: length of preoperative stay, type of operation, surgeon, anesthetist, and nurse presence during the surgery, duration of the surgery, blood loss greater than or equal to 1.5 liters during the surgery. The items audited were the indication, the drug(s) used together with their dose(s) and route of administration, the time interval between drug administration and first incision, the number of administrations, and the total duration of antibiotic prophylaxis.[15,16] The ECDC, NICE and WHO guidelines[12,17,18] were used as references (Table 1) and a rate of compliance with the recommendations was determined for each criterion analyzed and for the globality of analyzed criteria. For each audited indicator, the compliance with the ECDC, NICE and WHO directives was evaluated for each item by comparing the actual and recommended practice. Practices were considered "compliant" (coded as "1") if all items analyzed for each patient individually followed the criteria for the use of antibiotic prophylaxis. If an item did not comply with the recommendations, the practice was then considered "non-compliant" (coded as "0"). Total compliance is determined by the sum of codes for all patients.[16,19]

The presence of SSI was collected in the hospitalization records. Diagnostic criteria for surgical site infections are those locally applied at the University Clinics of Lubumbashi as reported in the files of patients. These include the presence of purulent discharge from the wound, abscess or extensive cellulitis, swelling, and inflammatory signs as described by the ECDC and WHO.[17,20]

Regarding statistical analyses, continuous data were reported using the medians and interquartile ranges (IQR) and categorical variables. A Mann-Whitney U test was performed to compare the median of continuous data. A Pearson chi-square test was conducted to compare categorical data. Additionally, logistic regression was used to quantify the risk factors by calculating Odds Ratio

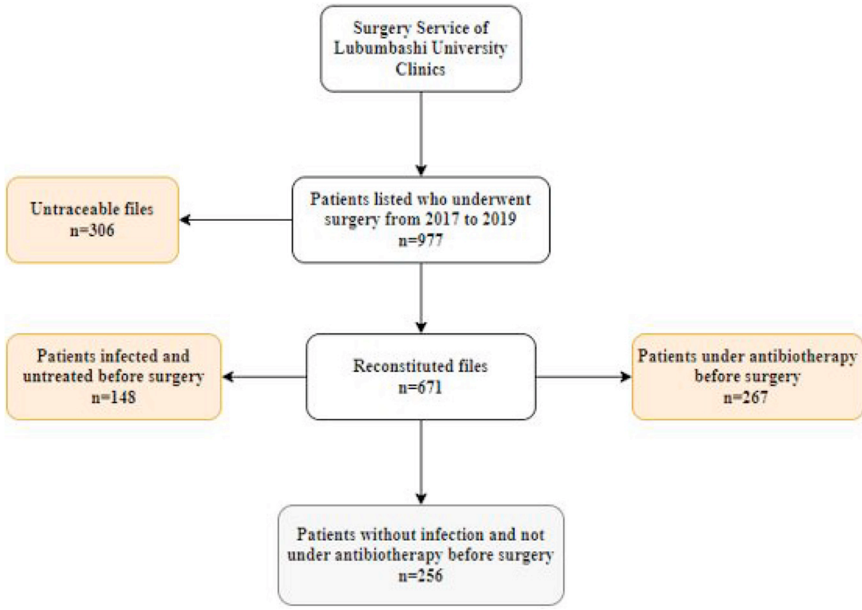

Figure 1. Data collection scheme.

Table 2
Demographic characteristics.

	Admission year			Sex		Age			
	2017	2018	2019	Male	Female	<20	20-40	41-65	66-89
n	67	61	128	144	112	14	169	50	23
%	26.1	23.9	50	56.25	43.75	5.5	66	19.5	9

(OR). Statistical analyses were performed using IBM SPSS Statistics version 23, and a *p-value* of <0.05 was considered statistically significant.

Ethical Consideration

The protocol of this study was approved by the Ethics Committee of the University of Lubumbashi under reference number UNILU/CEM/088/2022. Personal identification data were anonymized (use of encrypted codes) in accordance with the European General Data Protection Regulation[21] and the Declaration of Helsinki.[22]

Results

During the three-years period covered by this retrospective study, 977 surgery procedures were recorded (Figure 1).

While the retrieval of files for 306 operations proved unfeasible due to malfunctions in the archiving system (most of parts of files were missing), the files for 671 operations could be successfully reconstructed. Amongst these 671 files, 267 were excluded because the patients were on antibiotic therapy before surgery and 148 had a documented but untreated infection. The latest 256 files met the inclusion criteria with 50% of the cases being from 2019 (Table 2).

A little more than half of the patients included in this study were male (56%) and 66% were aged between 20 and 40 years (Table 2). The most frequently encountered surgical procedures were visceral and orthopedic surgeries (37.1 and 32% respectively). The average length of hospitalization was less than 10 days while 38.7% of patients have had hospital stays of up to 30 days (Table 3). The antibiotics used are presented in Table 4.

Table 4 shows that several patients received a combination of antibiotics. Amongst the 256 patients, 358 antibiotic administrations were prescribed. The top five most commonly prescribed antibiotics were cefotaxime 1 g, metronidazole 1.5 g/ 300 ml, amoxicillin 1 g + clavulanic acid 200 mg, ceftriaxone 1 g and piperacillin 4 g + tazobactam 500 mg. The major drugs were cephalosporins and penicillins which were utilized in more than 60% and 35.6% of patients, respectively. The other antibiotics were used in only 1 patient, except for ciprofloxacin which was administered to 10 patients, ofloxacin to 10 patients and clindamycin to 5 patients. The data collected do not agree with the guidelines established by ECDC, NICE, and WHO. These guidelines recommend the utilization of a single molecule of cefazolin or cefuroxime for most types of surgery. Especially, third-generation cephalosporins and antibiotic combinations, although they are not recommended for most cases, were extensively employed in Lubumbashi.

Also, only 11% (28/256) of patients received antibiotic prophylaxis before surgery. The administration time was respected only in 3.5% of the cases with 0% compliance with the rules for the *"number of administrations"* and *"duration of antibiotic prophylaxis"* (Figure 2). The route of administration chosen by surgeons for each antibiotic, according to each type of surgery, was compliant with the guidelines in 54.3% of cases. The intravenous route was most frequently selected (54.3%) while the oral route (45.7%) was the most mistakenly chosen for certain types of surgery. The doses were respected in more than 80% of cases.

From medical registries, a postoperative infection occurrence rate of 32.8% ($n = 84/256$) could be estimated. These 84 patients developed a surgical site infection, a very high overall prevalence which, incidentally, corresponds to the incidence of surgical site infections typically reported when a SAP is not applied.[9] The characteristics of patients who developed SSI were compared with those who did not (Table 5). A Pearson chi-square test showed a significant difference in the distributions of sex and type of surgery. Other characteristics were not significantly different. This was con-

Table 3
Surgical types and length of hospital stay.

	Surgery types						Length of hospital stay (Day)		
	Visceral	Orthopedic	Urinary tract	Cardiac	Gastro enterologic	Others	≤ 10	11 – 30	≥30
n	95	82	41	14	11	13	87	70	99
%	37.1	32	16	5.5	4.3	5.1	34	27.3	38.7

Table 4
Antibiotics prescribed for the 256 surgical patients included.

Surgery type	Antibiotic use	*N* = 256	ECDC, NICE and WHO recommendations
Visceral surgery	Amoxicillin 1g-clavulanic acid 0.2 g in IV	44/95 (46.3%)	Cefazolin or cefuroxime or amoxicillin-clavulanic acid in IV
	Cefotaxime 1 g in IV	34/95 (35.8%)	
	Piperacillin 4 g/Tazobactam 0.5 g in IV	5/95 (5.3%)	
	Ceftriaxone 1 g in IV	4/95 (4.3%)	
	Cefotaxime 1 g + metronidazole 1.5 g in IV	4/95 (4.3%)	
	Ampicillin 1 g in IV	1/95 (1%)	
	Amoxicillin 1 g-clavulanic acid 0.2 g + metronidazole 1.5 g in IV	1/95 (1%)	
	Cefotaxime 1 g + amoxicillin 1 g in IV	1/95 (1%)	
	Piperacillin 4 g/Tazobactam 0.5 g in IV + ofloxacin 0.4 g *per os*	1/95 (1%)	
Orthopedic surgery	Ceftriaxone 1 g + metronidazole 1.5 g in IV	27/82 (32.9%)	Cefazolin or cefuroxime in IV
	Cefotaxime 1 g + metronidazole 1.5 g in IV	21/82 (25.6%)	
	Amoxicillin 1 g-clavulanic acid 0.2 g + metronidazole 1.5 g in IV	9/82 (11%)	
	Cefotaxime 1 g + amoxicillin 1 g in IV	5/82 6.1%)	
	Piperacillin 4 g/Tazobactam 0.5 g in IV	3/82 (3.8%)	
	Metronidazole 1.5 g + clindamycin 0.3 g in IV	3/82 (3.8%)	
	Ceftriaxone 1 g + amoxicillin 1 g IV	2/82 (2.4%)	
	Amoxicillin 1 g-clavulanic acid 0.2 g + ceftriaxone 1 g in IV	2/82 (2.4%)	
	Piperacillin 4 g/Tazobactam 0.5 g + metronidazole 1.5 g in IV	2/82 (2.4%)	
	Azithromycin 0.5 g *per os*	1/82 (1.2%)	
	Cefotaxime 1 g in IV	1/82 (1.2%)	
	Ceftriaxone 1 g in IV	1/82 (1.2%)	
	Metronidazole 1.5 g in IV + erythromycin 1 g *per os*	1/82 (1.2%)	
	Metronidazole 1.5 g in IV + norfloxacin 0.4 g *per os* g	1/82 (1.2%)	
	Piperacillin 4 g/Tazobactam 0.5 g + lincomycin 0.6 g in IV	1/82 (1.2%)	
	Ceftriaxone 1 g + amoxicillin 1 g + metronidazole 1.5 g in IV	1/82 (1.2%)	
	Cefotaxime 1 g + amoxicillin 1 g + metronidazole 1.5 g in IV	1/82 (1.2%)	
Urologic surgery 16% (*n* = 41/256)	Cefotaxime 1 g in IV	20/41 (48.8%)	Cefazolin or cefuroxime in IV
	Ciprofloxacin 0.4 g in IV	10/41 (24.4%)	
	Ofloxacin 0.2 g in IV	8/41 (19.6%)	
	Clindamycin 0.3 g in IV	1/41 (2.4%)	
	Metronidazole 1.5 g in IV + nitrofurantoine 0.1 g *per os*	1/41 (2.4%)	
	Metronidazole 1.5 g in IV + ofloxacin 0.4 g *per os*	1/41 (2.4%)	
Cardiac surgery 5.5% (*n* = 14/256)	Cefotaxime 1 g in IV	5/14 (35.7%)	Cefazolin or cefuroxime in IV
	Ceftriaxone 1 g in IV	3/14 (21.4%)	
	Cefotaxime 1 g in IV + amoxicillin 1 g in IV	2/14 (14.3%)	
	Ceftriaxone 1 g + amoxicillin 1 g IV	2/14 (14.3%)	
	Amoxicillin 1 g- clavulanic acid 0.2 g in IV	2/14 (14.3%)	
Gastroenterological surgery 4.3% (*n* = 11/256)	Cefotaxime 1 g + metronidazole 1.5 g in IV	3/11 (27.2%)	Cefazolin or cefuroxime in IV
	Ceftriaxone 1 g + metronidazole 1.5 g in IV	3/11 (27.2)	
	Ceftriaxone 1 g in IV	3/11 (27.2)	
	Piperacillin 4 g/Tazobactam 0.5 g in IV	1/11 (9%)	
	Cefotaxime 1 g in IV + gentamycin 0.16 g in IV	1/11 (9%)	
Ophthalmological surgery 2.3% (*n* = 6/256)	Cefotaxime 1 g in IV	2/6 (33.8%)	Not determined
	Clindamycin 1 g + metronidazole 1.5 g in IV	2/6 (33.3)	
	Amoxicillin 1 g + metronidazole 1.5 g in IV	1/6 (16.7)	
	Metronidazole 1.5 g in IV	1/6 (16.7%)	
Oto-Rhino-Laryngological surgery 1.2% (*n* = 3/256)	Amoxicillin 1 g-clavulanic acid 0.2 g in IV	1/3 (33.3%)	Not determined
	Cefotaxime 1 g in IV	1/3 (33.3%)	
	Metronidazole 1.5 g in IV + cefalexin 0.5 g *per os*	1/3 (33.3%)	
Neurosurgery 1.2% (*n* = 3/256)	Cefotaxime 1 g in IV	3/3 (100%)	Cefazolin or cefuroxime in IV
Vascular surgery 0.4% (*n* = 1/256)	Amoxicillin 1g-clavulanic acid 0.2 g in IV	1/1 (100%)	Cefazolin or cefuroxime in IV

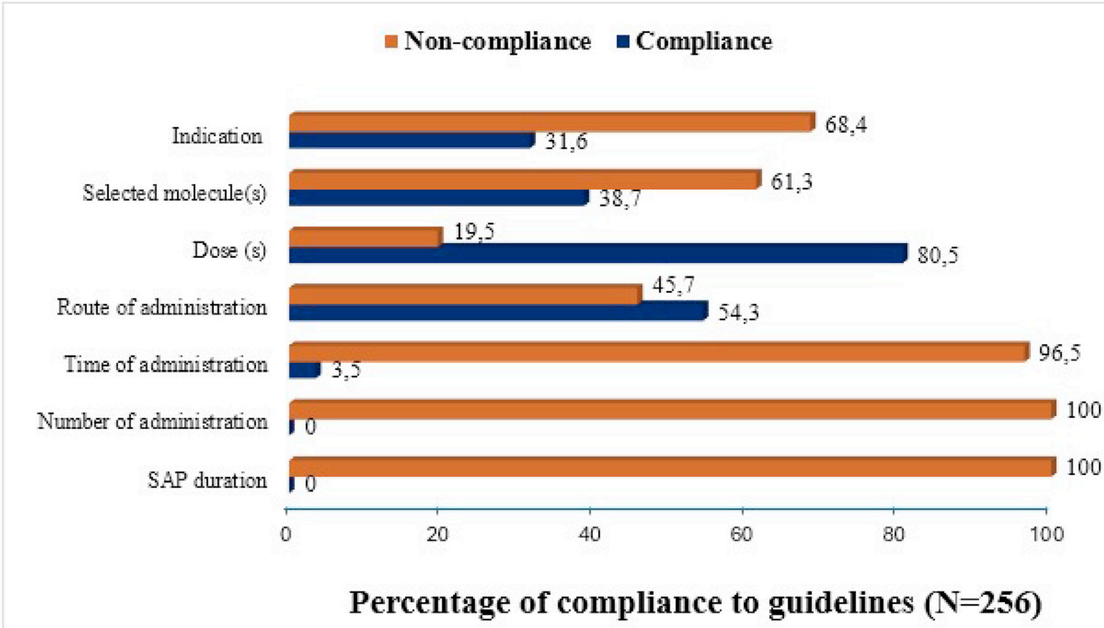

Figure 2. Compliance of surgery antibiotic prophylactic practices to National Institute for Health and Care Excellence and European Centre for Disease Prevention and Control guidelines.

Table 5
Comparison of the characteristics of patients with and without SSIs.

Characteristics	No SSI (n = 172)	SSI (n = 84)	*P-values*
Age, median (IQR)	36 (26–40.3)	36 (26–49)	0.394*
Sex (female), n (%)	126 (73.3)	31 (36.9)	<0,001†
Obesity, n (%)	5 (2.9)	6 (7.1)	0.117†
Length of preoperative stay (days), median [IQR]	6 (3–9)	6 (3–8)	0.334*
Surgery type, n (%)			<0,001†
Orthopedic	39 (22.7)	43 (51.2)	
Cardiac	9 (5.2)	5 (5.9)	
Gastroenterological	7 (4.1)	4 (4.8)	
Visceral	77 (44.8)	18 (21.4)	
Urologic	33 (19.2)	8 (9.5)	
Oto-Rhino-Laryngological	3 (1.7)	0 (0.0)	
Vascular	0 (0.0)	1 (1.2)	
Ophthalmological	3 (1.7)	3 (3.6)	
Neurological	1 (0.6)	2 (2.4)	
Blood loss ≥1.5L during surgery, n (%)	18 (10.5)	12 (14.3)	0.372†

IQR = interquartile range.
* Mann-Whitney U test.
† Pearson Chi-square test.

firmed by logistic regression. Men were 4.7 times more likely to develop a SSI than women (OR: 4.684; 95% CI [2.677 - 8.195]). Age, obesity, length of preoperative stay, and blood loss ≥1.5 L during surgery did not influence the occurrence of SSI. Regarding the type of surgery, logistic regression indicates that patients undergoing orthopedic surgery had a higher risk of infection (OR: 3.159; 95% CI [1.746 - 5.714]). In contrast, visceral surgery was more protected (OR: 0.303; 95% CI [0.158–0.582]). Finally, no specific antibiotic therapy was found to increase or decrease the risk of infection.

The average cost of antibiotics used per operation (mean ± standard deviation) was 62,311 ± 30,417 CDF (Congolese francs) (approximately 31 ± 15 €). This cost is underestimated and should be increased by the cost of antibiotics required for managing surgical infections.

Discussion

The objective of the current study was to identify the surgery antibiotic prophylaxis used in the University Clinics of Lubumbashi in DR Congo. To the best of our knowledge, this is the first study of its kind in a series of research in progress on surgical antibiotic prophylaxis compliance and its impact on health care cost and antimicrobial resistance in DR Congo.

From 2017 to 2019, 977 patients underwent surgery. Of these, 306 files were untraceable and 671 could be reconstituted. These reconstituted files allowed to exclude a series of patients with pre-existing infections or undergoing antibiotic therapy. The remaining 256 patients (sex ration, 1.28) had a median age of 36 [18–89] years mainly underwent visceral and orthopedic surgery, which correspond to the most frequently performed surgical procedures globally.[23,24] Visceral pathologies indeed represent a significant health burden in many countries, including DR Congo.[25] Hospital stays longer than 30 days (38.7%) can be attributed, at least in part, to the fact that, in the majority of cases, SAP was not administered or was administered incorrectly, and then ineffective.[26–28] Most of the registered antibiotics were administered in combination (358 antibiotic administrations were prescribed for 256 patients) and with multiple doses. This corroborates previous studies which demonstrated that non-recommended combinations of antibiotics are common in SAP.[29–33] The guidelines of ECDC and NICE foresee that, for several types of operations, antibiotics should be administered as monotherapy and before the start of the incision. Exception exist in certain specific operations where a combination of antibiotics is required to potentiate their effects and widen the spectra of antimicrobial activities.[12,34] Effectively, from a clinical perspective, the appropriate utilization of antimicrobial agents is of paramount importance to mitigate the emergence of bacterial resistance and to ensure the continued efficacy of antibiotics.[17,35,36]

The most frequently prescribed antibiotics in SAP at the University Clinics of Lubumbashi are cephalosporins (third generation), penicillins, nitroimidazoles and quinolones as shown in Table 4. This is similar to other studies on the use of antibiotics in hospitals, particularly in surgical settings.[24,37–39] These antibiotics, generally appreciated for their broad-spectrum activity, are also highly recommended by care monitoring agencies around the world.[34,40] However, retrieved data indicate that third-generation cephalosporins were predominantly employed, whereas the prevailing international recommendations indicate a preference for the first generations, notably cefazolin.[34,40,41] Several studies showed that, due the risk of rapid emergence of resistance, the third-generation cephalosporins, such as ceftriaxone and cefotaxime, should be avoided in prophylaxis.[12,19,42–44]

This retrospective study shows that antibiotics were administered with a good indication, in accordance with international guidelines, in only 31% of cases. A compliance with the guidelines for the antibiotic selection was observed in 39% of cases. Some authors found very low compliance for the duration (20.8%) and the dose (31.2%). Overall compliance was generally low in these studies (3.9%).[28,45–47] A number of studies indicate that the choice of an appropriate antibiotic in surgical prophylaxis should be based on several factors, including the patient's history of antibiotic allergy.[42] The specific surgical procedure, with the objective of killing the most prevalent bacteria present at the operative site, whilst ensuring the safety of the patient.[48–50] Ideally, the antibiotic should have favorable tolerability, low toxicity, long activity, high concentration at all concerned sites and low price.[51–53] The doses administered for antibiotics used after surgery were correct in more than 80% of cases, and the route of administration was appropriate in 54% of cases. However, the antibiotics were administered at the correct time for surgical prophylaxis in only 3.5% of patients, with no compliance with the number of administrations and duration. The most commonly recommended antibiotics for SAP should be administered ideally 30 minutes before incision to achieve optimal tissue concentrations for a bactericidal or bacteriostatic effect at the most probable period for a bacterial contamination, which is the moment of incision.[41,44,54]

However, most surgeons did not begin the SAP in the hour preceding incision and mainly continued the administration of SAP for a period exceeding 48 hours. This is probably attributable to the absence of a local protocol on surgical antibiotic prophylaxis. A rapid check indicates that this is the case in all the health facilities in the city of Lubumbashi and this, despite the now long-standing availability of international guidelines.[55,56] Other studies conducted in different countries have shown that many surgeons do not adhere to the recommended guidelines regarding the time of SAP administration. A notable difference has been observed between the European and the North American practices.[57–61] In accordance with the international guidelines, based on a huge number of studies, there is an absence of evidence to substantiate the prolongation of antibiotic prophylaxis beyond the standard 24-hours (or 48-hours) administration period, with the exception of hip prosthetics.[12,17,54]

The low compliance recorded in Lubumbashi may be attributable to the absence of pharmacist's educational intervention on the appropriate use of antibiotics in the studied hospital, especially about SAP. This is corroborated by the findings of Butt et al.,[58] Khan et al.[62] and Tiri et al.[63] Literature shows that the decision regarding the antibiotic required for a given patient is generally made by the surgeon. However, the time and the route of administration are often delegated to junior doctors.[10,63,64] The duration of the recommended antimicrobial prophylaxis being generally 24 hours for most surgeries and 48 hours for cardiac surgeries. However, doses should be repeated, if necessary, in accordance with the kinetic of each antimicrobial agent and the duration of the surgical intervention. In contrast, this study at the University Clinics of Lubumbashi shows that surgeons are solely responsible for selecting the antibiotic, determining the time of administration, and choosing the route of administration. Antibiotics were administered for more than 48 hours in all patients, that is not compliant with the guidelines. The observed noncompliance with SAP guidelines could be linked to several factors, including financial constraints, surgeon preferences, the absence of local protocols or commercial pressures from antibiotic sellers. In some African countries where living conditions are almost similar to those in DR Congo, but where guidelines exist, the adherence rate appears higher for each analyzed parameter. Indeed, the existence of local protocols appears as a main element in the application of prophylactic recommendations.[13,27,28,65]

The recorded prevalence of SAP misuse appears quite high when compared with that of other Sub-Saharan African countries where the prevalence of non-compliance ranges between 6.8 and 26%.[66] For example 14.8% in Cameroon,[67] 19 to 24% in Tanzania[68] and 25.2% in Nigeria.[69] In these countries, recommendations for SAP do exist but are not sufficiently promoted, which explains the still low compliance of practitioners. The occurrence of surgical site infections could be attributed to several causes such as surgical techniques, hospital hygiene, infrastructure, flow of people in the operating room, antibiotic prophylaxis, etc. Studies in other developing countries (Ethiopia, Tanzania and west African countries) indicate that, among all these possible causes, non-existing or low level operative antibiotic prophylaxis remains the most incriminated after asepsis.[43,70–72] The retrospective nature of the present study does not permit verification of the aseptic conditions of the studied surgeries.

An irrational use of antibiotics exerts a major impact on the cost of surgical care as previously shown.[73–80] This impact is particularly pronounced in populations with a low cost of living. In DR Congo, the World Bank estimates that the cost of living is less than $2.15 per day.[81]

Indeed, the study is local and certainly needs to be addressed by local opinion leaders and regulators. Nevertheless, our data do indicate a serious dissemination problem of guidelines, probably "encouraged" by commercial medical delegates. And we anticipate that this could be the case in the healthcare settings of many developing countries. We believe it's worth sharing these alarming findings with an international audience.

Conclusion

The analysis of the data on the utilization of antibiotics in surgical prophylaxis of 256 patients within the surgery department of the University Clinics of Lubumbashi in DR Congo revealed a concerning lack of adherence to international recommendations to limit surgical site infections. The study shows that the supposedly prophylactic utilization of antibiotics in surgery at the University Clinics of Lubumbashi rather corresponds to a post-surgical antibiotic therapy. The development and implementation of a SAP protocol is essential to improve SAP practices. In addition, to improve patient safety, better data traceability should be implemented by establishing digital archiving.

This study opens up track research perspectives, particularly to determine the impact of implementing a SAP protocol on infections rates, antimicrobial resistance, duration of hospitalization, and, consequently, on healthcare costs.

Author Contributions

V Ntabaza, A Pardo, and P Duez designed the study. V Ntabaza contributed to the data collection, data analyze and wrote the manuscript. J Bamps contributed to the statistical analysis. A Pardo, S Bakari, A Nachtergael, P Duez, S Patris and B Kahumba revised it critically for important intellectual content. S Patris and B Kahumba supervised the study. All authors approved the final manuscript for submission.

Declaration of competing interest

The authors have indicated that they have no other conflicts of interest regarding the content of this article.

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