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Parenteral Antibiotic Use at a General Surgery Department of a Large Teaching Hospital in Ghana

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Authors' contributions

This work was carried out in collaboration between all authors. Authors JM, MNAOA and FA designed the study, performed the statistical analysis, wrote the protocol and drafted the manuscript. Authors JM and FA managed the analyses of the study. Author NAAA supervised the data collection and reviewed the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Background: Inappropriate use of antimicrobial agents has been found to be common in developing countries where antibiotics are prescribed without indications and sometimes without bacteriological basis. This study evaluated the use of parenteral antibiotics at a general surgical department of a large tertiary care health facility in Ghana.
Methods: A prospective cross-sectional study was conducted by obtaining data on parenteral antibiotic use from computerised software records at the Surgical Pharmacy department using a pretested, specially designed data collection form. Information on parenteral antibiotic use such as name of parenteral antibiotic, dose, dosage regimen and duration of therapy were also extracted

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daily from in-patients' medical records using a designed data collection form. Results for culture and sensitivity testing and indications for parenteral antibiotic use were also documented. Self-administered questionnaires were then administered to 2 consultant surgeons, 6 specialist surgeons and 4 medical officers.

Results: The highest consumed parenteral antibiotic was metronidazole, with the least being amikacin. The mean number of parenteral antibiotics administered per patient was 2.03 (SD±0.64) while the mean duration of administration was 4.23 (SD±1.36) days. Surgical antibiotic prophylaxis was administered to 94.1% of patients operated upon. The commonest parenteral antibiotic administered as monotherapy was co-amoxiclav (amoxicillin +clavulanic acid). A combination of ciprofloxacin and metronidazole was administered to 54.5% of patients and 76% of patients who received surgical prophylaxis. Culture and sensitivity tests were conducted in only 6 (1.6%) of the patients. Two-thirds of the prescribers requested for culture and sensitivity tests in less than 25% of their patients, while over 90% of the surgeons indicated that prescribing decisions were based on previous experience. Almost all the patients (96.4%) had at least one drug-related problem with their prescriptions that required intervention. **These problems were wrong drug choice (2.1%), dosing problems (48.2%), drug use problems (49.6%) and adverse reactions (0.1%).**

Conclusion: Parenteral antibiotics were frequently used and prescribers rely more on experience than laboratory investigations. There were also drug-related problems identified including **wrong drug choice, wrong doses, drug use problems and adverse drug reactions** that required clinical interventions to prevent them from reaching patients. This has implications for the development of antibiotic-use policy to promote rational antibiotic use in surgery.

Keywords: Parenteral antibiotics; surgical prophylaxis; antibiotic resistance; culture and sensitivity test.

1. INTRODUCTION

Drug requirements of patients undergoing surgery vary from one patient to the other. The drugs patients receive are based upon the type of surgery to be done, the anaesthesia to be administered and other factors, such as age and the presence of comorbidities [1]. As such, selection of drugs should be based on rational use of medicines which necessitates that patients are given medications suitable for their clinical needs at appropriate doses for a suitable duration at the most affordable cost to them and their community [2]. Parenteral antibiotics are indispensable in modern medicine, very essential in both the prophylaxis and treatment of patients at the surgical department [3]. They are also among the drugs most commonly prescribed for patients undergoing surgery [4]. Therefore, accessibility, choice and appropriate use of parenteral antibiotics are of high priority. Judicious use of parenteral antibiotics will reduce the costs associated with healthcare delivery, the incidence of possible adverse effects in patients and the proliferation of antibiotic-resistant pathogenic organisms [3].

It has been observed that 64% of antibiotics prescribed are either not indicated or unsuitable in terms of drug selection or dosage. In many cases, antibiotics are used without a suitable bacteriological basis [5].

Although globally, there is a widespread inappropriate use of antibiotics, very few studies have been conducted in developing nations pertaining to this problem [6]. Furthermore, limited researches have been conducted at the Department of Surgery in Korle Bu Teaching Hospital with regards to parenteral antibiotic utilisation. Addressing the frequent misuse of antibiotics in hospitals will profoundly result in the elimination of irrational antibiotic use in hospitals and reduce the cost of health care considerably. However, before recommending any change, the current baseline practice must be evaluated using data on prescriptions and prescribing practices with the help of a drug utilisation study. The study, therefore, evaluated the utilisation of parenteral antibiotics and explored surgeons' prescribing practices at the General Surgery Unit of the largest teaching hospital in Ghana.

2. METHODS

2.1 Study Design and Setting

A cross-sectional study was conducted to evaluate the utilisation of parenteral antibiotics at the General Surgery Unit of Korle Bu Teaching Hospital. The Korle Bu Teaching hospital is a leading national referral centre in Ghana and the third largest hospital in Africa. It has a bed capacity of over 2000, with an average daily attendance of 1500 patients, about 250 of which

are admitted. The Department of Surgery is by far the largest department in the hospital with a bed capacity of 612. There are four wards in the General Surgery unit, each with 38 beds, making a total of 152 beds. Each ward of the surgical unit is manned, by two consultant surgeons, one specialist, two medical officers (residents), and two house officers. The average daily bed occupancy at the General Surgery unit is about 57%, and the average duration of hospital stay is 10days.

2.1.1 Sampling

A sample size of 385 patients was calculated using Cochran's sample size formula. Data was extracted from the medical records of the 385 patients selected purposively from the four wards of the general surgery unit. Three surgeons who had practised at the department for a year or more were selected from each of the four wards through simple random sampling by balloting without replacement. Two consultants, six specialists and four medical officers were also sampled to fill a self-administered questionnaire.

2.2 Data Collection and Analysis

Data on the consumption pattern of parenteral antibiotics at the Surgical Pharmacy was extracted from the computerised software at the Surgical Pharmacy using a pretested, specially designed data collection form. Data were also extracted daily from the medical records of 385 patients selected purposively from the General Surgery Department over the period of study. For each medical record, the patient demographic characteristics such as age, sex, diagnosis, National Health Insurance Scheme (NHIS) status, dates of admission and discharge, surgery status and duration of hospital stay were documented. Information on parenteral antibiotic use such as the name of parenteral antibiotic, dose, dosage regimen and duration of therapy were documented. Results for culture and sensitivity testing and indications for parenteral antibiotic use were also documented.

Medical records of patients admitted to the surgical wards who were administered one or more parenteral antibiotics were used for the study, whilst medical records of patients who died or were discharged against medical advice from the unit were excluded from the study. Data collected was coded and entered into Statistical Package for Social Sciences (SPSS) version 22 database for analysis. Descriptive analysis was performed on all the data. Results obtained were expressed in frequencies as percentages and were presented in tables and figures.

3. RESULTS

3.1 Descriptive Characteristics

Data was extracted from 385 patients' medical records of whom 197 (51.2%) were females. Majority of patients were between the ages of 41 and 50 years as shown in Table 1. The average (SD) length of stay was 9.14 (±9.19) days. The mean number (SD) of parenteral antibiotics administered to a patient was 2.03 (±0.64), while the mean (SD) duration of parenteral antibiotic use was 4.23 (±1.36) days.

The total number of parenteral antibiotics available at the Surgical Pharmacy over the study period was 16 of which only 6 were innovator brands. Only 2 of the antibiotics (amikacin and vancomycin) were not prescribed for patients during the period (see Fig. 1).

Though ciprofloxacin was the most prescribed parenteral antibiotic (n=294, 37.7%), the highest consumed parenteral antibiotic was metronidazole (n=846 bottles). A total of eleven different parenteral antibiotics were prescribed for patients over the period of study (Table 2).

Nine (81.8%) out of the 11 parenteral antibiotics used were eligible for reimbursement by national insurance authority. Out of the 306 patients who underwent surgery, 288 patients (94.1%) received parenteral antibiotic prophylaxis. A combination of ciprofloxacin and metronidazole was mostly administered to patients (n=210, 54.5%). Details of various parenteral antibiotics administered to patients during hospital stay are presented in Tables 3 & 4.

3.2 Parenteral Antibiotic Use Practices of Prescribers

Twelve surgeons responded to the self-administered questionnaires, 10 (83.3%) were male and 2 (16.7%) female. All the respondents indicated that they had used parenteral antibiotics during their practice. With the exception of one who used parenteral antibiotics for treatment, the rest of respondents used parenteral antibiotics for both treatments of infections and surgical prophylaxis. Eight surgeons (66.7%) stated that they sometimes request for culture and sensitivity tests, 3 (25%)

admitted that they did not request, while one surgeon (8.3%) indicated that he always requested for culture and sensitivity tests before prescribing parenteral antibiotics. Microorganism profile from culture and sensitivity testing is presented in Table 5.

Table 1. Characteristics of participants

Patients' details	Number (%)
Age (years)	
<20	12 (3.1)
20-30	78 (20.3)
31-40	73 (19.0)
41-50	85 (22.1)
51-60	63 (16.4)
61-70	52 (13.5)
>70	22 (4.4)
Number of parenteral antibiotics administered during hospital stay	
1	61 (15.8)
2	265 (68.8)
3	48 (12.5)
4	10 (2.6)
5	1 (0.3)
Surgeons' Details	
Rank (Years of experience in surgery)	
Medical officer (1-5years)	4 (33.3)
Specialist (6-10years)	6 (50.0)
Consultant (11-15years)	2 (16.7)

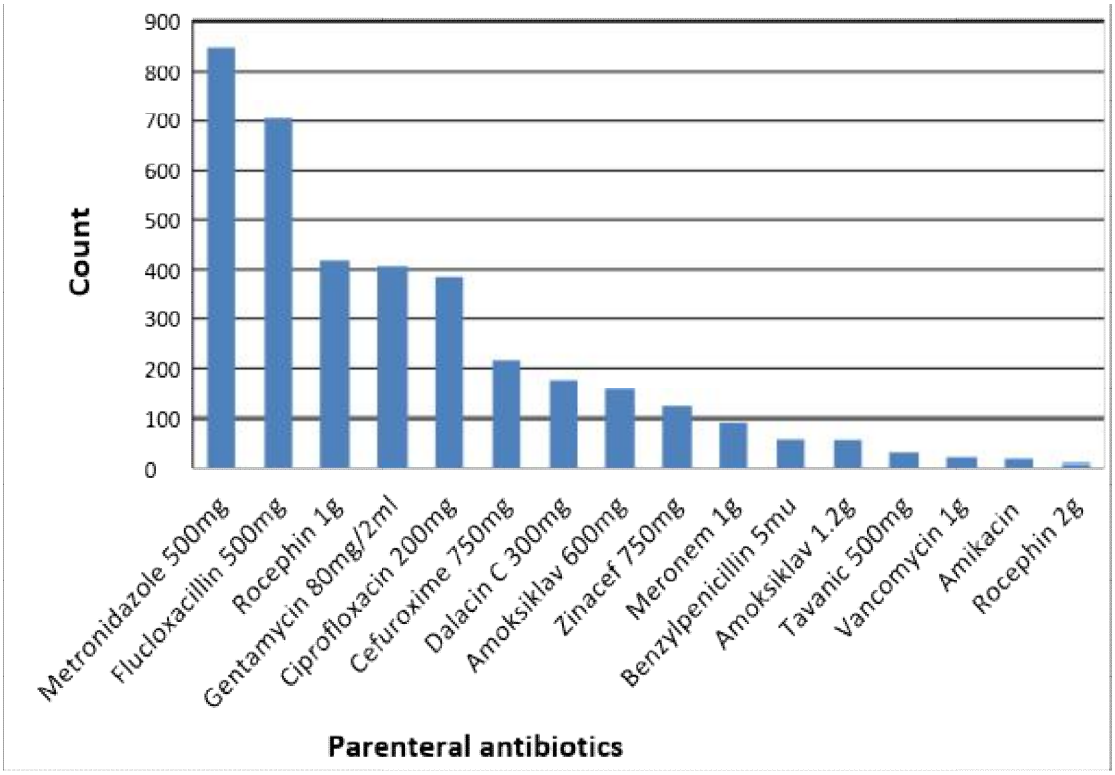

Fig. 1. Consumption pattern of parenteral antibiotics at the surgical pharmacy

Table 2. Parenteral antibiotics prescribed for patients

Therapeutic class, n(%)	Parenteral antibiotic	Frequency
Penicillin, 81(10.4)	Co-amoxiclav	76
	Benzylpenicillin	3
	Flucloxacillin	2
Cephalosporin, 50 (6.4)	Cefuroxime	41
	Ceftriaxone	9
Aminoglycoside, 3(0.4)	Gentamycin	3
Lincosamide, 53(6.8)	Clindamycin	53
Nitroimidazole, 288(36.9)	Metronidazole	288
Quinolone, 302(38.7)	Ciprofloxacin	294
	Levofloxacin	8
Carbapenem, 3(0.4)	Meropenem	3

Table 3. Diagnoses and Parenteral antibiotic combinations administered to patients

Parenteral antibiotics (n, %)	Diagnoses	Number of Patients
CXM +CLI +AMC +GEN +MTZ (1, 0.3)	Breast cancer	1
CIP +CLI (28, 7.3)	Diabetic ulcers &infections	20
	Cellulitis	6
	Other diagnoses	2
AMC +MTZ (10, 2.6)	Breast cancer	6
	Peritonitis	2
	Peptic ulcer disease	2
AMC +CIP +MEM +MTZ (1,0.3)	Appendicitis	1
AMC (45,11.7)	Breast cancer	31
	Goitre	7
	Hernia	3
	Peptic ulcer disease	2
	Diabetic ulcers &infections	1
	Other diagnoses	1
CIP +AMC +MTZ (10,2.6)	Intestinal obstruction	3
	Peritonitis	3
	Hernia	2
	Abdominal injury	2
CXM +CIP +MTZ (7,1.8)	Hernia	6
	Other diagnoses	1
CIP +MTZ (210,54.5)	Hernia	77
	Appendicitis	65
	Peptic ulcer disease	16
	Intestinal obstruction	15
	Gastrointestinal bleeding	9
	Haemorrhoids	7
	Peritonitis	6
	Other cancers	5
	Other diagnoses	4
	Abdominal injury	3
	Appendicitis +hernia	3
CTX +CIP +CLI+MTZ (1, 0.3)	Cellulitis	1
CIP +CLI +GEN +MTZ (1, 0.3)	Peritonitis	1
CXM +MTZ (14, 3.6)	Other cancers	9
	Other diagnoses	3
	Abdominal injury	2
CTX +CIP +MTZ (3, 0.8)	Appendicitis	1
	Abdominal injury	1
	Other cancers	1

Parenteral antibiotics (n, %)	Diagnoses	Number of Patients
CXM +AMC +CIP +MTZ (2,0.5)	Peptic ulcer disease	2
BPC +AMC +FLX (2,0.5)	Cellulitis	2
CIP +LEV +MTZ (2,0.5)	Intestinal obstruction	2
CIP +CLI +MTZ (18, 4.7)	Diabetic ulcers &infections	5
	Cellulitis	5
	Appendicitis	5
	Other diagnoses	2
	Hernia	1
CXM (15,3.9)	Hernia	6
	Other diagnoses	6
	Abdominal injury	2
	Other cancers	1

Key: AMC = Co-Amoxiclav; BPC = Benzylpenicillin; CIP = Ciprofloxacin; CLI = Clindamycin; CTX = Ceftriaxone; CXM = Cefuroxime; FLX = Flucloxacillin; GEN = Gentamicin; LEV = Levofloxacin; MEM = Meropenem; MTZ= Metronidazole

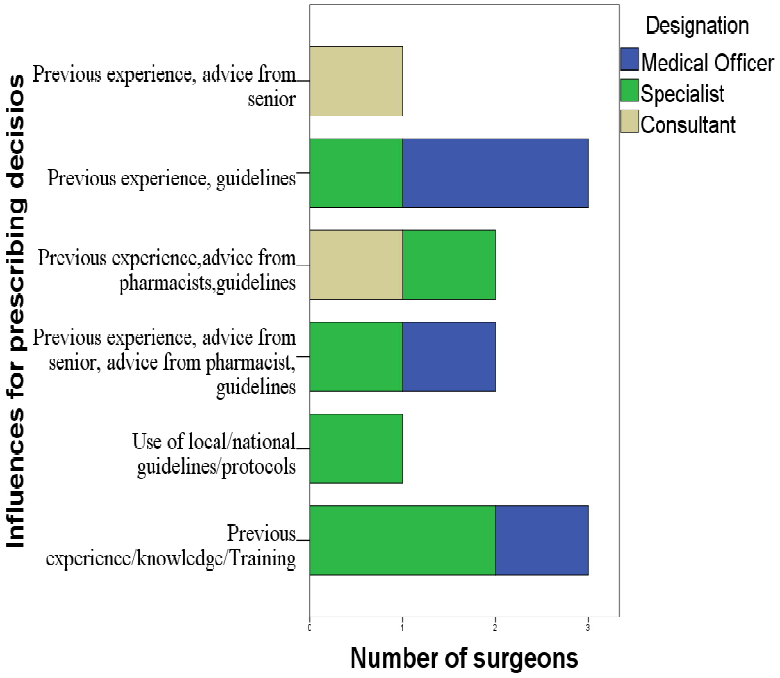

Fig. 2. Influences for participants' parenteral antibiotic prescribing decisions

Half of the respondents n=6 (50%) agreed that the parenteral antibiotics are abused at the general surgery unit. Most surgeons (n=11, 91.7%) prescribed parenteral antibiotics based on previous experiences. whiles a third of the respondents (n=4, 33.3%) prescribed parenteral antibiotics based on advice from pharmacists as shown in Fig. 2.

Of the total number of respondents, 83.3% (n=10) answered that their parenteral antibiotic prescribing decisions are influenced by guidelines including the Standard Treatment Guidelines(STG), British National Formulary (BNF), and World Health Organization guidelines.

A majority of the respondents n=11(91.7%) agreed that the current use of parenteral antibiotics at the department could lead to resistance. Half of the respondents (n=6, 50%) agreed that the frequent use of parenteral antibiotics at the general surgery unit without culture and sensitivity tests could contribute to the development of resistant pathogens (Fig. 3).

Table 4. Diagnoses and surgical prophylaxis combinations administered to patients

Surgical Prophylaxis (n, %)	Diagnoses	Number of patients
CIP+MTZ (219,76.0)	Appendicitis	69
	Hernia	64
	Intestinal obstruction	17
	Haemorrhoids	7
	Other cancers	6
	Peptic ulcer disease	17
	Gastrointestinal bleeding	8
	Cellulitis	5
	Diabetic ulcers &infections	5
	Other diagnoses	5
	Peritonitis	8
	Abdominal injury	5
	Appendicitis + hernia	3
CTX+CIP+MTZ(1,0.3)	Cellulitis	1
CTX (1,0.3)	Diabetic ulcers &infections	1
CTX+GEN+MTZ(1,0.3)	Peritonitis	1
CXM+MTZ(11,3.8)	Intestinal obstruction	2
	Other diagnoses	3
	Peptic ulcer disease	2
	Other cancers	2
	Abdominal injury	2
CTX+MTZ(2,0.7)	Abdominal injury	1
	Other cancers	1
CIP+CLI(6,2.1)	Diabetic ulcers &infections	5
	Other diagnoses	1
MEM(1,0.3)	Other diagnoses	1
AMC (9, 3.1)	Breast cancer	4
	Hernia	2
	Goitre	3
MTZ (6,2.1)	Hernia	6
MTZ+LEV(1,0.3)	Diabetic ulcers &infections	1
CLI+MTZ (4,1.4)	Diabetic ulcers &infections	4
CIP+AMC (1,0.3)	Intestinal obstruction	1
CXM (18,6.3)	Hernia	12
	Other diagnoses	6
CIP (7, 2.4)	Diabetic ulcers &infections	5
	Hernia	2

Key: AMC = Co-Amoxiclav; BPC = Benzylpenicillin; CIP = Ciprofloxacin; CLI = Clindamycin; CTX = Ceftriaxone; CXM = Cefuroxime; FLX = Flucloxacillin; GEN = Gentamicin; LEV = Levofloxacin; MEM = Meropenem; MTZ = Metronidazole

Over 80% of the surgeons n=10(83.3%) replied that parenteral antibiotic use can be properly regulated at the general surgery unit. They provided methods like the development of antibiotic guidelines and enforcing its use, collaborating with pharmacists during prescribing and establishing an antibiotic committee to supervise use of antibiotics.

3.3 Rational for Antibiotic Use

Six patients (1.6%) undertook culture and sensitivity tests. Blood samples constituted the most used culture sample (n=3, 50%) followed by wound swab (n=2, 33%) and Urine sample (n=1, 17%). Gram negative bacilli were identified in 4 of the reports (66.7%). The organisms included *E. coli, Aeromonas hydrophilia, Klebsiella spp., and Enterobacter spp.* There was no bacterial growth on two reports in which blood samples were taken. Sensitivity pattern obtained informed subsequent choice of antibiotics in all patients.

3.4 Drug-related Problems

Of the 385 patients studied, 371(96.4%) had at least one drug-related problem with their

prescription (Table 6). These identified problems were classified based on the Pharmaceutical Care Network Europe Foundation classification v5.01. The number of missed doses per patient ranged between 1- 66 missed doses, with mean number of missed doses found to be 7.41(SD ±5.37). There was one incidence of adverse drug event where a patient experienced allergic reactions with Clindamycin.

Table 5. Microorganisms identified from culture samples and sensitivity pattern obtained

Isolate	Microorganisms Identified	Sensitive to	Resistant to
Urine	*Eschericia Coli*	Cefuroxime Gentamycin Ciprofloxacin Nalidixic acid	Not available*
Blood	*Aeromonas hydrophilia*	Imipenem Meropenem Amikacin	Ceftazidime Cefepime Gentamycin Tobramycin Ciprofloxacin
Wound	*Klebsiella spp.*	Amikacin	Ciprofloxacin Meropenem Gentamycin
Wound	*Enterobacter spp*	Meropenem	Cefotaxime Levofloxacin Ampicillin Cefuroxime Co-amoxiclav Co-trimoxazole

Not available-E coli was sensitive to all antibiotics used for the sensitivity test as reported*

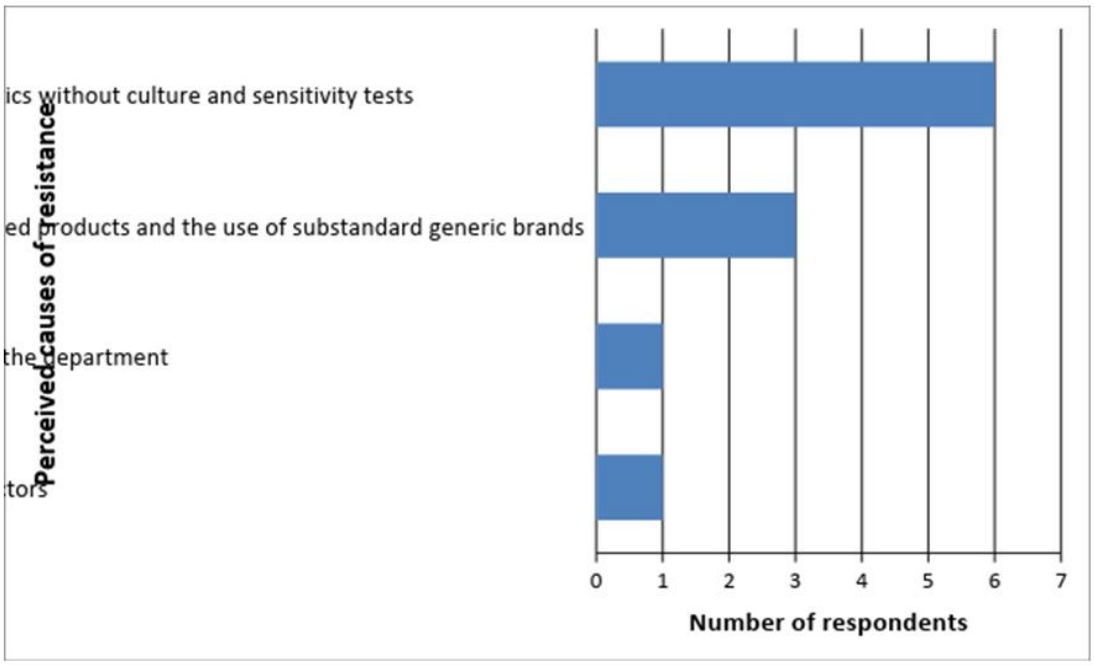

Fig. 3. Participants' reasons for possible causes of parenteral antibiotic resistance

Table 6. Drug-related problems identified

No	Primary domain	Code	Drug-related issue	Frequency(%)
1	Adverse reactions	P1.2	Side effect suffered(allergic)	1(0.1)
2	Drug choice problem	P2.3	Inappropriate duplication of therapeutic group	15(2.1)
3	Dosing problem	P3.1	Drug dose too low	275(39.2)
			Dosage regime not frequent enough	61(8.7)
		P3.2	Dosage regime too frequent	1(0.3)
4	Drug use problem	P4.1	Drug not taken/administered at all	348(49.6)

4. DISCUSSION

The study involved 385 patients of which 51.2% were female and 48.8% were male. The high number of female patients realised was in conformity with the number of female patients recruited in similar studies conducted in Accra (66%) and Kumasi (59.1%) [7,8,9]. This was however different from a study conducted in India where 59.57% of the patients were males and 34.42% were females [10]. Patients between the ages of 41-60years (38.5%) were in the majority while patients less than 20 years were the least (3.1%). This compares with two similar studies conducted in India in which the largest groups of patients 49% [11] and 43% [12] were those between the ages of 40-60 years.

The mean duration of hospital stay of 9.14(±SD 9.19) days was at variance with the mean duration of stay observed in a similar study conducted in northwest Ethiopia (14.2 days) [3], but similar to that obtained in southern India which was 9.46 days [12]. More than half of the patients had registered with the NHIS (57.9%), which is higher than the current documented percentage (38%) of the national population with active membership in the NHIS [13].

Out of the 385 patients involved in the study, 95 (24.7%) had hernia, 73 (19%) had appendicitis, and 42 (10.9%) had breast cancer. Other conditions included diabetic ulcers and infections (7.3%), peptic ulcer disease (6%), intestinal obstruction (5.2%), other cancers (5.2%), cellulitis (3.6%), peritonitis (3.4%), gastrointestinal bleeding (2.6%), abdominal injury (2.6%), haemorrhoids (1.8%), goitre (1.8%), appendicitis with hernia (0.8%) and other diagnoses (20%). All these diagnoses are consistent with the documented top causes of admission at the General Surgery Unit [14,15]. Similar diagnoses were observed in studies conducted at the Department of Surgery at Rajah Muthiah Medical College Hospital, where the common cases seen over the period of study included appendicitis 23.04%, breast cancer 4.25%, diabetic foot ulcer 29.78%, hernia 21.27% and carcinoma stomach 8.81% [10].

Response rate was 100% among the 12 surgeons who responded to the questionnaires, of which males (n= 10, 83.3%) were in the majority. The 2 females (16.7%) included a specialist and a consultant.

4.1 Antibiotic Use Practices

Over 60% of the parenteral antibiotics in the pharmacy during the study period were generic products (62.5%) while 37.5% were innovator products. This is in agreement with a study conducted by Michael A. Veronin which revealed that when measures are put in place to ensure quality and patients are informed when generic substitutions are administered to them, generic antibiotic use is less likely to cause problems [16]. The parenteral antibiotic that was used most frequently at the stores of the Surgical Pharmacy was metronidazole, followed by flucloxacillin, Rocephin 1 g, gentamicin and ciprofloxacin. The least used parenteral antibiotics were amikacin and Rocephin 2 g. The low consumption of Rocephin 2 g can be attributed to the fact that stocks which were initially unavailable were received four days before the end of data collection.

The parenteral antibiotic which was most frequently used at the General Surgery Unit wards as per the patient medical records was ciprofloxacin (37.7%), followed by metronidazole (36.9%), co-amoxiclav (9.7%) and clindamycin (6.8%) with flucloxacillin being the least used (0.3%). A similar study conducted at Shree Sayaji General Hospital in India revealed that metronidazole (17.4%) was among the most frequently prescribed antibiotics, consistent with this study. However, other frequently prescribed antibiotics found in the study conducted in India such as cefotaxime (17.7%), gentamicin (13.8%), cefadroxil (16%), were inconsistent with findings

from this study [11]. Over the period of study, amikacin and vancomycin, though available at the stores of Surgical Pharmacy, were not prescribed for patients at the General Surgery Unit wards. This could be due to the fact that vancomycin is predominantly prescribed for patients at the Neurosurgery Unit while gentamicin is preferred to amikacin when prescribing for patients at the Urology Unit [10].

Averagely, 2.03 (±SD 0.64) parenteral antibiotics were used for a mean duration of 4.23 (±1.36) days. The mean number of parenteral antibiotics used was at variance with that observed in southern Ethiopia (1.18) and India (1.13), but similar to that observed in surgical patients admitted at a teaching hospital in northwest Ethiopia (2.17) [3,12,17]. However, the mean duration of parenteral antibiotic therapy was similar to what was obtained in Pennsylvania (4.7 days) but dissimilar to the durations observed (7.0 and 6.6 days) in two separate studies in India [11,18,19]. It was also in contrast with the number of days observed in northwest Ethiopia (8.7 days) [3]. Furthermore, the results obtained in this study is in conformity with the World Health Organization (WHO) recommendations which advocate that antibiotics should be administered over a limited duration, such as 5-14 days, depending on the infection being treated. However, longer duration of therapy may be required in a few instances. It is also recommended that lack of response to antibiotic therapy after three days requires that the medication should be discontinued [20].

The minimum number of antibiotic prescribed was one, consistent with the minimum number of antibiotics prescribed in studies conducted in south India and northwest Ethiopia, but the maximum number of 5 was slightly higher than that observed in the studies conducted in south India (4 antibiotics) and northwest Ethiopia (4 antibiotics) [3,10,12]. However, a patient diagnosed with metastatic breast cancer in the advanced stage received the maximum number of parenteral antibiotics while on admission where co-amoxiclav, cefuroxime, metronidazole, gentamycin and clindamycin were administered. Multiple antibiotics are often prescribed when there is a need for synergism and prevention of resistance, or in instances where infections caused by multiple organisms are present or suspected [21]. Multiple antibiotic prescribing can, however, lead to an increased risk of drug allergies or toxicities. It can also lead to drug antagonism and an increased risk of colonisation with resistant bacterial organisms. This may not be cost effective for the patients [21,22].

Nine of the parenteral antibiotics administered over the period of study (81.8%) were on the NHIS list, whiles 2 (18.2%) were not. These two included meropenem and levofloxacin. This study revealed that quinolones (38.7%), nitroimidazoles (36.7%), penicillins (10.4%), lincosamides (6.8%) and cephalosporins (6.4%) were the most frequent parenteral antibiotic groups administered while other groups such as carbapenems (4%) and aminoglycosides (4%) were the least administered. This was not in conformity with groups of parenteral antibiotics administered to patients in a similar study conducted at surgical units of a general hospital in India [11]. Dissimilar findings were also realised from a study conducted in a teaching hospital in South India [12]. Differences in the choice of antibiotics observed may be due to differences in the pattern of prevalent organisms and the purpose for which the antibiotics are used [23,20]. Among the most frequently administered parenteral antibiotics included ciprofloxacin (37.7%), metronidazole (36.9%), co-amoxiclav (9.7%), clindamycin (6.8%) and cefuroxime (5.3%). This was in contrast with studies conducted in Cape Town where benzylpenicillin, amikacin and ceftriaxone were among the most frequently used parenteral antibiotics [24]. Findings from a study conducted at the Surgical Medical Emergency Unit of Korle Bu Teaching Hospital in which the commonly used antibiotics included ciprofloxacin, metronidazole and co-amoxiclav are consistent with findings from this study [8]. In similar studies at the SDA Hospital in Kumasi, the most highly used antibiotic was ciprofloxacin, consistent with findings from this study [9]. The study revealed that 11.7% (n=45) of patients were administered co-amoxiclav as monotherapy, followed by cefuroxime (n=15, 3.9%) and metronidazole (n=1, 0.3%) while all the other patients received parenteral antibiotic combinations. This was inconsistent with findings from a similar study conducted at an SDA hospital in Ghana which revealed that ciprofloxacin was the most prescribed antibiotic monotherapy followed by cefuroxime and ceftriaxone [9].

Most patients received a combination of two parenteral antibiotics (n=265, 68.8%). The commonest was a combination of ciprofloxacin and metronidazole (n=210, 54.5%). This was followed by a combination of ciprofloxacin and

clindamycin (n=28, 7.3%) which was administered to 71.4% of patients with diabetic ulcers and infections. A combination of cefuroxime and metronidazole (n=14, 3.6%) was also administered to 45% of patients diagnosed with other cancers. Metronidazole was usually combined with ciprofloxacin for both prophylaxis and treatment of infections in this study, consistent with findings from studies conducted at the Surgical Medical Emergency unit of Korle bu Teaching hospital and the SDA Hospital, both in Ghana [8,9]. Studies conducted in northwest Ethiopia and southern Ethiopia were however not in conformity with this finding [3,17]. The use of two or more antibiotics has a certain rationale, but indiscriminate antibiotic combinations may expose patients to several negative consequences [3]. Such unwanted effects may include the risk of toxicity due to the use of more than one antibiotic concurrently, increased cost, and emergence and spread of drug resistant microorganisms [21,22]. It is therefore proposed that the wide use of ciprofloxacin and metronidazole can result in the development of widespread resistance in the near future [25]. This assertion is confirmed by Jacobs M. as the increased use of ciprofloxacin to treat minor infections readily treatable with older, narrower spectrum antibiotics has resulted in the development of resistance to it by a wide range of bacteria in recent years. This has rendered ciprofloxacin significantly less effective than it would have been otherwise. Consequently, numerous pathogens, including some strains of enterococci, *Streptococcus pyogenes* and *Klebsiella pneumoniae* now exhibit resistance to ciprofloxacin [25,26,27].

4.2 Surgical Prophylaxis

The findings on the use of antibiotic prophylaxis where most patients receive a combination of ciprofloxacin and metronidazole (n=219, 76%).followed by cefuroxime (n=18, 6.3%), co-amoxiclav (n=9, 3.1%) and a combination of cefuroxime and metronidazole (n=11, 3.8%) were in contrast with that of a study conducted by Abula and Kedir where 45% of patients received antibiotic prophylaxis, with the commonest antibiotics being a combination of ampicillin and gentamicin, ampicillin and chloramphenicol, and ampicillin, gentamicin and chloramphenicol [3]. The use of antibiotics such as meropenem and a combination of metronidazole with levofloxacin as prophylaxis occurred rarely.

All the respondents admitted that parenteral antibiotics are used in their practice at the General Surgery Unit. Two surgeons indicated that they use parenteral antibiotics as surgical prophylaxis for all their patients operated upon. The use of parenteral antibiotics for some patients who are operated was confirmed by over 80% of the surgeons. Since most patients presented with conditions such as appendicitis, diabetic ulcers and infections, peptic ulcer disease and intestinal obstruction, this was in agreement with guidelines for surgical prophylaxis. The guidelines recommend that patients at a higher risk of wound infection based on factors such as comorbidity, wound class and duration of surgery should be provided surgical prophylaxis. It further proposes that in surgeries such as appendicectomy and colorectal surgery, antibiotic prophylaxis is highly recommended whiles in procedures such as incisional hernia repair and splenectomy, surgical antibiotic prophylaxis is not recommended [28,29,30,31].

Two thirds of the respondents stated that they sometimes request for culture and sensitivity tests in less than 25% of their patients, which is consistent with findings from a study conducted in Ethiopia which revealed that almost all patients who were operated were prescribed antibiotics empirically without doctors requesting for culture and sensitivity tests [3]. However, dissimilar findings from a study conducted in south India that concluded that antibiotic prescriptions were not supported by culture and sensitivity tests [12]. It is recommended that before starting antibiotic therapy, samples should be taken for culture and sensitivity testing because empirical antibacterial prescribing for unexplained pyrexia often results in difficulties in the establishment of patient diagnosis [23]. Respondents were evenly split on the adequacy of parenteral antibiotic use at the unit, with 50% agreeing that parenteral antibiotics are abused at the General Surgery Unit. This was consistent with a similar study conducted in Indianapolis in which participants recognised antibiotic overuse in their facilities [32].

4.3 Influencers of Antibiotic Choice

Respondents gave varied responses with regards to their choice for parenteral antibiotic prescribing decisions. Over 90% of surgeons declared that prescribing decisions are based on previous experiences with 83.3% admitting to the use of guidelines for parenteral antibiotic prescribing. The guidelines mentioned included

Standard Treatment Guidelines, British National Formulary, Departmental Guidelines and World Health Organization guidelines. However, there are no departmental guidelines for prescribing antibiotics at the General Surgery Unit.

A third of the respondents however answered that prescriptions are based on advice from pharmacists, while advice from seniors influenced the prescribing decisions of 25% of the respondents. Though influences for prescribing decisions are varied, similar influences for antibiotic prescribing decisions were realised in a study conducted by Quet et al. where the majority of antibiotic prescriptions were based on national guidelines, advice from peers and advice from older colleagues [33]. Studies conducted in India and London which revealed that antibiotic prescribing behaviour of seniors influenced the practice of junior doctors were in conformity with findings from this study [32,34]. The World Health Organization recommends that the choice of an appropriate antimicrobial agent is made easier when the causative organisms of an infection is known or can be assumed. However, the choice of antimicrobial should be guided by local or national resistance surveillance data and treatment guidelines [35].

4.4 Possible Causes of Parenteral Antibiotic Resistance and Regulation of the Use

According to respondents, possible causes of parenteral antibiotic resistance included frequent use of parenteral antibiotics at the unit without culture and sensitivity tests (50% of respondents) and the inability of patients to afford branded products leading to the use of substandard generic brands (25% of respondents). Abuse and over prescription of parenteral antibiotics by doctors at the unit (8.3% of respondents) as well as the absence of antibiotic guidelines at the department (8.3% of respondents) were also identified as possible causes of parenteral antibiotic resistance. The doctors recommended that development of antibiotic guidelines and enforcing its use would help to regulate parenteral antibiotic use at the general surgery unit. Others felt that collaboration between doctors and pharmacists when prescribing and the establishment of an antibiotic committee to supervise the use of parenteral antibiotics could contribute to regulation of use. Similar findings were obtained from a study conducted in Lao People's Democratic Republic where prescribers identified possible causes of antibiotic resistance as antibiotic overuse in hospitals and inadequate sources of information on antibiotic prescribing in hospitals. They recommended that restriction of antibiotic use and development of antibiotic guidelines could facilitate regulation of antibiotic use [33]. A survey conducted in India also revealed consistent findings, where most clinicians attributed the causes of antibiotic resistance to the absence of institutional antibiotic policy and recommended the implementation of antibiotic policy to curtail this occurrence [36].

Culture and sensitivity testing was done in 1.6% of patients, which was inconsistent with findings from other studies conducted at Shree Sayaji General Hospital, Mahatma Ghandi Medical College and Research Institute and the Surgical Medical Emergency Unit of Korle Bu Teaching Hospital where culture and sensitivity testing was done in 3.1%, 11% and 7.7% of patients under study respectively [8,9,12]. Antibiotic sensitivity pattern informed the subsequent choice of antibiotics in all patients. It is recommended that definitive therapy is initiated after culture and sensitivity results are known with treatment targeted towards the known pathogen [37]. Gam-negative baccili were identified in all the reports that showed growth which included *E.coli*, *Klebsiella spp., Aeromonas hydrophilia* and *Enterobacter spp*. All organisms, except *Aeromonas hydrophilia*, are coliforms. Identification of *E.coli* and *Klebsiella spp.* was consistent with findings from studies conducted in India and Ghana, which revealed common pathogens as *E. coli, Staphylococcus aureus, Klebsiella spp*. and *Pseudomonas aeruginosa* [10,38]. Susceptibility of *Aeromonas hydrophilia* and *Klebsiella spp.* to amikacin was also in conformity with findings from a study conducted in Ghana [38]. Shortages in the supply of some parenteral antibiotics during the period of study affected the consumption pattern at the Surgical Pharmacy.

5. CONCLUSION

Parenteral antibiotics were frequently used and prescribers rely more on experience than laboratory investigations. There were some drug-related problems identified that required interventions to prevent these from reaching patients. It is therefore important for the development of antibiotic-use policy to promote rational antibiotic use in surgery.

CONSENT

Written consent was sought from all the surgeons who filled the self-administered questionnaires. All information collected from patient medical records was coded and no names were recorded. Names of Surgeons who responded to questionnaires were also not recorded, and data could not be linked to any participant of the study in anyway.

ETHICAL CONSIDERATIONS

Ethical clearance was obtained from the committee on Human Research, Publication and Ethics of the Kwame Nkrumah University of Science and Technology School of Medical Sciences/Komfo Anokye Teaching Hospital (CHRPE/AP/354/15).

Permission was sought from the Head of Department of Surgery, Korle Bu Teaching Hospital.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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