Original Research Article

A study on prescribing pattern of cephalosporins utilization and its compliance towards the hospital antibiotic policy in surgery ward of a tertiary care teaching hospital in India

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ABSTRACT

Background: Extensive use of antibiotics is prevalent throughout India, and this is a matter of serious concern. There are several reports linking antibiotic usage to resistance. Towards addressing this problem, assessment of current prescribing pattern of antibiotics needs to be undertaken to monitor its appropriate use. This study was meant to assess the utilization of cephalosporins and its compliance towards the hospital antibiotic policy in surgery ward of a tertiary care teaching hospital.
Methods: A prospective observational study was conducted with 250 inpatients of surgery ward. The demographic details, lab investigations, clinical diagnosis and current treatment were noted. The collected data was analysed for utilization of cephalosporin using World Health Organization (WHO) core prescribing indicators and defined daily dose per 100 bed-days. The hospital antibiotic policy was used as a benchmark for analyzing compliance of therapy.
Results: Out of 250 patients, 69% was male and 31.2% was female population with mean age of 42.12±17.33 years. Majority of cases were clean-contaminated (36%) followed by clean (30.4%) and contaminated (17.6%) wounds. The average number of overall antibiotics and cephalosporins per encounter was 2.1 and 1 respectively. Among the total parenteral antibiotics, 63.9% were cephalosporins. Cephalosporins utilization was 2.68 DDD per 100 bed-days. Compliance with all the stated criteria was observed only in 124 (49.6%) patients.
Conclusions: The rate of prescribing of cephalosporins has increased evidently which may result in the occurrence of bacterial resistance. A suboptimal rate of compliance recommends a strict monitoring in the usage of cephalosporins with periodical updation of policy.

Keywords: Antibiotic utilization, Cephalosporins, Compliance, Antibiotic policy

INTRODUCTION

Antibiotics are one of the pillars of modern medicine and play a major role in prophylaxis as well as treatment of infectious diseases but the current scenario speaks of higher utilisation and development of resistance pattern.[1] Consumption of antibiotics in humans is increasing globally and in India as well.[2] Surgical site infection (SSI) is the most common cause of nosocomial infections following surgical procedures. The SSI has led to the widespread use of antibiotics which may contribute to the resistance towards the antibiotics.[3,4]

Cephalosporins were the most commonly used antibiotics due to its high antimicrobial potency, wide spectrum of activity and low adverse effects.[5-7] They are generally

classified into four generations in which first and second generation such as cefazolin and cefuroxime are mainly used as surgical prophylaxis (SP). Whereas, third generation cephalosporins (3GCs) such as cefotaxime, cefoperazone, ceftriaxone are generally not recommended for SP. Ceftriaxone in particular, is far exceeding the sales of any other drug for prophylaxis.[2,8] Despite these recommendations, they have been widely accepted as the most common antibiotics for SP.

The World Health Organization (WHO) has developed a standardized tool, WHO core prescribing indicators for measuring the drug utilization as well as the evaluation to identify inappropriate use of drugs.[9,10] The WHO also recommends the use of the ATC/DDD (anatomical therapeutic chemical per defined daily dose) index for the drug utilization studies.[11] Generally, the ATC/DDD index is used as the universal parameter for the evaluation of antibiotic use.[12]

A previous study conducted in our hospital has already predicted the overutilization of antibiotics in surgery ward and suggested on a need of a guideline for rationalizing antibiotic prescribing.[5] Hospital antibiotic policies were implemented in our tertiary care teaching hospital to encompass the physicians and surgeons to prescribe appropriate antibiotics according to the indication to avoid the emergence of bacterial resistance. However, the deviation from the policy may result in poor compliance; which leads to misuse of the antibiotics, prolonged hospital stay and increased healthcare expenses.[13] There are few studies reporting the compliance of prescribing pattern of cephalosporins towards the hospital guidelines in India. This study was undertaken to gain insight into the prevalent prescribing trends of cephalosporins utilization and compliance with the hospital antibiotic policy in surgery ward.

METHODS

This prospective observational drug utilization cohort study was performed in inpatients of surgery of Bharati Hospital and Research Centre, Pune over a period of 11 months from September 2017 to August 2018 to assess the cephalosporins utilization pattern and usage compliance with the hospital antibiotic policy (version 1.0.2015). A total of 250 patients (≥18 years), prescribed cephalosporins alone or in combination with other antibiotic were enrolled in the study. Patients with < 18 years and were not on cephalosporin therapy or been admitted other than surgery ward were excluded. The study has been approved by the institutional ethics committee. Patient's consent was taken for documentation.

The patient details like demography, disease condition, lab investigation, type of surgery, data on cephalosporins including its indication, dose, frequency, duration of therapy were noted in self pre designed pro forma. According to the National Academy of Sciences and the

National Research Council, surgical wounds are classified as clean, clean-contaminated and contaminated to pre-emptively identify the SSI risk in patients.[14,15] Clean wounds are uninfected operative wound which are primarily closed with no acute inflammation and the respiratory, alimentary, genital, or uninfected urinary tracts are not entered; no technique break (for example, elective inguinal herniorrhaphy). Clean-contaminated wounds arise from intentional, controlled entry in a hollow viscus (respiratory, alimentary, genital, or urinary tract) without subsequent contamination. Whereas, contaminated wounds are open, fresh, accidental wounds with non-purulent inflammation (for example, dry gangrene) along with major technique break or major spill from hollow organ.[16,17] Cephalosporins usage was categorized as prophylaxis (without evidence of infection), definitive (based on culture reports), empirical (clinical evidence of infection without organisms being isolated) therapy. The data obtained was processed and methodically examined by using WHO criteria typically in order to explain and interpret for drug utilization evaluation (DUE).[17] The data were also evaluated and analysed using the WHO core drug prescribing indicators which includes:[17]

- Average number of antibiotics per encounter = number of antibiotics prescribed / number of encounters surveyed.
- Percentage of cephalosporins within antibiotic prescribed = (number of cephalosporins prescribed / total number of antibiotics prescribed) × 100.
- Average number of parenteral antibiotics per encounter = number of parenteral prescribed / Number of encounters surveyed.
- Percentage of parenteral antibiotic prescribed = (number of parenteral antibiotics / total number of antibiotics prescribed) × 100.
- Percentage of antibiotics prescribed in generic name = number of antibiotics prescribed in generic name / total number of antibiotics prescribed) × 100.

The defined daily dose (DDD) concept was developed to overcome objections against traditional units of drug consumption. The DDD is defined as the assumed average use per day of the drug for its main indication in adults.[12] The method used for inpatients is the ratio of the total DDD per 100 bed-days. This index is called antimicrobial consumption index (ACI) of the hospital or population.[18]

$$ACI = DDD / \text{bed-days} \times 100$$

In this study, DDDs of anti-infective agents were listed for systemic use according to ATC/DDD 2016 index.[11] The study was carried out for a period of 335 days, the total number of inpatients beds was 150 and the occupancy index was 0.82.

Hospital antibiotic policy (version 1.0.2015) was used as a tool to evaluate the compliance of therapy in terms of

indication, dosage, frequency and duration of treatment.[19] This local hospital policy is detailed as Appendix I and is based on previously published standard guidelines.[20] In our hospital set up, some indications for infectious diseases were not mentioned in the antibiotic policy, such data was considered as non-assessable. The deviation was determined by comparing the observed cephalosporins prescribing in the chart records to the recommendations in the Hospital antibiotic policy. This was documented and the reason for it was obtained from the prescriber through direct verbal access. Data collected were analysed using chi-square test and fisher's exact test and also expressed as mean, median, standard deviation (SD) and percentage. A p value of <0.05 was accepted as statistically significant.

RESULTS

Out of total 250 patients assessed during the study period, 172 (68.8%) were males and 78 (31.2%) were females with a mean age of 42.12±17.33 years. There were 72 (30.4%) clean operations, 90 (36%) clean-contaminated and 44 (17.6%) were contaminated operations. The rest 40 (16%) patients were not performed any kind of surgical procedure. Out of the total 250 patients, 154 (61.6%) received cephalosporins empirically, 60 (24%) of patients were prescribed cephalosporins as prophylactic therapy and 36 (14.4%) of patients received cephalosporins as definitive therapy. The median duration of hospital stay was 6 days. Hospitalization period of patients who received single or two antibiotics together were similar but the hospitalization period of patients receiving three antibiotics was longer (9.77±6.16). Bacteriological investigations were done only in 70 (28%) patients of whom the growth was observed only in 34 cases (Table 1). The common organisms isolated were *Escherichia coli* (24 cases), *Klebsiella pneumonia* (6 cases), *Staphylococcus aureus* (2 cases), *Citrobacter* species (2 cases) and Methicillin and coagulase staphylococcus (2 cases).

The study showed that the third generation cephalosporins (88.6%) were commonly prescribed followed by second generation. Ceftriaxone (53.7%) and cefotaxime (30.3%) was found to be the most commonly prescribed 3GCs with a daily dose of 2 gm as parenteral form. The mean duration of treatment with cephalosporins was found to be 4.68 days (range 1-7 days). Cephalosporins were mainly indicated for intra-abdominal infections (34.4%) followed by SP (24%). Inpatients of 66.4% were co-prescribed with other antibiotics, of which metronidazole (69.9%) was found to be common.

Cephalosporin prescriptions were analysed for the usage pattern by using WHO drug prescribing indicators (Table 2). The average number of overall antibiotics and cephalosporins per encounter was found to be 2.1 and 1 respectively. The percentage of cephalosporins within the antibiotic prescribed was 67.9% and 64% of

cephalosporins were given in the parenteral form. The total number of antibiotics prescribed in generic name was found to be 26 (5%) in which cephalosporins were 20 (3.87%).

Table 1: Demographic and clinical characteristics of the study population (n=250).

No. of patients enrolled in the study	
Characteristics	**N (%)**
Gender	
Male	172 (68.8)
Female	78 (31.2)
Age (Mean±SD*, range)	42.12±17.33 years
Surgical wound classification	
Clean	76 (30.4)
Clean-contaminated	90 (36)
Contaminated	44 (17.6)
Not performed	40 (16)
Type of treatment	
Empiric	154 (61.6)
Definitive	60 (24)
Prophylactic	36 (14.40)
Bacteriological investigations	
Done	70 (28)
Not done	180 (72)
Hospitalization period of patients receiving antibiotics (mean±SD)	
Only one antibiotics (n=110, 44%)	7.54±4.55
Two antibiotics (n=104, 41.6%)	7.17±4.06
Three antibiotics (n=36, 14.4%)	9.77±6.16

*SD-Standard deviation.

Table 2: WHO core indicators assessing the drug prescriptions.

Core indicators	Total antibiotics	Cephalo-sporins
% of antibiotics prescribed	100	67.9
Average no. of parenteral antibiotics per encounter	1.9	1
% of parenteral antibiotics prescribed	88.8	64
% of antibiotics prescribed in generic name	5	3.87

The total consumption of cephalosporins throughout the study period in surgery ward was found to be 2.68 DDD per 100 bed days. The ACI of ceftriaxone (1.32 DDD per 100 bed-days) was high as compared to the other cephalosporins class of antibiotics. The antibiotic consumption index for parenteral were found to be 1.87 DDD per 100 bed days (Figure 1).

Table 3 summarizes the compliance of cephalosporins therapy with the hospital antibiotic policy. Out of 250 patients, 68 (27.2%) were observed to be complying with, an overall evaluation of indication, dose, duration and

frequency of administration of cephalosporins treatment according to the antibiotic policy. From the total, 124 (49.6%) were not according to the hospital antibiotic policy, whereas rest 58 (23.2%) of the data was not mentioned.

Table 3: Distribution of cephalosporin prescription based on DUE criteria.

Indication	Number	Compliance	Non-compliance	NA*
	N (%)	N (%)	N (%)	N (%)
Surgical prophylaxis	60 (24)	-	48 (80)	12 (20)
Abscess	38 (15.2)	14 (36.8)	22 (57.9)	29 (5.3)
Trauma	22 (8.8)	-	-	22 (100)
Intra-abdominal	86 (34.4)	46 (53.5)	40 (46.6)	-
Diabetic foot ulcer	6 (2.4)	-	6 (100)	-
Others[†]	38 (15.2)	8 (21.1)	8 (21.1)	22 (57.9)
Total	250	68(27.2)	124 (49.6)	58 (23.2)

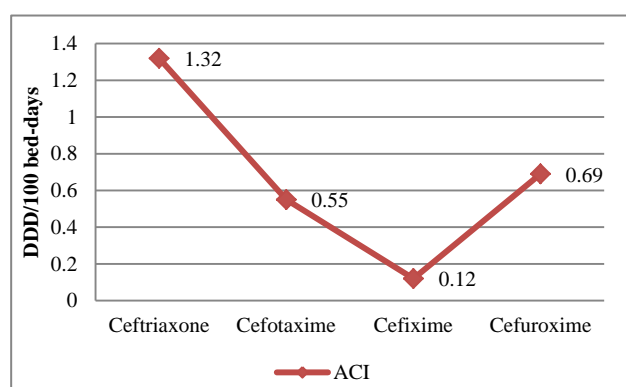† Head & neck; sternal, chest, perineal, lymphoma, *NA: non-assessable.

Figure 1: Antimicrobial consumption index of cephalosporins.

DISCUSSION

The appropriate choice and utilization of cephalosporins is essential to provide safe and effective therapy towards successful conditions.[21] The present study shows marginally higher utilization of cephalosporins in surgery (67.9%) which was similar to the studies reported by Pereira et al and Shankar et al.[22,23] The high utilization of cephalosporins often leads to the issues such as; antibiotics resistance, drug related problems and treatment cost.[21,22] The demographic details of patients revealed that the male (68.8%) preponderance was more than female which was similar to results obtained from various studies.[2,4,24] In this study most of the patients were aged 41 years with a mean age of 42.12±17 years. The results of the study population group are similar when compared to other studies.[3,4,22]

The present study revealed that the clean (30.4%) and clean- contaminated (36%) surgeries were mostly performed than the contaminated surgeries (17.6%) among the patients in the surgery ward. All these findings showed similarities with the results obtained from various studies.[14,25] The selection of antibiotics for surgical prophylaxis is influenced by the organism most commonly causing wound infection. According to the hospital antibiotic policy (version 1.0 2015) first and second generation cephalosporins such as cefazolin and cefuroxime were indicated for SP due its anti-staphylococcal activity; which is weaker but their action against gram-negative bacteria is stronger.[8,19] *E. coli* was the most frequent organism isolated, accounting for 24 cases of total organisms from the various samples. The low number of samples in our study makes it difficult to draw firm conclusions.

In this study, cephalosporins were mostly prescribed as empirical (61.6%) therapy. This finding is in good agreement with the results of the studies conducted at University hospital of West Indies, where two-third of the patients (67.9%) were treated with empiric antibiotics and Pereira et al where 68.2% were of empiric therapy.[22,26] The chances of post-operative infections are higher in the patient who underwent surgical procedure and most of the times the infection is caused by highly virulent bacteria. Thereby in most of the situations, physicians prescribe antibiotic therapy based on the clinical features of the patient and lab results, as the microbiological test are no availed within 3 days. It was observed that only 14.4% patients were prescribed cephalosporin on the basis of culture results. Though in many cases, no growth was detected. This may be the one of reason for the low percentage of usage of cephalosporins for the definitive therapy.

The hospitalisation period of patients who received three antibiotics was higher (9.77±6.61) as compared to the one and two antibiotics. The study result is consistent with that reported in a study conducted in Turkey where the use of three antibiotics was inappropriate and hospital stay was twice in the patients.[27] The increase in the number of antibiotics may increase the hospital stay and cost of treatment (p=0.01).

It was observed that bacteriological investigation was not done for more than half of patients (72%). These findings were consistent to the studies conducted at a specialized hospital and university hospital of West Indies, where culture reports took a mean of 3 and 3.7 days to become

available.[26,28] Prior to the initiation of any antibiotic treatment, the culture sensitivity test was not routinely performed in our hospital setting. The reasons were probably due to delay in obtaining the sensitivity reports (average of 3 days), economic burden on patient. The practice of antimicrobial culture sensitivity test was done only when patient was suspected of resistance towards an antibiotic or in severe infection or referred from other clinics or nursing homes. Micro-organisms such as *E. coli* and *Klebsiella pneumonia* strains showed higher resistance to cephalosporins antibiotics which is similar to the study conducted by Salah et al.[29] This might be due to the over use of broad spectrum cephalosporins resulting in emergence of multidrug resistance.

The study showed high usage of cephalosporins in surgery wards (48.2%) in which third generation (88.6%) cephalosporins was most commonly prescribed followed by second generation (11.4%). This result is in good agreement with the results of the various studies reported.[4,22,23] Whereas, a study conducted in a teaching hospital in Nepal reported the usage of cephalosporins was found to be low.[24] The high usage of third generation cephalosporins may be due to its broader antibacterial coverage. It was observed in this study that ceftriaxone was the most commonly prescribed approximately 54% which similar to the study conducted by Sileshi et al and Pereira et al showed maximum usage of ceftriaxone with 58% and 66% in surgery wards.[21,28] This may be due to its easy availability of the drug, good effectiveness and low toxicity rates.[6,7,10]

The mean duration of treatment with cephalosporins in the hospital was 4.68 days. This finding was lower as compared to results of the study conducted in Nepal.[24] The duration of antibiotics depends on the severity of the infections. It was observed that the most of the patients in this study were underwent clean surgeries and wound infection rate is comparatively low than contaminated surgeries.

The results of this study revealed that the average number of overall antibiotics per encounter were 2.1. This value is higher than the acceptable range of 1.6-1.8 drugs per encounter. An average of one cephalosporin was prescribed in each patient admitted. More than sixty percentage of cephalosporins within overall antibiotics prescribed showed deviation from the standards (20.0%-26.8%).[30] This might lead to the future antibiotic resistance. This observation suggests that prescribing practice of cephalosporin need to be strictly monitored despite of hospital antibiotic policy. The overuse of antibiotics may be due to patients prefers antibiotic for quick recovery or prescriber belief that the therapeutic efficacy of antibiotic is low. Parenteral administration of cephalosporins in this study was higher as compared to the standards recommended by WHO (13.4%-24.1%).[30] The possible reasons for the high use of parenteral can be the unwillingness of patient to stay in the hospital once parenteral drugs had been stopped and belief of patients

about the efficacy and faster onset of action of parenteral as compared to oral. WHO highly recommends prescribing medications by generic name as a safety precaution for patients because it identifies the drug clearly, enables better information exchange and allows better communication between health care providers. [31] The mean percentage of drugs prescribed by generic name was too low (5%) compared with the optimal value (100%).[30]

In this study, ACI of cephalosporins were found to be 2.68 DDD per 100 bed days which was comparatively much lower than the results reported by Kaya et al where ACI in the surgery unit were found to be 15.5 DDD per 100 bed days in 2011 and 14.5 DDD per 100 bed days in 2012 respectively.[32] Another similar study conducted by Sozen et al found ACI to be 38.7 DDD per 100 bed days.[12] This result can be linked to the fact that in tertiary care hospitals clinically more complicated and seriously ill patients are being treated as compared to other hospitals. In the current study, the ACI of third generation cephalosporins (1.87 DDD per 100 bed days) was found to be higher than second generation (0.81 DDD per 100 bed days). The ACI value was found to be lower, even though the compliance to cephalosporin use in the surgical ward was low. This may be related to its generalizability as it was not conducted in multicenter.

The study showed the high percentage of non-compliance (50.4%) towards the hospital antibiotic policy. Comparing with the hospital antibiotic policy (version 1.0.2015), most of the observed non-compliance (50.4%) was directed towards indication, dose, frequency and duration of administration. For SP, it was important to select an antibiotic with narrow anti-bacterial activity to reduce the risk of resistance. Broad spectrum antibiotics could be required later if the patient develops serious infections. According to the hospital antibiotic policy, antibiotic prophylaxis should not continue for more than 24 hrs and does not recommend an additional dose be administered post-operatively.[19] Surgical prophylaxis (SP) with the 3GCs is not recommended for most procedures (clean and clean-contaminated) because it leads to the unacceptable increase in the treatment cost as well as the emergence of resistance.[15,19] First and second generations (cefazolin, cefuroxime) are widely indicated for most of the surgical prophylaxis.[19] In the current study however, more than half of patients were administered by ceftriaxone with unnecessarily prolonged use of more than 24 hrs, against the recommendations of the policy. Other studies reported the same results.[33,34] This may be due to inaccessibility of antibiotics or severity of infections, which was justified by the surgeons. It is in contrast to the results of the study conducted by Sudanese in which they reported cefazolin and cefuroxime as the most commonly used.[35] In case of intra-abdominal infections, the majority of patients (45.9%) were prescribed with cefotaxime instead of ceftriaxone as mentioned in the policy. This may be due to the lesser cost of cefotaxime (Rs. 32) than ceftriaxone (Rs. 50),

which was clarified from the surgeons and also, it is difficult to diagnose surgical infections.

Limitations of our study include a small sample size and short duration of the study. The short duration of study (11 months) leads to lack of precise and accurate data as well as improper estimation of cephalosporins treatment outcomes. Also, the justification by the physician regarding the non-compliant to the hospital antibiotic policy was lacking.

The findings of the present study concluded that the utilization of cephalosporins, especially 3GCs was high and ceftriaxone was found to be most prevalently used cephalosporin amongst all others belonging to this class, for the treatment and prevention of infections. Cephalosporins were mainly indicated for intra-abdominal infections and surgical prophylaxis. It is evident from this study that the prescribing practices of antibiotics and parenteral showed deviation from WHO standards. This study shows a variation in compliance with the hospital antibiotic policy; moreover, the lack of specific recommendations for some indications increases the use of practices that are based on experiences of surgeon and are not always evidence based. To achieve the optimal compliance to the hospital antibiotic policy, so as to reduce risk of SSI and to prevent resistance and treatment cost we recommend the accessibility of guidelines on the hospital information system with strict periodic compliance audits and monitoring practices related to the rational use of cephalosporins. Also, further similar type of studies should be conducted to emphasize and re-emphasize the rational use of cephalosporins in the future.

ACKNOWLEDGEMENTS

REFERENCES

1. Laxminarayan R, Duse A, Wattal C, Zaidi AK, Wertheim HF, Sumpradit N, et al. Antibiotic resistance the need for global solutions. The Lancet Infect Dis. 2013;13(12):1057-98.
2. Laxminarayan R, Chaudhury RR. Antibiotic Resistance in India: Drivers and Opportunities for Action. PLoS Med. 2016;13(3):e1001974.
3. Patel D, Chhaiya S, Mehta D. Drug utilization study-pattern of use of anti-microbial drugs among post-operative patients in department of general surgery at a tertiary care hospital. Int J Basic Clin Pharmacol. 2017;6(6):1482-5.
4. Monjur F, Rizwan F, Ghosh N. Surgical site infection related risk factors and usage of antibiotics in two different tertiary care hospitals of Dhaka city, Bangladesh. Asian J Pharm Clin Res. 2018;11(8):184-8.
5. Raut A, Cherian T, Chauhan S, Pawar A. Antibiotic utilization pattern at the surgery department of a tertiary care hospital. Asian J Pharm Clin Res. 2017;10(6):131-4.
6. Khan AKA, Mirshad PV, Rashed MR, Banu G. A Study on the Usage Pattern of Antimicrobial Agents for the Prevention of Surgical Site Infections (SSIs) in a Tertiary Care Teaching Hospital. J Clin Diagn Res. 2013;7(4):671-4.
7. Ayinalem G, Gelaw B, Bela A, Linjesa J. Drug use evaluation of ceftriaxone in medical ward of Dessie Referral Hospital, North East Ethiopia. Int J ChemNatur Sci. 2013;1(1):12-6.
8. Abebe FA, Derbew F, Berhe DF, Berhe AH, Hishe HZ, Akaleweld MA. Drug use evaluation of Ceftriaxone:the case of Ayder Referral Hospital, Mekelle, Ethiopia. Int J Pharm Sci Res. 2012;3(7):2191-5.
9. Geroulanos S, Marathias K, Kriaras J, Kadas B. Cephalosporins in surgical prophylaxis. Journal of Chemotherapy.2001;13(Suppl 4):23-6.
10. Chandelkar U, Rataboli P. A study of drug prescribing pattern using WHO prescribing indicators in the state of Goa, India. Int J Basic Clin Pharmacol. 2014;3(6):1057-61.
11. Desalegn A. Assessment of drug use pattern using WHO prescribing indicators at Hawassa University teaching and referral hospital, south Ethiopia:a cross-sectional study. BMC Health Services Res. 2013;13(1):170
12. WHO Collaborating Centre for Drug Statistics Methodology: Guidelines for ATC classification and DDD assignment Oslo, 2016.
13. Aly AY, Omar AA, Badawy DA, Al-Mousa HH, Sadek AA. Audit of Physicians' Adherence to the Antibiotic Policy Guidelines in Kuwait. Med Princ Pract. 2012;21:310-7.
14. Testa M, Stillo M, Giacomelli S, Scoffone S, Argentero P, Farina E, et al. Appropriate use of antimicrobial prophylaxis:an observational study in 21 surgical wards. BMC Surg. 2015;15(1):63.
15. Ather Z, Lingaraju N, Lakshman S, Harsoor MS. Assessment of rational use of antibiotics in surgical prophylaxis and post- operative cases at district hospital Gulbarga. Int Surg J. 2017;4:555-9.
16. Eric HT, Dick GR. Text book of therapeutics:drugs and disease management. 6th edition. Baltimore: Williams and Wilkins. 1996.
17. WHO. Drug and therapeutic committee, a practical guide to drug use evaluation; Drug use evaluation (Drug utilization review), 2003;155.

18. Vooss AT, Diefenthaeler HS. Evaluation of prescription indicators established by the WHO in Getulio Vargas - RS. Braz J Pham Sci. 2011;47(2):385-90.
19. Hospital Infection Control Committee, Antibiotic Policy, version 1.0.2015. Pune:Bharati Vidyapeeth (Deemed to be University) Medical College Hospital and Research Centre; 2015: 1-63.
20. Venkatesh S, Chauhan LS, Gadpayle AK, Jain, TS, Ghafur A, Wattal C, et al. National Treatment Guidelines for Antimicrobial Use in Infectious Diseases. India: National Centre For Disease Control, MOHFW, Government of India; 2011: 1-64.
21. Mohamed OI, Saber-Ayad M. Antibiotic Misuse in Different Hospital Wards (A Pilot Study in an Egyptian Hospital). Asian J Pharm Clin. 2012;5:95-7.
22. Pinto Pereira L, Phillips M, Ramlal H, Teemul K, Prabhakar P. Third generation cephalosporin use in a tertiary hospital in Port of Spain, Trinidad: need for an antibiotic policy. BMC Infect Dis. 2004;4(1):59.
23. Shankar RP, Partha P, Shenoy NK, Easow JM, Brahmadathan KN. Prescribing patterns of antibiotics and sensitivity patterns of common microorganisms in the Internal Medicine ward of a teaching hospital in western Nepal: a prospective study. Ann Clin Microbiol Antimicrob. 2003;2:7.
24. Shankar P, Subish P, Upadhyay D, Dubey A, Deshpande V. Cephalosporin utilization in the inpatient wards of a teaching hospital in Western Nepal. JIOM. 2005;27:7-12.
25. Taye M. Wound infection in TikurAnbessa Hospital, surgical department. Ethiop Med J. 2005;43(3):167-74.
26. Chin V, Harding HE, Tennant I, Soogrim D, Gordon-Strachan GM, Frankson MA. Dynamics of antibiotic usage in the intensive care unit at the University hospital of the West Indies. West Indian Med J. 2010;59(2):159-64.
27. Tünger Ö, Dinç G, Özbakkaloglu B, Atman Ü, Algün Ü. Evaluation of rational antibiotic use. Int J Antimicrobial Agents. 2000;15(2):131-5.
28. Sileshi A, Tenna A, Feyissa M, Shibeshi W. Evaluation of ceftriaxone utilization in medical and emergency wards of Tikur Anbessa specialized hospital:a prospective crosssectional study. BMC Pharmacol Toxicol. 2016;17:7.
29. Kheder SI. Cephalosporin Usage and Resistance Trend in a Sudanese Hospital Surgical Wards. JPBMS. 2011;11(11):1-6.
30. Isah AO, Ross-Degnan D, Quick J, Laing R, Mabadeje AFB. The development of standard values for the WHO drug use prescribing indicators. ICUM/EDM/WHO. Available at: http://www.archives.who.int/prduc2004/rducd/ICIUM_Posters/1a2_txt.html. Accessed on 16 August 2016.
31. El Mahalli AA, Akl OA. Effect of adopting integrated management of childhood illness guidelines on drug use at a primary health care center:a case study from Egypt. J Family Community Med. 2011;18:118-23.
32. Bozkurt F, Kaya S, Gülsün R, Gulsun S, Deveci O, Dayan S, et al. Analysis of antimicrobial consumption and cost in a teaching hospital. J Infect Public Health. 2014;7:161-9.
33. Argaw NA, Shumbash KZ, Asfaw AA, Hawaze S. Assessment of surgical antimicrobial prophylaxis in Orthopaedics and Traumatology Surgical Unit of a Tertiary Care Teaching Hospital in Addis Ababa. BMC Res Notes. 2017;10(1):160.
34. Ayele Y, Taye H. Antibiotic utilization pattern for surgical site infection prophylaxis at DilChora Referral Hospital Surgical Ward, Dire Dawa, Eastern Ethiopia. BMC Research Notes. 2018;11(1).
35. Elbur A, Yousif M, ElSayed A, Abdel-Rahman M. An audit of prophylactic surgical antibiotic use in a Sudanese Teaching Hospital. Int J Clin Pharm. 2013;35(1):149-53.

APPENDIX I

Table 1: Antibiotic choice with dosing schedule.

Name of condition	Type 1 (community acquired)	Type 2 (health-care associated)	Type 3 (nosocomial infections)
Diabetic foot	IV Co-amoxiclav 1.2 gm q 8 h/ IV Ceftriaxone 1 gm q12 h if beta lactam allergy IV Clindamycin 600 q 8 h	IV PIP-TZ4.5 gmq6h If Suspected MRSA infection IV Vancomycin1 gm q 12 h	IV Meropenem 1gm q8h IV Imipenem + Cilastatin 1gm q6h IV/IV. If MRSA infection Vancomycin 1 gm IV q 12 h
Intra-abdominal extra-biliary and biliary	IV Ceftriaxone1-2 gm q 12 h+IV Metronidazole 500 mg q 8 h or IV PIP-TZ 4.5 gm q 6 h	IV Meropenem 1 gm q 8 h/ IV Imipenem-cilastatin 500 mg q 6 h	IV Meropenem 1gm q8h / IV Imipenem -cilastatin 500 mg q6h In case of suspected *Acinetobacter* or XDR Gram negative organisms Colistin.5 MU BD If MRSA or *Enterococcus* suspected IV Vancomycin 1 gm q12h / Teicoplanin (400mg IV q12h for 3 doses, then q24h) If VRE suspected Linezolid 600 mg IV q12h
Head and neck	Ceftriaxone 1 gm q 12 h IV + Metronidazole Or PIP-TZ 4.5 gm q 6 h IV. If MRSA suspected Add Vancomycin 1 gm IV q 12 h If CNS infection Ceftazidime 2 gm q8h IV instead of ceftriaxone/ PIP-TZ	Meropenem 2gm q 8 h IV + Vancomycin 1 gm q 12 h IV	If fungal infection suspected Ampho B If VRE suspected Linezolid If XDR or PDR Gram negative infection suspected Colistin 4.5MUBD If CNS infection add intrathecal antibiotics as above
Sternal chest abdominal perineal	Ceftriaxone 1gm q12h IV + Metronidazole Or PIP-TZ 4.5 gm q 6 h IV. If MRSA suspected Add Vancomycin 1 gm IV q 12 h		

Table 2: Antibiotic prophylaxis for surgery.

Procedure	Antibiotic
Clean surgeries (example: elective hernia repair, breast surgeries)	Cefazolin / cefuroxime
Orthopedic / neuro surgery	Cefazolin / cefuroxime
Cardiovascular / vascular surgery	Cefazolin / cefuroxime
Ophthalmic surgery	Topical quinolone. Systemic- cefazolin / cefuroxime
Head, neck and ENT surgery	Cefazolin / cefuroxime
Gastroduodenal	Cefuroxime / cefazolin
Biliary	Cefuroxime / cefazolin/ cefoperazone-sulbactum
Appendicular / colorectal surgery	Cefuroxime / cefazolin and metronidazole
Abdominal / vaginal hysterectomy / caesarian section	Cefazolin / cefuroxime +metronidazole
Urologic surgery	Cefuroxime (or as guided by urine culture)
Preoperative (cataract surgery)	Moxifloxacin eye drops 0.5% 4 times a day 2 days prior to surgery
Post-operative (cataract surgery)	Moxifloxacin eye drops 0.5% 4 times a day for 15 days