Journal of Applied Pharmacy

Mohamoud et al., J App Pharm 2016, 8:2
DOI: 10.4172/1920-4159.1000220

Research Article Open Access

Utilization Assessment of Surgical Antibiotic Prophylaxis at Ayder Referral Hospital, Northern Ethiopia

Said Aden Mohamoud[1], Teshager Aklilu Yesuf [2] and Eskinder Ayalew Sisay[3]*

[1]*Faculty of Health Sciences, Global Science University, Galkaio - Puntland, Somalia*
[2]*Department of Pharmacy, College of Health Sciences, Wollo University, Dessie, Ethiopia*
[3]*Department of Pharmacy, College of Health Sciences, Mekelle University, Mekelle, Ethiopia*

Abstract

Introduction: Surgical site infection represents a significant burden in terms of patients' morbidity, mortality and hospital costs which can be prevented using prophylaxis.

Objective: To assess rate of compliance to Surgical Antibiotic Prophylaxis (SAP) guidelines at Ayder Referral Hospital (ARH).

Method: Prospective cross-sectional study was conducted from 12th March to 28thApril, 2015. Data were collected using data abstraction checklist for all patients who underwent surgery and met inclusion criteria. SAP Guidelines and CDC Wound Classification were used as data assessment protocols. Epidata 3.1 and SPSS 16 were used for data entry and analysis of descriptive statistics.

Results: A total of 196 patients with mean age of 37.84 years were recruited (female, 58.7%). Of these, 62.2% received SAP but prophylaxis was needed in 58.2%. The total compliance to SAP guideline was 21.9% and 25% for national Standard Treatment Guideline (STG) and American Society of Health-system Pharmacist (ASHP) guideline respectively. Selection of SAP (national STG 100% versus ASHP Guideline 89.5%) was the most deviated parameter from SAP guidelines followed by duration (63.5%), indication (19.4%) and dose (10.4%). Most commonly used agent was ceftriaxone (85.2%).

Conclusion: Current practice of ARH is hugely divergent from SAP guidelines. Use of broader spectrum antibiotics for extended period was common.

Keywords: Compliance; Surgery; Antibiotics; Prophylaxis; Ethiopia

Introduction

Surgical site infection (SSI) is one of major complication of surgical procedures and it is the second most common nosocomial infection next to urinary tract infection [1]. It represents a significant burden in terms of patient's morbidity, mortality and hospital costs [2]. It is found that patients who develop SSI are up to 60% more likely to spend time in the intensive care unit, five times more likely to be readmitted to hospital and twice as likely to die as compared to patients without an SSI [2]. Surgical antibiotic prophylaxis (SAP) is administration of short course of antimicrobial agent prior to surgery to prevent SSI. Randomized controlled trials have consistently demonstrated that SAP is among the effective measures for preventing SSI [3,4]. For optimal prophylaxis, SAP should be used when indicated, and the selected agent should be with targeted spectrum of likely microbial that can contaminate the wound, and should be administered at sufficiently high concentrations that maintain bactericidal minimal inhibitory concentration in serum, tissues and surgical wound during the whole time that the incision is open and at risk of bacterial contamination [5].

Studies have shown that approximately 15% of all antibiotics in hospitals are used for SAP [6,7]. Furthermore, studies from different countries have found that SAP was used excessively and inappropriately [8-19]. A wide variation of overall compliance was seen that range from 0 to 71.9% in various surgical procedures, majority of these studies revealed that noncompliance were in terms of selection, timing of administration and prolonged duration of SAP; indication and dose of SAP were more satisfactory compliant than other parameters [20].

We have done this study to identify gaps and set appropriate recommendations in the practice of using antibiotics for surgical prophylaxis in our hospital that can improve utilization pattern of SAP. The study was done to assess the performance of SAP utilization as compared to other global studies. The study can be inferred for similar setups like us in the country to be used as a baseline study for supplementary surveys. Hence, this study was aimed to determine the rate of compliance to SAP guideline in terms of indication, selection, dose, route of administration and duration.

Methods

Study setting

Prospective cross-sectional study was conducted at Ayder Referral Hospital (ARH) from 12th March to 28th April, 2015. ARH is situated in Mekelle City, the capital of Tigray Regional State, which is 783 km away from the capital of Ethiopia, Addis Ababa. ARH is the only referral and teaching hospital in the region and has 400 beds. It provides services for about nine million people.

Data collection

Data abstraction checklist was prepared with slight modification of previously published studies [11,13,14]. The checklist was divided into four section namely, (1) Patient demographic and medical data (2)

***Corresponding author:** Eskinder Ayalew Sisay, Department of Pharmacy, College of Health Sciences, Mekelle University, P.O.Box 1871, Ayder Referral Hospital, Mekelle, Ethiopia, Tel: +251910072107; E-mail: eskipharma@gmail.com

Received: March 24, 2016; **Accepted:** April 22, 2016; **Published**: April 27, 2016

Citation: Mohamoud SA, Yesuf TA, Sisay EA (2016) Utilization Assessment of Surgical Antibiotic Prophylaxis at Ayder Referral Hospital, Northern Ethiopia. J App Pharm 8: 220. doi:10.4172/1920-4159.1000220

Surgical data (type of surgery, wound class, type of ward and length of hospital stay), (3) Surgical antibiotic prophylaxis usage data (use, name, dose, frequency and duration) and (4) Assessment of surgical antibiotic prophylaxis data (indication, selection, dose, route of administration, duration and total compliance). All relevant data were retrieved from patients' medical records. Data abstraction checklist form was pre-tested on small pilot scale (n=10) and subsequently modified to ensure that the data would provide valid information. Convenient sampling technique was used to enroll patients who underwent emergent and elective operations who met inclusion criteria. Would classification was performed with consultation of surgery residents. Data were collected by three trained fifth year pharmacy students.

Inclusion criteria

All patients who underwent clean, clean-contaminated and contaminated procedures were included.

Exclusion criteria

To avoid difficulty in distinguishing prolonged prophylaxis from post-operative infection treatment, all dirty/infected wounds and those patients who received therapeutic antibiotic before surgery were excluded from the study.

Data assessment protocol

The surgical procedures were grouped into clean, clean-contaminated and contaminated based on CDC Wound Classification [21]. The appropriateness of SAP usage was assessed against national Standard Treatment Guideline (STG) and one of the most reputable and internationally recognized SAP guideline, American Society of Health-System Pharmacist (ASHP) [5,22].

The appropriateness of SAP was evaluated with regard to need for SAP, choice of antibiotic, dose, dosage and total duration of prophylaxis. If more than one drug was given for single operation, all parameters for each drug were evaluated separately. Subsequently, a final assessment of the antibiotic use would be composed of by combining these separate drug evaluation. Any deviation from the guideline of one of the drugs would lead to a final assessment of the prophylactic course as noncompliant to the guidelines. If no antibiotic was recorded, it was assumed that antibiotics were not given. If antibiotic was given while it was not indicated, the parameters of antibiotic choice, dose and duration were not evaluated. Total compliance to SAP guideline was referred as the sum of 'indicated and administered with appropriate choice, dose, dosage form and duration' or 'not indicated and not administered' (Table 1). Since ceftriaxone is not included in the national STG, we assumed that the dose of ceftriaxone was appropriate if its dose was as recommended by ASHP guideline.

Statistical analysis

The collected data were coded, cleaned and entered into Epidata 3.1 and then exported to Statistical Package for the Social Sciences 16 (SPSS Inc, Chicago, Illinois, USA) for analysis. Frequencies and percentages were used to describe categorical variables while means and standard deviations were used to describe continuous variables.

Ethical consideration

Ethical clearance was obtained from Ethical Review Committee of College of Health Sciences, Mekelle University. Subsequently, a formal letter of permission was also obtained from the Department of Pharmacy and Medical Director of Ayder Referral Hospital. The issue of assuring privacy and confidentiality had been given more attention during the study by keeping the patient's name anonymously and using identification number to refer each study participants.

Results

Demographic and surgical data

During the study period, a total of 196 patients who underwent surgery and met our inclusion criteria were conveniently selected. Of total selected patients (n=196), 104 (58.7%) were females. Most of them, 103 (88.3%), were with no any comorbidity. The mean age of study participants was 37.84 ± 19.42 years. The mean duration of participants' hospital stay was 10.68 ± 6.07 days (Table 2).

Parameter	Noncompliance
Indication	Indicated but not administered Not indicated but administered
Selection	Agent differ from recommendation •Narrow - did not cover the anticipated range of bacteria •Broad/Unnecessary combination – cover more bacteria than anticipated
Dose	Dose differed from recommendation
Dosage	Dosage differed from recommendation
Duration	Duration greater than 24 h

Table 1: Criteria for assessment of compliance to SAP guideline.

Variable	Frequency (n=196)	Percentage (%)
Sex		
Male	81	41.3
Female	114	58.7
Age		
Mean (± SD)	37.84	19.42
Comorbidities		
Diabetes Mellitus (DM)	1	0.5
Hypertension (HTN)	11	5.6
Malnutrition	2	1.0
On corticosteroids	3	1.5
HIV	1	.5
Tuberculosis	4	2.0
DM+HTN	1	0.5
No comorbidities	173	88.3
Duration of Hospital Stay		
Mean (± SD)	10.39	6.07
Type of Ward		
General Surgery	100	51.0
Orthopedics	17	8.7
Pediatrics	27	13.8
Gyn/obstetrics	37	18.9
Miscellaneous	15	7.7
Type of Surgery		
Elective	148	75.5
Emergency	48	24.5
Type of Procedure		
Urology	25	12.8
Head and Neck	21	10.7
Neurosurgery	11	5.6
Orthopedics	22	11.2
Gynecology/Obstetrics	37	18.9
Abdominal	53	27.0
Skin and deep tissue	24	12.2
Vascular	3	1.5
Wound Class		
Clean	82	41.8
Clean-contaminated	88	44.9
Contaminated	26	13.3

Table 2: Demographic and surgical data of study participants at Ayder Referral Hospital, Ethiopia (12th March to 28th April, 2015).

Majority of patients, 100 (51.0%) were from general surgery ward while 37 (18.9%), 27 (13.8%) 17 (8.7%) and 15 (15%) participants were respectively from gynecology/obstetrics, pediatric, orthopedics and miscellaneous wards. More than three-fourth (75.5%) of the surgical operations were elective surgeries whereas 48 (24.5%) were emergency operations. Abdominal (27%) and vascular operations (1.5%) were the most and the least common procedures respectively. Eighty two (41.8%), 88 (44.9%) and 26 (13.3%) of the procedures were respectively clean, clean-contaminated and contaminated procedures.

Surgical antibiotic prophylaxis usage pattern

Of the selected participants (n=196), 122 (62.2 %) received SAP. The most commonly used SAP was ceftriaxone, 104 (85.2%). Of patients (n=115) to whom SAP were indicated and administered, 118 (96.7%) were given through parenteral route (Table 3).

Assessment of surgical antibiotic prophylaxis

Of the patients (n=122) to whom SAP were given, 115 (58.7%) had indication and 7 (3.6%) had no indication to use. And of the patients (n=74) to whom SAP were not given, 31 (15.8%) were indicated to use SAP but not administered (Table 4). Of the patients (n=115) to whom SAP were indicated and administered; 103 (89.6%), 6 (5.2%), 6(5.2%) of their administered doses were respectively accurately, sub-dose and over-dose. Whereas 42 (36.5%) and 73 (63.5%) of those patients to whom SAP was appropriately administered, duration of use was less than 24 h and greater than 24 h, respectively.

Selection of SAP (National STG 100% versus ASHP Guideline 89.5%) was the most common noncompliant to guidelines followed by duration (63.5%), indication (19.4%) and dose (10.4%). Route of administration was the only SAP parameter that met full compliance to SAP guidelines (Figure 1).

Of the selected participants, 62% received SAP and compliance to all the stated parameters under evaluation were respectively 0% and 3.1% for compliance to national STG and ASHP guideline. Conversely, 43 (21.9%) of the patients had no indication and were not given SAP. Therefore, the total compliance to SAP guideline in this study was 21.9% and 25% for national STG and ASHP guideline, respectively.

Discussion

This study aims to assess the practice of SAP at our hospital with regard to the compliance of national STG and one of the most reputable International SAP guidelines, ASHP. To our knowledge of literature search, this study is the first time in Ethiopia to extensively study the rate of compliance to SAP guidelines.

Variables	Frequency	Percentage
Antibiotic used (n=196)		
Yes	122	62.2
No	74	37.8
Total	196	100
Name of Antibiotic(s) used (n=122)		
Ceftriaxone	104	85.2
Ampicillin	2	1.6
Ceftriaxone+Metronidazole	12	9.8
Amoxicillin+Metronidazole PO+Ceftriaxone+Metronidazole IV	4	3.3
Total	122	100
Number of Antibiotic(s) used (n=122)		
One	106	86.9
Two	12	9.8
Four	4	3.3
Total	122	100

Table 3: SAP Utilization pattern at Ayder Referral Hospital, Ethiopia (12th March to 28th April, 2015).

Variables	National STG		ASHP Guideline	
	Frequency	Percentage	Frequency	Percentage
Indication				
Compliance				
Indicated and administered	115	58.7	115	58.7
Not indicated and not administered	43	21.9	43	21.9
Total	158	80.6	158	80.6
Noncompliance				
Indicated but not administered	31	15.8	31	15.8
Not indicated but administered	7	3.6	7	3.6
Total	38	19.4	38	19.4
Selection				
Compliance				
Adequate	0	0	12	10.4
Noncompliance				
Narrow	30	26.1	19	16.5
Broad/Unnecessary combination	85	73.9	84	73.0
Total	115	100	103	89.5
Dose				
Compliance				
Accurate	103	89.6	103	89.6
Noncompliance				
Sub-dose	6	5.2	6	5.2
Over-dose	6	5.2	6	5.2
Total	12	10.4	12	10.4
Route of Administration				
Compliance	115	100	115	100
Noncompliance	0	0	0	0
Duration				
Compliance				
<24 h	42	36.5	42	36.5
Noncompliance				
>24 h	73	63.5	73	63.5
Overall Compliance				
Compliance	43	21.9	49	25
Noncompliance	153	78.1	147	75

Table 4: Compliance to national STG and ASHP surgical antibiotic prophylaxis guideline at Ayder Referral Hospital, Ethiopia (12th March to 28th April, 2015).

The total compliance to SAP guideline in this study was 21.9% and 25% for national STG and ASHP guideline, respectively. This finding is in consistent from reports in United States 24.6% [17] and Netherland 28% [10] and it is higher than in Iran 0.9% [12] and Nicaragua 7.4% [18]. However, it is far lower than the results from study in Qatar 46.3% [16] and Germany 70.7% [8]. Majority of noncompliance in this study was inappropriate SAP selection and extending the duration of SAP use to more than 24 h.

In this study, 19.4% procedures were noncompliant to SAP guideline in terms of indication. Of these, 3.6% of participants were given SAP despite they were not indicated to them whereas 15.8% of participants who had indication to SAP were not given it. This finding is similar to reports from study in Nicaragua (23%) [18] but lower than in Italy (80.9%) [19].

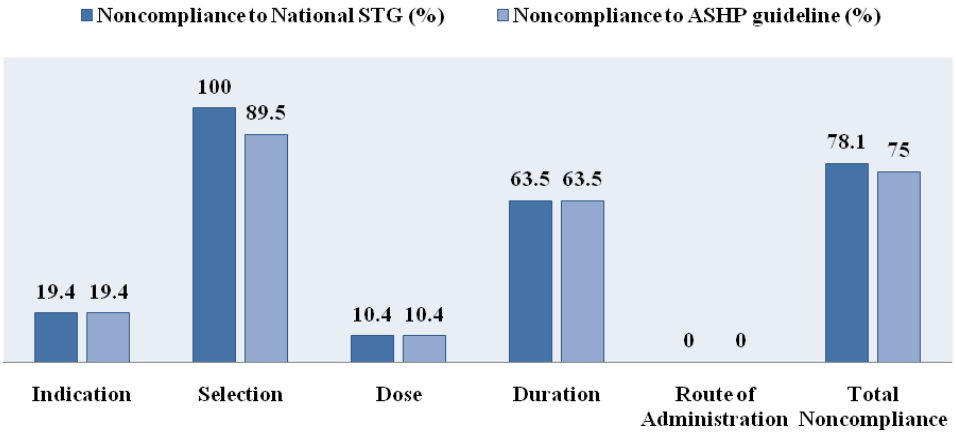

Figure 1: Noncompliance to SAP guideline across difference SAP parameters at Ayder Referral Hospital, Ethiopia (12th March to 28th April, 2015).

The present study demonstrates that ceftriaxone was excessively and inappropriately used for surgical antibiotic prophylaxis in ARH. One hundred and four (85.2%) of the participants were given ceftriaxone only as surgical prophylaxis despite the fact that national STG does not recommend it for any procedures whereas ASHP recommends its use to be limited as single agent for high risk biliary tract procedures and combined with metronidazole for colorectal surgery. As per the general principle of SAP, it is recommended to use antibiotic with narrowest antibacterial spectrum that is effective against the likely pathogens that would contaminate the wound. Ceftriaxone is broad spectrum antibiotic and therefore its use for SAP would rise to the emergence of resistance and would either lead to lack of response or preclude to use this drug for many severe infections (sepsis, meningitis, pneumonia, pyelonephritis etc.) that it is used to treat. Furthermore, ceftriaxone is more costly and less effective than cefazolin do in *S. aureus*.

Of the patients (n=115) to whom SAP were indicated and administered; 89.5% of them have been selected inappropriately. This corroborates the study from Iran (92.5%) [12] but higher than studies from Nicaragua (66.8%) [18], Sudan (64.4%) [14], Qatar (31.5%) [16] France (16.7%) [11], United States (10.8%) [17] and Netherland (8%) [10]. One of the main reported reasons for noncompliance with SAP selection was the use of agents having a broader spectrum than recommended. In this study, 73.0% patients for whom SAP use was recommended were given broad spectrum antibiotics or unnecessary combination. Similar finding was found in study from Sudan (56.3%) [14]. There is false belief that broad/multiple antibiotics are more effective in preventing SSIs [15].

Of the patients (n=115) to whom SAP were indicated and administered; 6 (5.2%) patients were administrated doses that were too high. Most of these patients were pediatrics in which SAP dosing was based on their body weight, they missed the fact that the maximum pediatric dose should never exceed the usual adult dose [5].

One of the common failures to compliance to SAP guidelines is prolonging the duration of SAP beyond the recommended time. In this study, 63.5% of the patients used SAP for more than 24 hours. This is similar to reports from studies in France (65%) [11] and Qatar (59.3%) [16] lower than that of Nicaragua (78.4%) [18] and Sudan (97%) [14]. However, the finding of this study is higher than Iran (46%) [12] and Netherland (18%) [10]. In general, guidelines recommend either single dose of prophylaxis or prophylaxis lasting only 24 h after operation. A systematic review of single versus multiple dose antimicrobial prophylaxis for major surgery studies in between 1974 - 1999 have shown that a single dose of antibiotic is just as effective as multiple doses and there are no differences on the prevention of SSI risk [23]. Moreover, prolonged use of SAP has been associated with emergence of resistant bacterial strains [24], increased incidence of antibiotic associated diarrhea as well as increased costs.

The hospital's supply of available antibiotics has been previously reported to have an important effect on the selection of SAP [25]. The most commonly used drugs for SAP were not available in ARH at the time of this study; the unavailable drugs include cefazolin, cefuroxime, ampicillin-salbuctam and neomycin. This is in line with study from Jordan [26] which found that 68.1% of inappropriate drug selection for SAP was contributed by drug unavailability. In contrast, different studies also stated that in spite of the availability of first line recommended SAP; most surgeons have been reported to fail to act in accordance with guidelines. Kasteren et al. [10] found that the main barriers to compliance to SAP guideline are lack of awareness of appropriate guidelines, lack of agreement of surgeon's with recommendation of guidelines and logistical limitations in the surgical suite and in the ward.

The findings of this study should be interpreted in the light of the following limitations. Primarily, it is single institution study with small sample size; so due care should be given if the results of this study are to be generalized for SAP practice across the other institutions in the country [27,28]. The study is a cross-sectional type and thus it did not investigate cause and effect relationship. Moreover, the current study did not consider two important parameters of SAP namely timing and redosing; these parameters are considered to be one of main cause of noncompliance to SAP guideline. Redosing might perhaps not crucial in this study because ceftriaxone was the most commonly used drug for SAP in ARH and it usually does not require redosing as it has long half-life. Likewise, we have retrieved some data from the medical records and accuracy depends on hospital records. Further studies, which take these variables into consideration, will be needed to solve these limitations.

Conclusion

The current practice of ARH is hugely divergence from SAP guidelines. Noncompliance to SAP guidelines was largely due to the use agents having broader spectrum than the recommended as well as

extending the duration of SAP beyond the recommended time.

This study suggests the need to avail most of the recommended SAP antibiotics, specifically cefazolin. It might also be important to perform continued surveillance of SAP practice, development of local SAP guideline centered on evidence based medicine with consideration of local context, continuous educational programs and training and recruitments of clinical pharmacist to all surgical wards.

Summary

Surgical site infection represents a significant burden in terms of patients' morbidity, mortality and hospital costs which can be prevented by prophylaxis. A prospective cross-sectional study was conducted from 12th March to 28th April, 2015 at Ayder Referral Hospital (ARH), northern Ethiopia to assess rate of compliance to Surgical Antibiotic Prophylaxis guidelines. Data were collected using data abstraction checklist for all patients who underwent surgery and met the inclusion criteria. SAP Guidelines and CDC Wound Classification were used as data assessment protocols. Epidata 3.1 and SPSS 16 were used for data entry and analysis of the descriptive statistics. A total of 196 patients with mean age of 37.84 ± 19.42 years were recruited (female, 58.7% of total). Of these, 62.2% received SAP but prophylaxis was needed in 58.2%. The total compliance to SAP guideline was 21.9% and 25% for national Standard Treatment Guideline (STG) and American Society of Health-system Pharmacist (ASHP) guideline respectively. Selection of SAP (national STG 100% versus ASHP Guideline 89.5%) was the most deviated parameter from SAP guidelines followed by duration (63.5%), indication (19.4%) and dose (10.4%) %). The current practice of ARH is hugely divergent from SAP guidelines.

Acknowledgement

We would like to thank the study patients for their willingness to participate in the study. We are also very much grateful to Ayder Referral Hospital's Medical Director and surgical staff for their kind cooperation during the data collection and naming of surgical wound type.

References

1. Wenzel RP (2007) Health care-associated infections: major issues in the early years of the 21st century. Clin Infect Dis 45 Suppl 1: S85-S88.
2. Perencevich EN, Sands KE, Cosgrove SE, Guadagnoli E, Meara E, et al. (2003) Health and economic impact of surgical site infections diagnosed after hospital discharge. Emerg Infect Dis 9: 196-203.
3. Bowater RJ, Stirling SA, Lilford RJ (2009) Is antibiotic in surgery a generally effective intervention? Testing a generic hypothesis over a set of meta-analyses. Ann Surg 249: 551-556.
4. Aiken AM, Karuri DM, Wanyoro AK, Macleod J (2012) Interventional studies for preventing surgical site infections in sub-Saharan Africa - A systematic review. Int J Surg 10: 242-249.
5. Bratzler DW, Dellinger EP, Olsen KM, Perl TM, Auwaerter PG, et al. (2013) Clinical practice guidelines for antimicrobial prophylaxis in surgery. Am J Health Syst Pharm 70: 195-283.
6. Ansari F, Erntell M, Goossens H, Davey P (2009) The European surveillance of antimicrobial consumption (ESAC) point-prevalence survey of antibacterial use in 20 European hospitals in 2006. Clin Infect Dis 49: 1496-1504.
7. Robert J, Péan Y, Varon E, Bru JP, Bedos JP, et al. (2012) Point prevalence survey of antibiotic use in French hospitals in 2009. J Antimicrob Chemother 67: 1020-1026.
8. Hohmann C, Eickhoff C, Radziwill R, Schulz M (2012) Adherence to guidelines for antibiotic prophylaxis in surgery patients in German Hospitals: a multicentre evaluation involving pharmacy interns. Infection 40:131-137.
9. Oh AL, Goh LM, Nik Azim NA, Tee CS, Shehab Phung CW (2014) Antibiotic usage in surgical prophylaxis: a prospective surveillance of surgical wards at a tertiary hospital in Malaysia. J Infect Dev Ctries 8: 193-201.
10. Kasteren MEv, Kullberg BJ, Boer ASd, Groot JM-d, Gyssen IC (2003) Adherence to local hospital guidelines for surgical antimicrobial prophylaxis: a multicentre audit in Dutch hospitals. J Antimicrob Chemother 51: 1389-1396.
11. Miliani K, L'Heriteau F, Astagneau P (2009) Non-compliance with recommendations for the practice of antibiotic prophylaxis and risk of surgical site infection: results of a multilevel analysis from the INCISO Surveillance Network. J Antimicrob Chemother 64:1307-1315.
12. Vessal G, Namazi S, Davarpanah MA, Foroughinia F (2011) Evaluation of prophylactic antibiotic administration at the surgical ward of a major referral hospital, Islamic Republic of Iran. East Mediterr Health J 17: 663-668.
13. Ozgun H, Ertugrul BM, Soyder A, Ozturk B, Aydemir M (2010) Peri-operative antibiotic prophylaxis: adherence to guidelines and effects of educational intervention. Int J Surg 8: 159-163.
14. Elbur AI, Yousif MA, Elsayed AS, Abdel-Rahman ME (2013) An audit of prophylactic surgical antibiotic use in a Sudanese Teaching Hospital. Int J Clin Pharm 35: 149-153.
15. Parulekar L, Soman R, Singhal T, Rodrigues C, Dastur FD, et al. (2009) How good is compliance with surgical anitbiotic prophylaxis guidelines in a tertiary care private hospital in India? A prospective study. Indian J Surg 71:15-18.
16. Abdel-Aziz A, El-Menyar A, Al-Thani H, Zarour A, Parchani A, et al. (2013) Adherence of surgeons to antimicrobial prophylaxis guideline in a tertiary general hospital in a rapidly developing country. Advances in Pharmacological Sciences 2013: 6.
17. Goede WJ, Lovely JK, Thompson RL, Cima RR (2013) Assessment of prophylactic antibiotic use in patients with surgical site infections. Hosp Pharm 48: 560-567.
18. van Disseldorp J, Slingenberg EJ, Matute A, Delgado E, Hak E, et al. (2006) Application of guidelines on preoperative antibiotic prophylaxis in León, Nicaragua. Neth J Med 64: 411-416.
19. Napolitano F, Izzo MT, Di Giuseppe G, Angelillo IF (2013) Evaluation of the appropriate perioperative antibiotic prophylaxis in Italy. PLoS One 8: e79532.
20. Ng RS, Chong CP (2012) Surgeons' adherence to guidelines for surgical antimicrobial prophylaxis - a review. Australas Med J 5: 534-540.
21. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR (1999) Guideline for Prevention of Surgical Site Infection. Infection Control and Hospital Epidemiology 20: 32.
22. Food, Medicine and Healthcare Administration and Control Authority of Ethiopia (2014) Standard Treatment Guidelines for General Hospital, (3rd edn.), Ethiopia.
23. McDonald M, Grabsch E, Marshall C, Forbes A (1998) Single versus multiple dose antimicrobial prophylaxis for major surgery: a systematic review. Aust N Z J Surg 68: 388-396.
24. Harbarth S, Samore MH, Lichtenberg D, Carmeli Y (2000) Prolonged antibiotic prophylaxis after cardiovascular surgery and its effect on surgical site infections and antimicrobial resistance. Circulation 101: 2916-2921.
25. Thomas JA, Martin V, Frank S (2000) Improving pharmacy supply-chain management in the operating room. Healthc Financ Manage 54:156-160.
26. Al-Azzam SI, Alzoubi KH, Mhaidat NM, Haddadin RD, Masadeh MM, et al. (2012) Preoperative antibiotic prophylaxis practice and guideline adherence in Jordan: a multi-centre study in Jordanian hospitals. J Infect Dev Ctries 6:715-720.
27. Gagliardi AR, Fenech D, Eskicioglu C, Nathens AB, McLeod R (2009) Factors influencing antibiotic prophylaxis for surgical site infection prevention in general surgery: a review of the literature. Can J Surg 52: 481-489.
28. Khan SA, Rodrigues G, Kumar P, Rao PG (2006) Current challenges in adherence to clinical guidelines for antibiotic prophylaxis in surgery. J Coll Physicians Surg Pak 16: 435-437.