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Original Article

Antibiotics Prescription Pattern and their Financial Burden before and after Intervention in Traumatic Injuries

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Abstract

Background: Antibiotics contribute to a lot of patients' treatment. However, improper prescription and wasteful use of antibiotics may lead to various side effects or complications such as medicinal resistance and lack of treatment, resulting in an excessive financial burden.
Objectives: The present study aimed to compare antibiotics prescription pattern and their financial burden before and after intervention based on prophylactic antibiotics guidelines in traumatic surgical sections.
Methods: This analytical and cross-sectional study was conducted in 2018 on patients undergoing surgery in 4 general, urology, neurosurgery, and orthopedics surgery sections. The sample consisted of 464 patients with traumatic injuries. A researcher-made questionnaire was used as a principal instrument for gathering data. The data was analysed using SPSS (version 21).
Results: The accordance of dose, method and kind of prescribed antibiotics with the instructions and guidelines after intervention increased to 29, 5.1 and 28.8%, respectively. There was a significant relationship between dose, method, and kind of prescribed antibiotic before and after the intervention ($P<0.05$). The financial burden of prescribed antibiotics before and after the intervention was 56400480 and 52789290 IRR, respectively.
Conclusion: Based on the results, the intervention was effective in accordance with dose, method and kind of prescribed antibiotics. Also, financial burden reduced by 6.4% after the intervention. Continuous monitoring of antibiotic prescription based on instructions, training instructions of prophylaxis antibiotics to physicians, and infectious monitoring committee meetings can prevent irrational prescriptions and reduce the excessive financial burden on society, government and insurance organizations.

Keywords: Prescription Pattern, Antibiotic Resistance, Traumatic injuries, Guidelines of prophylactic antibiotic, Financial burden.

Introduction

Appropriate use of antibiotic prophylaxis plays a crucial role in providing effective treatment strategies and better health care to patients.[1] One of the common methods for treating patients is medicinal treatment. The provision of scientific and standard guidelines for rational medicine prescription and consumption are key factor in effectiveness of treatment and accelerating of recovery.[1] Medications account for about 20 to 40% of the health budget in developing countries and 10 to 20% of health expenditures in developed countries. Therefore, it is necessary to pay a special attention to rational use of medications as a global issue.[2] In this regard, studies showed that 0.9% of GDP in developing countries is devoted to irrational drug prescriptions.[3]

Antibiotics are one of the most important and commonly used drugs, which are very effective in controlling microorganisms without harming human cells.[4] Despite the fact that antibiotic prescription is essential in most bacterial infections, not taking these drugs can endanger the patient's life. Most studies have shown that 30-60 % of prescription have been prescribed irrationally.[5] Irrational prescription of antibiotics includes the selection of inappropriate antibiotics, inappropriate dosage, inappropriate prescription methods and prescription at inappropriate times.[6] Each of these items can lead to numerous complications in patients such as changing the microbial flora, new infection, increased bacterial resistance and increased unnecessary costs.[7]

Increasing resistant species and reducing the efficacy of antibiotics impose financial burden on health systems. The cost of antimicrobial loss has been estimated to be from $ 21,000 million to $ 34,000 million in the United States and

nearly $ 1,500 million in Europe.[9] Since the most resistance has been occurred in countries with the most consumption, it is essential to regulate new and more effective policies to control the over-consumption of antibiotics around the world.[8]

One of the best practices in this regard is reviewing prescriptions based on existing protocols. There are various guidelines in the world for supporting adherence to the principles of prescribing preventive surgical antibiotics, which are based on valid scientific surgical, pharmacological and infectious resources, and all of them follow the scientific principles and rules, and there are no differences in their general principles.[10]

The emergence of antibiotic-resistant organisms is a global problem in societies and hospitals, despite the efforts of many organizations and experts to reduce the excessive use of antibiotics in hospitals, unfortunately, this trend continues in Iran.[11]

Most of the previous studies have only reviewed the patterns of antibiotics prescription, such as Eddine et al.,[4] Ahmad et al., in Sudan[5] and Selva et al.,[6] studies. However, few studies have examined the rationality of prophylactic prescriptions, especially their financial burden.

Due to the wasteful use of antibiotics, growing antibiotic resistance, lack of implementing the standard pattern in prescribing antibiotics in Iran, and the excessive financial burden of irrational prescription of these medicines on the health care system, it seems necessary to pay a special attention, review and implement required interventions in this section.

Objectives

The present study was conducted to compare antibiotics' prescription patterns based on the standard method before and after intervention in hospitalized patients in traumatic surgical sections as well as comparing their financial burden.

Materials and Methods

This analytical and cross-sectional study was conducted based on the available information in 2018 in patients with traumatic injuries admitted to surgery sections in one of the educational ttraumatic hospitals in Yazd city, Iran. The study population consisted of the hospitalized patients with traumatic injuries in 4 neurosurgery, general, urology, and orthopedic surgery sections. The sample size was estimated in accordance with the following equation:

$$n \geq \frac{\left(z_1 - \frac{\alpha}{2}\right)\sigma^2}{d^2}$$

In the present study, confidence coefficient and error percentage were considered 0.95, and 0.05, respectively and the sample size was calculated to be 384 patients. A total of 464 samples were included in the study. Then, the samples were divided into two groups: 228 patients were studied before the intervention and 236 patients after the intervention. The selection of patients was conducted by using random method and information of patients was recorded during 2018. For data collection, the researcher accessed patients' documentation, records and files and extracted the required information and inserted them in the related form. A researcher-made questionnaire containing different variables such as age, gender, hospital section, duration of hospitalization, type of surgery, surgery group, type of prescribed antibiotics and three questions about the accordance of the prescribed antibiotics with the supervised or managed guideline No. 8. The managed care guideline No. 8 is in relation to the use of prophylactic antibiotics before and after surgery. This guideline was codified by the Ministry of Health in Iran, which includes the principles for the prophylactic prescriptions before and after general, trauma, gynaecology and midwifery, urology, head, neck and ear, and orthopaedic surgeries. In the present study, the designed form of the questionnaire was studied by some hospital experts and specialists, and they confirmed and approved the validity of the content of the form. The forms were completed in two stages. Before the intervention, the records and files of 228 patients were observed and the related form was completed. Then, the intervention was conducted on physicians.

The intervention consisted of three stages. In the first stage, the guideline for prescribing prophylactic antibiotics was announced to sections and a copy version of the protocol was placed in sections. In the second stage, the protocol of prescription for each surgery group was designed in the form of flow-charts and placed in sections, and hence it can be observed by the physicians. Finally, in the third stage, meetings were held with physicians and the protocol of prescribing antibiotics based on the guideline was explained to them.

The financial burden of prescriptions before and after the intervention was calculated based on the type of antibiotics, number of prescriptions and price of each unit. These calculations were performed by the four surgery sections and

the rate of positive or negative growth of the financial burden after the intervention was estimated and compared with before the intervention. To calculate the financial burden of prescriptions, all information was extracted from the hospital information system. Therefore, according to the examined cases and the irrationality of the prophylactic prescriptions, the relevant cost for the cases was extracted according to the prescription date before and after the intervention for each of the studied individuals, and finally the total costs and financial burden were estimated.

The collected data were analysed using SPSS software (version 21) and descriptive statistics of frequency, percentage and Chi-square test to compare the prescribed dose, prescription method, and kind of prescribed antibiotic before and after the intervention. The significance level in all tests of the research was considered less than 0.05.

Results

Of 228 records studied before the intervention, 65.4% were male and 36% were between 20 to 40 years old. The duration of hospitalization for the majority of the patients (70%) was less than five days. Regarding the type of antibiotic, ceftriaxone was prescribed for 19.3%, Ceftazidime for 51.3 %, and Cefazolin for the rest of the cases.

Of 236 records studied after the intervention, 66.9% were male and 40.9% were between 21 to 40 years old. The duration of hospitalization for the majority of patients was between 1 to 5 days (78.6 %). About 26% of the patients were in the general surgery section, 31.2% in urology surgery, 8.4% in neurosurgery surgery, and 34.4% in orthopaedic surgery sections. Regarding the type of antibiotic, 24% of the patients received ceftriaxone, 72.1%, received Ceftazidime and 3.9% of the patients received Cefazolin (Table-1).

Before the intervention, 58%, 81.3%, and 40% of the prescribed dose, prescription method and kind of prescribed antibiotic, in the studied prescriptions were consistent with the guideline, respectively. According to the results, after the intervention, 87%, 86.4% and 68.8% of the prescribed dose, prescription method and prescribed antibiotics were consistent with the care guideline No. 8 in terms of the type of antibiotic. The results of paired sample T-test showed a significant relationship between the accordance of the prescriptions before and after the intervention (Table-2).

Assessing the relationship between background variables of the patients after the intervention showed that there was a significant relationship between the accordance of dose, method and kind of prescribed antibiotic with the guideline and patients' gender ($P<0.05$). Therefore, the degree or extent of compliance with the standards was significantly more in men. There was also a significant relationship between age difference and the prescribed antibiotic, and the highest compliance with the standards was related to the age group between 1 to 20 years. Moreover, there was a significant relationship between the accordance of dose, method and kind of prescribed antibiotic with the guideline and surgery groups, and the highest compliance was observed in urology and orthopaedic groups (Table-3).

Table 1. Sample characteristics

		Frequency (%)	
		before Intervention	**after Intervention**
Sex	Male	149 (65.4)	158 (66.9)
	Female	79 (34.6)	78(33.1)
Age Group	1-20	50 (22)	38(16.2)
	21-40	82 (36)	97(40.9)
	41-60	55 (24)	57(24.1)
	61-80	41 (18)	44(18.8)
hospitalization period (days)	1-5	160 (70)	185(78.6)
	6-10	47 (20.7)	40(16.9)
	11-15	14 (6)	6(2.6)
	16-20	7 (3.3)	5(1.9)
Surgery Group	general surgery	64 (28)	61(26)
	urology surgery	56 (24.7)	74(31.2)
	neurosurgery surgery	87 (38)	20(8.4)
	orthopedic surgery	21 (9.3)	81(34.4)
type of antibiotic	ceftriaxone	44 (19.3)	57(24)
	Ceftazidime	117 (51.3)	170(72.1)
	Cefazolin	67 (29.4)	9(3.9)

Table 2. Prescribed dose, prescription method, and the kind of prescribed antibiotic before and after the intervention according with the instruction

	accorded with the instruction	Frequency (%)		P Value
		before Intervention	after Intervention	
prescribed dose	Yes	132 (58)	205 (87)	0.007
	No	96 (42)	31 (13)	
prescription method	Yes	185 (81.3)	204 (86.4)	0.04
	No	43 (18.7)	32 (13.6)	
kind of prescribed antibiotic	Yes	91 (40)	162 (68.8)	0.001
	No	137 (60)	74 (31.2)	

Table 3. How to match the prescribed dose, prescription method, and the kind of prescribed antibiotic to guideline divided to demographic variables after the intervention

			prescribed dose				prescription method				kind of prescribed antibiotic			
			Yes	No	Total	Sig	Yes	No	Total	Sig	Yes	No	Total	Sig
Sex	**Male**	**Frequency**	144	14	158	0.02	143	15	158	0.04	119	39	158	0.003
		%	61	5.8	66.9		60.4	6.5	66.9		50.4	16.5	66.9	
	Female	**Frequency**	61	17	78		61	17	78		43	35	78	
		%	26	7.1	33.1		26	7.1	33.1		18.2	14.8	33.1	
Age Group (year)	**1-20**	**Frequency**	36	2	38	0.1	37	1	38	0.06	35	3	38	0.006
		%	15.6	0.6	16.2		15.6	0.6	16.2		14.9	1.3	16.2	
	21-40	**Frequency**	77	20	97		75	22	97		64	33	97	
		%	32.5	8.4	40.9		31.8	9.1	40.9		27.3	13.6	40.9	
	41-60	**Frequency**	51	6	57		51	6	57		29	28	57	
		%	21.4	2.6	24		21.4	2.6	24		12.3	11.7	24	
	61-80	**Frequency**	41	3	44		41	3	44		34	10	44	
		%	17.5	1.3	18.8		17.5	1.3	18.8		14.3	4.5	18.8	
Surgery Group	**general surgery**	**Frequency**	41	20	61	0.001	41	20	61	0.001	27	34	61	0.001
		%	17.5	8.4	26		17.5	8.4	26		11.7	14.3	26	
	urology surgery	**Frequency**	74	0	74		74	0	74		46	28	74	
		%	31.2	0	31.2		31.2	0	31.2		19.5	11.7	31.2	
	neurosurgery surgery	**Frequency**	9	11	20		8	12	20		9	11	20	
		%	3.9	4.5	8.4		3.2	5.2	8.4		3.9	4.5	8.4	
	orthopedic surgery	**Frequency**	81	0	81		81	0	81		80	1	81	
		%	34.4	0	34.4		34.4	0	34.4		33.8	0.6	34.4	

The financial burden of prescribed antibiotics before the intervention was equal to 56400480 IRR, which is more than those obtained after the intervention with 52789290 IRR. The results also showed that after of the intervention, the financial burden increased in two surgery sections and decreased in the other two sections, while the total financial burden decreased by 6.4% (Table-4).

Table 4. Financial Burden of Antibiotics Prescription before and after Intervention

Surgery Group	Before Intervention (IRR)	After Intervention (IRR)	Growth (%)
general surgery	14544840	11460170	-21.2
urology surgery	10306300	11258460	9.2
neurosurgery surgery	23520420	4469799	-80.9
orthopaedic surgery	8028913	25600860	218
Total	56400480	52789290	-6.4

Discussion

Based on the guidelines for prescribing dose, method and type of prescribed antibiotic, before the intervention, 18.7-60% of the prescriptions and after the intervention, 13 -31.2 % of the prescriptions were not consistent with the guidelines.

In a study that was conducted in Brazil, before implementing the prophylactic antibiotic protocol, the prescription or non-prescription of antibiotics were correct in 564% of patients.[7] In the Askarian et al.,[8] study only 0.9% of the cases were consistent with the guidelines, and in other studies in Spain[9] and Jordan[10], none of the studied antibiotic prescriptions were in accordance with the guideline. In another study conducted in Leon in Nicaragua only 7% of the cases were in accordance with the instructions.[11] Although the rate of infection after surgery decreases by using antibiotics, inappropriate use of antibiotics in surgeries still exists as a major problem that causes medicinal reactions, increased bacteria-resistant infections and imposed an unnecessary cost on the health care system.[12,13]

Regarding the prescribed dose after the intervention, about 87% of prescriptions were in accordance with the guideline, which increased to 29% in comparison to the before of intervention. The results of the Clinger et al.,[19] and Khalil et al.,[20] studies were consistent with the findings of the present study in terms of prescriptive dosage. In a study that was conducted in Jordan, only 27.9% of the prescribed antibiotics were in accordance with the appropriate dose, and only in 13% of them were consistent with guidelines in term of intervals of prescription.[10] In contrast, in Leon et al., study in Nicaragua, 20% of cases did not conform to instructions of the hospital in terms of the dose of the prescribed antibiotics.[11] In fact, a certain daily dose is the medium or average rate of preserving or maintenance dose of medicine in the main indication in adults. Information relating to the consumption rate of a drug by a determined daily dose is only an estimate of consumption rate and is not the representative of the real rate of consumption. Specific daily dose shows a constant unit of measurement that enables the researcher to evaluate the process of drug consumption pattern and compare it among different populations.[14]

In khan et al., study, complete compliance were observed with the guidelines in 11.2% of patients (129 of 1152). The choice of antimicrobial prophylaxis administration was appropriate in 380 cases (33%), with a higher rate of guideline adherence in appendectomy compared to inguinal hernia, pancreatic duodenectomy, and bariatric surgical procedures.[15] Previous studies reported different adherence rates with guidelines of 97.1%.[2] Giordano et al., reported a lower rate of guideline adherence (5.7%).[3]

Approximately, 86.4% of the prescriptions were in accordance with the guidelines of the prescriptions in the prescribing method, which showed a 5% increase in comparison to before the intervention or pre-intervention state. In a study by Schwarz et al., there was a relationship between antibiotic use methods and complying with guidelines of the prescriptions, and inconsistencies were observed between the prescription method and guidelines of the prescriptions in the outpatients.[16]

Regarding the kind of prescribed antibiotic after the intervention, 24% of the patients received ceftriaxone, 72.1% Ceftazidime, and 3.9% received Cefazolin. In contrast, in other studies, the most commonly prescribed antibiotics were cefuroxime and cefoperazone in orthopaedic surgeries[17] and the combination of ampicillin with acillin and acillin with metronidazole were the most commonly used regimens.[18] Comparing the results of this study with other similar studies in other countries showed a difference in highly-used antibiotics groups in these studies. This difference is clearly due to many reasons involved in antibiotic consumption patterns. For example, the difference can be attributed to the policy of imposing limitations or restrictions for the use of third-generation cephalosporin in European hospitals. Therefore, in order to accurately investigate the reasons for the increase in antibiotic use and choice of antibiotic kind, qualitative studies of drug consumption are needed in comparison to foreign studies. In order to prevent the irrational use of antibiotics, policies and measures must be carried out on antibiotic use at the macro and micro levels.

Regarding the kind of prescribed antibiotic, before the intervention, 60% of prescriptions were inconsistent with the guidelines, which this inconsistency decreased to 31.2% after the intervention. In a study conducted in Iran, 40.7% of prescriptions were suitable in terms of antibiotic type.[25] In Montazeri et al., study, only 37.7% of the prescriptions were consistent with the guideline.[26] Some studies in other countries also showed that 31% of the prescriptions were consistent with the guideline in terms of antibiotic type.[27]

The results implied that there was a significant relationship between the prescribed antibiotic and age difference, the highest consistency between age difference and meeting guidelines was observed in the age group of 1-20 years. In Tissot and Merle study, it was found that in public hospitals and some intensive care units, there was a relationship between age difference of patients receiving antibiotics and

meeting standard protocols, and the rate of consistency with standard protocols at early ages or childhood and elderly ages was more than middle ages and youth, which is in agreement with the findings of the present study.[19,20] Moreover, there was a significant relationship between the consistency of dose, method and type of prescribed antibiotics with the guidelines and surgical groups. The highest percentage of consistency was observed in urology and orthopaedic surgery groups. In a study in Australia, in 4% of heart surgeries and 13% of orthopaedic surgery groups, the prescription of antibiotic was not consistent with the guidelines.[21]

The results demonstrated that 6.4% of the financial burden of antibiotics prescription was reduced after the intervention. Therefore, it is important to pay special attention to financial burden along with other clinical implications in rational antibiotic prescriptions, especially in the situations that various government agencies such as the Ministry of Health and Insurance Organizations of Iran are facing financial problems.

Since the study of rational antibiotic prescription was conducted by infection control experts and physicians, there may be a percentage of error in determining whether the prescriptions are rational or irrational. Also, since the data on costs and financial burden were extracted from the hospital's information system, the failure to record some antibiotics may affect the results of the study. It should be noted that few studies have examined the financial burden of irrational antibiotic prescription, and therefore this study can provide valuable information regarding its financial burden. The research population were selected from traumatic patients who have undergone surgical treatment, and their treatment is highly dependent on antibiotics. Therefore, examining antibiotic prescriptions in this group can be useful for medical policymakers and the health economists.

Conclusions

Overall, it can be concluded that in the present study some surgeries were compatible with guidelines in all cases of prescribing antibiotics, and prescribing more than one type of antibiotic had the highest incompliance with guidelines in all surgery sections. Therefore, long-term prescription of antibiotics in the studied hospital has destructive effects on its economic system. Regarding the kind of antibiotic, each surgeon may act based on his experience; however, regarding the duration of using antibiotic, economic aspects, increased drug resistance and undesirable drug reactions should be considered, because they can pose serious problems to hospitals. Since the early and inappropriate use of antibiotics, as well as using ineffective dose and its inappropriate combination can influence bacteria to become resistant to common antibiotics, paying more attention to the antibiogram of bacteria isolated from patients, increasing people's awareness and knowledge about dangers of self-therapy and intractable treatment with antibiotics may be effective on the reduction of the bacterial resistance. Undoubtedly, codification standard treatment guidelines, if possible, and preparing oral forms of antibiotics can contribute to making injection forms of rational antibiotic use. Selection of antibiotic or changing it based on laboratory results and counselling with microbiologists can be one of the safest ways for prescribing antibiotics which lead to making antibiotic use rational and on the other hand can reduce excessive private payments as well as present and future costs of medicines and financial burden on society, government and insurance organisations.

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Authors' Contribution

All authors pass the four criteria for authorship contribution based on the International Committee of Medical Journal Editors (ICMJE) recommendations.

Conflict of Interests

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References

1. Khan Z, Ahmed N, Zafar S. ur Rehman A; Ullah Khan F; Saqlai M; et al. Audit of antibiotic prophylaxis and adherence of surgeons to standard guidelines in common abdominal surgical procedures. East Mediterr Health J. 2020;26. doi:10.26719/emhj.20.025
2. Klinger G, Carmeli I, Feigin E, Freud E, Steinberg R, Levy I. Compliance with surgical antibiotic prophylaxis guidelines in pediatric surgery. European Journal of Pediatric Surgery.

2015;3(02):199-202. doi:10.1055/s-0034-1368798
3. Giordano M, Squillace L, Pavia M. Appropriateness of surgical antibiotic prophylaxis in pediatric patients in Italy. infection control & hospital epidemiology. 2017;38(7):823-31. doi:10.1017/ice.2017.79
4. Eddine SBZ, Cooper-Johnson K, Ericksen F, Brookes CC, Peppard WJ, Revolinski SL, et al. Antibiotic Duration and Outcome Complications for Surgical Site Infection Prevention in Traumatic Mandible Fracture. Journal of Surgical Research. 2020;247:524-9. doi:10.1016/j.jss.2019.09.050
5. Ahmed F, Koko A, Mohamed O, Elhag R, Khalifa S, Mohamed M, et al. Antibiotics prescreption pattern and resistance profile of common isolates at Soba university hospital in Khartoum, Sudan, a retrospective cross sectional study. 2020. doi:10.21203/rs.3.rs-22973/v1
6. Selva P. Antibiotic Prescription Pattern Among The In-Patients Of A Tertiary Care Hospital. International Journal of Research in Pharmaceutical Sciences. 2020;11(2):132-6. doi:10.26452/ijrps.v11iSPL2.2155
7. Prado MA, Lima MPJ, Gomes IdRH, Bergsten-Mendes G. The implementation of a surgical antibiotic prophylaxis program: the pivotal contribution of the hospital pharmacy. American journal of infection control. 2002;30(1):49-56. doi:10.1067/mic.2002.118409
8. Askarian M, Reza Moravveji A, Assadian O. Prescription of prophylactic antibiotics for neurosurgical procedures in teaching hospitals in Iran. American journal of infection control. 2007;35(4):260-2. doi:10.1016/j.ajic.2006.04.214
9. Garcна-V6zquez E, Fern6ndez LB, Pareja A, Gymez J, de la Rubia A. [Pharmacoeconomic results of introducing antimicrobial prophylaxis in surgery at a university hospital]. Cirugia espanola. 2008;84(6):333-6. doi:10.1016/S0009-739X(08)75045-0
10. Al-Momany NH, Al-Bakri AG, Makahleh ZM, Wazaify M. Adherence to international antimicrobial prophylaxis guidelines in cardiac surgery: a Jordanian study demonstrates need for quality improvement. J Manag Care Pharm. 2009;15(3):262-71. doi:10.18553/jmcp.2009.15.3.262
11. Van Disseldorp J, Slingenberg E, Matute A, Delgado E, Hak E, Hoepelman I. Application of guidelines on preoperative antibiotic prophylaxis in Leyn, Nicaragua. Neth J Med. 2006;64(11):411-6.
12. Webb AL, Flagg RL, Fink AS. Reducing surgical site infections through a multidisciplinary computerized process for preoperative prophylactic antibiotic administration. The American journal of surgery. 2006;192(5):663-8. doi:10.1016/j.amjsurg.2006.08.014
13. Suehiro T, Hirashita T, Araki S, Matsumata T, Tsutsumi S, Mochiki E, et al. Prolonged antibiotic prophylaxis longer than 24 hours does not decrease surgical site infection after elective gastric and colorectal surgery. Hepato-gastroenterology. 2007;55(86-87):1636-9.
14. Kuster S, Ruef C, Ledergerber B, Hintermann A, Deplazes C, Neuber L, et al. Quantitative antibiotic use in hospitals: comparison of measurements, literature review, and recommendations for a standard of reporting. Infection. 2008;36(6):549-59. doi:10.1007/s15010-008-7462-z
15. Khan Z, Ahmed N, ur Rehman A, Khan FU, Hamid SM. Pattern of antibiotic prophylaxis usage and timing of administration in common paediatric surgeries: a retrospective cross-sectional study in teaching hospitals. Drugs & Therapy Perspectives. 2020;36(1):26-32. doi:10.1007/s40267-019-00692-y
16. Schwarz S, Kehrenberg C, Walsh T. Use of antimicrobial agents in veterinary medicine and food animal production. International journal of antimicrobial agents. 2001;17(6):431-7. doi:10.1016/S0924-8579(01)00297-7
17. Yeap J, Lim J, Vergis M, Yeung PA, Chiu C, Singh H. Prophylactic antibiotics in orthopaedic surgery: guidelines and practice. Medical Journal of Malaysia. 2006;61(2):181.
18. Giri BR, Pant HP, Shankar PR, Sreeramareddy CT, Sen PK. Surgical site infection and Antibiotics use pattern in a tertiary care hospital in Nepal. Journal-Pakistan medical association. 2008;58(3):148.
19. Tissot E, Limat S, Cornette C, Capellier G. Risk factors for catheter-associated bacteriuria in a medical intensive care unit. European Journal of Clinical Microbiology and Infectious Diseases. 2001;20(4):260-2. doi:10.1007/s100960100480
20. Merle V, Germain J-M, Bugel H, Nouvellon M, Lemeland J-F, Czernichow P, et al. Nosocomial urinary tract infections in urologic patients: assessment of a prospective surveillance program including 10,000 patients. European urology. 2002;41(5):483-9. doi:10.1016/S0302-2838(02)00069-6
21. Bull A, Russo P, Friedman N, Bennett N, Boardman C, Richards M. Compliance with surgical antibiotic prophylaxis-reporting from a statewide surveillance programme in Victoria, Australia. Journal of Hospital Infection. 2006;63(2):140-7. doi:10.1016/j.jhin.2006.01.018