Evaluation of the Adherence to the Antimicrobial Prophylaxis Guidelines before Cardiac Surgeries in a Specialized University Hospital: A Unicenter Cross-Sectional Study from Iran

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Abstract

Background: Surgical site infection (SSI) is the most common reason for patient readmission after surgery. Because most cases of surgical site infection are preventable with antimicrobial prophylaxis, adherence to appropriate guidelines is critical. The aim of this study was to evaluate adherence to guideline recommendations for antimicrobial prophylaxis of surgical site infections at Shahid Chamran Heart Hospital, Isfahan, Iran.

Methods: This cross-sectional observational study was conducted using prospective data collected from December 2021 to June 2022 in the cardiac surgery ward of Chamran Hospital. Adherence to "Clinical practice guidelines for antimicrobial prophylaxis in surgery (2013)" was assessed using data from patient records regarding the type, dosage, timing, and duration of antimicrobial prophylaxis.

Results: A total of 363 patients were included in this study. The compliance rate with the guideline in terms of the type, dosing, initiation time, redosing and duration of the antimicrobial agent was 99.72%, 1.6%, 98.8%, 29.28%, and 0% respectively.

Conclusion: The present study revealed relatively low adherence to the guidelines in terms of dosing, re-dosing and duration of antimicrobial prophylaxis at Chamran Heart Hospital. Based on the results, developing a local guideline is highly recommended.

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Keywords: Antimicrobial Prophylaxis; Surgical Site Infection; Cardiac Surgery

Introduction

One of the most common and costly nosocomial infections is Surgical Site Infections (SSIs) (1, 2). The occurrence of SSI is associated with an increase in patient morbidity and mortality. Although the prevalence of SSIs has decreased over time due to efforts to prevent them, the annual prevalence of SSIs in the United States varies from 160,000 to 300,000 cases at a cost of $ 3.5 billion to $ 10 billion (3). SSIs are the most common reason for patient readmission after surgery and can increase length of hospital stay and emergency department referrals. Since preventive measures such as the administration of prophylactic antibiotics are so effective in reducing SSI rates, adherence to appropriate guidelines is critical to the proper use of antimicrobial prophylaxis and the reduction of SSI rates in hospitals (4).

The incidence of surgical site infection is higher in low to moderate-income countries than in high-income countries. It is estimated that SSIs occur in 2 to 5% of patients who undergo outpatient surgery in the United States of America each year (5). Therefore, considering the importance of the issue and the high prevalence of these infections, it is necessary to provide proper guidelines

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for effective antibiotic prophylaxis before surgery and to perform medical procedures correctly in healthcare centers. Additionally, the guidelines should mention the appropriate management of patient conditions in case of these infections. On the other hand, due to the issue of antibiotic resistance and its high prevalence, selecting the right antimicrobial treatment to manage these types of infections is another challenge we face. Antimicrobial prophylaxis before surgery involves prescribing the proper antibiotic agent based on the possible organisms involved to reduce the risk of post-operative infections (6). Choosing the right agent for this purpose depends on the anatomy of the surgical area and its goal is to achieve maximum coverage of common pathogens. Some other factors such as cost, safety, ease of administration, pharmacokinetic profile, bactericidal activity and hospital resistance pattern should be considered in choosing the right agent (7).

A study was conducted for six consecutive months, from February 1 to July 31, 2019, in the surgical wards of "Besat" teaching hospital, a tertiary referral hospital in western Iran, Out of 264 patients, 248 (93.94%) received antibiotic prophylaxis. However, only 32.2% of the procedures fully adhered to all parameters of the AHSP guidelines. In a significant percentage of procedures, prophylactic antibiotics were inappropriately administered for more than 24 hours (59.21%). As for antibiotic selection (92.1%), dose (88.6%), and timing of administration (89.9%), the adherence rate to guideline recommendations was relatively satisfactory (8).

There was a similar study conducted at the general surgery and orthopedic wards of a teaching hospital affiliated with Mazandaran University of Medical Sciences that over the course of one year, a total of 759 patients who underwent various surgeries were included in this study. The mean age of the patients was 32.02 ± 18.79 years. The most common types of surgeries performed were repairs for hand and foot fractures. Out of all the prophylactic antibiotics administered, approximately 56.4% were in accordance with the guidelines set by the American Society of Health System Pharmacists (ASHP) for prophylaxis indication. Cefazolin was the most frequently used antibiotic, and it was deemed appropriate in 104 out of 168 surgical procedures (62%). However, there were instances where gentamicin, metronidazole, and ceftriaxone were used inappropriately. The duration of antibiotic usage adhered to the ASHP guideline in only 100 out of 168 procedures, while in 68 procedures, the duration exceeded the recommended time. Additionally, the dose of antibiotics was lower than recommended in 98 procedures, and higher than recommended in one procedure (9).

To the best of our knowledge, we have found a few recent studies that are similar to ours in our country.

The aim of the present study was to evaluate the adherence to guideline recommendations for antimicrobial prophylaxis for surgical site infection at Shahid Chamran Heart Hospital in Isfahan, Iran.

Methods

This was a cross-sectional observational study conducted in the surgical ward of Shahid Chamran Heart Hospital, affiliated with Isfahan University of Medical Sciences (IUMS). Data were collected prospectively from December 2021 to June 2022. All patients who were candidates for cardiac surgery during this 6-month period were included in this study.

Patient demographics (such as age, gender, and weight), type and duration of surgery, type, dosage, and timing of initiation and discontinuation of the antimicrobial agent were collected from patient records. Finally, guideline adherence to ''Clinical Practice Guidelines for Antimicrobial Prophylaxis in Surgery (2013)" was assessed in relation to the following aspects, and the results were expressed as percentages (10).

1) Was the type of antibiotic agent chosen correctly?
2) Was the prescribed dosage of the antimicrobial agent, correct?
3) Was the antimicrobial treatment initiated in time before surgery?
4) Considering the duration of the surgery and the half-life of the antimicrobial agent, was it necessary to redose the antibiotic? And if so, did this happen at the right time?
5) Was the duration of antibiotic prophylaxis in accordance with the guideline?

In addition, all patients were followed for a total of 3 months for the occurrence of SSI. The prevalence of SSI and the pattern of cultured microorganisms were also reported.

Since no intervention was performed on the patients, there are no specific ethical considerations. The conducted study was approved by the Ethics Committee of Isfahan University of Medical Sciences. All data were analyzed by Excel 2016 software.

Results

A total of 363 patients (272 men and 91 women) were enrolled in this study. The most common procedure performed was CABG[1] (67.7%). The mean age of the patients was 59.67 (±10.2) years with a minimum of 21 and a maximum of 88 years. In addition, all patients weighed less than 120 kg. (Table 1)

Table 1. Demographic and clinical characteristics of participants

Characteristics		N (%)
Gender	Male	272 (75)
	Female	91 (25)
Age	Less than 65 YO[2]	254 (69.97)
	More than 65 YO	109 (30.03)
Surgery type	CABG	246 (67.7)
	MVR/AVR	45 (12.4)
	CABG+ MVR/ AVR	23 (6.3)
	Tamponade	16 (4.4)
	Bentall	11 (3)
	Ventricular mass	7 (1.9)
	ASD	7 (1.9)
	Heart transplantation	2 (0.5)
	Pericarditis surgery	1 (0.2)
	Endarterectomy	1 (0.2)
	Aortic arch replacement	1 (0.2)
	Cardiac rupture	1 (0.2)
	Epicardial lead replacement	1 (0.2)
	Sternum repair	1 (0.2)
Body weight	Less than 120 kg	363 (100)
	More than 120 kg	0 (0)

CABG, Coronary Artery Bypass Graft; MVR, Mitral Valve Replacement; AVR, Aortic Valve Replacement; ASD, Atrial Septal Defect.

Among the cases studied, the most commonly prescribed antibiotic was intravenous cefazolin (98.6%), vancomycin was prescribed in three patients, and the combination of vancomycin and cefazolin and the combination of vancomycin and meropenem were prescribed in two other patients (the estimated guideline adherence was 99.72%) (Table 2). In approximately all patients, the antibiotic was administered 1 hour before surgery (estimated guideline adherence was 98.8%) (Table 3). The dose of cefazolin administered was 1 g in 359 (98.8 %) patients and 2 g in only one (0.2 %) patient (estimated guideline adherence was 1.6%) (Table 4). The duration of the surgery was more than 4 hours in 256 patients (70.7 %), and none of the patients received an additional dose of antibiotics during the surgery (estimated guideline adherence was 29.28%) (Table 5).

Table 2. Types of antibiotics used in the studied patients and their adherence to the guideline

Antibiotic	N (%)	Adherence to guideline	Overall adherence
Cefazoline	358 (98.62)	Yes	99.72 %
Vancomycin	3 (0.8)	Yes	
Vancomycin + Cefazoline	1 (0.2)	Yes	
Vancomycin + Meropenem	1 (0.2)	No	

Table 3. Initiation time of antibiotic prophylaxis and its adherence to the guideline

Antibiotic	Initiation time	N (%)	Adherence to guideline	Overall adherence
Cefazoline	Within one hour before surgery	359 (98.8)	Yes	98.8 %
Vancomycin	Within one hour before surgery	5 (1.3)	No	

Table 4. Administered dose of antibiotic prophylaxis and its adherence to the guideline

Antibiotic	Dose	N (%)	Adherence to guideline	Overall adherence
Cefazoline	1 gr	358 (98.6)	No	1.6 %
Cefazoline	2 gr	1 (0.2)	Yes	
Vancomycin	1 gr	5 (1.3)	Yes	

Regarding the duration of antibiotic administration, it was continued in all patients until the day of discharge (estimated guideline adherence was 0%) (Table 6).

During the follow-up period, 15 cases of SSI were

1.Coronary Artery Bypass Graft

2.Year Old

detected, and the overall prevalence of SSI was 4.13%.

Regarding the microorganisms cultured, the most common isolates were as follows: Staphylococcus aureus 2 cases (13.33%) (1 MRSA, 1 MSSA), Citrobacter Freundii 2 cases (13.33%), Micrococcus 1 case (6.67%), non-hemolytic Streptococcus 1 case (6.67%) and Staphylococcus epidermis (6.67). Additionally, 53.33% of cultures were reported as negative (Table 7).

Table 5. Administration of redosed antibiotic during surgery if needed and its adherence to the guideline

Antibiotic	Duration of surgery	Redose	N (%)	Adherence to guideline	Overall adherence
Cefazoline	More than 4 hours	No	256 (70.7)	No	29.28 %
	Less than 4 hours	No	101 (27.9)	Yes	
Vancomycin	-	No	5 (1.3)	Yes	

Table 6. Duration of antibiotic prophylaxis and its adherence to the guideline

Duration of prophylaxis	N (%)	Adherence to guideline	Overall adherence
More than 48 hours	363 (100)	No	0 %
Less than 48 hours	0 (0)	No	

Table 7. Wound culture results based on microorganisms in patients with SSI incidence

Wound culture result	N (%)
Negative	8 (53.33)
Staphylococcus aureus	2 (13.33)
(MSSA: 1, MRSA: 1)	
Citrobacter freundii	2 (13.33)
Micrococcus	1 (6.67)
Non-hemolytic Streptococcus	1 (6.67)
Staphylococcus epidermis	1 (6.67)

MRSA, Methicillin-Resistant Staphylococcus Aureus; MSSA, Methicillin-Sensitive Staphylococcus Aureus.

Discussion

In the conducted study, the degree of adherence to the guideline was as follows: the type of antibiotic selected 99.72% (Table 2), the initiation time 98.8% (Table 3), the prescribed dose 1.6% (Table 4), redosing of antibiotics during the procedure, if necessary, 29.48% (Table 5), and the duration of antibiotic prophylaxis 0% (Table 6). According to the conducted study, there was more than 90% agreement regarding the type of antibiotic chosen and the timing of administration of the first dose of antibiotic prophylaxis before surgery, and the main cases of noncompliance with the guideline were insufficient dose of prescribed cefazolin and long duration (more than 48 hours) of antimicrobial prophylaxis.

According to guideline recommendations, cefazolin is considered the antibiotic of choice for surgical prophylaxis due to its great effectiveness against MSSA and a broad spectrum of gram-negative bacteria. Vancomycin is not routinely recommended for this purpose; however, it may be used in place of (or added to) cefazolin in cases of high MRSA prevalence, and in patients previously colonized with MRSA. In this study, good adherence to guidelines was observed in the choice of antimicrobial agent and cefazolin was prescribed in (98/6%) of patients. Since we could not report the exact prevalence of MRSA in our center due to the high rate of negative cultures (only two cases of SA were detected), no recommendations can be made for the use of vancomycin.

Al-Momany et al., investigated the extent to which antibiotic prophylaxis is in accordance with relevant guidelines in a Jordanian hospital. Items examined included the type, dosage, timing of administration, and duration. Full compliance with the guideline was not found for any of the procedures. Compliance with the relevant guideline was 1.7%, 27.9%, 99.1%, and 39.4% for the type, dosage, timing, and duration, respectively (11)

In a study conducted in the Philippines, percent compliance with the guideline was reported as follows: appropriate antibiotic dosing 39%, appropriate timing of initiation 45%, correct redosing 93%, and duration 67% (12).

In another study conducted by Mousavi et al., 22% of surgeries met all guideline recommendations. The least

compliant were duration of prophylaxis (14%) and type of antimicrobial agent (35%) (13).

In most similar studies, as in the present study, the duration of antimicrobial prophylaxis was the variable that was most frequently not adhered to. Compared with similar studies, there was greater agreement in our study regarding the correct selection of the antibiotic agent and the timing of administration of the first dose, but less agreement was observed regarding the correct dosage of antibiotics compared with similar studies.

Regarding postoperative infections, the rate of SSI in our study was 4.13%, which is comparable to worldwide studies (0.5% to 7.8%) (14). However, about 50% of cultures were reported as negative, which may be due to the fact that samples were collected after the administration of the antimicrobial agent, which can be mentioned as one of the limitations of our study. For this reason, we couldn't determine the most common microorganism causing SSI, the rate of MRSA (to assess the need to use Vancomycin), and the rate of Gram-negative microorganisms (to assess the need to add an antibiotic with gram-negative coverage in case of choosing vancomycin as the only antimicrobial agent) in our center.

Conflict of interest

The authors declare that they have no conflict of interest in this work.

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