Original Article

An observational study of perioperative antibiotic-prophylaxis use at a major quaternary care and referral hospital in Saudi Arabia

ABSTRACT

Context: The use of perioperative antimicrobial prophylaxis has been consistently considered an effective means of reducing the risk of surgical site infections. However, inappropriate use of surgical antibiotic prophylaxis is associated with complications such as reduced treatment efficacy, development of antibiotic resistance, and increased health-care costs.

Aims: The aim of this study is to investigate the adherence to international/national guidelines regarding the use of surgical antibiotic prophylaxis in the perioperative period.

Settings and Design: King Faisal Specialist Hospital and Research Centre (KFSH&RC) a 1589-bed tertiary/quaternary care and referral hospital based in Riyadh, Saudi Arabia.

Subjects and Methods: A retrospective observational study, in which antibiotic prophylaxis parameters were assessed against recommendations provided by international/national guidelines in elective/emergency procedures performed at the general operating suite. Data was obtained from the medical records starting of 174 cases over a period of 2 weeks in May 2016.

Results: Preoperative antibiotic prophylaxis (PAP) was prescribed for 118 (78.7%) patients, 72 (61%) of which were "recommended," whereas 46 (39%) were "not recommended." Of the 72 patients for whom the antibiotics were "recommended" and given, 19 (26.4%) received "inadequate" choice of antibiotics, 50 (69.4%) received a sub-therapeutic dose, 14 (19.4%) had "improper" timing of the first dose, 11 (15.3%) were given an "inappropriate" second intraoperative dose, and 43 (59.7%) had an unnecessarily extended duration of prophylaxis. The overall compliance to guidelines was achieved in only 23 (15.3%) patients.

Conclusions: A significant gap between current KFSH & RC practice and international/national guidelines regarding surgical antibiotic prophylaxis usage has been demonstrated which calls for immediate action to ensure effective guideline adoption and implementation.

Key words: Anesthesia; perioperative antibiotic prophylaxis; Saudi Arabia; surgery; surgical site infection

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Introduction

Surgical site infections (SSIs) are defined as infections that occur within a 30-day of an invasive procedure (or 90 days in case of implanted prosthetics). SSIs account for nearly 20% of all hospital-associated infections.[1-5] Appropriate preoperative antibiotic prophylaxis (PAP) can reduce SSIs by as much as 80%.[3] This stems from the ability of antibiotics to limit the growth of contaminating bacteria.[6] Added benefits include reduced morbidity and mortality, shortened hospital stay, and diminished hospital costs.[7,8] However, the inappropriate use of surgical prophylactic antibiotics can lead to complications including increased antimicrobial resistance, reduced efficacy, various adverse effects, and higher hospital costs.[1,3,8,9]

Objectives

The aim of this study is to investigate the adherence to international/national guidelines of surgical antibiotic prophylaxis and evaluate the use of perioperative prophylactic antibiotics in procedures done at King Faisal Specialist Hospital and Research Centre (KFSH&RC).

Subjects and Methods

Data of 174 surgical operations performed at KFSH&RC, a 1589-bed tertiary/quaternary care, and referral hospital based in Riyadh, Saudi Arabia, were collected retrospectively. Data was gathered from patient charts and computer medical records starting from May 1, 2016, to May 12, 2016.

Inclusion criteria

Patients who had their operations done at the general operating suite, covering all types of procedures except cardiac and obstetric, were included in the search strategy.

Exclusion criteria

Patients whose primary diagnosis was suggestive of a preoperative infectious disease or those who received nonprophylactic antibiotics 48 h before the operation, were excluded from the study.

Patients who had more than one operation had their data logged in separately according to their case and were evaluated as an independent patient.

Total data of 150 patients were acquired after applying the exclusion criteria.

The following variables were recorded:[1]

- Patient demographics (MRN, age, weight)
- Date of operation
- Type of operation performed
- Time at start and end of operation
- Classification of operation (clean, clean-contaminated, or contaminated)
- Status of operation (elective or emergency)
- Primary diagnosis
- American Society of Anesthesiologists score (ASA score)
- Previous adverse reactions or allergies to antibiotics.

Parameters of antimicrobial prophylaxis were specified by:[1]

- Name of antibiotic
- Dosage of antibiotic
- Time of antibiotic administration
- Route of administration
- Postoperative antibiotics given and their duration of administration.

Surgical services covered in this study included neurosurgery, general and oncologic surgery, pediatric, plastic, liver transplant, kidney transplant, breast and endocrine, colorectal, ophthalmology, orthopedic, oral and maxillofacial, urology, gynecology and infertility, otolaryngology, and pain management.

The collected data of antibiotic parameters were assessed against guidelines published by Scottish Intercollegiate Guidelines Network (SIGN), American Society of Health-System Pharmacists (ASHP) and Saudi Ministry of Health (MOH).[1,6,10]

The indication of PAP was considered "RECOMMENDED" if it was designated "RECOMMENDED," "HIGHLY RECOMMENDED" or "SHOULD BE CONSIDERED" by the SIGN guideline, and "NOT RECOMMENDED" if it was not.[1] Accordingly, PAP administration has been deemed to be "APPROPRIATE" if it matched the indications by the SIGN guideline and "INAPPROPRIATE" if it did not.[1]

Regarding the choice of antibiotics with respect to the spectrum of coverage of the most probable bacteria encountered at a particular surgical site; three variables were plotted based on recommendations found in SIGN, ASHP, and MOH guidelines.[1,6,10] The variable was "NARROW" if the antibiotic given did not cover the expected range of bacteria encountered, "ADEQUATE" if it covered the anticipated bacteria and "BROAD/UNNECESSARY" if it covered more bacteria than anticipated.[1,6,10,11]

Regarding the timing of antibiotic administration; a "PROPER" value was plotted if the antibiotic prophylaxis was given within 60 mins before incision, "TOO LATE" if received after incision, and "TOO EARLY" if the antibiotic was administered more than an hour before surgical incision.[6]

Regarding antimicrobial dosage, the first preoperative antibiotic dose was labeled "ACCURATE" if it corresponded with the dose mentioned in the MOH and ASHP guidelines, and was labeled "SUBDOSE" if it was less than the recommended dose.[6,10] An intraoperative second dose was considered "APPROPRIATE" if it was given in prolonged operations where time has surpassed half the usual dosing interval of that antibiotic based on evidence mentioned in the ASHP guideline.[6]

Regarding the duration of prophylaxis, "APPROPRIATE" was designated to a single preoperative dose given, and "NOT APPROPRIATE" if prophylaxis was extended postoperatively, excluding arthroplasty surgeries, in which it was considered "APPROPRIATE" if antibiotic prophylaxis was given for a duration not exceeding that of a 24-h limit, based on recommendations offered by the SIGN and ASHP guidelines.[1,6]

If PAP was administered while it was not recommended by the SIGN guideline, it was deemed "INAPPROPRIATE," and therefore, the related parameters were not evaluated.

Finally, the overall assessment was considered "CONCORDANT" if the prescription's parameters adhered to the recommendations provided by the guidelines regarding the indication, choice, dosing, and time of PAP, as well as the duration of antibiotic prophylaxis. Any deviation from the criteria mentioned above deemed the prescription "DISCORDANT."[11]

Statistical and data analysis

Data entry was accomplished using an electronic data recording spreadsheet (Excel software). Quantitative values were reported as means and standard deviations (SDs), whereas frequencies and percentages were used to describe qualitative variables. Excel was used for data analysis and to provide illustrations of the obtained data and results using tables along with bar and pie charts.

Results

A total of 150 operations of patients with the mean age of 32.5 (SD 20) years who had their surgical procedures performed within the month of May, were incorporated in the study. One hundred and thirty-seven (91.3%) of which, were elective while the remaining 13 (8.7%) operations were emergency cases. Seventy-four (49.3%) operations were classified as clean, 74 (49.3%) were clean-contaminated, whereas two (1.3%) of the surgical interventions were contaminated. The most common operations performed were plastic surgeries (22.7%), followed by procedures done under general surgery (16%), breast and endocrine (11.3%), urology (10.7%), orthopedic (10%), and neurosurgery (9.33%) departments. The rest of procedures were performed under other departments and comprised the remaining 20%. Ninety-eight (65.3%) cases lasted <2 h while 52 (34.7%) exceeded the 2-h duration. Table 1 provides a general overview of the patient demographics and surgical information, aided by [Figure 1] illustrating the frequency of the different types of surgical procedures.

PAP was prescribed in 118 (78.7%) cases (AB group), whereas the remaining 32 (21.3%) cases did not receive any PAP (non-AB group). Seventy-two patients (61%) from the AB group received a "RECOMMENDED" antibiotic prescription and were labeled by the (AB-R group), whereas 46 patients (39%) were given preoperative antibiotics that were "NOT RECOMMENDED" and were labeled by (AB-NR group). In the non-AB group, 12 (37.5%) patients did not receive a "RECOMMENDED" antibiotic prescription (non-AB-R group), whereas the remaining 20 (62.5%) patients were not given a "NOT RECOMMENDED" antibiotic prescription (non-AB-NR group). However, out of the total 150 procedures where antibiotic prophylaxis was either given or not, 92 (61.3%) were compliant with the SIGN guideline and thus considered "APPROPRIATE" (AB-R + non-AB-NR groups), whereas the remaining 58 (38.7%) were noncompliant and were considered "INAPPROPRIATE" (AB-NR + non-AB-R groups). Table 2 provides a breakdown of patients in relation to PAP, supplemented by illustrations presented in Figure 2.

Cephazolin (1 g) was the most commonly prescribed antibiotic in this study, used preoperatively in 88.1% (104) of the cases

Table 1: Patient demographics and surgical information

Variables	Number	Percentage
Age		
Mean (SD)	32.54 (20.03)	-
ASA		
1	34	22.67
2	85	56.67
3	25	16.67
4	1	0.67
Missing	5	3.33
Wound classification		
Clean	74	49.33
Clean-contaminated	74	49.33
Contaminated	2	1.33
Surgical status		
Elective	137	91.33
Emergency	13	8.67
Surgery duration (hours)		
<1 h	55	36.67
1<××<2	43	28.67
2<××<4	40	26.67
4<××<6	7	4.67
×>6	5	3.33

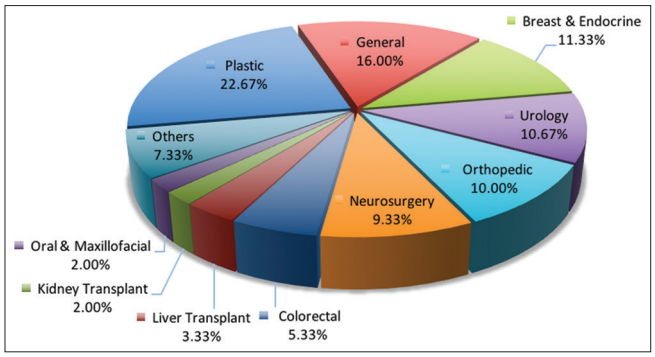

Figure 1: Frequency of types of surgeries

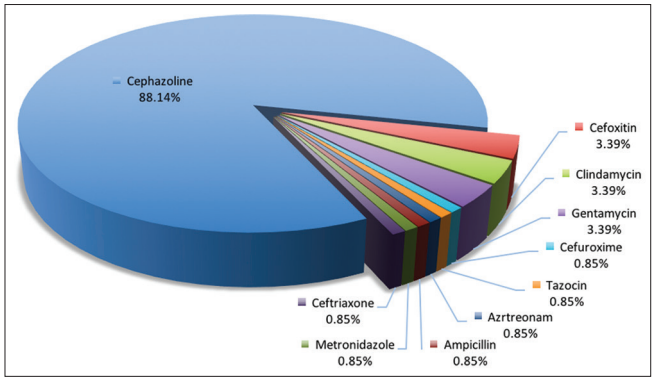

Figure 3: Frequencies of preoperative antibiotic prophylaxis

Table 2: Relation of patients to preoperative antibiotic prophylaxis (PAP) adminstration

Variable	Number	Percentage
Patients who recieved PAP (AB group)	118	78.70
Patients who did not receive PAP (non-AB group)	32	21.30
Total	150	100
Patients who received a recommended PAP (AB-R group)	72	61
Pateints who received a non-recommended PAP (AB-NR group)	46	39
Total	118	100
Patients who did not receive a recommended PAP (non-AB-R group)	12	37.50
Patients who did not receive a non-recommended PAP (non-AB-NR group)	20	62.50
Total	32	100.00
Guideline-compliant (Apropriate) PAP prescription (AB-R group + non-AB-NR group)	92	61.30
Non guideline-compliant (Inapropriate) PAP prescription (AB-NR group + non-AB-R group)	58	38.70
Total	150	100.00

PAP: Preoperative antibiotic prophylaxis

which received a PAP (AB group) and was given postoperatively in 69.5% (41) of the cases [Table 3]. The frequencies of the antibiotics prescribed pre- and post-operatively for surgical prophylaxis are presented in Figures 3 and 4, respectively.

Out of the patients for whom the prophylaxis was "RECOMMENDED" and was given (AB-R group), 53 (73.6%)

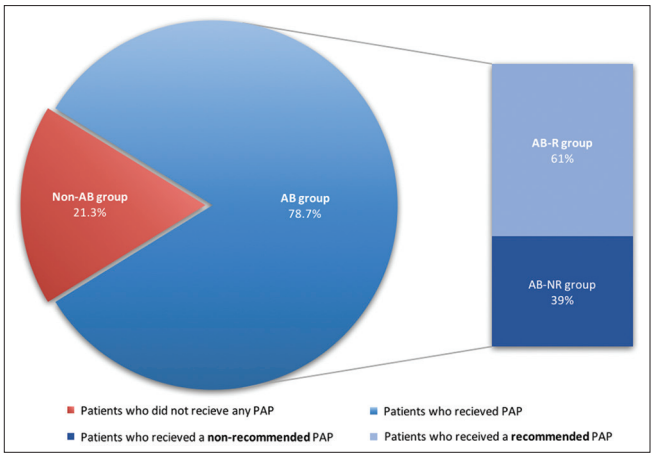

Figure 2: Patients in relation to preoperative antibiotic prophylaxis

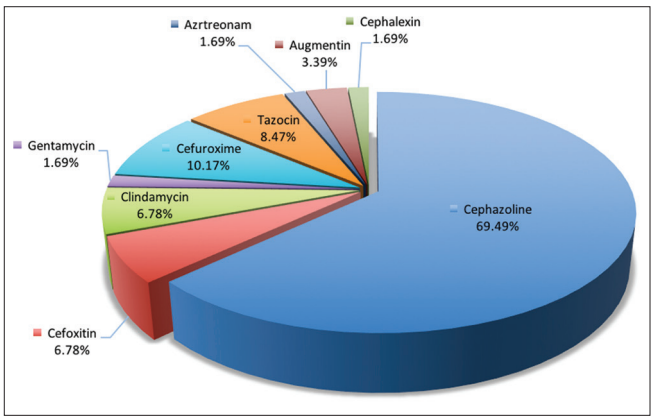

Figure 4: Frequency of postoperative antibiotic prophylaxis

were given an "ADEQUATE" choice of antibiotics, 18 (25%) were given a "NARROW" choice, where the antibiotics administered did not cover the anticipated range of bacteria most likely encountered, and one (1.4%) patient received a broad-spectrum antibiotic that covered more bacteria than anticipated [Table 4].

Regarding the accuracy of the first preoperative antibiotic dosing in the AB-R group, 50 (69.4%) patients were given a sub-therapeutic dose, and one (1.4%) patient had a missing dose, whereas only 21 patients (29.2%) received the accurate antibiotic dosing [Table 4].

Fifty-eight (80.6%) patients in the AB-R group had their antibiotics given at the "PROPER" time (within 60 mins before incision), whereas the remaining 14 (19.4%) patients had their antibiotics either administered "TOO EARLY" (11.1%), or "TOO LATE" (8.3%).

Out of the AB-R group, 61 (84.7%) patients received a second intraoperative dose "APPROPRIATELY," where the operation time has surpassed half the usual dosing interval of that antibiotic, whereas 11 (15.3%) patients were given an "INAPROPRIATE" second intraoperative dose [Table 4].

Table 3: Frequencies of antibiotics prescribed preoperatively and postoperatively for surgical prophylaxis

Name of antibiotic	Preoperative antibiotic prophylaxis (AB Group=118 pts)		Postoperative (*n*=59)	
	Number	Percentage	Number	Percentage
Cephazoline	104	88.14	41	69.49
Cefoxitin	4	3.39	4	6.78
Clindamycin	4	3.39	4	6.78
Gentamycin	4	3.39	1	1.69
Cefuroxime	1	0.85	6	10.17
Tazocin	1	0.85	5	8.47
Azrtreonam	1	0.85	1	1.69
Ampicillin	1	0.85	-	-
Metronidazole	1	0.85	-	-
Ceftriaxone	1	0.85	-	-
Augmentin	-	-	2	3.39
Cephalexin	-	-	1	1.69

Table 4: Evaluation of preoperative antibiotic prophylaxis (PAP) parameters (AB-R group)

Parameters	Number	Percentage
Choice of preoperative antibiotic		
Narrow	18	25.00
Adequate	53	73.61
Broad/unnecessary combination	1	1.39
First preoperative dose		
Accurate	21	29.17
Sub-dose	50	69.44
Missing	1	1.39
Timing of administration of first preoperative dose		
Too early	8	11.11
Proper	58	80.56
Too late	6	8.33
Second intraoperative dose		
Apropriate	61	84.72
Inapropriate	11	15.28
Duration of antibiotic prophylaxis		
Apropriate	29	40.28
Inapropriate	43	59.72
Total number of patients (AB-R group)	72	100.00

Regarding the duration of antibiotic prophylaxis in the AB group, 59 cases (50%) were considered "INAPPROPRIATE" due to the unnecessarily extended duration of prophylaxis, 39 (66%) of whom had their antibiotic prophylaxis continued for more than 24 h [Tables 4 and 5] provides a general assessment of the antibiotic prescription parameters.

In summary, compliance with the appropriate PAP indication provided by the SIGN guideline was achieved in 61.3% of the cases. Nearly 73.6% of patients who received the recommended antimicrobials adhered with the adequate choice of antibiotics mentioned in ASHP guidelines and only 29.2% conformed with the accurate dosing mentioned in ASHP and MOH guidelines. A proper timing of prophylaxis administration was attained in 80.6% of the cases where a PAP was recommended and was given. Out of all the patients who received a PAP, half had an appropriate duration of prophylaxis. The overall compliance with the above-mentioned criteria including an appropriate antibiotic prophylaxis duration was achieved in only 23 (15.3%) cases of all the prescriptions audited. An overall evaluation of compliance with antibiotic guidelines is presented in Table 6, supported by illustrations shown in Figures 5 and 6.

Discussion

The results mentioned in our study show a wide discrepancy between our hospital's practice and the recommendations offered by international and national guidelines regarding PAP. In about 38.7% of the total operations that were studied, PAP was administered when it was "not recommended" or absent when it was "recommended," showing that PAP perhaps was prescribed regardless of the surgical intervention. Adherence to the guidelines regarding the PAP indication, choice, dosing, re-dosing, and timing, as well as the prophylaxis duration, was attained in only 15.3% of all cases evaluated. This nonadherence could be attributed to the lack of awareness or improper application of international and national standards by health-care providers in our hospital.

Cefazolin was the most commonly prescribed prophylactic antibiotic in our study, and this conformed with the guideline recommendations of using antimicrobial agents with the narrowest spectrum of activity required for efficacy in preventing postoperative infections.[1,6,10] Cefazolin is a relatively narrow-spectrum first-generation cephalosporin that is highly effective in combating Gram-positive cocci including staphylococci, which are the main culprit in postoperative infections.[12] Cefazolin is generally considered in most PAP guidelines as the first-choice antibiotic for clean operations, in addition to providing coverage for many clean-contaminated operations.[1,6] However, additional pathogens to staphylococci such as anaerobes, *Escherichia coli*, and other enterobacteriaceae are predominantly recognized as perpetrators in SSIs following operations below the diaphragm. Therefore, second generation cephalosporins with anaerobic coverage, or an alternative such as cefazolin plus metronidazole, are recommended.[1,6]

Our study results show that most patients received sub-therapeutic doses, mostly of cefazolin (1 g), whereas 29.17% of the patients were given an accurate PAP dose. This is concerning because antibiotic dosing is a major determinant of achieving adequate serum and tissue concentrations of antimicrobial agents for effective prophylaxis of SSIs.[6]

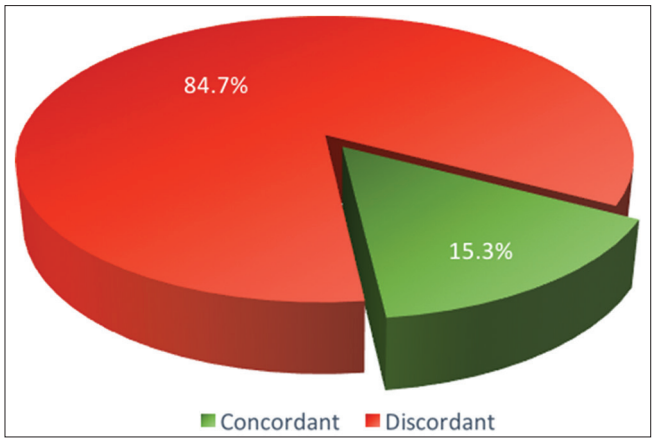

Figure 5: Overall compliance of prescription parameters to guidelines

Table 5: Evaluation of the duration of antibiotic prophylaxis

Parameters	Frequency	Percentage
Duration of antibiotic prophylaxis		
Apropriate	59	50
Inapropriate	59	50
Total	118	100
Duration of antibiotic prophylaxis (in hours)		
×<24 h	39	66.10
×>24 h	20	33.90
Total	59	100

Table 6: Evaluation of compliance to antibiotic guidelines

Parameters	Frequency	Percentage
PAP indication		
Compliant	92	61.33
Non-compliant	58	38.67
Choice of PAP		
Compliant	53	73.61
Non-compliant	19	26.39
First PAP dose		
Compliant	21	29.17
Non-compliant	51	70.83
Timing of administration of first PAP dose		
Compliant	58	80.56
Non-compliant	14	19.44
Duartian of antibiotic prophylaxis		
Compliant	59	50
Non-compliant	59	50
Overall compliance to guideline		
Concordant	23	15.33
Discordant	127	84.67
Total	150	100.00

PAP: Preoperative Antibiotic Prophylaxis

The timing of administration of PAP is also of importance when it comes to ensuring successful prophylaxis against postoperative infections. About 20% of the cases which received a recommended PAP had their prophylaxis given at an improper time. For reducing the rates of postoperative

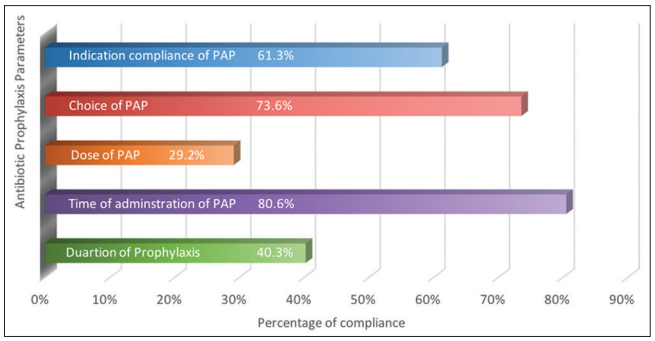

Figure 6: Compliance of (AB-R group)'s prescription parameters to guidelines

SSIs, evidence showed that administration of PAP within a 60 min window before the incision is generally recommended to provide sufficient serum and tissue levels exceeding the minimum inhibitory concentrations for the anticipated organisms.[6]

Re-dosing of intraoperative antimicrobial prophylaxis is encouraged in prolonged operations as a means of reducing postoperative infection risk.[1,6] ASHP recommends re-administration of antibiotic prophylaxis at an interval of approximately two times the half-life of the agent in patients with normal kidney function.[6] For example, the recommended re-dosing interval of cefazolin, which has a 1.2–2.2 h half-life in adults with normal renal function, is 4 h.[6] Appropriate re-dosing was attained in about 84% of the cases in our study.

Although the optimal duration of antibiotic prophylaxis is not known, international guidelines advocate the use of a single dose of antibiotic prophylaxis with enough half-life to cover the entire length of the procedure.[1,2] Unnecessary administration of postoperative antimicrobials is not encouraged and is considered an unsafe practice. Only in a few specific cases such as arthroplasty is where evidence associated the continuing of antimicrobial prophylaxis for 24-hs with lower rates of reoperations than a single dose.[1] All (100%) the patients who received postoperative antibiotic prophylaxis in our study had their duration of prophylaxis extended beyond single doses and thus considered "inappropriate" per the guidelines. Sixty-six percent of those patients had their prophylactic antibiotics even continued for more than 24 hs postoperatively. Prolonging the use of prophylaxis in such patients put them at increased the risk of acquiring multi-resistant microbes such as cephalosporin-resistant enterobacteriacea, vancomycin-resistant enterococci, and *Clostridium difficile*, in addition to the ensuing increases in medical care costs.[1,6]

The study has not been free of limitations. Although our data sample size is statistically considered sufficient, higher

accuracy could be achieved with a bigger sample. Due to the relatively short period of data collection of 2 weeks, data of 150 cases were obtained. Despite that, our study has shown significant deviation from the guidelines. Although we collected specific data regarding the SSI risk status of patients such as high ASA scores, extremes of age, prolonged procedure durations, and emergency status of operations, there were some conditions such as intraoperative spillage and immunosuppression that were not evaluated. It is believed that this did not affect our results as they are rare occurrences.

Conclusions

Overall compliance to international and national guidelines regarding the indication, choice, dosing, timing, and duration of surgical antibiotic prophylaxis of only 15.3% shown in our study demonstrates a wide gap between international and national standards and our hospital practice. This nonadherence may be attributed to the lack of awareness of those recommendations. The effect of nonadherence to such guidelines at KFSH & RC could affect the patient outcome negatively mainly resulting in increased the risk of development of SSI, increased antibiotic resistance and higher hospital costs.

Mechanisms should be in place to assess any disparities in practice against the guidelines and address the reason for these differences where appropriate. Based on the results of our study, a working group for perioperative antibiotic prophylaxis must be established and is necessary to ensure adoption of local hospital guidelines and implementation of a program of continuing education. Further support by the active involvement and provision of collaborating multidisciplinary teams, which involve surgical, anesthesia, microbiology, pharmacy, nursing, and management can help in making a quality improvement program a success.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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