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RESEARCH ARTICLE

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Quantity and quality profiles of antibiotics pre, on, and post surgery in a hospital setting

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Abstract

Background Providing proper antibiotics is undoubtedly crucial to prevent infections during surgery. *Objective* This study set out to evaluate the medication administration in antibiotic prophylaxis using both quantitative and qualitative methods. *Setting* The study employed a retrospective design and observed patients who underwent surgical procedures during hospitalization at a private hospital in Indonesia within the period of January–June 2019. *Methods* The data obtained were evaluated quantitatively and qualitatively; and analyzed descriptively. The quantitative evaluation used the defined daily dose (DDD) per 100 bed-days. The qualitative evaluation was expressed as the percentage of antibiotic suitability based on antibiotic administration, i.e. (1) type; (2) timing; (3) dosage; (4) duration; and (5) route. *Main outcome measure* Suitability of antibiotic prophylaxis in a hospital setting. *Results* There were 164 prescriptions recorded from 20 types of surgical procedures, of which the most common was cholecystectomy (23 patients, 14%). Most antibiotics were administered 61–120 min before the incision time (55 patients, 37%), and had a duration of more than 24 h (119 patients, 80%). The total DDD per 100 bed-days for pre-, on-, and post-surgery antibiotic use were 44.2, 33.3, and 66.7 respectively. The suitability profiles of the antibiotics used according to the Antibiotic Use Guideline for Hospital (2018) were as follows: 26.3% right type, 52.9% right time, 24.8% right dosage, 19.1% right duration, 91.8% right route, while according to American Society of Health-System Pharmacists Therapeutic Guidelines (2014) there were 17.6% right type, 53.4% right time, 16.4% right dosage, 19.1% right duration, and 96.6% right route. *Conclusion* Ceftriaxone was the first-choice prophylactic antibiotic administered in this Indonesian hospital. The data indicate a considerable non-compliance with local and international guidelines.

Keywords Antibiotic prophylaxis · DDD per 100 bed-days · Inappropriate prescriptions · Surgery

Impacts on practice

- Evaluating antibiotic prophylaxis is useful for assessing the possibility of inappropriate antibiotic use.
- Surgeons tend to prescribe prophylactic antibiotics for all types of surgery despite the absence of prerequisites for some of them.
- Frequent inappropriate use of antibiotics can increase the cost of treatment and antibiotic resistance in patients.
- Increasing adherence to guidelines and the use of appropriate prophylactic antibiotics are important points in prevention of surgical site infection and control of microbial resistance.
- To increase adherence, training is needed to normalize antibiotic selection in accordance with international and local guidelines.

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Introduction

The National Institute for Health and Care Excellence [1] indicates prophylactic antibiotics in clean, clean-contaminated, and contaminated surgeries, but therapeutic antibiotics for procedures with dirty or infected surgical wounds. Therapeutic antibiotics are used to eradicate or inhibit the growth

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of suspected or proven bacteria whilst prophylactic antibiotics are given to prevent infection in patients with high-risk procedures, and the target of their administration is to reduce the number of bacteria present and help the natural defenses of the host so that no infection occurs [2–4]. Most antibiotic prophylaxis, including the use of cefazolin, is recommended 30–60 min before incision—2 h if vancomycin or a fluoroquinolone is used—to ensure that the presence of antibiotics in serum and tissue can reach the target during the surgery [5, 6].

The Hospital National Antimicrobial Prescribing Survey (2020) analyzed 26,714 prescriptions from 324 hospitals in Australia and found that inappropriate prophylactic antibiotic prescriptions in surgical patients was the highest of the 20 most common indications, such as community-acquired pneumonia, medical prophylaxis, cystitis, and cellulitis/erysipelas. In that study, use of surgical prophylactic prescriptions for more than 24 h decreased over six years, from 41.1% in 2013 to 28.0%. The most common reasons for inappropriate prescriptions include: spectrum too broad (23.7%), incorrect dose or frequency (20.3%), and incorrect duration (20.0%) [7, 8].

Inappropriate antibiotic therapy, including excessive use of antibiotics, inappropriate dosages, and prolongation of therapy, potentially results in problems, such as the emergence of microorganisms resistant to some antibiotics. Antibiotic resistance makes treating the cause of infection increasingly difficult and causes prolonged illness, treatment, and hospital stay, loss of protection for patients undergoing surgery and other medical procedures, and increased costs and mortality [9–12].

The use of antibiotics in preventing infections is essential to reduce the risks associated with surgery and resistance. For this reason, maximizing the quality of prophylactic antibiotic prescribing for surgery and antibiotic therapy (to treat existing infections) requires a appropriate strategy. In Indonesia, to control the incidence of resistance in hospitals, the Minister of Health has issued Regulation No. 8 (2015) on the Antimicrobial Resistance Control Program in Hospitals [13–16]. Judicious antibiotic use includes monitoring antibiotic use patterns and antibiotic resistance patterns. As an attempt to evaluate the type and amount of antibiotics, antibiotic use patterns can be assessed quantitatively by calculating Anatomical Therapeutic Chemical/Defined Daily Dose (ATC/DDD) per 100 bed-days; these patterns can also be determined qualitatively to evaluate the suitability of antibiotic use by analyzing the appropriateness of indications, timing, dose, duration, and route of administration [11, 14, 15].

Aim of the study

This study was designed to evaluate the use of prophylactic antibiotics in surgical patients quantitatively and qualitatively.

Ethics approval

This retrospective study involving human participants was in accordance with the ethical standards of the institutional ethical committee University of Surabaya with the Ethics Agreement No. 109/KE/XI/2019.

Methods

Study design

The study employed a retrospective design and observed patients who underwent surgical procedures during hospitalization at a private hospital in Surabaya within the period of January–June 2019. Surgical procedures are commonly categorized by: (A) degree of urgency, (B) the seriousness of surgery, (C) the field of surgery, (D) type of surgery.

(A) Degree of urgency: (1) elective surgery: is a planned operation that can be ordered in advance as a result of a surgeon's judgment. (2) emergency surgery: surgery to treat trauma or acute illness in patients who come to the emergency department, or surgery which is not planned for patients being treated in other ways, or patients who have been waiting for elective surgical procedures.

(B) The seriousness of surgery: (1) major, (2) intermediate, and (3) minor. The category is determined by the surgeon in the hospital. Generally: major surgeries are usually extensive and require overnight treatment or an extended stay in the hospital. These operations include extensive work such as entering body cavities, removing organs, or changing anatomy. Minor surgeries are generally superficial and do not require penetration of a body cavity.

(C) The field of surgery: including orthopedic, ocular, neurosurgery, cardiac, surgical oncology, and general surgery.

(D) Type of surgery: (1) clean surgery: operations performed on areas without pre-surgical infection, without opening the tract (respiratory, gastrointestinal, urinary, biliary), planned surgery, or primary skin closure with or without the use of closed drains. (2) clean-contaminated surgery: operations performed on the tract (digestive, biliary, urinary, respiratory, reproductive except for the ovaries) or surgeries without significant contamination. (3) contaminated surgery: operations that open the gastrointestinal tract, bile duct, urinary tract, airway to the oropharynx, reproductive tract except for the ovaries with real contamination (gross spillage) [15, 18–20].

The inclusion criteria included patients aged ≥ 18 years who had complete inpatient medical records, including diagnosis, surgery, length of stay, name of drug, dosage, and the number of antibiotics used. The exclusion criteria were (1) surgical patients who had to undergo Intensive Care Unit (ICU) treatment, (2) patients who had an infection before a surgical procedure, and (3) patients who were discharge against medical advice or died during the period of the study.

The use of antibiotics was classified into three stages, namely pre-, on-, and post-surgery. Here, pre-surgery represents the antibiotic given before the day of surgery, on-surgery includes the antibiotic given on the day of surgery—i.e., 120 min before to < 24 h after surgery, and post-surgery is where the antibiotic was administered > 24 h after surgery.

The use of antibiotics is classified into 0, 1, 2, 3 antibiotics where 0 means not using antibiotic, 1 using one antibiotic, 2 using a combination of two antibiotics, and 3 using a combination of three antibiotics.

Data analysis

The data obtained were then evaluated quantitatively and qualitatively and analyzed descriptively. The quantitative evaluation used the DDD per 100 bed-days, which was calculated using the formula below:

$$\frac{DDD}{100} bed\text{-}days = \frac{total\ antibiotics\,(gram) \times 100}{DDD\ WHO\,(gram) \times LOS}$$

where DDD WHO, defined daily dose determined by WHO; LOS, total length of stay.

The qualitative evaluation was expressed as the percentage of antibiotic suitability based on antibiotic administration characteristics, namely (1) type; (2) timing; (3) dosage; (4) duration; and (5) route, and the comparison with Antibiotic Use Guideline in Hospital and American Society of Health-System Pharmacists (ASHP) Therapeutic Guidelines [6, 17, 19].

The research results were analyzed descriptively. The total DDD and percentage of antibiotic suitability are reported in tables.

Results

There were 708 surgical patients from January to June 2019, but only 164 patients met the inclusion and exclusion criteria and had medical records available (Fig. 1). Table 1 illustrates

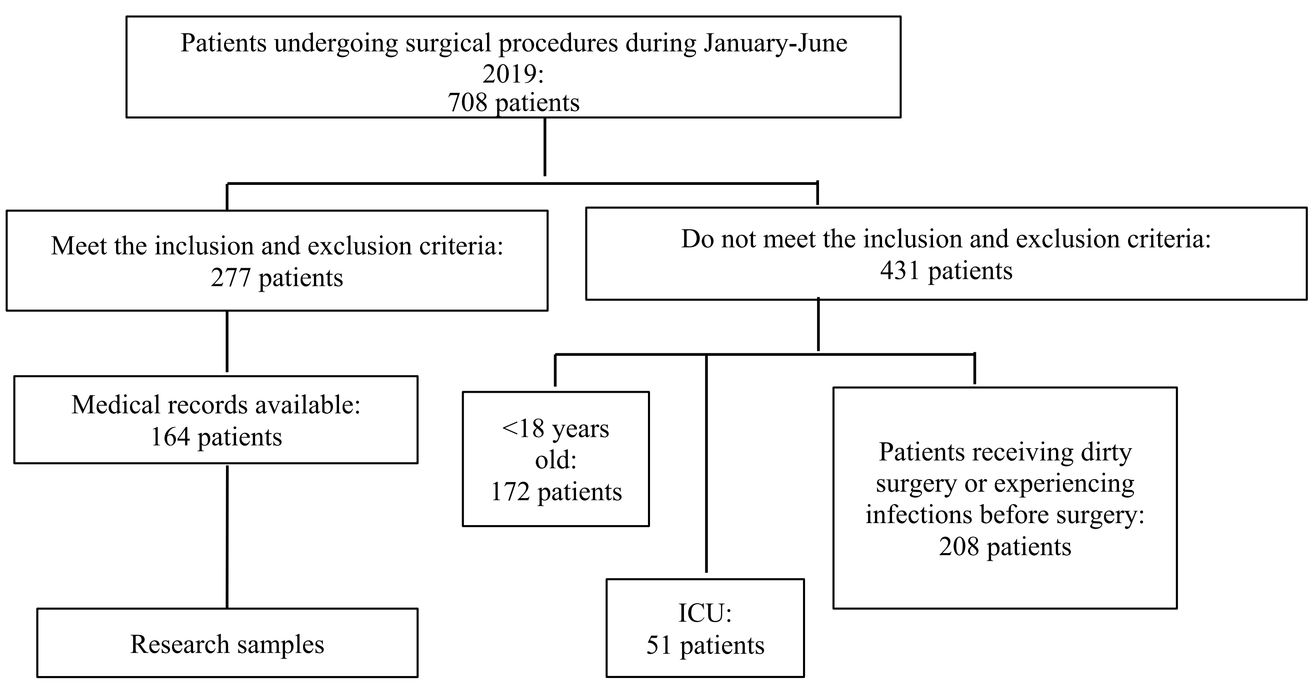

Fig. 1 The flowchart of the research data collection. *ICU* Intensive Care Unit

Table 1 The demographic characteristics of the research samples

Characteristics	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Total	%
Age (years)								
18–25	3	1	4	1	1	4	14	8
26–35	7	4	4	7	8	4	34	21
36–45	6	10	8	5	6	2	37	23
46–55	8	5	10	4	3	5	35	21
56–65	4	4	3	1	4	4	20	12
≥ 65	3	5	2	6	4	4	24	15
Mean ± SD	44.61 ± 15.38	47.86 ± 13.73	42.87 ± 13.56	47.38 ± 17.13	44.92 ± 15.45	45.33 ± 18.03	45.50 ± 1.85	
Total	31	29	31	24	26	23	164	100
Gender								
Male	15	8	9	13	9	7	61	37
Female	16	21	22	11	17	16	103	63
Total	31	29	31	24	26	23	164	100
Status of hospital bill payment								
Private	18	15	17	15	10	10	85	52
BPJS	13	14	14	9	16	13	79	48
Total	31	29	31	24	26	23	164	100

Jan January, *Feb* February, *Mar* March, *Apr* April, *Jun* June, *SD* standard deviation, *BPJS* Badan Penyelenggara Jaminan Sosial (Indonesia's Healthcare and Social Security Agency)

the demographic information of these patients. All patients had four categories of surgeries, they were divided into with number of groups. There were 20 types of surgical procedures, of which the five most common types were cholecystectomy (23 patients, 14%), herniotomy (18 patients, 11%), arteriovenous (AV) shunt (18 patients, 11%), appendectomy (17 patients, 10%), and myomectomy (14 patients, 9%). 97% (159) were elective surgeries, and 41% (81) were major surgeries. 57% (94) were rated as clean surgeries. See Table 2 for details.

Table 3 illustrates the profile of patients based on the number, timing, interval, and duration of antibiotic use. Most patients (129, 79%) received a single antibiotic. Fifty-five patients (37%) that antibiotics were administered

Table 2 Profiles of research samples based on the surgical procedure

Characteristics	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Total	%
Degree of urgency								
Elective	31	28	29	24	26	21	159	97
Emergency	0	1	2	0	0	2	5	3
Total	31	29	31	24	26	23	164	100
The seriousness of surgery								
Minor	0	8	3	0	0	0	11	7
Intermediate	11	8	14	5	9	2	49	30
Major	13	8	10	15	15	20	81	49
Complex	7	5	4	4	2	1	23	14
Total	31	29	31	24	26	23	164	100
The field of surgery								
Clean	14	19	22	12	13	14	94	57
Clean-contaminated	15	9	8	12	12	9	65	40
Contaminated	2	1	1	0	1	0	5	3
Total	31	29	31	24	26	23	164	100

Jan January, *Feb* February, *Mar* March, *Apr* April, *Jun* June

Table 3 Profiles of the research samples based on the use of antibiotics

Characteristics	Jan 2019	Feb 2019	Mar 2019	Apr 2019	May 2019	Jun 2019	Total	%
Number of antibiotic uses								
0 Antibiotic	3	7	3	1	0	1	15	9.15
1 Antibiotic	23	21	24	20	24	18	130	79.26
2 Antibiotics	5	1	3	3	2	4	18	10.98
3 Antibiotics	0	0	1	0	0	0	1	0.61
Total	31	29	31	24	26	23	164	100
Timing of antibiotic use								
Pre surgery	0	0	0	0	0	0	0	0
On surgery	7	6	13	0	0	4	30	20
Post surgery	0	0	0	0	0	0	0	0
Pre-on surgery	0	0	0	0	0	0	0	0
On-post surgery	19	15	11	15	25	17	102	69
Pre-on-post surgery	2	2	4	8	1	0	17	11
Total	28	23	28	23	26	21	149	100
Interval of antibiotic use								
0–30 min	11	4	5	7	3	5	35	24
31–60 min	4	1	5	8	7	7	32	21
61–120 min	9	10	12	6	10	8	55	37
> 120 min	4	8	6	2	6	1	27	18
Total	28	23	28	23	26	21	149	100
Duration of antibiotic use								
< 24 h	7	6	13	0	0	4	30	20
> 24 h	21	17	15	23	26	17	119	80
Total	28	23	28	23	26	21	149	100

Jan January, *Feb* February, *Mar* March, *Apr* April, *Jun* June, *min* minutes, *h* hours

Table 4 Quantities of antibiotic use within the period of January–June 2019

No	ATC code	Antibiotics	DDD per 100 bed-days			Total DDD per 100 bed-days
			DDD pre	DDD on	DDD post	
1	J01CA04	Amoxicillin	–	–	0.72	0.72
2	J01DB04	Cefazolin	0.74	2.82	1.55	5.11
3	J01DD01	Cefotaxime	–	0.04	0.04	0.08
4	J01DD02	Ceftazidime	–	0.14	–	0.14
5	J01DD04	Ceftriaxone	14.71	22.57	38.34	75.62
6	J01DD62	Cefoperazon sulbactam	12.26	3.06	10.17	25.49
7	J01DE01	Cefepime	1.47	0.14	1.45	3.06
8	J01DH02	Meropenem	14.34	1.59	4.94	20.87
9	J01GB03	Gentamicin	–	–	0.17	0.17
10	J01MA12	Levofloxacin	–	0.14	0.64	0.78
11	J01XD01	Metronidazole	0.74	2.82	8.63	12.19
Total			44.24	33.31	66.67	144.22

DDD defined daily dose

61–120 min before the incision time. Thirty patients (20%) that antibiotics were administered on the day of surgery only, 102 patients (69%) that antibiotics started on the day but continued afterward; and 119 patients (80%) had more than 24 h duration of antibiotics.

The total DDD per 100 bed-days for pre-, on-, and post-surgery antibiotics use, were 44.2, 33.3, and 66.7. Table 4 summarizes the DDD for each antibiotic used. Eleven different antibiotics were used in prophylaxis in this study, of which ceftriaxone was the most commonly used with 75.6 DDD/100 bed-days.

Qualitatively, the percentage of suitability was evaluated by comparing not only the antibiotic selection but also the timing, dosage, duration, and route of antibiotic administration described in Antibiotic Use Guideline Hospital and ASHP Therapeutic Guidelines. Table 5 presents the summarized results of the suitability of the antibiotic use.

Discussion

The quantitative evaluation

The quantitative evaluation of antibiotic use using DDD/100 bed-days as a measurement unit was intended to identify antibiotic use patterns: a high DDD indicates frequent antibiotic use. In this study, ceftriaxone was the most commonly used antibiotic with 75.6 DDD/100 bed-days, meaning that for 100 days of treatment at the hospital, about 76 patients received one ceftriaxone DDD daily. This figure is higher than a cross-sectional retrospective study that involved 463 surgical patients at a University Hospital in Surabaya that found the use of ceftriaxone for prophylaxis at 21.1 DDD/100 days of surgery [21]. The high DDD/100 bed-days for the administration of ceftriaxone can indicate an inappropriate antibiotic selection because based on ASHP Therapeutic Guidelines, the first-choice antibiotic for most surgical procedures in USA is cefazolin [6, 22]. However, the most common infecting microorganism and their resistance

Table 5 Summary of antibiotic suitability profiles according to Antibiotic Use Guideline Hospital (2018) [19] and ASHP Therapeutic Guidelines (2014) [6]

Surgical procedures	% right type		% right time		% right dose		% right duration		% right route	
	AUGH	ASHP	AUGH	ASHP	AUGH	ASHP	AUGH	ASHP	AUGH	ASHP
Herniotomy (n = 18)	0	0	0	11.11	0	0	0	0	0	100
AV shunt (n = 18)	5.56	5.56	11.11	11.11	5.56	5.56	11.11	11.11	27.78	27.78
Myomectomy (n = 14)	0	0	50	50	0	0	21.43	21.43	100	100
Mammary tumor excision (n = 8)	50	50	75	75	50	50	37.5	37.5	100	100
AFF plate (n = 7)	14.29	14.29	85.71	85.71	14.29	14.29	28.57	28.57	100	100
Tumor excision (n = 7)	14.29	28.57	42.86	42.86	14.29	28.57	14.29	14.29	100	100
Soft tissue tumor excision (n = 6)	16.67	16.67	50	50	16.67	16.67	66.67	66.67	100	100
Thyroidectomy (n = 5)	100	100	80	80	100	100	60	60	100	100
Axillary tumor excision (n = 5)	0	0	20	20	0	0	0	0	100	100
Caesarean section (n = 4)	50	25	50	50	25	0	50	50	100	100
Mastectomy (n = 2)	0	0	0	0	0	0	50	50	100	100
Cholecystectomy (n = 23)	60.87	4.35	43.48	43.48	60.87	4.35	8.7	8.7	100	100
Appendectomy (n = 17)	64.71	0	41.18	41.18	58.82	0	11.76	11.76	100	100
URS (n = 9)	0	0	70	80	0	0	20	20	100	100
TURB (n = 4)	25	25	75	75	25	25	0	0	100	100
Colonoscopy (n = 4)	0	0	66.67	66.67	0	0	0	0	100	100
Hepatoscopy (n = 2)	100	100	100	100	100	100	0	0	100	100
Whipple procedure (n = 1)	0	0	0	0	0	0	0	0	100	100
Abscess drainage-incision (n = 5)	0	0	100	100	0	0	20	20	100	100
Fistulectomy (n = 4)	50	0	50	50	50	0	0	0	100	100
Post appendicitis excision (n = 1)	0	0	100	100	0	0	0	0	100	100
Average	26.26	17.59	52.91	53.38	24.79	16.4	19.05	19.05	91.8	96.56

AUGH Antibiotic Use Guideline Hospital *ASHP* American Society of Health-System Pharmacists *AV* arteriovenous, *AFF* atypical femoral fractures, *URS* ureteroscopy, *TURB* transurethral resection of a bladder patterns have not been compared between Indonesia and the USA for all operations and this is discussed below.

Prophylactic antibiotics must have bactericidal properties and be effective against aerobic and anaerobic pathogens that are most likely to contaminate surgical areas, such as *Staphylococcus* and *Streptococcus* on the skin, coliforms (*Escherichia coli* and similar organisms), and normal flora found in the incised skin [23, 24]. Inappropriate use of prophylactic antibiotics can reduce the effectiveness of antibiotics, increase the risk of surgical site infection, and the incidence of antibiotic resistance [25].

The qualitative evaluation

Choice of antibiotic

The choice of antibiotic depends on the type of surgery. Cholecystectomy, one of the most common procedures, is the surgical removal of gallstones and is classified as a clean-contaminated surgery. According to Antibiotic Use Guideline Hospital (2018), the first-choice prophylactic antibiotic for cholecystectomy is ceftriaxone, but ASHP Therapeutic Guidelines recommends cefazolin [6, 19]. Moazeni and Imani [26] prepared bacterial cultures from patients with cholelithiasis and found that the most identified microorganism was *E. coli*. Similarly, Soman et al. [27] also categorized *E. coli* as the most frequently isolated organism; the third-generation cephalosporin, ceftriaxone, is suitable for its effectiveness against gram-negative bacteria like *E. coli* [27]. Ceftriaxone also has a long half-life, 5–9 h, which means that a certain bactericidal level of antibiotic is sustained during a surgical procedure, and accordingly, the administration of additional doses for long-term surgeries is unnecessary [28].

Another very common surgical procedure was AV shunt insertion but of the 18 patients receiving it, 13 were not given prophylactic antibiotics. Antibiotic Use Guideline Hospital and ASHP Therapeutic Guidelines recommend the administration of cefazolin but only one patient received it. A retrospective study by Gray et al. [29] found that 244 of 294 patients (83%) undergoing arteriovenous fistula (AVF) and arteriovenous graft (AVG) from November 2014 to July 2016 received prophylactic antibiotics, and two of those patients experienced surgical site infection (0.68%) [29]. Since the incidence of surgical site infection in patients receiving and not receiving prophylactic antibiotics during the AV Shunt procedure is not significantly different, most surgeons at the study hospital do not practice antibiotic prophylaxis for this surgery.

In this study, 18 patients (11.0%) undergoing hernia surgeries received prophylactic antibiotics without any indications stated in the Antibiotic Use Guideline Hospital. This result is 0% (0/18) in conformity to Antibiotic Use Guideline Hospital and ASHP Therapeutic Guidelines, respectively. Through a meta-analysis study, Sanchez-Manuel et al. (2012) observed 7843 patients with hernias (4703 were given prophylactic antibiotics, but 3140 were not) and found that the incidence of infection occurred in 3.1% of the prophylactic group and 4.5% of the control group (OR 0.64; 95% CI 0.50–0.82) [30].

Timing of administration

Information on the right timing of antibiotic administration is essential as it can ensure that the antibiotics present in serum and tissue can reach the target during the surgery [31]. The recommended time for antibiotic use based on Antibiotic Use Guideline Hospital and ASHP Therapeutic Guidelines is less than 60 min before the incision, or less than 120 min if vancomycin or fluoroquinolones are used [6]. Of 164 patients in this study, 52.9% conformed to the Antibiotic Use Guideline Hospital and 53.6% to ASHP Therapeutic Guidelines, with a majority of antibiotics administered 60–120 min before the incision (55 patients, 37%). Inappropriate timing of antibiotics can increase surgical site infection, as proven in a retrospective cohort study by Hwan et al. (2013). They analyzed 32,459 surgeries consisting of orthopedic, colorectal, vascular, and gynecological surgical procedures from 2005 to 2009 in 112 hospitals and found that the surgical site infection incidence rate was higher when prophylactic antibiotics were administered longer than 60 min before the incision (OR 1.34; 95% CI 1.08–1.66) compared with an administration within 60 min before incision (OR 1.26; 95% CI 0.92–1.72) [32].

Dosage selection

The dose of antibiotics is determined by factoring in the pharmacokinetic profile of antibiotics and patient conditions, such as body weight, to ensure that the concentration of antibiotics in serum and tissue is adequate for surgical prophylaxis [6, 33]. According to Antibiotic Use Guideline Hospital, the recommended dosage varies depending on the type of surgical procedure, but is generally 1 g of ceftriaxone or 1 g of cefazolin. According to ASHP Therapeutic Guidelines, the recommended dosage of ceftriaxone in adults is 2 g, or 2 g cefazolin and 3 g cefazolin for patients weighing ≥ 120 kg. Since the patients sampled in this study did not weigh ≥ 120 kg, the dose used for cefazolin was 2 g [19].

Duration of prophylaxis

Prophylactic antibiotics are given in a duration of no longer than 24 h, except for cardiothoracic procedures where up to 48 h is allowable [6]. Most patients in this study (80%) used antibiotics for more than 24 h. There were 17 patients (11%) who received antibiotics from the time of admission to the hospital until they were about to be discharged. Seventeen of these patients underwent cholecysctectomy, appendectomy, colonoscopy, hepatoscopy, and TURB, none of which required antibiotics > 24 h. Of the 149 patients who used antibiotics, the right duration based on the Antibiotic Use Guideline Hospital and ASHP Therapeutic Guidelines was found in 19.1% and 18.4%, respectively. Branch-Elliman et al. [34] observed 79,058 patients who underwent heart surgery, orthopedic joint replacement, colorectal surgery, and vascular surgery from 2008 to 2013 and found that the relative risks of postoperative *Clostridium difficile* infection in non-cardiac surgery where prophylactic antibiotics were administered for 24 to < 48 h, 48 to < 72 h, and > 72 h were 1.31 (95% CI 1.21–1.42), 1.72 (95% CI 1.47–2.01), and 1.79 (95% CI 1.27–2.53) compared to < 24 h [34].

Route of administration

Based on the Antibiotic Use Guideline Hospital and ASHP Therapeutic Guidelines, the recommended route of surgical prophylactic antibiotics is intravenous because it has a rapid onset of reaction and its levels in blood and tissue can be predicted [6].

Overall, this study identified inappropriate antibiotic prescribing: duration (81,0%), dose (75,2%), choice of antibiotic (73.7%), time of giving (47.1%), and route (8.2%); compared to The Hospital National Antimicrobial Prescribing Survey (2016) in Australia, that found improper duration (29.9%), wrong dosage (27.6%), and procedures that did not require antibiotics (22.0%) [35].

The high rate of antibiotic use that did not comply with the Antibiotic Use Guideline Hospital shows the lack of agreement between surgeons and the Antibiotic Use Guideline Hospital. This finding is similar to Soman et al. [27], who found that non-compliance with the hospital's antibiotic policy was up to 50.4% [26]. Aly et al. [36] found that adherence to selection, dosage, route, frequency, and duration of antibiotics was only 30.4%. Reasons for prescribing surgical prophylaxis without an approved indication included fears of complications, a greater confidence from the surgeon when the patient received antibiotics, or surgeons who disagreed with the guidelines [36].

Limitations

The limitation of this study lies in its retrospective design that collected data from available medical records. Hence, patients who met the inclusion and exclusion criteria but had incomplete medical record records had to be excluded. Also, inappropriate antibiotic selection may indicate that surgeons disagree with the current Antibiotic Use Guideline Hospital, which also refers to ASHP Therapeutic Guidelines. For this reason, the use of antibiotics preferred by surgeons and proposed by Antibiotic Use Guideline must be in agreement, and only then, will every surgeon comply with the Antibiotic Use Guideline.

Conclusion

Based on the quantity, ceftriaxone was the first-choice prophylactic antibiotic administered to patients registered at a private hospital in Surabaya between January and June 2019 even though often this did not conform to guidelines for the use of antibiotics in hospitals as well as international guidelines. It is necessary to carry out further research regarding the factors that influence the prescribing of antibiotics by the surgeon and the impact of the inappropriate use of antibiotics.

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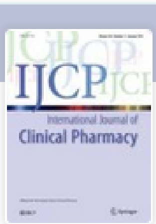

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