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Research Article

Antibiotics Stewardship in Cesarean Section at a Public Hospital in Surabaya, Indonesia

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Abstract
Cesarean section (CS) is a procedure performed to save the mother and fetus through an incision in the mother's abdomen and uterus. The high rate of CS in Indonesia correlates with the risk of surgical site infections (SSI), making the use of prophylactic antibiotics important. The use of antibiotics has health impacts on the community, one of which is antibiotic resistance. This study aims to determine antibiotic usage patterns and their compliance with the National Formulary and the Antimicrobial Stewardship Program (PPRA), and the profile of mothers who experience SSI at a public hospital in Surabaya. This retrospective observational quantitative study used medical record data from CS patients from January to June 2024, and the data were analyzed using descriptive statistics and Defined Daily Dose (DDD) methodology to evaluate antibiotic utilization. The results showed cefazolin 2 grams was the most widely used antibiotic (88.64%) with a DDD/100 bed days value of 14.10. Compliance of antibiotic usage patterns with the Antimicrobial Use Guideline (PPAB) reached 88.64%. SSI occurred in 1.31% of patients, especially in pregnancies of more than 2 times. The use of antibiotics at a public hospital in Surabaya is the rational use of antibiotics, the incidence of SSI is smaller than the established standard of 1.5%.

Keywords: antibiotics, cefazolin, cesarean section, DDD/100 bed days, rational antibiotic use, surgical wound infection

Pengelolaan Penggunaan Antibiotik pada Seksio Sesarea di Sebuah Rumah Sakit Umum di Surabaya, Indonesia

Abstrak
Seksio sesarea (SC) merupakan tindakan pembedahan yang dilakukan untuk menyelamatkan ibu dan janin melalui sayatan pada dinding perut dan rahim. Tingginya angka SC di Indonesia berkorelasi dengan risiko infeksi luka operasi (ILO) sehingga penggunaan antibiotik profilaksis menjadi penting. Penggunaan antibiotik memiliki dampak kesehatan terhadap masyarakat, salah satunya adalah resistensi antibiotik. Penelitian ini bertujuan untuk mengetahui pola penggunaan antibiotik serta kesesuaiannya dengan Formularium Nasional dan Program Pengendalian Resistensi Antimikroba (PPRA), serta profil ibu yang mengalami ILO di salah satu rumah sakit umum di Surabaya. Penelitian ini merupakan studi observasional retrospektif kuantitatif yang menggunakan data rekam medis pasien SC dari Januari hingga Juni 2024, dan dianalisis secara deskriptif serta menggunakan metode *Defined Daily Dose* (DDD) untuk mengevaluasi penggunaan antibiotik. Hasil penelitian menunjukkan bahwa cefazolin 2 gram merupakan antibiotik yang paling banyak digunakan (88,64%) dengan nilai DDD/100 hari rawat sebesar 14,10. Tingkat kepatuhan terhadap Formularium Nasional dan Pedoman Penggunaan Antibiotik (PPAB) mencapai 88,64%. ILO terjadi pada 1,31% pasien, terutama pada ibu dengan riwayat kehamilan lebih dari dua kali. Penggunaan antibiotik di salah satu rumah sakit umum di Surabaya tergolong rasional, dengan angka kejadian ILO lebih rendah dari standar yang ditetapkan, yaitu 1,5%.

Kata kunci: antibiotik, cefazolin, seksio sesarea, DDD/100 hari rawat, penggunaan antibiotik rasional, infeksi luka operasi

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Introduction

Cesarean section (CS) is a surgical procedure performed to save the lives of mothers and fetuses when complications occur during pregnancy and labor. This procedure is performed when normal vaginal delivery is not possible due to the risk of other medical complications.[1] The World Health Organization (WHO) sets the ideal rate for CS at 10–15% of total births.[2] However, the prevalence of CS continues to increase globally and nationally. Basic Health Research (RISKESDAS) data in Indonesia reported that 9.8% of 49,603 births between 2010 and 2013 were delivered by CS, with DKI Jakarta having the highest rate (19.9%) and Southeast Sulawesi the lowest (3.3%).[3] By 2018, the number of CS deliveries had further increased. In Asia, urban areas also report high CS rates, such as the Maldives (39.07%), India (23.64%), Bangladesh (21.82%), Vietnam (21.72%), Pakistan (17.75%), and Indonesia (17.25%), which all exceed the WHO recommendation.[4]

Despite its benefits, CS procedures are associated with a higher risk of complications, particularly surgical site infection (SSI). SSI is among the most common nosocomial infections in surgical patients and ranks as the second or third most frequent nosocomial infection overall. According to WHO, the cumulative incidence of SSI is 0.9% in the United States (2014) and ranges from 0.75 and 9.5% in various types of surgery in Europe (2010–2011). WHO reported a combined SSI incidence in low- and middle-income countries of 11.8%. In the Asia-Pacific region, reported SSI incidences vary widely by 2.8% in Australia (2002–2013), 2.0–9.7% in the Republic of Korea, 4% in China (2000–2017), and 7.8% in Southeast Asia and Singapore.[5] The use of prophylactic antibiotics can reduce the risk of SSI.

Prophylactic antibiotics are highly recommended for patients to reduce the risk of post-operative wound infection. The use of prophylactic antibiotics, especially for CS, has been shown to be effective in reducing morbidity, cost, and length of stay after surgery.[6] There are several types of prophylactic antibiotics for CS, one of which is cefazolin. The overall SSI rate in patients receiving cefazolin 2 g as prophylactic antibiotic is very low (1.2%).[7] Administration of cefazolin before skin incision has been shown to reduce wound infection compared to after umbilical cord clamping. However, beyond effectiveness, the rational use of antibiotics in CS must be ensured in accordance with the National Formulary and the Antimicrobial Use Guideline (PPAB). Rationality involves appropriate drug selection, dosing, timing of administration, route, and duration of therapy, based on clinical evidence. To evaluate these aspects, antibiotic consumption can be measured using the Defined Daily Dose (DDD) per 100 bed days methodology, which allows for monitoring prescribing patterns and benchmarking against stewardship standards.[8] Despite the known benefits of prophylactic antibiotics, studies in Indonesia indicate that antibiotic use in CS patients is often excessive or inappropriate. While such practices may reduce SSI rates, they also increase the risk of antimicrobial resistance. Limited research has specifically examined cefazolin prophylaxis in CS patients using the DDD/100 bed days approach combined with appropriateness assessment, leaving a gap in understanding how antibiotic stewardship principles are being implemented in clinical practice. Therefore, the objective of this study was to evaluate the utilization pattern and appropriateness of prophylactic antibiotic use, particularly cefazolin, in CS patients at a public hospital in Surabaya, using the DDD/100 bed days method and PPAB. We hypothesize that, although cefazolin is widely

used as prophylactic antibiotic in CS, its utilization may show deviations from rational use indicators, which could contribute to the risk of antimicrobial resistance.

Methods

This is a quantitative study with an observational design that will be analyzed descriptively with a retrospective data collection approach. The sample of this study consisted of elective and emergency CS patients at a public hospital in Surabaya in the period January–June 2024. The inclusion criteria limited the sample only to patients who received antibiotic therapy. Patients who were referred to other hospitals or had incomplete medical record data were excluded from the study. DDD/100 bed days was calculated using the WHO ATC/DDD methodology, with patient-days defined as the total number of CS inpatient hospital days during the study period. Appropriateness of antibiotic use was assessed according to the National Formulary and the PPAB criteria, including the selection of antibiotic, dose, timing of administration (within 30–60 minutes before skin incision), route of administration, and duration of therapy (single dose or ≤24 hours for prophylaxis). Collected variables included patient demographics (age, parity, body mass index [BMI]), type of surgery (elective or emergency CS), length of hospital stay, history of previous CS, onset of labor, number of fetuses, gestational age, fetal presentation, comorbidities, and cause of maternal death if present.

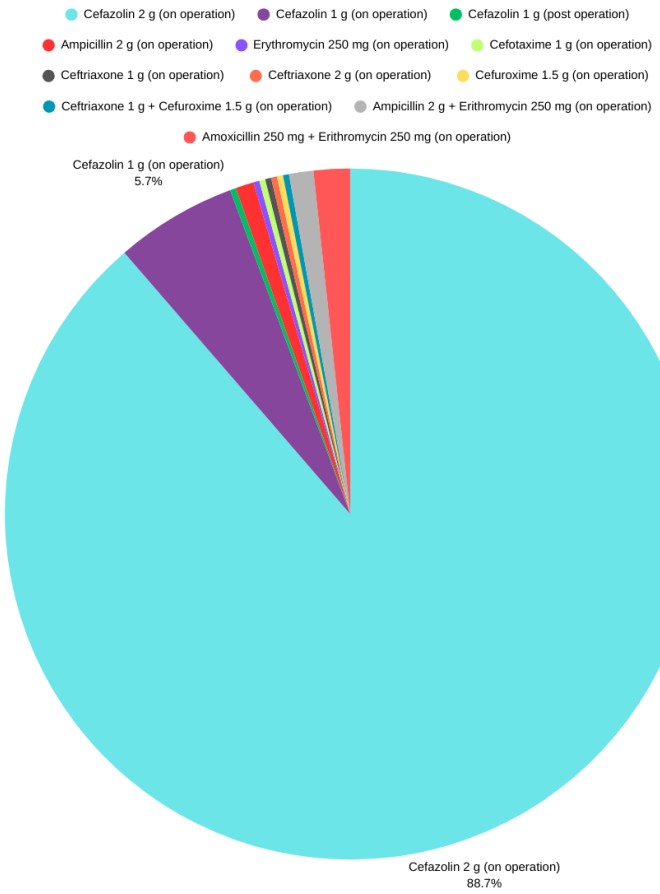

Figure 1. Pattern of Antibiotics Usage

Therapeutic data collected were type of antibiotic, dose, timing, route, and duration of administration. Data were analyzed descriptively using Microsoft Excel 2021. Results were presented as mean, frequency, and percentage. This research provides ethical approval from the Public Hospital, Surabaya's Institutional Ethical Committee Number: 3336/104/4/XI/2024.

Results

Data collection was conducted in January 2025, with the sampling period spanning from January 2024 to June 2024. The total population obtained in this study consisted of 340 patients. A total of 324 patients met the inclusion criteria and were included as research samples, comprising 19 patients who underwent elective CS and 305 patients who underwent emergency CS. A total of 12 patients were excluded from the study due to incomplete medical records.

Table 1 presents data from a total of 324 deliveries, comprising 305 emergency CS and 19 elective CS procedures. The majority of mothers in both groups were aged 20–35 years. Emergency CS cases exhibited a more diverse range of medical histories compared to elective CS. Most mothers had a BMI within the normal range (18.9–29.9) and were multiparous. More than half of the mothers undergoing emergency CS had no prior history of CS. All deliveries were performed via CS. The majority of mothers had a gestational age of less than 37 weeks, with cephalic presentation being the most common. The length of hospital stay was generally more than three days. The mortality rate in the emergency CS group was 4.92%, whereas no maternal deaths were observed in the elective CS group. This difference may be attributed to the urgent nature of emergency CS, which often involves patients with unstable hemodynamic status or severe obstetric complications, leaving less time for preoperative optimization and increasing perioperative risk.[9] Sepsis was the leading cause of maternal death in this study (35.7% of cases), aligning with global evidence that delays in recognizing and treating infection significantly worsen outcomes in emergency obstetric surgeries. For instance, a multicenter study in Indonesia found that severe preeclampsia/eclampsia (42%) and postpartum hemorrhage (16%) were more common causes of death, while sepsis accounted for only 9%.[10] Cardiogenic shock also contributed to high mortality risk in the peripartum period; among cases with cardiogenic shock, mortality reached 18.8%.[11]

Table 2 shows that the majority of patients (287) received 2 grams of cefazolin prior to CS in accordance with the National Formulary and the PPAB, with a compliance rate of 88.64%. This finding is illustrated in Figure 1, where the pie chart clearly shows that cefazolin 2 g administered prior to surgery dominates prophylactic antibiotic use, while other antibiotics represent only a small proportion. Among these patients, 84 had a hospital stay of ≤3 days, while 203 stayed for more than 3 days. In this group, 4 patients developed SSI, and 14 maternal deaths were recorded. Additionally, 22 patients received an extra 1-gram dose of cefazolin during surgery, with a compliance rate of 5.68% according to the National Formulary and the PPAB. Among these patients, 6 had a hospital stay of ≤3 days, while 16 stayed for more than 3 days. However, no clear relationship was found between the type of prophylactic antibiotic administered and these clinical outcomes. This indicates that although cefazolin was predominantly used and compliance with guidelines was high, it is essential to consider other factors such as patient risk profiles and comorbidities, which may have a greater influence on outcomes.

Table 1. Demographic Characteristics

Criteria		Emergency CS N (%)	Elective CS N (%)
Age (years)	<20	9 (2.95)	-
	20–35	231 (75.74)	16 (84.21)
	>35	65 (21.31)	3 (15.79)
Medical History	Pregnancy, childbirth and the puerperium	37 (12.13)	1 (0.33)
	Diseases of the circulatory system	10 (3.28)	-
	Endocrine, nutritional and metabolic diseases	10 (3.28)	2 (0.66)
	Diseases of the respiratory system	8 (2.62)	-
	Certain infectious and parasitic diseases	14 (4.59)	-
	Diseases of the blood and blood-forming organs and certain disorders involving the immune mechanism	5 (1.64)	1 (0.33)
	Diseases of the digestive system	1 (0.33)	1 (0.33)
	Diseases of the nervous system	1 (0.33)	-
	Diseases of the genitourinary system	2 (0.66)	-
	Neoplasm	1 (0.33)	-
Body Mass Index (BMI)	≤18,9	8 (2.62)	-
	19–24,9	94 (30.82)	6 (31.58)
	25–29,9	95 (31.15)	7 (36.84)
	30–34,9	67 (21.97)	3 (15.79)
	35–39,9	26 (8.52)	1 (5.26)
	≥40	15 (4.92)	2 (10.53)
Length of Stay	≤3	105 (34.43)	7 (36.84)
	>3	200 (65.57)	12 (63.16)
Discharged from the hospital	Improvement	290 (95.08)	19 (100)
	Mortality	15 (4.62)	-
	Sepsis Shock	5 (1.64)	-
	Cardiogenic Shock	5 (1.64)	-
	Cardiac Arrest	2 (0.66)	-
	PH crisis	1 (0.33)	-
	HIV	1 (0.33)	-
	Congenital Heart Disease	1 (0.33)	-
Parity	Nullipara	88 (28.85)	3 (15.79)
	Multipara	217 (71.15)	16 (84.21)
Previous CS	No	165 (54.10)	6 (31.58)
	Yes	140 (45.90)	13 (68.42)
Number of Fetuses	Singleton	301 (98.69)	18 (94.74)
	Multiple	4 (1.31)	1 (5.26)
Gestational Age (weeks)	<37	178 (58.36)	9 (47.37)
	≥37	127 (41.64)	10 (52.63)
Fetal Lie and Presentation	Cephalic presentation	241 (79.02)	2 (10.53)
	Transverse lie	39 (12.79)	13 (63.42)
	Breech presentation	25 (8.20)	4 (21.05)

However, no clear relationship was found between the type of prophylactic antibiotic administered and these clinical outcomes. This indicates that although cefazolin was predominantly used and compliance with guidelines was high, it is essential to consider other factors such as patient risk profiles and comorbidities, which may have a greater influence on outcomes. All patients who developed SSI had received 2 grams of cefazolin as prophylaxis, administered 30–60 minutes prior to incision, fully in line with the guidelines. In summary, the data indicate a strong adherence to antibiotic prophylaxis guidelines, with cefazolin being the predominant choice for CS procedures.

The analysis of antibiotic use in Table 3, using DDD per 100 bed days method, indicates that the highest on-surgery antibiotic usage was cefazolin, with a value of 14.10 DDD/100 bed days. That means the majority of patients received cefazolin 2 g, showing a strong adherence to the national guideline. Antibiotic usage guidelines directly influence the DDD/100 bed days value for a given antibiotic. The quantity of antibiotic use at a public hospital in Surabaya differs from that reported in hospitals in West Java found that the highest DDD/100 bed days value was observed for ceftriaxone (intravenous injection), reaching 62.58 DDD/100 bed days. In comparison, the DDD/100 bed days for cefazolin in our study was 14.10, which is considerably lower. This suggests that the use of cefazolin in our setting is relatively conservative, potentially reflecting the focus on its role as a prophylactic antibiotic for cesarean sections, while ceftriaxone in the referenced study was likely used more broadly for therapeutic purposes.

In Table 4, data were obtained from four patients who developed SSIs following CS, with the onset of infection occurring between 10 to 20 days postoperatively. All patients were women pregnant with their third child, each with varying ages. The underlying medical diagnoses varied among the patients and included preeclampsia, placenta accreta, chronic hypertension, diabetes mellitus, and other conditions. All patients received 2 grams of cefazolin administered 30 minutes prior to skin incision, followed by a 15-minute infusion. The use of antibiotics in all cases was in accordance with the National Formulary and the PPAB. Moreover, all SSI cases occurred in patients with a parity of three or more, suggesting that higher parity may represent an additional risk factor for SSI. Multiparity may elevate SSI risk due to factors such as weakened tissue integrity and longer surgical times resulting from intra-abdominal adhesions. Similar multifactorial strategies incorporating extended prophylaxis regimens have shown SSI reduction from 6.12% to 1.42%, although not reaching statistical significance.[12]

Discussion

The majority of patients undergoing CS in this study were young adults aged 20–35 years, with multiparous women representing a significant proportion, especially in emergency CS cases. High BMI was common, with many patients classified as overweight or obese, both of which are known risk factors for pregnancy complications. Multiparity was particularly notable, as all patients who developed SSI were multiparous (parity ≥3), suggesting a possible association between higher parity and increased SSI risk.

While detailed demographic factors such as fetal presentation, gestational age, and twin pregnancies were assessed, these were not found to have a direct relationship with antibiotic prophylaxis outcomes. Therefore, further analysis should focus on how these clinical variables interact with antibiotic effectiveness and SSI prevention rather than

Table 2. Table of Antibiotic Usage

Administered Antibiotics	Compliance with National Formulary and PPAB	Reason for Unsuitable Regimen	N (324)	LOS		Incidence of SSI	Maternal Mortality
				≤3	>3		
Cefazolin 2 grams is administered over 15 minutes, 30 minutes prior to incision.	Appropriate	-	287	84	203	4	14
Cefazolin 2 grams is administered over 15 minutes, 30 minutes prior to incision, followed by an additional dose of 1 gram administered intraoperatively.	Appropriate	-	22	6	16	0	0
Cefazolin 2 grams is administered over 15 minutes, 30 minutes prior to incision, followed by 1 gram every 8 hours postoperatively for up to 48 hours.	Inappropriate	Extended duration >24h, against PPAB recommendation	1	0	1	0	0
Cefotaxime 1 gram is administered over 15 minutes, 30 minutes prior to incision.	Inappropriate	Incorrect dose (should be 2 g pre-incision)	1	0	1	0	0
Ceftriaxone 1 gram is administered over 15 minutes, 30 minutes before incision.	Inappropriate	Antibiotic not recommended for prophylaxis in PPAB	1	0	1	0	0
Ceftriaxone 2 grams is administered over 15 minutes, 30 minutes before incision.	Inappropriate	Antibiotic not recommended for prophylaxis in PPAB	1	0	1	0	0
Cefuroxime 1.5 grams is administered over 15 minutes, 30 minutes before incision.	Inappropriate	Antibiotic not recommended for prophylaxis in PPAB	2	0	2	0	0
Ceftriaxone 1 gram and cefuroxime 1.5 grams are administered over 15 minutes, 30 minutes before incision.	Inappropriate	Antibiotic not recommended for prophylaxis in PPAB	1	0	1	0	0

Table 2. Table of Antibiotic Usage (cont.)

Administered Antibiotics	Compliance with National Formulary and PPAB	Reason for Unsuitable Regimen	N (324)	LOS		Incidence of SSI	Maternal Mortality
				≤3	>3		
Ampicillin 2 grams is administered over 15 minutes, 30 minutes before incision.	Inappropriate	Antibiotic not recommended for prophylaxis in PPAB	1	1	0	0	0
Ampicillin 2 grams is administered over 15 minutes, 30 minutes before incision, followed by oral amoxicillin 250 mg every 8 hours and erythromycin 250 mg every 6 hours for 5 days, starting 2 days postoperatively.	Inappropriate	Antibiotic not recommended for prophylaxis in PPAB	5	2	3	0	1
Ampicillin 2 grams and erythromycin 250 mg tablets are administered every 6 hours, starting preoperatively and continuing for 48 hours.	Inappropriate	Antibiotic not recommended for prophylaxis in PPAB	1	1	0	0	0
Erythromycin 250 mg tablets are administered every 6 hours, starting preoperatively and continuing for 48 hours, followed by oral amoxicillin 250 mg every 8 hours and erythromycin 250 mg every 6 hours for 5 days, starting 2 days postoperatively.	Inappropriate	Antibiotic not recommended for prophylaxis in PPAB	1	0	1	0	0
Total			**324**	**94**	**230**	**4**	**15**

descriptive demographic characteristics.

The most commonly used antibiotic at a public hospital in Surabaya is cefazolin, administered in intravenous injection form. It is given at a dose of 2 grams, 30 minutes before incision over 15 minutes, in 88.64% of patients, with an additional intraoperative dose administered in 5.68% of cases. A similar pattern of antibiotic use was observed the majority of antibiotics used in CS are in line with the guidelines. The types of prophylactic antibiotics (i.v.) used are varied; the majority were cefazoline (74.5%), ceftriaxone (14.5%), and cefotaxime (11.6%) (13). The concentration of free (unbound) cefazolin in umbilical cord plasma remains above 8 mg/L in less than 50% of cases when either the dose is less than 2 grams or when administration occurs less than one hour before incision. Administering 2 grams of cefazolin one hour before incision has been shown to achieve adequate drug levels in both the mother and the fetus (via umbilical cord blood) in more than 50% of cases. This 2-gram dosage is preferred due to the increased total clearance of cefazolin during pregnancy, necessitating a higher dose for surgical prophylaxis in pregnant women to achieve the same antibacterial effect as in non-obstetric surgeries. Cefazolin also has a longer half-life in neonates compared to adults. When administered at 2 grams to the mother one hour before surgery, it remains effective and provides clinically approved exposure levels in neonates.14 While cefazolin monotherapy is the recommended prophylactic agent for cesarean sections, evidence suggests that adding an adjunctive antibiotic before incision can provide additional benefits in certain high-risk populations. A meta-analysis reported significant reductions in SSI when cefazolin was combined with an adjunctive agent compared to cefazolin alone (relative risk, 0.46; 95% confidence interval [CI], 0.34–0.63; based on three randomized controlled trials). Moreover, the duration of hospital stay was significantly shorter in the combination group (weighted mean difference, −1.46 days; 95% CI, −2.21 to −0.71; two randomized controlled trials). However, no significant difference was found in maternal febrile morbidity between the two groups (relative risk, 0.38; 95% CI, 0.11–1.25; two randomized controlled trials). These findings suggest that while cefazolin alone remains effective and aligned with current guidelines, the use of dual regimens may be considered for high-risk patients to further reduce the risk of SSI and shorten hospitalization.[15] The additional

Table 3. Analysis of Antibiotic Usage Quantity Using the DDD/100 Bed Days Method

ATC Code	Antibiotics	Route of Administration	WHO DDD	DDD/100 Bed Days Pre-Operative	DDD/100 Bed Days On-Operative	DDD/100 Bed Days Post-Operative
J01DB04	Cefazolin	Parenteral	3	-	14.10	-
J01CA01	Ampicillin	Parenteral	6	-	0.29	-
J01CA04	Amoxicillin	Parenteral	3	-	-	0.07
J01DD01	Cefotaxime	Parenteral	4	-	0.11	-
J01DD04	Ceftriaxone	Parenteral	2	-	0.50	-
J01DC02	Cefuroxime	Parenteral	3	-	0.54	-
J01FA01	Erythromycin	Oral	1	0.07	-	0.07
Total DDD/100 Bed Days				**0.07**	**15.61**	**0.14**

intraoperative dose aims to maintain stable tissue concentrations. Cefazolin has been proven to suppress bacterial colonization at the surgical site, is compatible with anesthetic agents, and has a lower tendency to induce bacterial mutations. Microbiological culture and resistance data were not collected in this study, which limits the ability to correlate SSI cases with specific pathogens or resistance patterns. Future research should include such data to better guide antibiotic selection and stewardship strategies.

The use of antibiotics is quantitatively assessed using the Anatomical Therapeutic Chemical (ATC) Classification System. The regulations governing antibiotic use directly influence the DDD/100 bed days value for a particular antibiotic. The higher the daily antibiotic usage, the greater the frequency of administration, leading to an increased total antibiotic dose received by patients. An increase in the total administered dose correlates with a higher DDD value. The DDD/100 bed days value is influenced by the total length of stay (LOS) and the total grams of antibiotics used. A higher total DDD/100 bed days value indicates a greater level of antibiotic consumption within 100 patient days. Analysis of antibiotic use based on the DDD/100 bed days method shows that the most frequently used intraoperative antibiotic at a public hospital in Surabaya is cefazolin, with a value of 14.10 DDD/100 bed days. The quantity of antibiotic use at a public hospital in Surabaya differs from that reported in hospitals in West Java found that the highest DDD/100 bed days value was observed for ceftriaxone (intravenous injection), ranging 10–76.15 DDD/100 bed days.[16] In comparison, the DDD/100 bed days for cefazolin in our study was 14.10, which is considerably lower. Hospital pharmacists and antimicrobial stewardship teams play a crucial role in ensuring rational antibiotic use. In this context, their involvement in auditing prophylactic antibiotic practices, providing education to clinicians, and monitoring resistance trends could help reduce SSI rates and prevent overuse of cefazolin.

PPAB recommends administering 2 grams of cefazolin as prophylaxis for cesarean sections, given 30–60 minutes before the skin incision, which aligns closely with both WHO and American College of Obstetricians and Gynecologists (ACOG) recommendations. According to WHO, a single-dose first-generation cephalosporin, such as cefazolin, is sufficient for most cesarean deliveries, with no need for postoperative prophylactic antibiotics.[17] Similarly, ACOG advises a single pre-incision dose of cefazolin, with the addition of adjunctive azithromycin in high-risk patients, such as those undergoing emergency CS with ruptured membranes or prolonged labor.[17] However, a gap exists in PPAB: it does not specifically address high-risk populations or the use of dual regimens. Recent studies have demonstrated that adding azithromycin to cefazolin can significantly reduce rates of SSI and shorten hospital stay among these high-risk patients. Furthermore, neither PPAB nor local hospital guidelines explicitly include protocols for monitoring antimicrobial resistance patterns, which are essential for updating prophylactic strategies.

The appropriateness of antibiotic use in CS patients at a public hospital in Surabaya, according to the National Formulary and the PPAB, indicates that cefazolin 2 grams, administered via intravenous drip in 100 mL of water for injection, normal saline (0.9% NaCl), or 5% dextrose, injected 30–60 minutes before incision over 15 minutes, had a compliance rate of 88.64%; 5.68% of patients received an extra dose during surgery. Patients receiving ampicillin or erythromycin for seven days were typically those with premature rupture of membranes (PROM) or preterm premature rupture of membranes (PPROM). Additional

Table 4. Table of Surgical Site Infection Incidents

Patient and Clinical Characteristics		Patient Code			
		A68	B35	N10	D37
Time of SSI Occurrence		12 days after CS	10 days after CS	12 days after CS	20 days after CS
Parity		Gravida 3	Gravida 3	Gravida 3	Gravida 3
Age (years)		29	30	32	35
Diagnosis		Severe preeclampsia, fetal IUGR, brain-sparing effect, oligohydramnios (AFI 7.1)	Placenta accreta, anemia	Chronic hypertension, Evans syndrome, class 1 obesity, anemia, history of placenta accreta.	Preeclampsia, gestational DM, suspected fetal congenital anomaly, uterine myoma.
Antibiotics	Type of Antibiotics	Cefazolin	Cefazolin	Cefazolin	Cefazolin
	Antibiotics Dosage	2 grams	2 grams	2 grams	2 grams
	Timing of Antibiotic Administration	30 minutes before incision, administered over 15 minutes	30 minutes before incision, administered over 15 minutes	30 minutes before incision, administered over 15 minutes	30 minutes before incision, administered over 15 minutes
Compliance with National Formulary		Appropriate	Appropriate	Appropriate	Appropriate
Compliance with Antimicrobial Use Guideline		Appropriate	Appropriate	Appropriate	Appropriate

intraoperative antibiotic administration was generally given in cases of blood loss exceeding 1500 mL or surgeries lasting more than three hours to maintain stable tissue antibiotic concentrations. In this study, 11.36% of cases were non-compliant with PPAB, most commonly involving the use of ceftriaxone instead of the recommended cefazolin. Clinically, physicians may have selected ceftriaxone for patients perceived to be at higher risk of infection, such as those with comorbidities or undergoing emergency cesarean sections with ruptured membranes.

A total of four patients (1.31%) experienced SSI despite receiving cefazolin 2 grams as prophylaxis, administered 30–60 minutes before incision in accordance with the National Formulary and the PPAB. A study recorded a higher SSI rate was 9.85% at 2018 at the University Clinical Center of Kosovo, Clinic for Obstetrics and Gynecology.[18] The SSI incidence at a public hospital in Surabaya is relatively low compared to these hospitals. Infections can delay wound healing, increasing both morbidity and mortality rates. Additionally, SSI leads to extended hospitalization and higher treatment costs.[19] All patients who developed SSI had a parity of three or more. This finding aligns with the study by Jabbar, Perveen and Naseer (2016) which reported that pregnant women with a parity of ≥3 were more likely to experience SSI compared to those with a lower parity.[20] SSI may have occurred despite adherence to prophylactic protocols due to unmeasured factors such as intraoperative blood loss, prolonged surgical duration, or suboptimal hygiene practices, which were not captured in this study.

This study did not include microbiological culture or antibiotic resistance data, which limits the ability to assess whether pathogens causing SSI exhibit resistance patterns that could undermine the effectiveness of cefazolin prophylaxis. A systematic review of antimicrobial resistance in Indonesia during the past decade revealed alarmingly high resistance rates to third-generation cephalosporins up to 70% for both *Escherichia coli* and *Klebsiella pneumoniae* underscoring the need for local surveillance to guide antibiotic choice.[21] Furthermore, the study's retrospective design may have underreported SSI occurrences, particularly those developing post-discharge, as seen in similar settings where approximately 30–60% of SSIs were detected only after patients left the hospital.[18]

Conclusions

The most frequently used antibiotic was cefazolin 2 grams, administered to 88.64% of patients, with 5.68% receiving an additional 1-gram intraoperative dose. It was given via intravenous infusion in 100 mL of water for injection, normal saline (NaCl 0.9%), or dextrose 5%, over 15 minutes, within 15–60 minutes before incision, in line with the National Formulary and the PPAB. The DDD for cefazolin was 14.10 DDD/100 bed days, indicating a moderate level of antibiotic utilization. High compliance with these protocols (88.64%) was associated with a low SSI rate of 1.31%. However, all SSI cases occurred among multiparous women (gravida ≥3), suggesting that standard prophylaxis may be insufficient for this high-risk group.

All four patients who developed SSI had a parity of three, suggesting a strong link between multiparity and the risk of postoperative infection. In addition, each patient had significant comorbidities, such as preeclampsia, gestational diabetes, placenta accreta, obesity, and anemia, all of which are well-established factors that impair wound healing and increase susceptibility to infection. Notably, all patients received cefazolin 2 g intravenously, administered 30

minutes before incision, in full compliance with the National Formulary and the PPAB. These findings indicate that the occurrence of SSI was likely driven by patient-related factors rather than non-compliance with prophylactic antibiotic protocols.

To further improve outcomes, strengthening the implementation of PPAB, ongoing monitoring of antibiotic use and SSI rates, and the inclusion of routine microbiological testing are recommended. Future research should evaluate local antibiotic resistance patterns, the impact of stewardship interventions on clinical outcomes, and the cost-effectiveness of tailored prophylaxis, particularly for high-risk populations such as multiparous women.

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Conflict of Interest

The author declares that there is no conflict of interest in this study.

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