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Jalan Raya Kalirungkut, Surabaya, 60293

Telepon (031) 2981110

Email : [mpi@unit.ubaya.ac.id](mailto:mpi@unit.ubaya.ac.id)

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**Dr. apt. Rika Yulia, Sp.FRS.**

**Dr. apt. Fauna Herawati**

**Hidayati Adi Putri**

Magister Farmasi - Universitas Surabaya

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***Appropriateness of Antibiotic Prophylaxis Use and Surgical Site Infection in Caesarean Section Patients***

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1                   **Appropriateness of Antibiotic Prophylaxis Use and Surgical Site**  
2                   **Infection in Caesarean Section Patients**

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4                   Hidayati Adi Putri <sup>a</sup>, Fauna Herawati <sup>b\*</sup>, Rika Yulia <sup>b</sup>

5  
6                   <sup>a</sup> Master of Pharmaceutical Science Program, Faculty of Pharmacy, University  
7                   of Surabaya, Surabaya, Indonesia

8                   <sup>b</sup> Department of Clinical Pharmacy, Faculty of Pharmacy, University of  
9                   Surabaya, Surabaya, Indonesia

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24                   \* Corresponding author at e-mail address: fauna@staff.ubaya.ac.id

25 **Abstract**

26 Caesarean Section (CS) is a clean-contaminated surgery. Patients undergoing  
27 CS are at risk of developing a surgical site infection (SSI). Antibiotic prophylaxis  
28 serves as a critical preventive strategy of infections in the surgical site. The  
29 objective of this study is to evaluate the appropriateness of prophylactic  
30 antibiotics use by analyzing type, dose, route, timing and duration of antibiotic  
31 administration using the Gyssen flowchart as well as to monitor the incidence of  
32 SSIs in patients undergoing CS. The study was conducted retrospectively from  
33 January to May 2025 at a General Hospital in Bondowoso, and obtained 191  
34 samples (11 emergency CS patients and 180 elective CS patients). In general,  
35 the study results demonstrated that the appropriate use of antibiotics was  
36 58.64% (90.91% in emergency CS patients, 56.67% in elective S patients).  
37 Inappropriate timing of administration is the most prevalent category of  
38 inappropriateness, which occurred in 71 patients (37.17%). Postoperative SSI  
39 were identified in two patients (0.93%). Although the evaluation of antibiotic  
40 administration shows a high rate of inappropriate antibiotic use, the incidence of  
41 SSI is very low (0.93%).

42 **Key Words:** Appropriate use of antibiotics; prophylactic antibiotics; surgical site  
43 infections; Caesarean section

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46 **1. Introduction**

47 Caesarean section (CS) is a high-risk delivery procedure. CS patients  
48 are predisposed twenty-five times greater than those undergoing vaginal

49 delivery. Furthermore, the morbidity rate for CS is significantly greater, reaching  
50 27.3 per 1,000 cases, compared to only 9 per 1,000 cases in vaginal deliveries  
51 [1]. Caesarean section is classified as a clean-contaminated procedure, as it  
52 involves a controlled entry into the genitourinary tract without significant  
53 contamination. This procedure predisposes patients to infections at the surgical  
54 site [2]. Surgical site infections (SSIs) are the leading cause of postoperative  
55 morbidity, representing approximately 90% of such cases. As a critical  
56 postoperative complication, SSIs pose a significant burden by increasing patient  
57 morbidity and length of stay [3].

58 The administration of prophylactic antibiotics serves as a vital preventive  
59 strategy. Compared to placebo, prophylactic antibiotics significantly diminish  
60 various postoperative complications in Caesarean section patients. This  
61 intervention significantly lowers the incidence of postpartum febrile morbidity,  
62 localized and systemic infections [4]. To effectively prevent surgical site  
63 infections (SSIs), the selection of an appropriate prophylactic antibiotic is  
64 essential. According to the clinical guidelines for Caesarean section issued by  
65 the Indonesian Society of Obstetrics and Gynecology (POGI) [5], Cefazolin at a  
66 dose of 1–2 grams is the recommended prophylactic agent. Although Cefazolin  
67 is the sole recommended prophylactic agent for Caesarean section patients,  
68 many hospitals still utilize alternative antibiotics. Such inappropriate use is a  
69 serious concern, as it can escalate patient mortality and morbidity while driving  
70 the development of antimicrobial resistance [6].

71 Antimicrobial resistance has evolved with remarkable speed. The rapid  
72 proliferation and dissemination of resistant bacteria have led to a significant

73 decline in our capacity to effectively treat infectious diseases [7]. In an effort to  
74 reduce antibiotic resistance, WHO implements Antimicrobial Stewardship  
75 Programmes (ASPs). These programs serve as a strategic framework to  
76 optimize the utilization of antibiotics through the application of evidence-based  
77 interventions [7,8]. In alignment with these global efforts, Indonesian regulations  
78 mandate that hospitals implement Antimicrobial Resistance Control Programs  
79 (known locally as PPRA), integrated within national hospital accreditation  
80 standards. As a key quality indicator, hospitals must perform both quantitative  
81 and qualitative evaluations of antibiotic utilization [9].

82 Qualitative evaluation of antibiotic use is conducted using the Gyssens  
83 flow chart as a validated tool for assessing the appropriateness of antimicrobial  
84 therapy. This algorithm facilitates the analysis of antibiotic appropriateness by  
85 assessing the selection of the antimicrobial agent, dosage, route of  
86 administration, duration of therapy, and the timing of administration [10,11].  
87 According to a study conducted at Cut Meutia Hospital in Aceh [11], it was  
88 found that all prophylactic antibiotic use in Cesarean section (C-section)  
89 patients was classified as Category IVa (selection of a less effective agent)  
90 relative to the 2013 ASHP Guidelines. Inappropriate antimicrobial prophylaxis  
91 serves as a critical risk factor, potentially compromising patient outcomes by  
92 increasing susceptibility to Surgical Site Infections (SSIs).

93

94 **2. Materials and methods**

95 **2.1. Data Collection**

96 . Data were retrospectively collected from the medical records of CS  
97 patients at a general hospital in Bondowoso for the period of January–May  
98 2025. The inclusion criteria comprised patients aged 17 years and older with  
99 complete documentation of antibiotic utilization. Conversely, patients who were  
100 referred to other hospitals were excluded from the study.

101 **2.2. Data Analysis**

102 The clinical data extracted from each patient medical record included the  
103 type of antibiotic, dosage, timing of administration, route, and duration of  
104 therapy. Each antibiotic prescription was subsequently classified according to  
105 the Gyssens flow chart. Category 0 : Appropriate antibiotic use. Category I:  
106 Inappropriate timing of administration. Category II: Inappropriate administration,  
107 subdivided into: IIa: inappropriate dose, IIb: inappropriate interval, and IIc:  
108 inappropriate route. Category III: Appropriate indication, dose, interval, and  
109 route, but inappropriate duration, subdivided into: IIIa: duration too long and IIIb:  
110 duration too short. Category IV: Appropriate indication, dose, interval, route, and  
111 duration, but inappropriate selection, subdivided into: Iva: more effective  
112 alternative available, IVb: less toxic alternative available, IVc: more cost-  
113 effective alternative available, and IVd: narrower-spectrum alternative available.  
114 Category V: No indication for antibiotic use, Category VI: Incomplete medical  
115 records, rendering the case unevaluable. A descriptive analysis was performed  
116 via Microsoft Excel to determine the percentage breakdown of antibiotic use  
117 based on the Gyssens classification.

118        *2.3. Ethical Approval*

119        This study received ethical clearance from the University of Surabaya  
120        Ethics Committee (Ref. No: 600/KE/VI/2025), issued on June 10, 2025..

121        **3. Result and discussion**

122        *3.1. Result*

123        Based on the review of medical records, a total of 191 samples met the  
124        inclusion criteria, with no samples meeting the exclusion criteria, as illustrated in  
125        Figure 1. Among the 191 patients, the predominant age group was 20–30 years  
126        (56.02%), with a majority having a three-day length of stay (64.92%). Regarding  
127        the type of procedure, elective CS accounted for the largest proportion at  
128        94.24% (Table 1).

129        Most antibiotic administration patterns in this study aligned with the  
130        national clinical standards for Cesarean sections set forth by the Central Board  
131        of POGI (58.64%). All routes of administration, dosages, and durations of  
132        therapy were fully compliant with the guidelines. Inappropriate antibiotic use  
133        was identified in one emergency CS patient within the antibiotic selection  
134        category (9.09%). Conversely, for elective CS patients, the most frequent non-  
135        compliance was related to inappropriate timing of administration (39.44%), as  
136        detailed in Table 2.

137        The prophylactic antibiotics administered to emergency CS patients  
138        included cefazolin (90.91%) and cefotaxime (9.09%). In elective CS, cefazolin  
139        was utilized in 96.11% of cases, while cefotaxime accounted for 3.89% (Table  
140        3). Regarding the timing of administration, the most frequent inappropriate  
141        antibiotic use in CS patients was administration within less than 30 minutes prior

142 to incision (35.00%), as shown in Table 4. Surgical site infections (SSIs)  
143 occurred in two patients: one case was associated with appropriate antibiotic  
144 use, while the other occurred in a patient who received antibiotics at an  
145 inappropriate time (Table 5).

### 146 *3.2. Discussion*

147 This study involved 191 Cesarean section patients who met the inclusion  
148 criteria, with no samples meeting the exclusion criteria. Regarding patient  
149 demographics, the most prevalent age group was 20–30 years, accounting for  
150 56.02% of the total study population. This age range represents the peak  
151 reproductive age for women. The high frequency of CS procedures within this  
152 study aligns with obstetric epidemiological data, which indicates that the  
153 majority of births occur during this period [12]. The most frequent length of stay  
154 (LOS) was three days (64.92%). This finding is consistent with the study  
155 conducted by Panghesthi et al., [13] which demonstrated that the majority of  
156 patients maintained a stable postoperative status without significant  
157 complications.

158 Based on the evaluation of antibiotic utilization in emergency CS  
159 patients, the observed inappropriateness was attributed to the selection of the  
160 antibiotic. Specifically, cefotaxime was administered to one emergency patient  
161 (9.09%). This antibiotic was also utilized in elective CS patients, accounting for  
162 3.89% of that group. Cefotaxime is considered a preferred antibiotic in cases  
163 involving premature rupture of membranes (PROM). This preference is  
164 attributed to its efficacy in inhibiting the growth of *Escherichia coli*, which is one  
165 of the primary pathogens associated with infections in patients experiencing

166 PROM [14]. According to both the World Health Organization (WHO) and  
167 standard antibiotic guidelines, cefotaxime is not the preferred agent for surgical  
168 prophylaxis in Cesarean sections. As a third-generation cephalosporin,  
169 cefotaxime is generally less effective against *Staphylococcus* and  
170 *Streptococcus* species compared to first-generation alternatives. However, it  
171 exhibits greater potency and efficacy against Gram-negative bacteria and  
172 penicillinase-producing species [15]. A study by Muzayyanah et al. [16]  
173 demonstrated that no signs of surgical site infections (SSIs) emerged within 24–  
174 48 hours postoperatively when cefotaxime and ceftriaxone were utilized as  
175 prophylactic antibiotics for CS. Furthermore, the stability of the maternal clinical  
176 status reinforces these findings, indicating no adverse developments In a study  
177 conducted by Ayuni et al. [17] regarding antibiotic utilization at a hospital in  
178 Lampung, it was revealed that 81.5% of cases involved inappropriate antibiotic  
179 selection with the ASHP Therapeutic Guidelines. Nevertheless, therapeutic  
180 outcomes based on the patients' body temperature indicated favorable clinical  
181 results for the mothers.

182 Cefazolin is the recommended prophylactic antibiotic for CS patients.  
183 The suggested dosage is 2 g for patients with normal body weight and 3 g for  
184 those with a body weight exceeding 120 kg [18]. The prophylactic antibiotics  
185 were administered exclusively via the intravenous (IV) route, with the duration of  
186 therapy limited to a maximum of 24 hours post-incision. Cefazolin was selected  
187 as the prophylactic agent due to its efficacy in inhibiting the growth of  
188 *Staphylococcus* spp., *Streptococcus* spp., *Escherichia coli*, and *Klebsiella* spp.,

189 which are the primary pathogens responsible for surgical site infections (SSIs)  
190 [17,19,20].

191         Based on the research findings, the timing of prophylactic antibiotic  
192 administration was inappropriate in 39.44% of elective CS cases. According to  
193 the Clinical Guidelines for Cesarean Section issued by the Central Board of the  
194 Indonesian Society of Obstetrics and Gynecology (POGI) [5], the optimal timing  
195 for administration is 30–60 minutes prior to incision. Administering prophylaxis  
196 within this 30–60 minute ensures that antibiotic concentrations in the tissue  
197 reach effective bactericidal levels at the time of the initial incision. Inappropriate  
198 timing of prophylactic antibiotic administration may elevate the risk of surgical  
199 site infections (SSIs). Most SSIs manifest between 6 and 10 days post-incision,  
200 presenting with clinical symptoms such as localized pain, fever, wound  
201 discharge, and erythema [21]. A study by Massey et al. [22] indicated that  
202 antibiotic administration within 60–120 minutes prior to surgery showed no  
203 significant difference in the incidence of SSIs compared to administration within  
204 the 30–60 minute window, although the quality of evidence was considered low.  
205 Research conducted by Rubin et al. [23] demonstrated that there was No  
206 statistical correlation between antibiotic administration timing (less than 30  
207 minutes versus 30–60 minutes prior to surgery) and the incidence of postpartum  
208 infections.

209         In this study, SSIs occurred in two patients (0.93%). One case was  
210 categorized as an emergency CS, while the other was an elective CS. The  
211 clinical characteristics of the SSIs observed were wound dehiscence and the  
212 presence of purulent discharge (pus) at the surgical site. Based on Table 5, one

213 SSIs occurred in a patient who received antibiotic prophylaxis more than 60  
214 minutes prior to the procedure. However, this finding is insufficient to conclude  
215 that a prophylaxis window exceeding 60 minutes directly increases the risk of  
216 SSIs. A study by Wijayanti et al. [24] demonstrated that there was no significant  
217 association between the inappropriate use of antibiotics and the occurrence of  
218 SSIs. Proper use of antibiotics does not entirely eliminate the risk of SSIs. The  
219 results of this study indicate that SSIs still occurred even when antibiotics were  
220 administered correctly. Therefore, the occurrence of SSIs in CS patients is not  
221 solely influenced by antibiotic use. Other contributing factors may include  
222 maternal age over 30, obesity, premature rupture of membranes (PROM),  
223 nosocomial infections, emergency surgery, duration of surgery, and blood loss  
224 exceeding 1500 cc [25].

#### 225 **4. Conclusion**

226 The administration of prophylactic antibiotics for CS patients at a hospital in  
227 Bondowoso was largely compliant with the Clinical Guidelines for Cesarean  
228 Sections issued by the Central Board of the Indonesian Society of Obstetrics  
229 and Gynecology (POGI). Accuracy in dosage, route of administration, and  
230 duration of prophylactic antibiotic use was achieved across all patients.  
231 Inconsistencies in the selection of antibiotic types occurred in one emergency  
232 CS patient (9.09%) and seven elective CS patients (3.89%). Regarding the  
233 timing of administration, the most frequent non-compliance in elective patients  
234 was the antibiotic being administered less than 30 minutes prior to the  
235 procedure (19.44%). SSIs occurred in two patients (0.93%). The inappropriate  
236 use of prophylactic antibiotics in these CS patients has not yet shown a direct

237 correlation with the occurrence of SSIs. There are other factors beyond the use  
238 of prophylactic antibiotics that may influence the incidence of SSI.

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241 management of the General Hospital in Bondowoso for their cooperation and  
242 the facilities provided during the data collection process

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324 **Table 1. Patient Demographic Data**

Characteristics		Number(n)	Percentage(%)
<b>Age</b>	17-20	16	8,38
	21-30	107	56,02
	31-40	60	31,41
	41-50	8	4,19
	<b>Total</b>	191	100,00
<b>Mean ± SD</b>		28,45±6,46	
<b>Length of Stay</b>	2	16	8,38

	3	124	64,92
	4	45	23,56
	5	5	2,62
	6	1	0,52
	<b>Total</b>	191	100,00
	Mean ± SD	3,22 ±0,65	
<b>Surgical</b>			
<b>Category</b>	Emergency CS	11	5,76
	Elective CS	180	94,24
	<b>Total</b>	191	100,00

325

326 **Table 2. Appropriateness of Antibiotic Use Based on the Gysen**  
327 **Flowchart**

Cate- gory	Description	Emergency CS		Elective CS	
		Numb er (n)	Percentage( %)e (%)	Numb er (n)	Percentage( %)
0	Appropriate Use	10	90,91	102	56,67
I	Incorrect Timing (Inappropriate timing)	0	0	71	39,44
II a	Incorrect Dose	0	0	0	0,00
II b	Incorrect Interval	0	0	0	0,00
II c	Incorrect Route of	0	0	0	0,00

Administration					
IIIa	Duration too long	0	0	0	0,00
IIIb	Duration too short	0	0	0	0,00
IVa	More effective antibiotic available	0	0	0	0,00
IVb	Less toxic antibiotic available	0	0	0	0,00
IVc	Cheaper antibiotic available	0	0	0	0,00
IVd	Narrower spectrum antibiotic available	1	9,09	7	3,89
V	No indication for antibiotic use	0	0	0	0,00
<b>Total</b>		<b>11</b>	<b>100</b>	<b>180</b>	<b>100</b>

Parameter	Emergen	Elective CS	Total
	cy CS (n = 11)	(n = 180)	%
Appropriate use (Category 0)	90,91%	50,25%	52,34%
Suboptimal use (Category I-V)	9,09%	43,33%	41,36%

328

329 **Table 3. Data Jenis Antibiotik Profilaksis yang digunakan**

Types of Prophylactic Antibiotics Administered	Emergency CS		Elective CS	
	Number (n)	Percentage (%)	Number (n)	Percentage (%)
Cefazolin	10	90,91	173	96,11
Cefotaxime	1	9,09	7	3,89
<b>Total</b>	<b>11</b>	<b>100</b>	<b>180</b>	<b>100</b>

330

331 **Table 4. Prophylactic Antibiotic Timing Profile in Elective CS**

Time-to-Administration for Antibiotic Prophylaxis	Number (n)	Percentage (%)
< 30 minutes before incision	63	35,00
30-60 minutes before incision	94	52,22
>60 minutes before incision	23	12,78
<b>Total</b>	<b>180</b>	<b>100</b>

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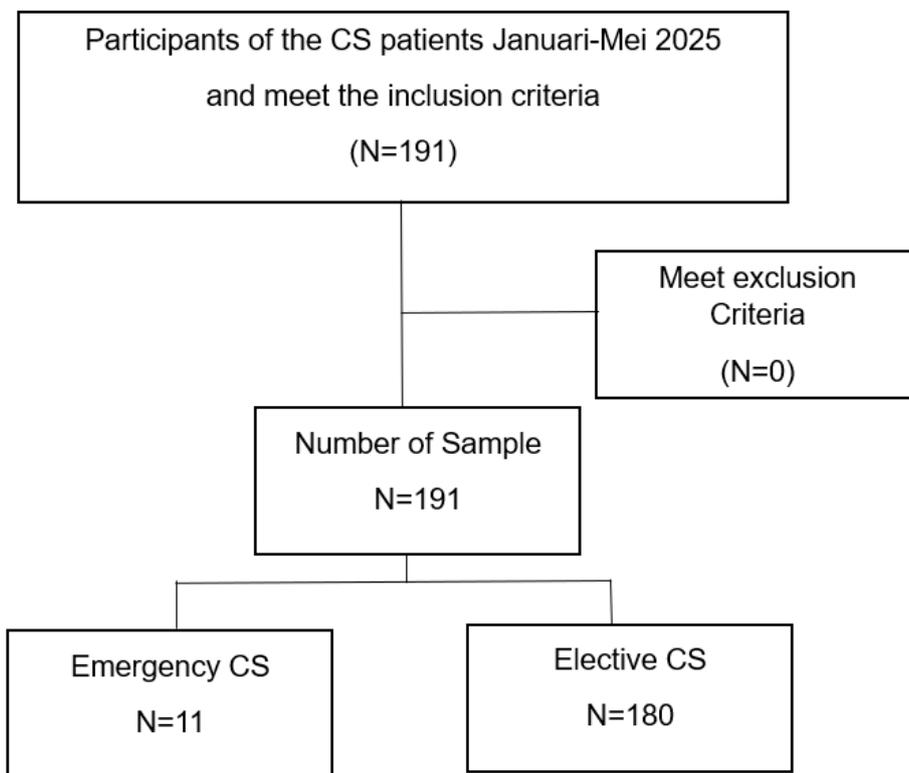
335 **Table 5. Surgical Site Infection (SSIs) Occurrence**

Characteristic	SSIs (n)	Percentage(%)	No SSI (n)	Percentage (%)
<b>Emergency CS</b> Appropriate use of antibiotics	1	100,00	9	90,00
Inappropriate	0	0,00	1	10,00

Antibiotic Selection					
<b>Total</b>		1	100	10	100
<b>Elective CS</b>	Appropriate use of antibiotics	0	0,00	102	56,98
	Inappropriate Antibiotic Selection	0	0,00	7	3,91
	Sub-optimal Timing	1	0,52	70	39,11
	<b>Total</b>	1	0,52	179	100

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337 **Figure captions**



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339 **Figure 1. Participant Recruitment Process**

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