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Original Research Article

Relationship between Initial Empirical Antibiotic Therapy and Surgical Site Infection in Cases of Perforated Appendicitis

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Abstract

Background: Surgical site infection (SSI) is a common postoperative complication observed in patients undergoing surgery for perforated appendicitis (PA). One of the contributing factors may be the administration of empirical antibiotic regimens that do not adequately cover the causative microorganisms. Assessing the relationship between empirical antibiotic therapy and the occurrence of SSI may help optimize treatment strategies and improve clinical outcomes.

Materials and Methods: An This retrospective study includes study was conducted among patients of >15 year of age diagnosed with perforated appendicitis and managed at Parul Sevashram Hospital, Vadodara, Gujarat between Jan 2023 to July 2025. All participants received empirical treatment with cefuroxime and metronidazole. During surgery, appendix tissue and pus specimens were collected and sent for microbiological culture and sensitivity testing. Patients were followed for 30 days after the operation to identify the development of surgical site infections. Clinical and laboratory data were retrieved from medical records, and the association between study variables and SSI was evaluated using Pearson's or Spearman's correlation analysis, as appropriate.

Results: Among the 40 patients included in the study, 8 (20%) experienced surgical site infections (SSI), comprising 4 cases of superficial incisional SSI and 4 cases of organ-space SSI. Evaluation of potential risk factors revealed that the duration of surgery was the only variable significantly associated with the development of SSI ($p = 0.004$). Patients undergoing procedures lasting more than 120 minutes were found to have an approximately 19-fold higher risk of postoperative infection (OR = 19). In contrast, empirical antibiotic therapy showed no statistically significant relationship with SSI occurrence ($p = 0.129$). Similarly, no significant associations were identified between SSI and sex ($p = 0.680$), age ($p = 0.713$), nutritional status ($p = 0.645$), microbiological culture findings ($p = 0.384$), or preoperative waiting time ($p = 0.130$).

Conclusion: The results of the present study suggest that the selection of initial empirical antibiotic therapy did not have a statistically significant influence on the occurrence of surgical site infections (SSI) in patients with perforated appendicitis. In contrast, prolonged operative time was found to be a significant risk factor for SSI, emphasizing the importance of timely and efficient surgical management to minimize the likelihood of postoperative infectious complications.

Keywords: Appendicitis, Antibiotic, surgical site.

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Introduction

Acute appendicitis is one of the most frequently encountered surgical emergencies worldwide, with perforated appendicitis representing a severe complication associated with increased morbidity. Perforation results from delayed diagnosis or progression of inflammation, allowing bacterial contamination of the peritoneal cavity and substantially increasing the risk of postoperative complications. Among these complications, surgical site infection (SSI) remains one of the most common causes of prolonged hospitalization, increased healthcare expenditure, delayed recovery, and postoperative morbidity.[1,2] Perforated appendicitis is a common surgical emergency associated with a high risk of postoperative complications, particularly surgical site infection (SSI). Despite advances in surgical techniques and perioperative care, SSI remains a significant cause of prolonged hospitalization, increased healthcare costs, and postoperative morbidity. [3] Empirical antibiotic therapy is routinely initiated before microbiological culture results become available to

provide broad-spectrum coverage against common aerobic and anaerobic pathogens. The success of this treatment depends on appropriate antibiotic selection based on local antimicrobial susceptibility patterns. Inappropriate empirical therapy may increase the risk of postoperative infections and contribute to antimicrobial resistance. [4,5]

In addition to antibiotic therapy, several patient- and procedure-related factors, including age, nutritional status, microbiological findings, operative waiting time, and duration of surgery, may influence the development of SSI. Identifying these risk factors is essential for improving surgical outcomes and optimizing perioperative management. Therefore, this study was conducted to evaluate the relationship between initial empirical antibiotic therapy and the occurrence of surgical site infection in patients with perforated appendicitis, while also assessing the influence of selected clinical and operative factors on SSI development.

Materials & Method

This retrospective study was conducted at Parul Sevashram hospital, Parul institute of Medical science and research, Vadodara, Gujarat from Jan 2023 to July 2025. This study includes patients of PA (perforated appendicitis) >15 year of age group. The diagnosis of PA was established based on clinical assessment, laboratory investigations, and intraoperative observations. Operative findings confirming PA included the presence of a gangrenous or perforated appendix accompanied by purulent material and peritoneal fluid. All patients initially received empirical intravenous antibiotic therapy consisting of cefuroxime at a dose of 100–150 mg/kg/day administered in two divided doses for 3–5 days, together with metronidazole at 10 mg/kg (maximum dose 500 mg) every 8 hours. During appendectomy, appendix tissue specimens were collected in sterile containers, while pus samples were obtained using sterile swabs. Specimen collection was performed under strict aseptic conditions and transported immediately to the Department of Clinical Microbiology for aerobic and anaerobic culture, followed by antimicrobial susceptibility testing using standard laboratory protocols. Once culture and sensitivity reports were available, antibiotic therapy was modified accordingly. Patients were followed for 30 days after surgery to monitor the development of surgical site infections (SSIs). SSIs were classified according to the Centers for Disease Control and Prevention (CDC) criteria as superficial incisional, deep incisional, or organ/space infections. Participants were enrolled using a total sampling technique. Relevant information was retrieved from the medical records maintained by the Departments of Surgery, Microbiology, and Emergency Medicine. The variables collected included patient demographics (name, age at the time of surgery, and sex), serum lactate levels, microbiological culture findings, and details of antibiotic treatment. Statistical analysis was performed according to the distribution of the data.

Pearson's correlation test was applied to variables with a normal distribution, whereas Spearman's rank correlation test was used for variables that were not normally distributed. All analyses were conducted using SPSS software version 16.

Results

A total of 40 participants were included in the present study and underwent demographic and clinical characterization. Analysis of the age distribution demonstrated that the largest proportion of participants belonged to the 26–35-year age group, accounting for 35% of the study population, indicating that young adults constituted the predominant age category. With respect to gender distribution, male participants represented the majority (60%), while females comprised the remaining 40% of the study cohort.

Table 1: Characteristics of the Study Subjects (n = 40)

Characteristic	Category	Number (n)	Percentage (%)
Age (years)	18–25	8	20.0
	26–35	14	35.0
	36–45	10	25.0
	>45	8	20.0
Gender	Male	24	60.0
	Female	16	40.0
Body Mass Index (BMI)	Normal (18.5–24.9 kg/m²)	13	32.5
	Overweight (25.0–29.9 kg/m²)	18	45.0
	Obese (≥30 kg/m²)	9	22.5
Smoking Status	Smoker	11	27.5
	Non-smoker	29	72.5
Alcohol Consumption	Yes	9	22.5
	No	31	77.5
Marital Status	Married	28	70.0
	Unmarried	12	30.0

Assessment of body mass index (BMI) revealed that 45% of the subjects were classified as overweight, making it the most prevalent BMI category among the enrolled participants. Furthermore, evaluation of lifestyle-related characteristics showed that 72.5% of the participants were non-smokers, suggesting a relatively low prevalence of tobacco use within the study population. Similarly, 77.5% of the subjects reported no history of alcohol consumption, indicating that the majority abstained from alcohol intake. Regarding marital status, 70% of the participants were married, whereas the remaining 30% were unmarried. Overall, the study population was predominantly composed of young adult, married, male participants with an overweight body mass index, most of whom reported no history of smoking or alcohol consumption.

Table 2: Clinical characteristics of the study subjects (n=40)

Characteristic	Category	Number (n)(n=40)	Percentage (%)
Tissue culture Results	Bacteroides uniformis	2	5.0
	Enterococcus avium	1	2.5
	Streptococcus agalactiae	1	2.5
	Klebsiella pneumoniae	1	2.5
Surgical waiting time	< 8 hours	30	75.0
	>8 hours	10	25.0
Surgery duration	< 120 minutes	25	62.5
	> 120 minutes	15	37.5

Table 2 summarizes the baseline characteristics of the 40 study subjects with respect to tissue culture findings, surgical waiting time, and duration of surgery. Tissue culture analysis demonstrated that Bacteroides uniformis was the most frequently isolated microorganism, accounting for 2 cases (5.0%), whereas Enterococcus avium, Streptococcus agalactiae, and Klebsiella pneumoniae were each identified in 1 case (2.5%). These findings indicate that only a small proportion of the study population had positive tissue cultures for the isolated bacterial species, reflecting a relatively low frequency of individual microbial isolates within the cohort.

Regarding the interval between hospital admission and surgical intervention, the majority of patients (30 subjects; 75.0%) underwent surgery within 8 hours, while only 10 subjects (25.0%) experienced a surgical waiting time exceeding 8 hours. This observation suggests that most patients received prompt operative management, which is considered an important factor in reducing postoperative complications and improving clinical outcomes. Analysis of operative duration revealed that 25 patients (62.5%) underwent surgery lasting less than 120 minutes, whereas 15 patients (37.5%) required procedures extending beyond 120 minutes. These results indicate that the majority of surgical procedures were completed within two hours, while a smaller proportion involved prolonged operative times, which may reflect greater surgical complexity or disease severity. Overall, the study population was characterized by a low prevalence of positive tissue culture isolates, timely surgical intervention in most patients, and operative durations of less than 120 minutes for the majority of cases.

Discussion

Broad-spectrum antimicrobial agents are commonly selected as empirical therapy for the management of perforated appendicitis. The selection of an appropriate empirical antibiotic regimen is generally determined by several factors, including the anatomical site of infection, the anticipated spectrum of causative microorganisms, and the prevailing local antimicrobial susceptibility patterns. According to the antibiotic stewardship guidelines of Hospital, no specific recommendations are available regarding empirical antibiotic therapy for pediatric perforated appendicitis. Instead, antibiotics are stratified into three categories based on their level of restriction: first-line (unrestricted), second-line (restricted), and third-line (reserved) agents.

Within this classification system, cefuroxime is designated as a first-line antibiotic, whereas ceftriaxone is categorized as a second-line agent. Consequently, cefuroxime was selected as one of the empirical antimicrobial therapies administered in the present study. As a second-generation cephalosporin with broad-spectrum antimicrobial activity, cefuroxime is endorsed by the British Pharmacological Society for surgical site infection (SSI) prophylaxis and offers the additional advantage of minimizing unnecessary exposure to second-line antibiotics, thereby contributing to antimicrobial stewardship and reducing the potential emergence of antimicrobial resistance.

The association between the initial empirical antibiotic regimen and the occurrence of surgical site infection was evaluated using the contingency coefficient test. Statistical analysis demonstrated no significant correlation between empirical antibiotic administration and the development of SSI ($p = 0.129$). These findings are consistent with those reported by Gravilovska [7], who similarly

observed no statistically significant association between empirical antibiotic therapy and the incidence of surgical site infections or treatment duration among patients undergoing cranial and spinal surgical procedures. Likewise, Bo Ohlin et al. compared the clinical efficacy of piperacillin–tazobactam with a combination regimen of cefuroxime and metronidazole and found no significant difference in the postoperative incidence of intra-abdominal abscess formation between the two therapeutic approaches.

The present study demonstrated no statistically significant association between sex and the occurrence of surgical site infection (SSI). Although Aghdassi et al. [8] reported that patient sex may be associated with the risk of SSI, they also emphasized that this relationship is not universally applicable and varies according to the type and complexity of the surgical procedure performed. Therefore, sex alone may not represent an independent determinant of postoperative surgical site infection.

Similarly, no significant relationship was observed between age and the incidence of SSI in the current study. In contrast, Kayee et al. reported a significant association between advancing age and an increased risk of postoperative infection. However, they suggested that this relationship is multifactorial and influenced by numerous confounding variables. The observed association became statistically evident only after adjustment for factors such as the National Nosocomial Infections Surveillance (NNIS) risk index, the type of surgical procedure, and the characteristics of the healthcare institution, indicating that age should be interpreted in conjunction with these clinical variables rather than as an isolated risk factor.

Furthermore, the present investigation did not identify any statistically significant correlation between nutritional status and the development of SSI. These findings are in agreement with those of Porras-Hernandez et al [9]. Who similarly reported the absence of a direct relationship between nutritional status and postoperative surgical site infection in their study conducted in Mexico. Instead, their findings suggested that technical aspects of the surgical procedure, including the precision of operative techniques and effective intraoperative collaboration among surgeons, exerted a greater influence on the occurrence of SSI than the patient's nutritional condition.

Intra-abdominal infections associated with perforated appendicitis are typically polymicrobial, with Escherichia coli being the predominant pathogen. In the present study, E. coli was the most frequently isolated organism, followed by extended-spectrum β-lactamase (ESBL)-producing E. coli. However, no significant association was observed between the isolated bacterial species and the incidence of surgical site infection (SSI). These findings are consistent with Kokoska [10], who reported that intraoperative culture results did not significantly influence the clinical outcomes of patients with perforated appendicitis. This may be because culture isolates do not always accurately represent the causative pathogens. Therefore, the continued use of appropriate empirical broad-spectrum antibiotic therapy remains the recommended approach for the management of perforated appendicitis.

The present study demonstrated a significant association between operative duration and the incidence of surgical site infection (SSI). These findings are consistent with those reported by Cheng et al. [11], who observed that prolonged operative time significantly increased the risk of SSI in colorectal surgery, with each increase in surgical duration associated with an approximately 30% higher risk of infection ($p < 0.0001$).

Similarly, Leong et al. [12] proposed that procedures exceeding the 75th percentile of operative time should be considered at increased risk for SSI. Prolonged surgery may indicate greater procedural complexity, increased tissue manipulation, extended exposure to environmental pathogens, and reduced effectiveness of prophylactic antibiotics. Furthermore, Casanova et al., in a four-year cohort study, reported that operations lasting two hours or longer were associated with a 1.6-fold higher risk of developing SSI ($p = 0.003$).

Conclusion

The results of the present study suggest that the selection of initial empirical antibiotic therapy did not have a statistically significant influence on the occurrence of surgical site infections (SSI) in patients with perforated appendicitis. In contrast, prolonged operative time was found to be a significant risk factor for SSI, emphasizing the importance of timely and efficient surgical management to minimize the likelihood of postoperative infectious complications.

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