



Meta-Analysis on the effectiveness of the Use of Prophylactic Antibiotics in Preventing Surgical Site Infection in Patients with Hernia Surgery

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ABSTRACT

The administration of prophylactic antibiotics in hernia surgery patients is currently controversial, with varying opinions regarding their necessity. The European Hernia Society guideline does not recommend prophylactic antibiotics in patients with hernia surgery, while recent studies found that prophylactic antibiotics in hernia surgery patients can be given routinely and are effective in reducing surgical site infections. This study aims to determine the effectiveness of prophylactic antibiotics for preventing surgical site infection in patients with hernia surgery. This research is a systematic review using articles with a randomized controlled trial (RCT) research design using Indonesia and English language within the last 10-year of publication year. Twenty-four RCTs that met the inclusion and exclusion criteria were used to address the research problem. The results showed that a total of 207 patients experienced the incidence of surgical site infection in patients with hernia surgery, including 78 patients (4.5%) in the antibiotic group and 129 patients (7.88%) in the control. A significant difference was found between the antibiotic and the control groups in preventing surgical site infections, with a P-value < 0.0001 (OR = 0.56; 95% CI = 0.42–0.75). Conclusion: Surgical site infections are less likely to develop when a prophylactic antibiotic is administered to patients with hernia surgery

Keywords: prophylactic antibiotics, surgical site infection, hernia surgery

1. INTRODUCTION

Surgical Site Infection (SSI) is one of the complications associated with the surgical process. It commonly occurs within 30 days in the area of the surgical incision after the surgical procedure. According to data from the National Nosocomial Infections Surveillance (NNIS) [1], surgical site infection is the third most frequently reported nosocomial infection, accounting for 14% to 16% of all nosocomial infections among inpatients and 38% among surgical patients. The occurrence of surgical site infections has the potential to increase morbidity, mortality, costs, and the duration of patient hospitalization [2].

One of the health problems that require surgical intervention is a hernia. It is estimated that over 20 million operations on hernias worldwide are done every year [3]. Hernia surgery is classified as a clean surgical procedure in the digestive surgery category and is almost always an elective procedure performed under sterile conditions. However, surgical site infection complications can still occur in hernia surgeries, even with clean surgical techniques [4]. Based on a prospective study by Juvany [5], out of a total of 101 patients who underwent hernia surgery, 16 patients (16%) experienced surgical site infections.

Prophylactic antibiotics are commonly used to prevent or reduce the occurrence of surgical site infections during surgical procedures. However, the use

of prophylactic antibiotics in hernia surgery is still a subject of controversy. The European Hernia Society guidelines [6] do not recommend the use of prophylactic antibiotics in hernia surgery, while a previous systematic review by Manuel [36] states that prophylactic antibiotic in hernia surgery can be given routinely and effectively reduces surgical site infections. However many of the trial included in the previous review by Manuel were published in the 1980s and 1990s.

Given this background, a literature review will be conducted to update the effectiveness of prophylactic antibiotics in preventing surgical site infections in hernia surgery patients based on current patient demographics.

2. METHODS

The research conducted is a systematic literature review and meta-analysis using articles with randomized controlled trial (RCT) designs in either Indonesian or English, published between the years 2010 and 2020. The search for articles was performed on databases such as PubMed and Google Scholar using the keywords "prophylactic antibiotic" AND "wound infection" AND "hernia repair" and "prophylactic antibiotic AND surgical site infection AND hernia surgery". The articles included in the study covered research topics on adult patients undergoing hernia surgery with prophylactic antibiotic intervention compared to placebo or no antibiotics, with the outcome being the occurrence of surgical site infections. Articles that were not accessible in full text were excluded from the research. The analysis of the articles was based on the relevance of the content to the research topic, completeness of the source's bibliographic information, source reputation, risk of bias, and article quality.

Two independent reviewers assessed the article using the inclusion and exclusion criteria as the basis for the studies selection and use the Critical Appraisal Skills Programme (CASP checklist) to assess the study

quality. The selected articles were then combined into a single unit and subjected to statistical analysis using Review Manager 5.4 software

3. RESULTS AND DISCUSSION

3.1. Article Selection

Based on the article search conducted, a total of 64 articles were found in the PubMed database, and 998 articles were found in the Google Scholar database. After removing duplicates, there were 1018 articles. These articles then underwent screening based on their titles, abstracts, and relevance to the inclusion and exclusion criteria. Out of the 1018 articles, 994 were excluded from the study, leaving 24 selected articles for further analysis that addressed the research topic.

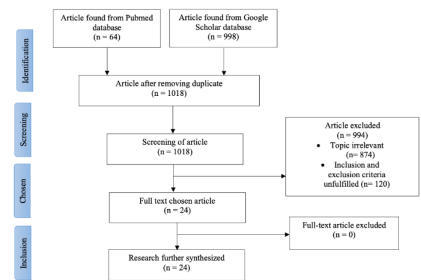


Figure 1 Article selection.

3.2. Chosen Article

The selected 24 articles involved research subjects who were hernia patients undergoing surgery. The majority of the subjects were adult male patients. Almost all subjects included in the studies had inguinal hernias, and the research was conducted in various locations across Asia. The characteristics of included articles are presented in Table 1.

Table 1. The occurrence of Surgical Site Infection Based on Studies

No	Author/year	Total Sample	Location of Research	Hernia Type	Result
1	Yadav, <i>et al</i> (2020)	200	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 6 out of 100 patients (6%) in the antibiotic group and 8 out of 100 patients (8%) in the control group.
2	Kahla, <i>et al</i> . (2019)	40	Mesir	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 1 out of 20 patients (2.5%) in the antibiotic group and 2 out of 20 patients (5%) in the control group.
3	Santhi, <i>et al</i> (2018)	60	India	Hernia inguinalis	The occurrence of Surgical Site

No	Author/year	Total Sample	Location of Research	Hernia Type	Result
					Infection (SSI) was observed in 0 out of 30 patients (0%) in the antibiotic group and 1 out of 30 patients (3%) in the control group.
4	Ray, <i>et al</i> (2018)	100	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 3 out of 50 patients (6%) in the antibiotic group and 4 patients out of 50 patients (8%) in the control group.
5	Sethi, <i>et al</i> (2017)	60	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 1 out of 30 patients (3%) in the antibiotic group and 1 out of 30 patients (3%) in the control group.
6	Siddiqui, <i>et al</i> (2017)	40	Bangladesh	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 2 out of 20 patients (10%) in the antibiotic group and 5 out of 20 patients (25%) in the control group.
7	Alagarsamy, <i>et al</i> (2017)	100	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 5 out of 50 patients (10%) in the antibiotic group and 7 out of 50 patients (14%) in the control group.
8	Bahar, <i>et al</i> (2015)	395	Iran	Hernia inguinalis, hernia epigastrik, hernia umbilikal, hernia insisional	The occurrence of Surgical Site Infection (SSI) was observed in 6 out of 237 patients (4.4%) in the antibiotic group and 2 out of 158 patients (1.3%) in the control group.
9	Vinoth, <i>et al</i> (2015)	60	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 2 out of 30 patients (6.7%) in the antibiotic group and 3 out of 30 patients (10%) in the control group.
10	Razack, <i>et al</i> (2015)	200	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 7 out of 94 patients (7.4%) in the antibiotic group and 8 out of 86 patients (9.5%) in the control group.
11	Akhtar, <i>et al</i> (2015)	150	Pakistan	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 2 out of 75 patients (2.7%) in the antibiotic group and 5 out of 75 patients (6.7%) in the control group.
12	Mazaki, <i>et al</i> (2014)	200	Jepang	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 2 out of 100 patients (2%) in the antibiotic group and 13 out of 100 patients (13%) in the control group.
13	Kochhar, <i>et al</i> (2014)	217	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 4 out of 106 patients (3.8%) in the antibiotic group and 5 out of 106 patients (4.7%) in the control group.
14	Ullah, <i>et al</i> (2013)	166	Pakistan	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 6 out of 83 patients (7.2%) in the antibiotic group and 15 out of 83 patients (18%) in the control group.
15	Javi, <i>et al</i> (2013)	54	Indonesia	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 1 out of 27 patient (3.7%) in the antibiotic group

No	Author/year	Total Sample	Location of Research	Hernia Type	Result
					and 2 out of 27 patients (7.4%) in the control group.
16	KC B, <i>et al</i> (2013)	60	Nepal	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 0 out of 30 patients (0%) in the antibiotic group and 1 out of 30 patients (3.3%) in the control group.
17	Ergul, <i>et al</i> (2012)	200	Turki	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 5 out of 100 patients (5%) in the antibiotic group and 7 out of 100 patients (7%) in the control group.
18	Goyal, <i>et al</i> (2011)	200	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 1 out of 100 patients (1%) in the antibiotic group and 3 out of 100 patients (3%) in the control group.
19	Othman I. (2011)	98	Saudi Arabia	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 4 out of 50 patients (8%) in the antibiotic group and 6 out of 48 patients (12.5%) in the control group.
20	Phanthabordeekorn W (2011)	106	Thailand	Hernia inguinalis	No occurrence of Surgical Site Infection (SSI) observed in the antibiotic group and control group.
21	Al Fatah (2011)	200	Mesir	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 3 out of 100 patients (3%) in the antibiotic group and 5 out of 100 patients (5%) in the control group.
22	Shankar, <i>et al</i> (2010)	450	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 172 patients (7%) in the antibiotic group and 17 out of 162 patients (10.4%) in the control group.
23	Ijaz, <i>et al.</i> (2010)	100	Pakistan	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 2 out of 50 patients (4%) in the antibiotic group and 5 out of 50 patients (10%) in the control group.
24	Thakur, <i>et al.</i> (2010)	55	India	Hernia inguinalis	The occurrence of Surgical Site Infection (SSI) was observed in 3 out of 29 patients (10.3%) in the antibiotic group and 4 out of 26 patients (15.3%) in the control group.

3.3. Article Quality and Reputation

The search for articles revealed 24 articles (Table 1) that will be analyzed for their quality. An article with a score of 9-11 on the checklist was classified as having a

good quality, 6-8 on the checklist rated as moderately good, and ≤5 on the checklist rated as poor quality. Article quality and reputation scoring can be seen in Table 2.

Table 2. Article quality and Reputation Scoring

No	Author	CASP Checklist	Article Quality
1	Goyal, <i>et al.</i>	7/11	Moderately good quality
2	Othman I.	8/11	Moderately good quality
3	Bahar, <i>et al.</i>	7/11	Moderately good quality
4	Shankar, <i>et al.</i>	7/11	Moderately good quality

No	Author	CASP Checklist	Article Quality
5	Vinoth, et al.	9/11	Good quality
6	Sethi, et al.	7/11	Moderately good quality
7	Razack, et al.	7/11	Moderately good quality
8	Ullah, et al.	8/11	Moderately good quality
9	Siddiqui, et al.	7/11	Moderately good quality
10	Ergul, et al.	8/11	Moderately good quality
11	Alagarsamy, et al.	8/11	Moderately good quality
12	Phanthabordeekorn W	9/11	Good quality
13	Yadav, et al.	7/11	Moderately good quality
14	Mazaki, et al.	9/11	Good quality
15	Kahla, et al.	7/11	Moderately good quality
16	Ijaz, et al.	7/11	Moderately good quality
17	Thakur, et al.	8/11	Moderately good quality
18	Kochhar, et al.	8/11	Moderately good quality
19	Al Fatah	8/11	Moderately good quality
20	Javi, et al.	7/11	Moderately good quality
21	Akhtar, et al.	7/11	Moderately good quality
22	KC B, et al.	7/11	Moderately good quality
23	Santhi, et al.	8/11	Moderately good quality
24	Ray, et al.	8/11	Moderately good quality

3.4. Bias Assessment

The assessment of bias is conducted based on selection bias (randomization and allocation bias), performance bias, detection bias, attrition bias, and reporting bias. The bias assessment for each article can be seen in Figure 2.

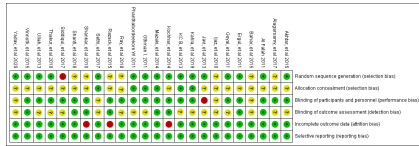


Figure 2. Bias Assessment.

3.5. Prophylactic Antibiotic

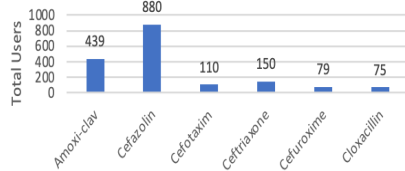


Figure 3. Total Use of Prophylactic Antibiotic.

Based on the research articles obtained, the prophylactic antibiotics used consist of six types: cefazolin [10, 11, 13, 14, 17, 19, 21-23, 27], Co-amoxiclav [8, 9, 15, 25, 26], Cefuroxime [16, 24, 29], Cefotaxime [12, 18, 30], Ceftriaxone [20, 31], and

Cloxacillin [28]. A placebo or no antibiotic was used as the comparative control. Among these antibiotics, Cefazolin was the most frequently used prophylactic antibiotic in the collected research results.

Based on the six types of prophylactic antibiotics (Figure 3), the antibiotic classes used consisted of Penicillin (Amoxiclav and Cloxacillin) and Cephalosporin (Cefazolin, Cefotaxime, Ceftriaxone, and Cefuroxime). These antibiotic classes are effective against a wide range of Gram-Positive and Gram-Negative microorganisms [32], particularly those commonly found as pathogens in surgical site infections, such as *S. aureus*. Aside from the efficacy of the antibiotics, the antibiotics chosen were based on their safety, pharmacokinetics, and reasonable cost per dose. Cephalosporin antibiotics, especially Cefazolin, are widely used and generally considered the first-choice prophylactic antibiotic for surgical procedures [34].

3.6. Surgical Site Infection Occurrence

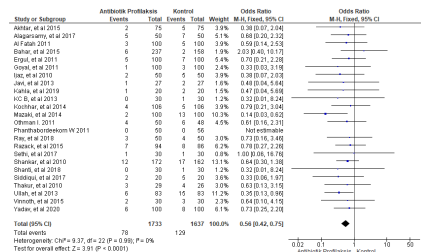


Figure 4. Forest plot on surgical site infection

occurrence on prophylactic antibiotics group and control group on hernia post- surgery patients

The occurrence of surgical site infections (SSI) was observed during the specified follow-up period in each study, usually for 1 month after the surgery. The follow-up results showed that some patients experienced surgical site infections in all studies (as seen in **Figure 4**), both in the antibiotic group and the control group, except for the study by Phanthabordeekorn W. (2011). Phanthabordeekorn reported that there were no patients who experienced surgical site infections in either the antibiotic group (0%) or the control group (0%). The total incidence of surgical site infections among all hernia surgery patients in this research was 78 patients (4.5%) in the antibiotic group and 129 patients (7.88%) in the control group. The incidence rate of surgical site infections was higher in the control group compared to the antibiotic group.

Based on the statistical analysis conducted on the 24 articles, a significant difference was found between the antibiotic group and the control group in preventing surgical site infections, with a P-value < 0.0001 (OR = 0.56; 95% CI = 0.42–0.75). The results between the studies appear to be homogeneous, indicating no heterogeneity (Chi2 P = 0.99 and I2 = 0%). The use of two types of antibiotic classes in this research, namely Penicillin and Cephalosporin, does not seem to demonstrate a significant difference in their effect on the occurrence of surgical site infections.

Based on the 24 articles, two of them showed significant differences in the incidence of surgical site infections. In the study conducted by Ullah [15], the patients who experience SSI reach a total of 21 cases out of 186 patients, with 6 cases out of 83 patients (7.23%) in the antibiotic group and 15 cases out of 83 patients (18.1%) in the control group. On the other hand, in the study by Mazaki [21], the patients who experienced SSI reached a total of 15 cases out of 200 patients, with 2 cases out of 100 patients (2%) in the antibiotic group and 13 cases out of 100 patients (13%) in the control group. The remaining 22 studies did not show significant differences in their results.

According to guidelines from EHS [6] and the International Guidelines for Groin Hernia Management [33], the use of prophylactic antibiotics is not recommended for hernia surgery because it is not significant in reducing the amount of SSI occurrence. Findings in this study and the recommended guidelines showed a significant difference in preventing or reducing SSI occurrence. Hernia surgery is categorized as a clean surgical procedure where the risk of surgical site infection is considered low, typically less than 5%. However, the findings from the collected articles indicate that the incidence of surgical site infections in hernia surgery appears to be higher than what was

originally estimated. Several factors may contribute to this discrepancy, including patient-related, procedural, and microbial factors. Patient-related factors, such as advanced age, poor nutritional status, and the presence of comorbidities like diabetes mellitus, can increase the risk of surgical site infections. Procedural factors such as surgical preparation, operative equipment, the operating room environment, operative duration, and surgical technique can significantly influence the risk of infection. Microbial factors, including the type and quantity of microorganisms present at the surgical site.

The reported bacterial cultures from several studies included in the analysis are *S. aureus* [9-11, 13, 14, 16, 17, 21, 23-26, 28, 30, 31], *Hemolytic streptococci* (*Streptococcus pyogenes*) [9, 26], *Pseudomonas aeruginosa* [9, 21], *S. epidermidis* [10, 23, 26], Streptococci [11, 14], *Klebsiella pneumoniae* [10, 13, 16], *E. coli* [11, 14, 16], *Enterobacteria* [11], *Enterococcus faecalis* [21], *Coagulase-negative Staphylococcus* [17], *Corynebacterium spp.*, and *Methicillin-resistant S aureus* [21]. The majority of the studies reported that the bacterium *S. aureus* was most commonly found in surgical site infections. *S. aureus* is often part of the normal endogenous flora present in patients [35].

The results of this study are consistent with previous meta-analyses conducted by Manuel [36], which also showed significant differences between the prophylactic antibiotic group and the control group in preventing surgical site infections in hernia surgery patients, with respective P-values of 0.004 and 0.003.

Based on the results of this study, prophylactic antibiotics can be given to hernia surgery patients. However, before administering prophylactic antibiotics, it is still necessary to pay attention to the patient's conditions and risk factors.

There are several limitations in this study. First, we included only those studies published between 2010 and 2020. The reviewer considered article that was published before 2010 to be outdated. Second, we only included articles that use Indonesian and English language. Other language is excluded because of the cost and time involved in translating. Another limitation is that there are several articles with unobtainable full-text. Some relevant articles may be missed due to these limitations

CONCLUSION

The effectiveness of prophylactic antibiotic use shows a significant difference in preventing surgical site infections in hernia surgery patients compared to the placebo or without prophylactic antibiotic group; therefore, it can be given to patients who undergo hernia surgery, taking into account their risk factors.

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