International Journal of Health Sciences and Research
Vol.13; Issue: 12; December 2023
Website: www.ijhsr.org
ISSN: 2249-9571

Review Article

A Role of Prophylactic Antibiotics in Preventing Surgical Site Infection: Current Practice and Future Direction

Dr. P. Dhivyaprasath[1], Abi Monika A P[2], Aarthi A[3], S. Abirami[4], Aditya J[5]

[1]Assistant Professor, Department of Pharmacy Practice, [2,3,4,5] Pharm. D Interns,
Swamy Vivekanandha College of Pharmacy, Elayampalayam, Tiruchengode – 637205, Namakkal District, Tamil Nadu, India.

Corresponding Author: Dr. P. Dhivyaprasath

DOI: https://doi.org/10.52403/ijhsr.20231235

ABSTRACT

A surgical site infection (SSI) occurs within 30 days after surgery. SSIs can present as deep infections affecting the muscle and fascia or superficial infections. Every year, between 160,000 and 300,000 people are diagnosed with surgical site infections. SSI causes a significant burden on healthcare systems. One of the most important strategies to avoid SSIs is antibiotic prophylaxis. The level of incidence of SSI that has persisted for several decades in spite of advances in prophylactic antibiotic therapy and preoperative bacterial decolonization. There is no doubt that rigorous adherence to numerous evidence-based interventions concerning perioperative sterility, technique, and prophylaxis are essential. This review highlights the significant impact of SSIs on patient morbidity, healthcare resources and the importance of preventive measures. It also emphasizes the need for adherence to infection prevention guidelines. Additionally, it stresses the role of antibiotic prophylaxis in preventing SSI and the challenges posed by multi drug resistant bacteria. It concludes that it is necessary to manage and prevent SSIs to improve patient outcomes and to reduce healthcare costs.

Keywords: Surgical site infection, MRSA, Antibiotic therapy, Antibiotic resistance, Emerging trends.

INTRODUCTION

A surgical site infection (SSI) occurs within 30 days after surgery, if an incision or operative site is infected. Surgical site infections (SSIs) can present as deep infections affecting the muscle and fascia layers, or as superficial infections affecting the skin and subcutaneous tissue, or as organ/space infections involving any portion of the body other than the location of the incision **[1]**. The development of SSI is complex and can be influenced by a number of patient risk factors, including age, comorbidities, smoking status, obesity, malnourishment, immunosuppression, cancers, and the type of wound contamination **[2]**. These infections are characterized by localized inflammatory signs and symptoms, such as warmth, redness, swelling, and purulent discharge, and they are frequently linked to systemic symptoms including leukocytosis and fever **[1]**. Guidelines on measures for the prevention of SSI that are relevant to all surgical subspecialties have been issued by the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and the National Institute for Health and Care Excellence (NICE) **[3]**. First of all, SSIs have the potential to significantly

- increase patient morbidity
- lengthen hospital stays and
- in extreme circumstances cause death.

Furthermore, in order to effectively manage the infection, SSIs may need further surgical operations including debridement or implant removal. After Alexander Fleming's 1928 discovery of penicillin, antibiotics were made available to medical professionals. However, less than a century later, multi drug resistant bacteria are becoming more common, access to antibiotics is becoming more limited, and worries about the microbiome's impact on human health and disease are becoming more pressing **[4]**. One of the most important strategies to avoid SSIs is antibiotic prophylaxis, or giving antibiotics prior to surgery **[1]**. These include hair removal, skin cleansing procedures, maintaining intraoperative normothermia, administering preoperative antibiotic prophylaxis, using plastic adhesive skin barriers, supplementing oxygen flow at a high rate, protecting wounds, sterilizing instruments, preparing the bowel, extending the incision, and closing it later than planned. The annual number of SSI diagnoses and treatments ranges from 160,000 to 300,000, and they place a significant strain on healthcare systems because of difficulty with wound healing, greater discomfort following surgery, reoperation, lengthier hospital stays, diminished quality of life, and look. A patient's comorbidities, a lengthy surgical procedure, contaminated and unclean wounds, and a high American Society of Anesthesiologists (ASA) score are all significant risk factors for surgical site infections (SSIs), which makes emergency surgery a risk factor for the condition. The World Society of Emergency Surgery (WSES) created a position paper on SSI prevention in the operating room in response to these factors **[2]**. Hence in this review we had discussed about the role of prophylactic antibiotics in surgical site infections.

EPIDEMIOLOGY

Surgery-related infections (SSIs) are frequent infections linked to healthcare that occur in surgical patients at different rates based on the type of surgery, patient health, and compliance with infection prevention guidelines **[1]**. SSIs occur frequently, complicating between 1% and 10% of surgical procedures, and using a significant amount of healthcare resources as a result. The majority of SSIs ought to be avoidable by addressing important care bundle components **[4]**. Every year, between 160,000 and 300,000 people are diagnosed with surgical site infection. These individuals pose a significant burden on healthcare systems due to factors such as increased pain following surgery, delayed wound healing, prolonged hospital stays and reduced quality of life. Following abdominal surgery, the incidence of all SSI types can reach 14% of all hospital-acquired infections; the most prevalent type is the incisional superficial SSI, which frequently manifests first and is simple to diagnose **[2]**.

TYPES

SSI falls into three categories: organ or space infection, deep incision, and superficial incision. Each year, it causes a considerable amount of surgical morbidity and mortality **[5]**.

- Superficial SSIs: These infections are mainly restricted to the skin and subcutaneous tissue, which are the outermost layers of the surgical site. They frequently show up as outward symptoms of infection, like warmth, redness, swelling, and purulent discharge. Although SSIs on the surface are typically less invasive than those on their counterparts, they must be taken into account. They can worsen if untreated, potentially resulting in more serious issues or even the emergence of organ/space or deep SSIs **[1]**.
- Deep SSIs: Unlike superficial SSIs, which only affect the superficial layers of the surgical site, deep SSIs affect the layers of muscle and fascia that lie beneath the incision. These
- infections are known for being invasive, which increases the risk of complications like abscess formation,

necrosis of the surrounding tissue, or harm to important structures. Higher rates of morbidity are linked to deep SSIs, which frequently necessitate lengthy hospital stays, additional surgeries, and strict medical supervision to treat the underlying infection and keep the patient safe **[1]**.

- Organ/space SSIs: These infections can affect any part of the body other than the site of the incision. Because these infections may affect important organs or bodily cavities, they can be especially difficult to diagnose and treat. Organ/space SSIs may need longer courses of antibiotic therapy in addition to surgical intervention, such as reoperation or drainage procedures, to effectively clear the infection. Close observation and a multidisciplinary approach to treatment are necessary for these infections due to their complexity and potential for serious consequences **[1]**.

RISKS

Surgical site infections are associated with a number of risk factors, including distinguishable, intrinsic, and extrinsic factors. These risk factors can be changed or remain unchanged. Modifiable intrinsic risk factors include glucose, respiratory conditions, alcoholism, smoking, obesity, immunocompromised individuals, albumin, and bilirubin. Age, recent radiation therapy, and a history of skin and soft tissue infections are the ones that cannot be changed. The hospital facility's risks (inadequate ventilation, increased traffic in the operating room, inadequate equipment sterilization), procedural risk factors (such as emergency and more complex surgeries and wound classification), and intraoperative risk factors (such as the length of the surgery, blood transfusions, the maintenance of asepsis, the surgical cleaning of the hands and the use of poor quality gloves, hypothermia and poor glycemic control) are examples of extrinsic risk factors **[6]**.

CURRENT PRACTICE OF ANTIBIOTICS IN SSI

Comprehensive guidelines for antibiotic prophylaxis in surgical settings are largely provided by professional organizations, such as the ACS, CDC, and WHO. These guidelines create their recommendations to particular surgical procedures, acknowledging that not all surgical procedures have the same risk of surgical site infections (SSIs). They take into account the specifics of every surgery, including the surgical site, the patient's features, and the surgical methods used. This tailored strategy makes sure that the prophylactic antibiotic selections closely match the distinct infection risks associated with various surgeries **[1]**. The first Global Guidelines for the Prevention of Surgical Site Infections by the World Health Organization (WHO) was introduced in 2018 **[7]**.

According to recent guidelines from the American Association of Endocrine Surgeons, adults with thyroid disease can be managed without antibiotic prophylaxis in the majority of cases when standard transcervical thyroid surgery is performed; however, this recommendation is based on a single randomized controlled trial (RCT), and the American Thyroid Association's guidelines make no mention of AP **[8]**. Given that the skin is a major source of pathogens, understanding skin preparation is essential to the prevent SSI. Despite extensive research on the subject, no plastic surgery organization or the Centers for Disease Control have recommended preoperative antiseptic agents to prevent surgical site infections (SSIs) **[9]**. In 2017, the CDC released new evidence-based guidelines for the prevention of SSIs, and the European Centre for Disease Prevention Control (ECDC) modified its surveillance protocol by shortening the follow-up period for SSI diagnosis **[10]**.

Some of the major modifications made to the CDC guideline for the prevention of SSI were:

- Maintaining normothermia intraoperatively,
- Giving antimicrobials when indicated prior to incision to ensure an appropriate bactericidal concentration of the agent is established in the serum and tissues, and
- Keeping blood glucose levels within a normal range in patients without diabetes **[10]**.

A care bundle, according to the Institute for Healthcare Improvement (IHI), is a simple collection of three to five evidence-based procedures that, when used in combination, enhance patient outcomes **[3]**. Surgical antibiotic prophylaxis (SAP) misuse continues and raises the risk of SSI even after new guidelines were produced. Studying the most recent data on SAP administration practices is essential for reducing this. First and second generation cephalosporins, such as cefazolin and cefuroxime, were the most frequently reported antibiotics in the literature **[11]**.

Suitable Choice of Antibiotics for SSI

The protocols are strong when it comes to choosing the right antibiotics for prophylaxis. Antibiotics with the best spectrum of activity against the most likely pathogens encountered during particular surgical procedures are given priority. In order to guarantee that the antibiotics selected continue to be effective in the face of regional resistance trends, these guidelines also take into account local patterns of antibiotic resistance. By reducing needless broad-spectrum use, this deliberate antibiotic selection promotes antibiotic stewardship and strengthens the prophylactic effect. A preference toward first-line medications, like cefazolin, is fundamental to the selection of antibiotics. These antibiotics have a well-established safety profile and a broad spectrum of activity against common surgical pathogens, making them preferred for use in many surgical procedures **[1]**. In a study it had shown that administration of prophylactic antibiotics lowers the incidence of surgical site infections. 73.3% of patients receive antibiotics, particularly after surgery Cefotaxime (80.7%), metronidazole (63.5%), cefradine (13.6%), and amoxicillin/clavulanate (11.6%) were the most commonly prescribed antibiotics **[5]**. Antibiotic resistance is more likely to develop when antibiotics are used inappropriately, which can also increase medical expenses.

On the other hand, SSIs can also lead to higher hospital expenses, longer hospital stays, and in rare cases, death in otherwise healthy patients **[8]**.

Superficial skin infections can be prevented by

- Clean versus sterile technique in superficial cutaneous procedures
- Topical decolonization
- Preoperative antibiotic prophylaxis and
- the use of antiseptic **[9]**.

The two most often applied substances are povidone iodine and chlorhexidine. Both agents are found in aqueous and alcohol-based solutions. By releasing a free iodide molecule that damages microbial DNA and proteins, povidone-iodine kills skin flora. Povidone iodine's antimicrobial activity is wide-ranging and its aqueous form can remain effective for up to two hours **[9]**.

Using nasal Mupirocin and chlorhexidine body wash for nasal decolonization in individuals with Staphylococcus aureus (S. aureus) infection is a basic method to lower the risk of surgical site infection. The implementation of decolonization and the use of antibiotic prophylaxis with Vancomycin has been approved to reduce the risk of SSIs upon the identification of patients with MSSA or MRSA **[6]**.

A number of requirements, such as the prescribed indication, dosage, infusion time, and duration, must be addressed for antibiotic prophylaxis to be considered adequate:

- Treatment suggestions based on the type of surgery and expected level of contamination (not usually advised in minor procedures or short, clean surgeries without prosthesis placement).

- Altered according to the patient's characteristics (body mass index, hepatic or renal function, and other factors that might influence how the antibiotic is distributed).
- Pay attention to the type of antibiotic: it should not promote resistance but rather cover common microorganisms.
- Appropriate route of administration: usually intravenous
- Administration time and site: in the surgical setting (30–60 min before starting the procedure, never more than 120 min)
- Repeat the intraoperative dose if the procedure takes longer than twice the antibiotic's real half-life (measured from the end of infusion to the first dose) or if there is more than 1500 mL of perioperative hemorrhage.
- Sufficient duration: usually one dosage [12].

Depending on the location and level of colonization or contamination of the surgical procedure, different bacteria may be isolated from surgical site infections (SSIs). The most common bacteria isolated from patients' skin flora are commensal gram-positive cocci. The patients usually undergoing clean (Class I) surgery (e.g., breast, thyroid) in which the surgical site is limited to skin and subjacent soft tissue (the gastrointestinal, genitourinary, or respiratory tracts have not been opened). However, intestinal or genitourinary tract flora—typically facultative or aerobic gram-negative bacilli can also colonize the skin of some particular body areas, such as the groin and perineum. First- and second-generation cephalosporin antibiotics, such as cefazolin, cefuroxime, cefoxitin, or cefazolin plus metronidazole, are the most often prescribed antibiotics for SAP. With the possible exception of ertapenem, broad-spectrum antibiotics shouldn't be used for SAP because they might be needed down the road if a patient gets an MDR postoperative infection. The history of beta-lactam antibiotic allergies should be taken into account when choosing SAP. To determine whether a true allergy exists, patients should be thoroughly questioned about their history of antibiotic hypersensitivity prior to the administration of SAP. Despite the existence of clinical practice guidelines for SAP for ten years, inappropriate prescribing practices continue to be prevalent at high rates. These practices can lead to unfavorable consequences for patients, interfere with their progress, and exacerbate antimicrobial resistance (AMR) **[13]**. A clinical pharmacist's interventions, such as publishing evidence-based standard protocols and up-to-date therapeutic information, conducting educational sessions on diagnosis and prescription, raising public awareness through media messages, and conducting reviews of antibiotic prescription patterns, can all help to promote the quality use of medicine **[14]**.

CHALLENGES IN PREVENTION OF SSI

Antimicrobial Resistance and Surgical Antibiotic Prophylaxis

The standards that establish if SAP is acceptable; important organisations like the World Health Organisation (WHO) and the Centres for Disease Control and Prevention (CDC) regularly update their recommendations. This guideline offers instructions on how to treat patients who have bacterial infections and specifies how to prescribe antibiotics for SAP **[15]**. Surgical site infections, which rank second only to transfusion among outcomes assessed by the National Surgical Quality Improvement Programme, are the primary cause of healthcare-associated infections, which have become the most common complication of contemporary surgery **[16]**.

Surgical antibiotic prophylaxis is still the cornerstone of prevention and one of the most successful, widely-applicable, and economically sensible ways to stop endogenous and exogenous wound infections. Based on modelling the effectiveness of current standard surgical prophylaxis regimens for surgical

populations in the United States, it is estimated that:
(1) 40–50% of surgical site infections are resistant to the standard prophylactic agents for the procedure
(2) If these trends continue, there could be tens or hundreds of thousands more infections annually.
Antimicrobial resistance is on the rise and is sometimes referred to as the "next pandemic." It has the potential to significantly alter present infection prevention strategies and have an influence on healthcare systems as a whole **[17]**.

EMERGING TRENDS IN PREVENTING SSI

Methods for preventing surgical site infections are starting to change in light of these new paradigms and clinical data. Overall, this evolution is marked by a move from aseptic to medicinal approaches to prevention and from a hospital-centered to a patient-centered model of etiology. Many of the measures are common and cover the whole perioperative period, although some are procedure-specific. Surgical antibiotic prophylaxis is still the cornerstone of preventive and one of the most comprehensive, widely used, and economically viable ways to stop endogenous and exogenous wound infection. Antimicrobial resistance is commonly referred to as the "next pandemic" since it has the potential to significantly alter healthcare systems and upend present infection prevention strategies **[17]**. To combat antimicrobial resistance, new therapeutic options will become available in the future **[6]**. In the perioperative stages of surgery, SSIs can develop due to a number of established risk factors. Optimizing clinical factors, including blood glucose management, hypothermia, antibiotic prophylaxis, oxygen saturation, skin decontamination, S. aureus nasal decontamination and decolonization, and blood glucose control, has a demonstrable effect on infection rates, even though not all of them are adjustable **[18]**. Antibacterial sutures and wound protectors appear to have important roles in preventing SSI in intra-abdominal infections **[2]**. Sutures provide a surface that is suitable for bacterial adhesion, colonization, and biofilm formation. A wound incision containing foreign materials (medical implants or sutures) acts as a reservoir to keep exogenous bacteria safe from the host defence mechanism and as an anchoring surface for the formation of biofilms **[19]**. The level of incidence of SSI that has persisted for several decades in spite of advances in prophylactic antibiotic therapy and preoperative bacterial decolonization. There is no doubt that rigorous adherence to numerous evidence-based interventions concerning perioperative sterility, technique, and prophylaxis were essential **[20]**.

CONCLUSION

This review highlights the significant impact of SSIs on patient morbidity, healthcare resources and the importance of preventive measures. It also emphasizes the need for adherence to infection prevention guidelines. Additionally, it stresses the role of antibiotic prophylaxis in preventing SSI and the challenges posed by multi drug resistant bacteria. It concludes that it is necessary to manage and prevent SSIs to improve patient outcomes and reduce healthcare costs.

Declaration by Authors
Ethical Approval: Not Required
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Dhole S, Mahakalkar C, Kshirsagar S, et al. Antibiotic Prophylaxis in Surgery: Current Insights and Future Directions for Surgical Site Infection Prevention. Cureus. 2023 Oct 28 ;15(10):1-16.
2. De Simone, B., Sartelli, M., Coccolini, F. *et al.* Intraoperative surgical site infection control and prevention: a position paper and

future addendum to WSES intra-abdominal infections guidelines. World Journal of Emergency Surgery. 2020 Feb 10;15(1):1-23.
3. Wolfhagen N, Boldingh QJ, Boermeester MA, de Jonge SW. Perioperative care bundles for the prevention of surgical-site infections: meta-analysis. British Journal of Surgery. 2022 Oct 1;109(10):933-42.
4. Andersson R, Soreide K, Ansari D. Surgical infections and antibiotic stewardship: in need for new directions. Scandinavian Journal of Surgery. 2021 Mar;110(1):110-2.
5. Adzillina E, Sundari S. Trends of research on antibiotic prophylaxis and surgical site infection: A bibliometric review based on VOS viewer by Scopus database. World Journal of Advanced Research and Reviews. 2023;17(2):033-44.
6. Pinchera B, Buonomo AR, Schiano Moriello N, Scotto R, Villari R, Gentile I. Update on the management of surgical site infections. Antibiotics. 2022 Nov 11;11(11):1-15.
7. Rasa K, Kilpatrick C. Implementation of World Health Organization guidelines in the prevention of surgical site infection in low- and middle-income countries: what we know and do not know. Surgical Infections. 2020 Sep 1;21(7):592-8.
8. Polistena A, Prete FP, Avenia S, Cavallaro G, Di Meo G, Pasculli A, Rondelli F, Sanguinetti A, Sgaramella LI, Avenia N, Testini M. Effect of antibiotic prophylaxis on surgical site infection in thyroid and parathyroid surgery: a systematic review and meta-analysis. Antibiotics. 2022 Feb 22;11(3):1-15.
9. Ruffolo AM, Sampath AJ, Colbert S, Golda N. Preoperative considerations for the prevention of surgical site infection in superficial cutaneous surgeries: A systematic review. Facial Plastic Surgery & Aesthetic Medicine. 2021 Jun 1;23(3):205-23.
10. Horgan S, Hegarty J, Drennan J, Keane D, Saab MM. The effect of interventions on the incidence of surgical site infections in acute care settings: A systematic review. Journal of Tissue Viability. 2023 Nov 13;1-14.
11. Brocard E, Reveiz L, Regnaux JP, Abdala V, Ramon-Pardo P, del Rio Bueno A. Antibiotic prophylaxis for surgical procedures: A scoping review. Revista Panamericana de Salud Publica. 2021 Jun 4;45(1):1-7.
12. Badia JM, Pérez IR, Manuel A, Membrilla E, Ruiz-Tovar J, Muñoz-Casares C, Arias-Díaz J, Jimeno J, Guirao X, Balibrea JM. Surgical site infection prevention measures in General Surgery: Position statement by the Surgical Infections Division of the Spanish Association of Surgery. Cirugía Espanola (English Edition). 2020 Apr 29;98(4):187-203.
13. Sartelli M, Boermeester MA, Cainzos M, Coccolini F, de Jonge SW, Rasa K. Six long-standing questions about antibiotic prophylaxis in surgery. Antibiotics (Basel). 2023; 12 (5): 1-16.
14. Butt SZ, Ahmad M, Saeed H, Saleem Z, Javaid Z. Post-surgical antibiotic prophylaxis: Impact of pharmacist's educational intervention on appropriate use of antibiotics. Journal of infection and public health. 2019 Nov 1;12(6):854-60.
15. Hassan S, Chan V, Stevens J, Stupans I. Factors that influence adherence to surgical antimicrobial prophylaxis (SAP) guidelines: a systematic review. Systematic reviews. 2021 Dec;10:1-20.
16. Long DR, Alverdy JC, Vavilala MS. Emerging paradigms in the prevention of surgical site infection: the patient microbiome and antimicrobial resistance. Anesthesiology. 2022 Aug 1;137(2):252-62.
17. Princess I. Challenges in the Prevention of Surgical Site Infections in India. Apollo Medicine. 2023 Aug 7; 1-4.
18. Lamagni T, Elgohari S, Harrington P. Trends in surgical site infections following orthopaedic surgery. Current opinion in infectious diseases. 2015 Apr 1;28(2):125-32.
19. Chua RA, Lim SK, Chee CF, Chin SP, Kiew LV, Sim KS, Tay ST. Surgical site infection and development of antimicrobial sutures: a review. European Review for Medical & Pharmacological Sciences. 2022 Feb 1;26(3).
20. Wojnarski CM, Elgudin Y, Rubelowsky JJ, Wilson BM, Donskey CJ, Cmolik BL. Emerging trends in mediastinitis: National Veterans Health Administration experience with methicillin-resistant Staphylococcus aureus prevention. The Journal of Thoracic and Cardiovascular Surgery. 2021 Oct 1;162(4):1125-30.

How to cite this article: P. Dhivyaprasath, Abi Monika A P, Aarthi A, S. Abirami, Aditya J. A role of prophylactic antibiotics in preventing surgical site infection: current practice and future direction. *Int J Health Sci Res.* 2023; 13(12):293-299. DOI: *10.52403/ijhsr.20231235*

******