Surgical Site Infections and Antimicrobial Stewardship: A Global Health Perspective

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Abstract : The surgical site infections (SSIs) have been identified as one of the most common healthcare-associated infections, and they still pose a significant public health issue on a global scale. The occurrence of these infections is associated with increased morbidity rates, prolonged periods of hospitalization, higher medical costs, and mortality rates. The inappropriate and excessive use of antibiotics has contributed to the development of antimicrobial resistance, which makes it more challenging to prevent and treat SSIs. Antimicrobial stewardship programs focus on the rational use of antibiotics and can lead to lower rates of resistance and better patient outcomes. This paper explores the global impact of SSIs, etiology, classification, risk factors, preventive measures, and the significance of antimicrobial stewardship in healthcare settings.

Keywords: Surgical Site Infection, Antimicrobial Stewardship, Antibiotic Resistance, Healthcare-Associated Infection, Global Health, Infection Prevention

I. INTRODUCTION

Among the most prevalent types of HAI, surgical site infections (SSIs) still pose a serious public health problem around the world today. Such conditions often result in morbidity, prolonged hospital stays, additional expenses for treatment, and even in the worst case, patient deaths. Although great advancements have been achieved in surgical procedures, sterilization, and prophylactic antibiotics, there is still a significant number of SSIs cases globally, especially in developing and some developing countries.

Generally, there are three main types of SSIs: superficial incisional infections, deep incisional infections, and infections of organs or spaces. Although the incidence rates of the first type have been decreased due to the development of minimally invasive surgery and effective prevention, organ/space SSIs are the key problems that require special attention from clinicians.

Since cancer patients with advanced digestive system diseases face a high probability of being affected by organ/space SSIs due to complicated surgery, weakened immunity, and longer operation time, it is important to take into account the intraoperative and early postoperative risk factors of organ/space infections in surgical.

Thus, the purpose of this research is to determine the key factors that increase the risk of developing organ/spaces SSIs and the potential impact of antimicrobial stewardship in lowering infection rates.

II. Objectives of the Study.

1. To understand the causes and effects of surgical site infections.
2. To study the importance of antimicrobial stewardship in healthcare.
3. To identify major risk factors associated with SSIs.
4. To analyze global challenges related to antibiotic resistance.

III. Classification of Surgical Site Infections

SSIs can be broadly divided into three types depending on the extent and location of infection.

3.1 Superficial Incisional SSI

Superficial incisional SSI involves only the skin and subcutaneous tissue around the surgical incision. It usually occurs within 30 days after surgery and is characterized by redness, pain, swelling, warmth, and purulent discharge.

General Characteristics:

- Localized redness and tenderness
- Incisional swelling
- Fever
- Formation of pus
- Common Pathogens

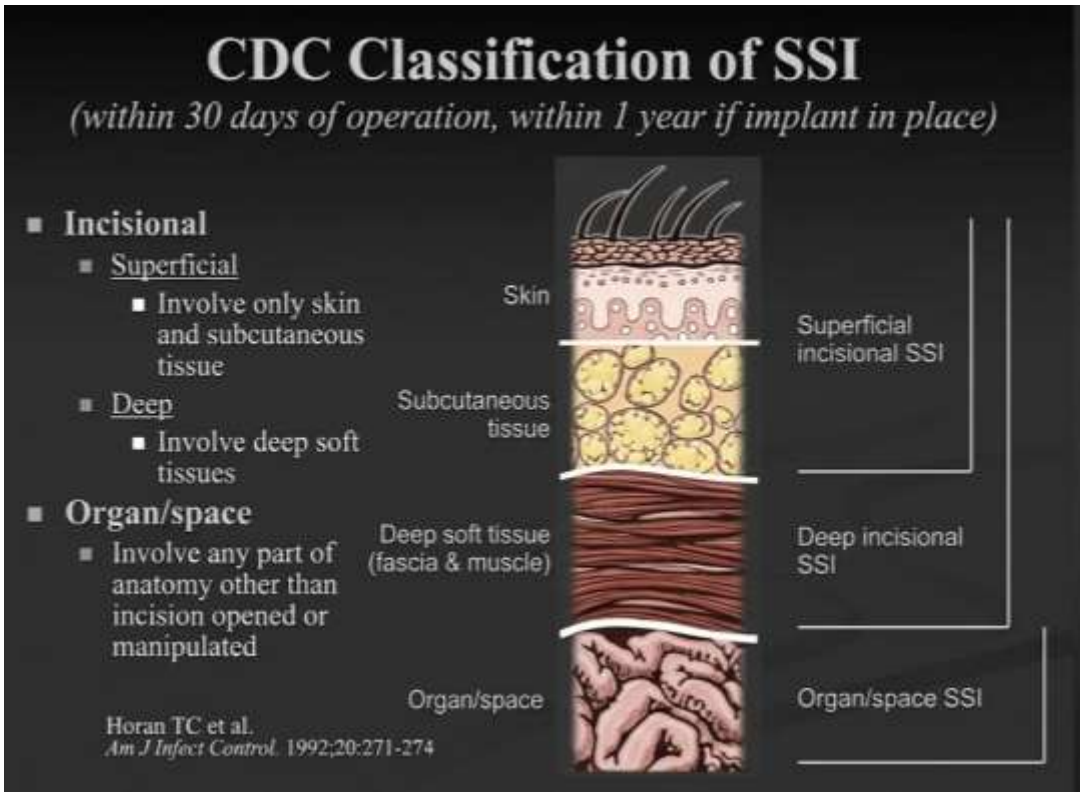

Fig 3.1.1: CDC classification of surgical site infections showing superficial incisional, deep incisional, and organ/space SSIs.

3.2 Deep Incisional SSI

Deep surgical site infections are serious postoperative complications that occur beneath the skin incision, involving muscle and fascial layers. Unlike superficial infections, deep SSIs extend into deeper tissues and often require aggressive treatment.
These infections usually develop within 30 days after surgery or up to one year if an implant is present.

Causes

- Contamination during surgery
- Poor sterile techniques
- Prolonged surgery duration
- Weak immune system

Symptoms

- Persistent pain
- Fever
- Swelling and redness
- Wound reopening
- Pus discharge

Risk Factors

- Diabetes mellitus
- Obesity
- Smoking
- Malnutrition
- Advanced age
- Long hospital stay

Management

- Antibiotic therapy
- Surgical drainage
- Debridement of infected tissue
- Repeat surgery in severe cases

3.3 Organ/Space SSI

Organ/space SSIs occur in internal organs or body spaces involved during surgery. These are among the most severe forms of surgical site infections and are associated with increased morbidity and mortality.

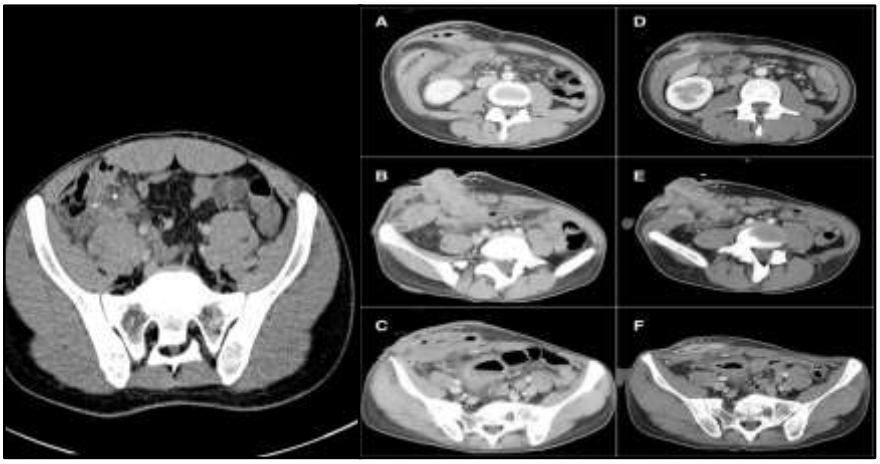

Fig 3.3.1 Organ/space surgical site infection affecting internal organs and body cavities

Characteristics

- Abscess formation
- Internal organ infection
- Severe systemic symptoms
- Longer hospitalization

Common Pathogens

- Gram-negative bacteria
- Anaerobic bacteria
- Resistant organisms such as MRSA

Management

- Source control
- Drainage procedures
- Targeted antibiotic therapy
- Surgical intervention if necessary

IV. Epidemiology and Burden

SSIs represent a substantial part of healthcare-associated infections across the world. They are prevalent in low- and middle-income countries because of inadequate healthcare facilities, shortage of infection control measures, overcrowded hospitals, and lac k of proper antimicrobial regulation.

From global epidemiological studies:

- SSIs are responsible for infecting millions of individuals each year.
- Low- and middle-income countries experience higher incidences of SSIs than developed countries.
- SSIs cause extended hospitalization periods and result in increased health care costs.
- Resistance to antibiotics is growing around the world in SSI pathogens.

Despite strict infection control policies and effective antimicrobial management in high-income countries, the problem of antimicrobial resistance continues to escalate.

V. Pathogenesis of SSI

The pathogenesis of SSIs is characterized by the colonization and growth of microorganisms in surgical wounds.

Infection Process

1. Wound contamination during surgery.
2. Microorganism colonization in tissue.
3. Growth of bacteria.

4. Damage to tissue and inflammatory response.
5. Clinical infection formation.

Factors affecting the likelihood of infection are:

1. Amount of microorganisms introduced
2. Strength of the microorganisms
3. Host immunity
4. Foreign bodies present

VI. Common Pathogens in Surgical Site Infections

Surgical site infections arise from different types of microbes based on the nature of the surgery being performed and the medical condition of the patient.

6.1 Gram Positive Bacteria

- **Staphylococcus aureus**
  It is one of the commonest causes of SSIs. The methicillin-resistant Staphylococcus aureus is particularly worrisome as it is resistant to several antibiotics.
- **Coagulase-negative Staphylococci**
  Often found in infection involving implants.
- **Enterococcus species**
  Common causes of infections during abdominal surgeries.

6.2 Gram Negative Bacteria

- **Escherichia coli**
  Frequently isolated in gastrointestinal surgeries.
- **Klebsiella pneumoniae**
  Associated with resistant infections including ESBL-producing strains.
- **Pseudomonas aeruginosa**
  Common in burn units and ICU-related infections.

6.3 Anaerobic Bacteria

- **Bacteroides fragilis**
  Frequently involved in colorectal surgeries.
- **Clostridium species**
  Can cause severe wound infections and tissue necrosis.

VII. Risk Factors for Surgical Site Infections

Various patient and surgical factors contribute to an increased risk of developing an SSI..

7.1 Patient Factors

- Diabetes
- Obesity
- Smoking
- Undernutrition
- Immunosuppressed state
- Advanced age
- Antibiotic treatment history

7.2 Surgical Factors

- Extended surgical time
- Emergency surgeries
- Poor aseptic techniques
- Incomplete skin preparation
- Implants/prosthetics use

7.3 Hospital Factors

- Substandard infection control measures
- Overcrowding

VIII. Mechanisms of Antimicrobial Resistance

Pathogens involved in SSIs develop resistance through multiple mechanisms.

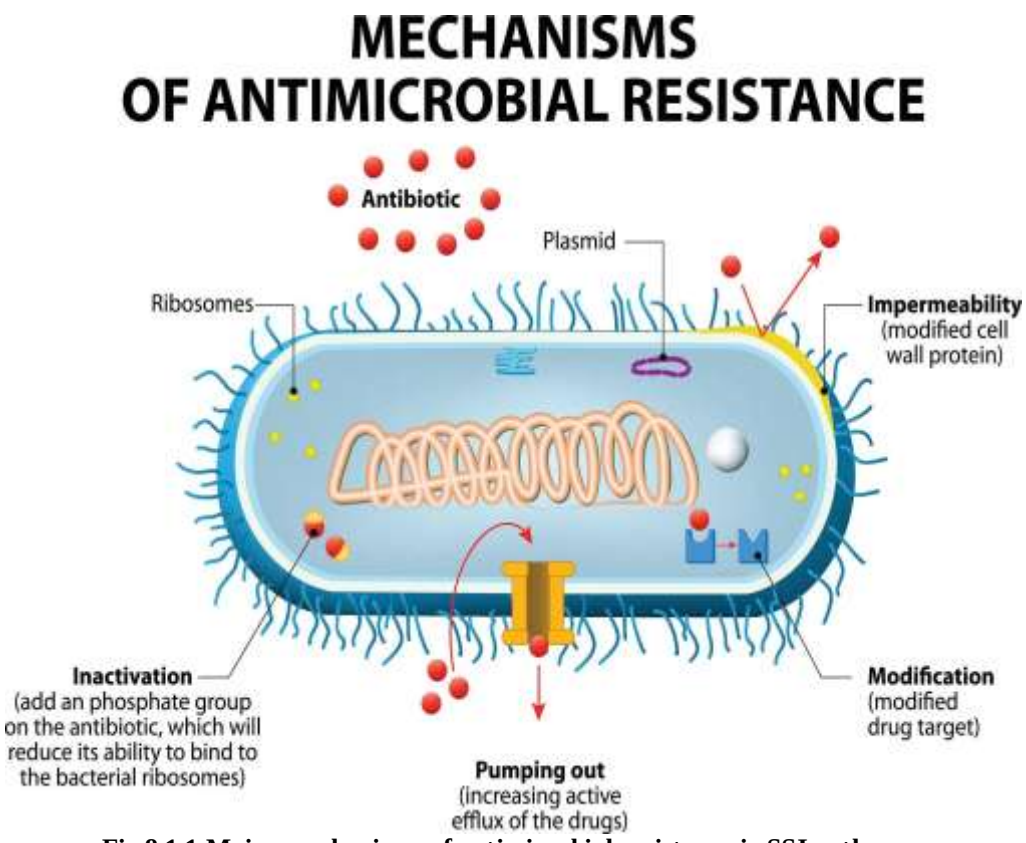

Fig 8.1.1 Major mechanisms of antimicrobial resistance in SSI pathogens.

8.1 Enzymatic Degrading

This type of resistance occurs when there are bacteria capable of producing certain types of enzymes. For instance, enzymes known as beta-lactamases and extended-spectrum beta-lactamases (ESBLs) degrade antibiotics before being active.

8.2 Change in Target Sites Structure

Organisms may also be resistant through structural modification of the antibiotic target site in bacterial cells. An example of this form of resistance is seen in MRSA, which changes penicillin binding protein and results in resistance against methicillin and similar antibiotics.

8.3 Efflux Pumps

Efflux pumps refer to transport proteins which pump antibiotics out of bacterial cells. The reduction of antibiotic levels in bacteria cells enables microorganisms to survive against an administered antibiotic.

8.4 Decreased Permeability

Reduced permeability refers to instances where the permeability of the bacterial membrane is changed. The consequence of decreased permeability of the outer membrane in particular, is a reduction in the uptake of antibiotics by the cell.

8.5 Biofilm Formation

Bacterial biofilms are communities of bacteria attached to surfaces. These include medical devices or tissues. Bacteria in biofilms resist destruction by antibiotics or immune defenses. Variables of the study contains dependent and independent variable. The study used pre-specified method for the selection ofvariables. The study used the Stock returns are as dependent variable. From the share price of the firm the Stock returns are calculated. Rate of a stock salable at stock market is known as stock price.

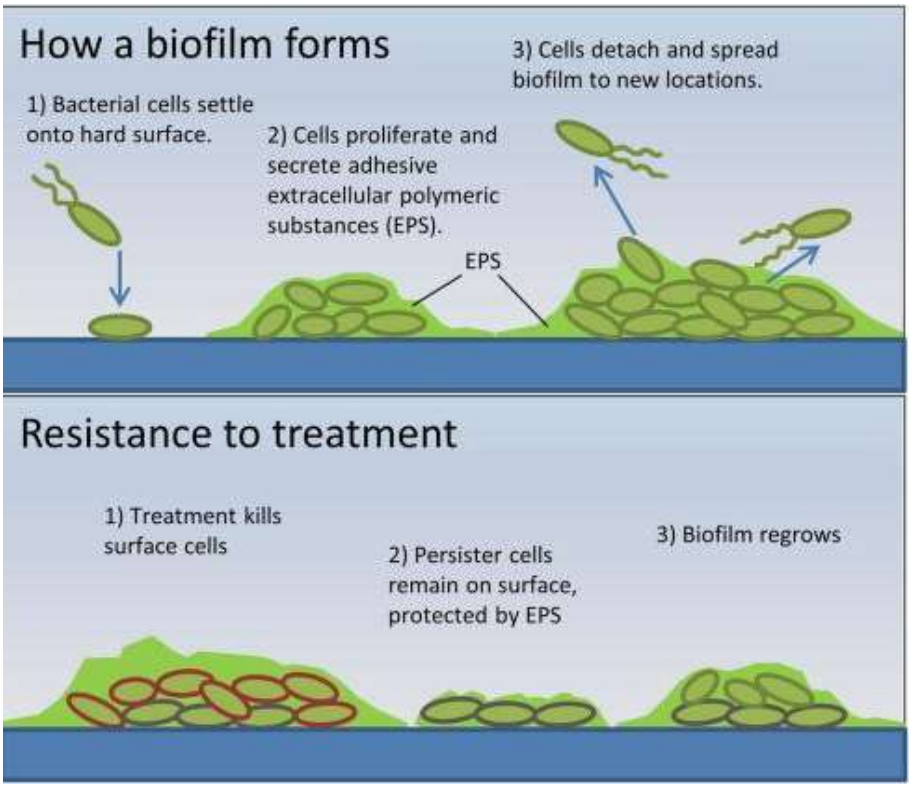

Fig 8.5.1 Biofilm formation on surgical implants contributing to chronic infections and antibiotic resistance.

IX. Role of Antimicrobial Stewardship in SSIs

Antimicrobial Stewardship AMS involves planned efforts to facilitate the appropriate use of antimicrobials.

Goals of AMS

- Enhance patient results
- Decrease antimicrobial resistance
- Prevent unnecessary antibiotic use
- Cut healthcare expenses

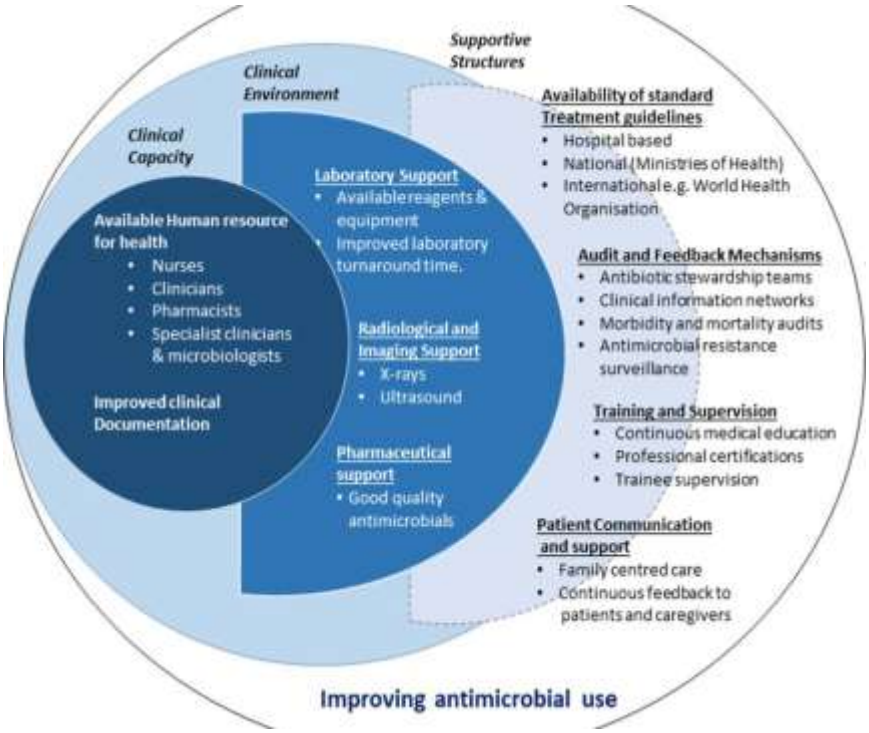

Fig 9.1.1 Core principles of antimicrobial stewardship in surgical practice.

9.1 Optimal Surgical Antibiotics Prophylaxis

AMS guarantees:

- Antibiotic selection
- Right timing prior to incision
- Dosing
- Short duration of prophylaxis

Most surgical antibiotics prophylaxis should not last more than 24 hours.

9.2 Culture-Directed Antimicrobial Therapy

Culture and susceptibility tests assist healthcare providers to prescribe targeted antibiotics instead of broad-spectrum empirical antibiotics

X. Prevention Strategies for Surgical Site Infections

Fig 10.1 Infection prevention and control measures used to reduce surgical site infections.

10.1 Preoperative Measures

- Proper skin preparation with antiseptics
- Timely surgical antibiotic prophylaxis
- Control of diabetes and blood sugar
- Smoking cessation before surgery
- Proper nutrition and patient hygiene

10.2 Intraoperative Measures

- Strict aseptic and sterile techniques
- Proper sterilization of surgical instruments
- Surgical hand hygiene
- Minimizing surgery duration
- Proper tissue handling during surgery

10.3 Postoperative Measures

- Proper wound care and dressing
- Regular monitoring for infection signs
- Hand hygiene by healthcare workers
- Rational use of antibiotics
- Patient education about wound care

10.4 Infection Control Measures

- Hospital infection surveillance programs

- Staff training and awareness
- Isolation precautions for resistant infections
- Implementation of antimicrobial stewardship programs

Conclusion

Surgical Site Infections (SSIs) continue to be a persistent problem in contemporary medicine, causing additional harm to patients, extended hospitalization, rising medical expenses, and increased mortality rates. Moreover, the increasing prevalence of antimicrobial resistance has made SSIs even more difficult to prevent and treat.

Antimicrobial stewardship is crucial for managing SSIs through the promotion of responsible antimicrobial utilization, minimizing the need for antimicrobials, and avoiding the transmission of resistant microbes. Appropriate infection control strategies, prompt surgical prophylaxis, sterilization measures, and effective diagnosis are also crucial for minimizing the incidence of SSIs.

It is vital to implement a multi-sectorial strategy by collaborating with health care providers, infection control specialists, policy makers, and international health organizations to ensure surgical safety and address the issue of antimicrobial resistance.

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