

A photograph of medical supplies on a desk, including a syringe in a tray, a pill container, and a clipboard with a medication schedule chart. A hand is holding a pen over the chart.

Surgical infections and antibiotics prophylaxis in surgery.

- **Done by:**

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A photograph of various surgical instruments, including two pairs of forceps and several scalpels, laid out on a blue surface. The instruments are metallic and have different shapes and sizes. A dark blue banner with orange text is overlaid on the right side of the image.

Objectives of the lecture:

- Introduction to Surgical Infections
- Types of SSIs
- Risk Factors & Pathophysiology
- Prevention Strategies
- Antibiotic Prophylaxis & Resistance
- Treatment of Established Surgical Infections
- Guidelines and Recommendations

Definition:

What is a Surgical Site Infection (SSI)

- A **surgical site infection (SSI)** is an infection that occurs at or near the surgical incision within 30 days of a procedure (or within 90 days if prosthetic material is involved). SSIs result from the contamination of the surgical site by microorganisms, either from the patient's skin, the operating environment, or external sources during surgery. SSIs can involve the superficial tissues, deeper structures, or organs and can lead to a range of complications from mild wound infections to severe systemic illness.





Incidence of SSIs

- **Incidence: Prevalence of SSIs in Different Types of Surgeries**
- The incidence of SSIs depends on the type of surgery, the level of contamination, and patient factors (e.g., comorbidities). Here's a general breakdown of SSI prevalence:
- **Clean Surgeries (e.g., orthopedic, cardiac):**
 - **Incidence:** Low, typically 1-2%.
 - **Examples:** Total joint replacements, cardiac bypass.
- **Clean-Contaminated Surgeries (e.g., GI or GU surgeries):**
 - **Incidence:** 3-7%.
 - **Examples:** Hysterectomy, bowel resection.
- **Contaminated Surgeries (e.g., emergency surgeries, trauma):**
 - **Incidence:** 10-15%.
 - **Examples:** Emergency appendectomy, trauma surgery.
- **Dirty or Infected Surgeries:**
 - **Incidence:** Can be as high as 40%.
 - **Examples:** Surgeries involving necrotic tissue or established infections (e.g., ruptured appendix).

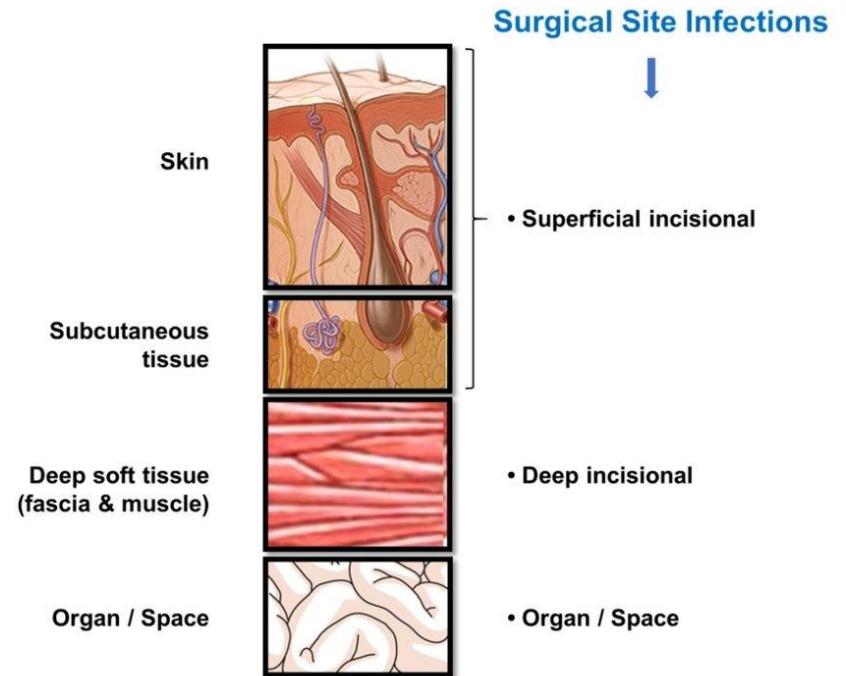
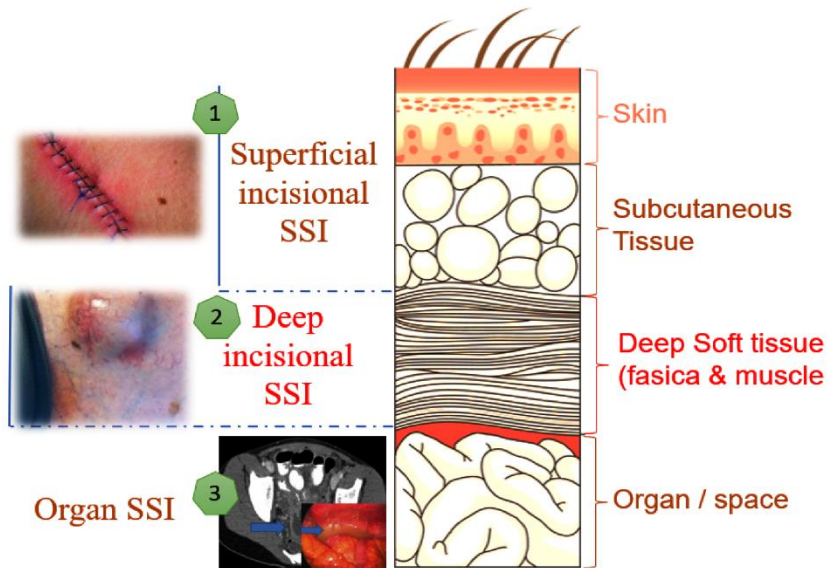
A photograph of various surgical instruments, including forceps and scalpels, arranged on a blue surface. A dark blue banner with red text is overlaid on the right side of the image.

Types of Surgical Site Infections (SSIs):

based on the location of the infection relative to the surgical incision:

- **1. Superficial Incisional SSI**
- **Location:** Involves only the skin and subcutaneous tissue around the incision.
- **Symptoms:** Redness, swelling, warmth, pain, and sometimes pus or drainage at the surgical site.
- **Causes:** Poor skin preparation, contamination during surgery, or patient-related factors (e.g., diabetes).
- **2. Deep Incisional SSI**
- **Location:** Affects the deeper tissues beneath the skin, such as fascia and muscle layers.
- **Symptoms:** Increased pain, fever, abscess formation, and deep wound drainage.
- **Causes:** Inadequate sterilization or contamination during surgery, extended surgery time, or patient-related factors (e.g., obesity).
- **3. Organ/Space SSI**
- **Location:** Involves any part of the body other than the skin, fascia, or muscle layers that was opened or manipulated during surgery (e.g., organs, cavities).
- **Symptoms:** Can include fever, pain at the surgical site, abscess formation, or signs of systemic infection (e.g., sepsis).
- **Examples:** Peritonitis after abdominal surgery, infections in joints after orthopedic procedures.
- **Causes:** Internal contamination during surgery, bowel perforation, or inadequate prophylaxis.
- Each type has different management strategies, and the severity can range from mild (superficial) to life-threatening (organ/space infections).





Types of Surgical Site Infections (SSIs): (cont.)

- **Based on Timing of Onset**
- SSIs can also be classified by when they occur after the surgery:
- **Acute SSI:**
 - Occurs within 30 days of the surgery (or up to 90 days for surgeries involving implants).
 - Typically caused by bacteria introduced during surgery or from the patient's skin.
- **Delayed/Chronic SSI:**
 - Develops after 30 days (or after 90 days in the case of implants) and can take months to manifest.
 - Often associated with low-virulence pathogens like coagulase-negative staphylococci, or biofilm formation on prosthetic materials.



Impact of SSIs:

- **A. Complications:**
 - **Wound Dehiscence:** Reopening of the surgical wound.
 - **Abscess Formation:** Pockets of infection that may require drainage or further surgery.
 - **Sepsis:** Severe systemic infection leading to organ failure, shock, or even death.
- **B. Extended Hospital Stay:**
 - SSIs can prolong hospital stays by several days or weeks, increasing healthcare resource use.
 - Patients with SSIs stay in the hospital **7-11 days longer** on average compared to those without infections.
- **C. Increased Morbidity:**
 - SSIs lead to delayed healing, chronic wound issues, and reduced patient mobility and functionality, especially in surgeries like joint replacements.
- **D. Increased Mortality:**
 - SSIs increase the risk of death, especially in patients with comorbid conditions (e.g., diabetes, immunocompromised patients).
- **E. Healthcare Costs:**
 - The financial burden of treating SSIs is substantial, including costs for extended hospital stays, additional surgeries, antibiotic treatments, and wound care.

Patient Admissions

399,627

Surgical Procedures

25,849

Identified SSIs

618

SSI Rate:

2.76 per 100 surgical procedures

estimated cost between \$4147 and \$22,239 per SSI*

*not accounting for the cost to backfill patients or the cost of the intervention to prevent the SSIs.2

A top-down view of various medical supplies arranged on a grey surface. On the left, there are two pairs of surgical scissors, several scalpels of different sizes, a pair of tweezers, and a digital thermometer. Below these are a small vial of yellow capsules and a metal pill dispenser containing a mix of colorful capsules. In the center, a syringe with a needle is in a metal tray, and a clipboard with a 'DAILY REPORT SCHEDULE' form is open. To the right of the clipboard is a clear plastic IV bag and a black stethoscope. A person's hand is visible at the bottom, holding the clipboard. An orange semi-transparent banner is overlaid across the middle of the image, containing the title text.

Risk Factors & Pathophysiology

A photograph of various medical instruments, including two pairs of surgical scissors and several metal probes or scalpels, arranged on a blue surface. The image is partially obscured by a dark blue banner with an orange top edge that contains the title.

Protective mechanisms

- **Mechanical** barrier: skin ,mucus
- **Chemical** barrier: low gastric ph
- **Humoral** barrier: antibodies ,complement and opsonins
- **Cellular** barrier: phagocytic cells ,macrophages and killer lymphocytes

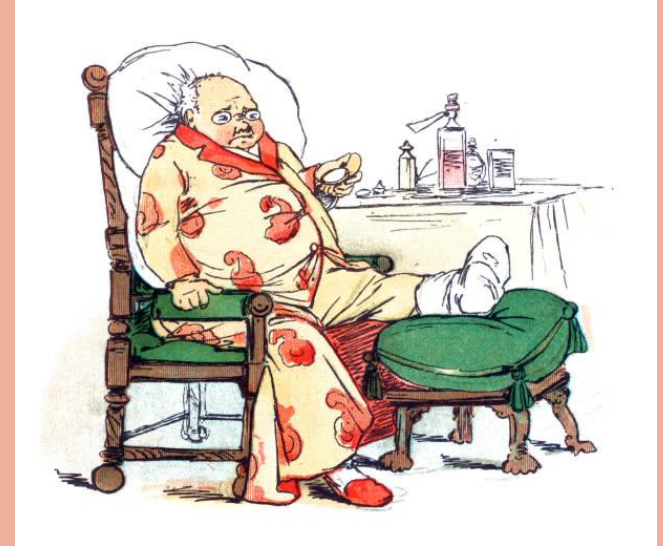
A photograph of various surgical instruments, including two pairs of scissors and several scalpels, arranged on a blue surface. The image is partially obscured by a dark blue banner with an orange top edge.

Risk factors

- Patient related factors
- Surgery related factors
- Environmental factors

Patient related factors

- Elderly
- Obesity
- Malnutrition
- Diabetes
- Immunosuppression
- Smoking
- Pre-existing infections
- Chronic illnesses, cancer



surgery related factors

- Length of surgery
- Type of surgery: GIT/RT (alters mucous)
- Surgical technique
- Type of incision: deep/large/contaminated
- Emergency surgery: less sterile condition
- Reoperation: second surgery at the same site
- Presence of drain or catheter



Environmental related factors

- Operating room sterility
- Tools sterilization and disinfection
- Inadequate ventilation or air
- Hospital acquired infections: multi-drug resistant organisms
- Post-operative care: wound care or dressing



A collection of surgical instruments, including two pairs of forceps and several scalpels, are laid out on a blue surface. A dark blue banner with the word 'Pathophysiology' in white text is overlaid on the right side of the image.

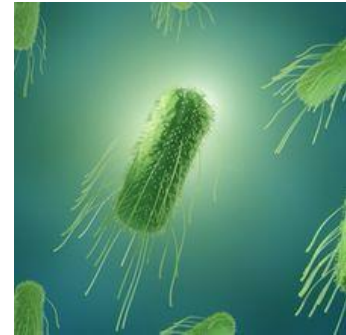
Pathophysiology

1. Disruption of normal barrier

- **Skin integrity:** the skin acts as a natural barrier to infection. surgical incisions break this barrier , making it easier for bacteria to enter.
- **Mucosal integrity:** surgeries involving the gastrointestinal or respiratory tracts can disrupt mucosal barriers increasing the risk of contamination by endogenous flora.

2. Microbial Invasion

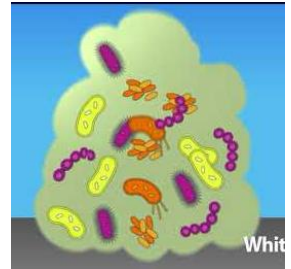
- **Bacterial contamination:** bacteria can be introduced to the surgical site from the skin , air, instruments , or room environment
- Common pathogens :
 - staphylococcus aureus (MRSA)
 - Staphylococcus epidermidis
 - E.Coli
 - Pseudomonas aeruginosa
- **Colonization of the wound :** once bacteria enters the wound it can adhere to tissues or foreign bodies(sutures , implants) and begin to multiply



Pathophysiology

3. Biofilm formation

- **Adhesion to surface:** bacteria can form biofilms on the surface of tissues, sutures or prosthetic devices. Biofilms protect bacteria from immune responses and antibiotics making the infection harder to eradicate.
- **Altered metabolism:** within biofilms, bacteria often shift to a slower metabolism, which further reduces the effectiveness of antibiotics and immune system



A photograph of various surgical instruments, including two pairs of forceps and several scalpels, laid out on a blue surface. The instruments are metallic and arranged in a row. A dark blue banner with the word 'Pathophysiology' in white text is overlaid on the right side of the image.

Pathophysiology

4. Host immune response

- **Innate immune activation** :the body's initial response involves neutrophils and macrophages , which attempt to clear bacteria through **phagocytosis**. Inflammatory cytokines are released ,attracting more cells to the site .
- **excessive inflammation** : in severe or poorly controlled infections, excessive inflammation can lead to tissue damage and delayed healing.
- **Tissue necrosis** : if blood supply to the area is compromised, it can lead to necrosis , further impairing the body s ability to fight off infection.

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Pathophysiology

5.Alteration in local environment:

- **Hypoxia and poor perfusion ,altered PH:**surgical wounds can experience reduced blood flow due to tissue handling, edema, or pre-existing conditions(e.g. diabetes). This impairs oxygen delivery, limiting the function of immune cells and promoting bacterial growth.
- **Foreign bodies** : the presence of foreign materials(implants,sutures..) provides a surface for bacteria to adhere and form biofilms , increasing the risk for infection.

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Pathophysiology

6. Bacterial toxins and enzymes

- **Toxin production** :some bacteria release toxins that directly damage and inhibit immune response .
- **Enzymes** : (proteases and collagenase) that degrade tissue.



Pathophysiology

7.Systematic infection(sepsis)

- Widespread inflammation , organ dysfunction , can be life threatening

8.Delayed or defective wound healing

- Chronic infections: infections that persist can lead to chronic non healing wounds
- Fistula formation: in severe infections abnormal connections may form between organs or skin , further complicating recovery .

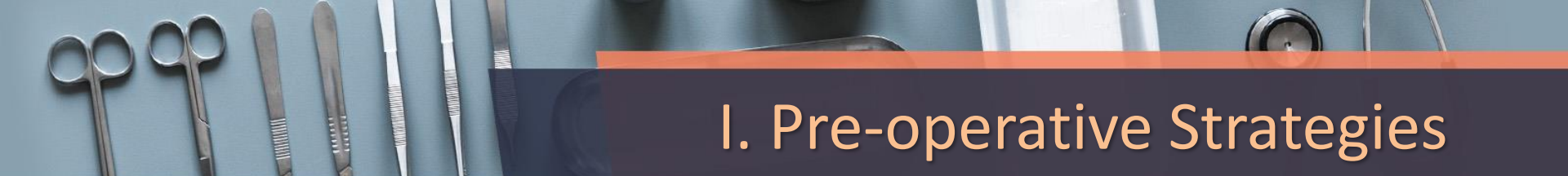


Surgical site Infection (SSI) prevention strategies

Surgical site Infection (SSI) prevention strategies :

- Pre-operative Strategies
- Intra-operative Strategies
- Post-operative Strategies





I. Pre-operative Strategies

1-Patient Assessment and Optimization:

- **screen for infections** : like HAI ,MRSA + treat accordingly
- **Identify patients risk factors**: high risk for SSIs (e.g., diabetes, obesity, immunocompromised states).
- **Optimize medical conditions**: Manage comorbidities, such as glycemic control in diabetic patients and smoking cessation at least 4wks prior surgery

4-Patient Education

- **Preoperative Counseling**: Inform patients about the importance of adherence to preoperative instructions.

2-Skin Antisepsis and showering:

- **Chlorhexidine Alcohol-Based Solutions**: Used for skin preparation to reduce infection rates.
- **Hair Removal**: If necessary, remove hair using clippers instead of razors to minimize micro-abrasions.

3-Antibiotic Prophylaxis:

- **Timing**: Administer prophylactic antibiotics within 60 minutes before incision.
- **Selection**: Choose appropriate antibiotics based on the procedure and local resistance patterns.



Summary box 5.15

Avoiding surgical site infections

- Staff should always wash their hands between patients
- Length of patient stay should be kept to a minimum
- Preoperative shaving should be done immediately before surgery
- Antiseptic skin preparation should be standardised
- Attention to theatre technique and discipline
- Avoid hypothermia perioperatively and ensure supplemental oxygenation in recovery



II. Intra-operative Strategies

1-Aseptic Technique:

- **Hand Hygiene:** Strict adherence to hand hygiene protocols by all surgical team members.
- **Sterile Field Maintenance:** Ensure that the sterile field is maintained throughout the procedure.

3-Surgical Techniques

- **Minimize Tissue Trauma:** Use minimally invasive techniques when possible. Employ gentle tissue handling and minimal cautery to reduce thermal damage.
- **Wound Closure:** Use appropriate techniques for wound closure, ensuring that the edges are well approximated.

2-Environmental Controls:

- **Operating Room (OR) Maintenance:** Maintain optimal temperature, proper air ventilation and humidity levels in the OR; use air filtration(HEPA) systems to reduce airborne contaminants.
- **Traffic Control:** Limit the number of personnel in the OR and restrict movement to minimize contamination.

4-Duration of Surgery

- **Time Management:** Aim to minimize the duration of surgery as prolonged procedures are associated with increased SSI risk.

5-Maintaining Normothermia:

- **Prevent hypothermia** by maintaining normal body temperature throughout surgery. which can impair immune function and increase infection risk

6. Oxygenation:

- **Administer supplemental oxygen**, as it promotes tissue healing and reduces infection risks



III. Postoperative Strategies

1-Wound Care:

- **Dressing Protocols:** Use sterile dressings on the surgical wound and maintain a clean, dry environment. Provide clear instructions for wound care to the patient.
- **Monitoring for Infection:** Regularly assess the surgical site for signs of infection and educate patients on symptoms to watch for signs of infection (e.g., redness, swelling, discharge).

2-Antibiotic Stewardship:

- **Postoperative Antibiotics:** Administer only when clinically indicated; avoid routine use beyond 24 hours post-surgery to prevent resistance unless specific indications arise.

3-Follow-Up Care:

- **Regular Check-Ups:** Schedule follow-up appointments to monitor recovery and address any complications promptly

4-Patient Education:

- **Hygiene Instructions:** Educate patients on proper hygiene practices during recovery and the importance of reporting any signs of infection

To Sum it Up :-

Implementing these comprehensive strategies across all phases of the surgical process can significantly

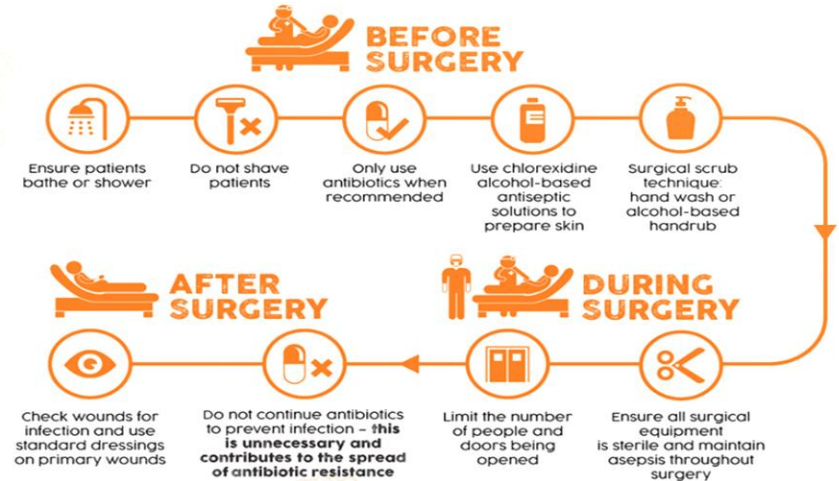
- **Reduce** the incidence of surgical site infections
- **Improve** patient outcomes **and enhance** overall healthcare quality.

Continuous education and adherence to **best practices** among healthcare providers are essential for the sustained effectiveness of these preventive measures.

STOP INFECTIONS AFTER SURGERY

WHAT'S THE SOLUTION?

A range of precautions - **before, during and after surgery** - reduces the risk of infection





Antibiotic prophylaxis



When to use prophylaxis ?

- Prophylactic antibiotics are used when there is a risk of wound contamination with bacteria during surgery , to prevent infection after surgery or instrumentation and should be used before bacterial growth becomes established
- I. clean-contaminated
 - II. contaminated operations
 - III. Clean surgeries with a prosthetic implant

Why ?

Because the results of infection are so catastrophic that even a small risk of infection is unacceptable

A photograph of various surgical instruments, including two pairs of forceps and several scalpels, laid out on a blue surface. The instruments are metallic and appear clean. A dark blue banner with orange text is overlaid on the right side of the image.

When to not use prophylaxis ?

- In non-prosthetic clean surgery
- Why ?

Because most trials showed no clear benefit as the infection rates without antibiotics are so low.

A collection of surgical instruments, including two pairs of forceps and several scalpels, are laid out on a blue surface. A dark blue banner with orange text is overlaid on the right side of the image.

When to replace prophylaxis with treatment

- I. When wounds are heavily contaminated
- II. when an incision is made into an abscess

Why ?

Due to the assumption that the wound is inevitably infected and so treatment is needed rather than prophylaxis.

So a 5-day course of therapeutic antibiotics may be justified

What are the required levels of antibiotics ?

- Ideally, maximal blood and tissue levels should be present at the time at which the first incision is made and before contamination occurs
- antibiotics with a short tissue half life should be avoided

Why ?

Because Tissue levels of the antibiotic should remain high throughout the operation



What are the required levels of antibiotics ?

- Intravenous administration at induction of anaesthesia is optimal

Why ?

Because unexpected delays in the timing of surgery may occur before then and antibiotic tissue levels may fall off before the surgery starts

When to repeat the prophylactic administration ?

- I. In long operations
- II. when there is excessive blood loss
- III. when unexpected contamination occurs

Why?

because tissue antibiotic levels often fall faster than serum levels so, antibiotics may be repeated at 4-hourly intervals during the surgery



A collection of surgical instruments, including two pairs of forceps and several scalpels, are laid out on a blue surface. A dark blue banner with the title 'General rules' in orange text is positioned over the right side of the image.

General rules

- There is no evidence that further doses of antibiotics after surgery are of any value in prophylaxis against infection and the practice can only encourage the development of antibiotic resistance.
- How to choose the best antibiotic for prophylaxis ?
 - depending on the expected spectrum of organisms likely to be encountered, which will depend on :
 1. The site of surgery
 2. Type of surgery
 3. whether or not the patient has any antibiotic allergies



General rules

- Patients with known valvular disease of the heart (or with any implanted vascular or orthopaedic prosthesis) should have prophylactic antibiotics during dental, urological or open viscus surgery.

- Why ?

to prevent bacterial colonisation of the valve or prosthesis during the transient bacteraemia which can occur during such surgery.

TABLE 5.4 SSI rates relating to wound contamination with and without using antibiotic prophylaxis.

Type of surgery	Infection rate with prophylaxis (%)	Infection rate without prophylaxis (%)
Clean (no viscus opened)	1–2	1–2
Clean-contaminated (viscus opened, minimal spillage)	3	6–9
Contaminated (open viscus with spillage or inflammatory disease)	6	13–20
Dirty (pus or perforation, or incision through an abscess)	7	40

A photograph of various surgical instruments, including two pairs of forceps and several scalpels, laid out on a blue surface. An orange and dark blue banner is overlaid on the right side of the image.

Summarization

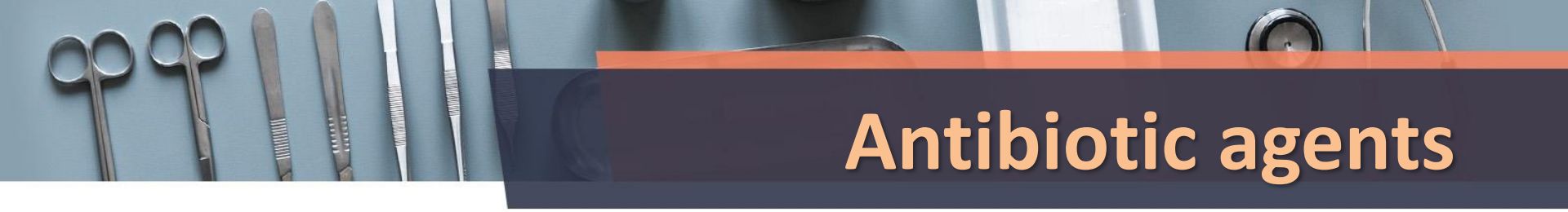
Summary box 5.12

Antibiotic prophylaxis

- Not required in clean surgery unless a prosthesis is implanted
- Use antibiotics that are effective against expected pathogens within local hospital guidelines
- Plan for single-shot intravenous administration at induction of anaesthesia
- Repeat only during long operations or if there is excessive blood loss
- Patients with heart valve disease or a prosthesis should be protected from bacteraemia caused by dental work, urethral instrumentation or visceral surgery



Treatment of established surgical infection

A background image showing various surgical instruments (scissors, forceps, and scalpels) and a stethoscope on a light blue surface.

Antibiotic agents

1- Penicillin :

- Blocks the synthesis of the bacterial wall → osmotic instability and lysis.
- Active against most gram (+) bacteria .

2- Cephalosporin:

- Bactericidal by inhibiting bacterial cell wall synthesis.
- Arranged into generations.
- For gram (+) and (–) bacteria.

Antibiotic agents

3-Erythromycin :

- Bacteriostatic ; bactericidal in higher dose.
- Inhibit bacterial protein synthesis.
- Treatment OF CHOICE in treating **myco**plasma and **Legion**naire`s disease.



Antibiotic agents

4- Tetracyclines :

- For gram (+) and (–) not sensitive to penicillin
- Good for TB
- Bacteriostatic
- Interfere with protein synthesis
- For actinomycosis and nocardiosis
- Should be avoided in early childhood causing yellow discoloration of teeth.





Antibiotic agents

5- Chloramphenicol :

- Broad spectrum and bacteriostatic.
- Inhibit protein synthesis.
- Well absorbed orally and parenterally.
- Drug OF CHOICE of typhoid fever and other salmonella infection.
- Good for meningitis and H.influenzae.





Antibiotic agents

6- Aminoglycoside :

- Bactericidal.
- For gram (+, -) and mycobacteria.
- Toxic side effects : -auditory branch damage – nephrotoxic.





Antibiotic agents

7- Sulphonamides– Trimethoprim :

- Effective against community acquired gram (–)
- Orally administered
- Has limited usefulness in nosocomial infection

8- 4th generation of fluoroquinolones :

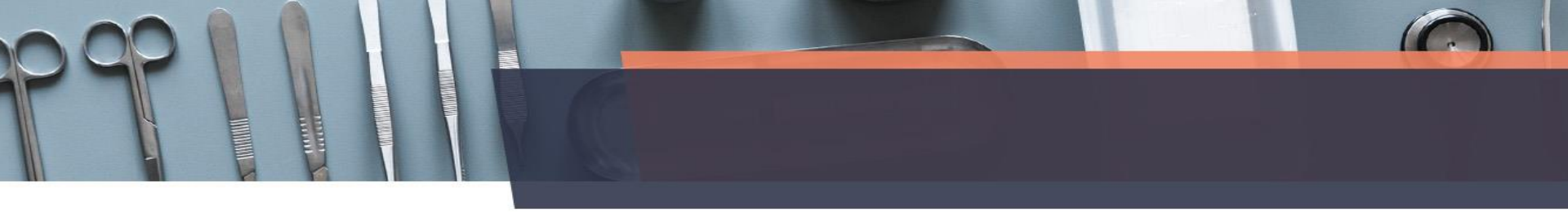
- Good for nosocomial infections
- Good activity against nearly all gram (–) organism



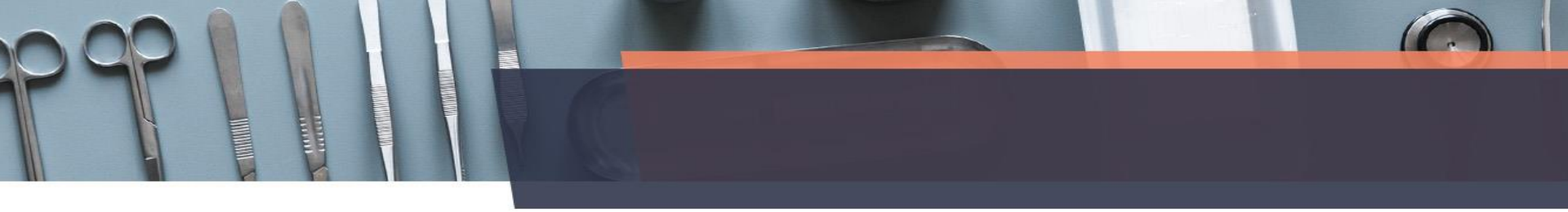
A top-down view of various medical supplies arranged on a grey surface. In the center is a clipboard with a 'DAILY REPORT SCHEDULE' form. To the left are several metal scalpels and a small container of white pills. Above the clipboard is a syringe in a metal tray. To the right is a clear plastic IV bag and a stethoscope. Below the clipboard is a metal tray containing many colorful capsules and pills. A semi-transparent orange banner with the text 'Antibiotics resistance' is overlaid on the right side of the image.



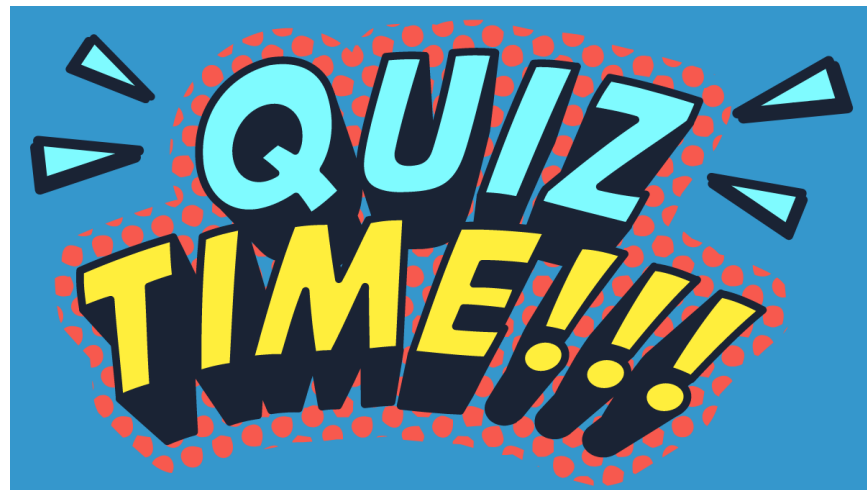
- In surgery, organisms like *Staphylococcus aureus* may develop resistance to antibiotics, particularly methicillin, leading to difficult-to-treat MRSA infections. Additionally, surgical site infections caused by gram-negative bacteria like *Pseudomonas aeruginosa* can resist antibiotics through mechanisms such as the production of beta-lactamases or efflux pumps, complicating treatment.



- Now here are some antibiotics and how some microorganisms become resistant to them:
- 1) Penicillin: Resistance to penicillin often arises due to the production of beta-lactamases by bacteria, which break down the antibiotic's beta-lactam ring. Alterations in penicillin-binding proteins can also lead to decreased efficacy.
- 2) Erythromycin: Bacteria can develop resistance to erythromycin-through methylation of ribosomal RNA, preventing the antibiotic from binding, or by efflux pumps that expel the drug from the cell.
- 3) Cephalosporin: Resistance to cephalosporins typically occurs through the production of extended-spectrum beta-lactamases (ESBLs) or AmpC enzymes, which degrade the antibiotic.



- 4) Tetracycline: Bacteria often resist tetracycline by using efflux pumps to remove the antibiotic from the cell or ribosomal protection proteins that prevent the drug from binding to its target.
- 5) Aminoglycoside: Resistance to aminoglycosides usually involves the modification of the antibiotic by bacterial enzymes, such as acetyltransferases, or mutations in ribosomal RNA that reduce drug binding.



- Please scan the QR code to access the Quiz!

- Thank you for listening