Antibiotic Prophylaxis in Surgery

Prevention of Surgical Site Infection

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Introduction

- Background: Infection of the surgical site is a common but avoidable complication of any surgical procedure.

  Bacterial contamination of the surgical site is inevitable, from the patient's own flora or the environment.

A U.K. study (1993) showed the prevalence of wound infection to be 2.6% among 12947 patients of different surgical specialties.

It is based on the concept that bacterial contamination occurs during surgery, and that the administration of
the antibiotic used for prevention must be timed for optimum blood levels during the operation.

Bacterial contamination of collections of blood or body fluid introduces organisms to an excellent culture medium, and abscess formation frequently follows. The administration of antibiotics once an abscess has formed is seldom sufficient definitive treatment. However, the complication can be prevented if there are high concentrations of antibiotic in these collections, making them an unfavourable culture medium. Antibiotic prophylaxis should therefore be administered immediately before, or during, surgery. Further prophylaxis for 48hours postoperatively is justified if oozing of blood or tissue fluid from internal raw surfaces is expected to continue during this period. The choice of antibiotic is dictated by the likely pathogenic contaminants.

Goals of antibiotic prophylaxis

- Reduce the incidence of surgical site infection (SSI)
- Minimize the effect on the patient's normal bacterial flora.
- Minimize adverse side effects of antibiotics.
- Minimize the emergence of antibiotics resistant strains of bacteria.
- Cost effectiveness.

Criteria for defining a surgical site infection

- Superficial incisional SSI: involving the skin and the subcutaneous tissue. Occurs within 30 days after the operation and shows at least one of the followings: A(1/ pain 2/ swelling 3/ redness 4/heat 5/ tenderness)

B Purulent drainage

C Isolation of organisms

- Deep incisional SSI:1/ Purulent drainage from the deep incision but not from organ or space component of the surgical site.

2/ Deep incision dehiscence or deliberate opening

3/ Fever, localized pain or tenderness

4/ An abscess formation

- Organ/space SSI: 1/ An abscess or infection found by radiological, histopathological means or at reoperation

2/ Purulent discharge from the drain or culture isolation.

Site specific classification of organ space SSI infection

- 1/ Gastrointestinal tract 2/ Intraabdominal
- 1/ Male or female reproductive tract
- 1/ Breast
- 1/ Upper respiratory tract 2/lower respiratory tract
- 1/Sinusitis 2/ Ear,mastoiditis
- 1/Oral cavity
- 1/ Eye other than conjunctivitis
- 1/ Mediastinitis 2/ Pericarditis 3/Myocarditis 4/ Endocarditis
- 1/ Arterial or venous infection
- 1/ Osteomyelitis 2/ Joint or bursa 3/ Disc space
- 1/ Brain abscess 2/ Meningitis, ventriculitis 3/ Spinal abscess

Guidelines to antibiotic prophylaxis of SSI

- Risk factors for SSI
- Common pathogens
- Benefits and risks of antibiotic prophylaxis
- Administration of intravenous prophylactic antibiotic
- Cost effectiveness
- Factors to be considered in auditing practice
- Antibiotic prophylaxis other than for SSI control

Risk factors for surgical site infection

- Classification of operation
- Insertion of prosthetic implants
- Duration of surgery
- Co morbidities

Classification of operations

- Clean: No inflammation. Alimentary,genitourinary or respiratory not entered. No break in aseptic technique.
- Clean contaminated: Alimentary, genitourinary or respiratory tracts entered but without significant spillage.
- Contaminated: There is acute inflammation without pus, macroscopic spillage or opened wounds operated within four hours.
- Dirty: The presence of pus, previous perforated hollow viscous or open injuries more than four hours.

Insertion of prosthetic implant

- Implants has a detrimental effect on the host defences. As a result a lower inoculum of bacteria is needed to cause SSI of a prosthetic implant than a viable tissue, this increases the incidence of SSI

Duration of surgery

- The risk is additional to that of classification of the operation.

Co morbidities

- ASA score of >2 is associated with an increased risk of SSI, and this is additional to the classification of the operation.
- ASA: 1: Normal healthy person

  2: Mild systemic disease

  3:Severe systemic disease that limits activities of the patient

  4: Incapacitating disease with a constant threat to life.

  5: Not expected to survive more than 24 hours with or without an operation.

Common pathogens antibiotic susceptibility

- SSI for a skin wound at any site: 1/ Staph aureus . 90% remains sensitive to flucloxacillin, macrolides and clindamycin. 2/ Beta haemolytic streptococci. 90% remains sensitive to penicillin macrolides and clindamycin
- Additional pathogens: Head and neck surgery: 1/Oral anaerobes. 95% remains sensitive to metronidazole and co-amoxyclav
- Additional pathogens: Operations below the waist: 1/ Anaerobes. 95% remains sensitive to metronidazole and co-amoxyclav 2/ E. coli and other entrobacteriaceae. Complex resistance, but 90% remains sensitive to second generation cephalosporins, gentamicin or beta lactam beta lactamase inhibitors.
- Insertion of prosthesis, graft or shunt: 1/ Coagulase negative Staph.90% remains sensitive to flucloxacillin, clindamycin or microlides. 2/Staph aureus. 2/3 are MRSA but beta lactam antibiotics are still appropriate.

Table 4.5 Suggested prophylactic regimens for operations at risk

Type of surgery	Organisms encountered	Prophylactic regimen suggested
Vascular	*Staphylococcus epidermidis* (or MRCNS) *Staphylococcus aureus* (or MRSA) Aerobic Gram-negative bacilli (AGNB)	Three doses of flucloxacillin with or without gentamicin, vancomycin or rifampicin if MRCNS/MRSA a risk
Orthopaedic	*Staphylococcus epidermidis/aureus*	One to three doses of a broad-spectrum cephalosporin (with anti-staphylococcal action) or gentamicin beads
Oesophagogastric	Enterobacteriaceae Enterococci (including anaerobic/ viridans streptococci)	One to three doses of a second-generation cephalosporin and metronidazole in severe contamination
Biliary	Enterobacteriaceae (mainly *Escherichia coli*) Enterococci (including *Streptococcus faecalis*)	One dose of a second-generation cephalosporin
Small bowel	Enterobacteriaceae Anaerobes (mainly *Bacteroides*)	One to three doses of a second-generation cephalosporin with or without metronidazole
Appendix/colorectal	Enterobacteriaceae Anaerobes (mainly *Bacteroides*)	Three doses of a second-generation cephalosporin (or gentamicin) with metronidazole (the use of oral, poorly absorbed antibiotics is controversial)

MRCNS, multiply resistant coagulase-negative staphylococci; MRSA, methicillin-resistant *Staphylococcus aureus*.

Recommended Antibiotic Prophylaxis for Adult Patients (>16yrs) Undergoing General Surgery in NHS Fife

Procedure	SIGN 104 and NHS Fife Recommendation	Suggested antibiotic(s)
UPPER GI		
Oesophageal surgery	Recommended	Amoxicillin + Gentamicin + Metronidazole
Stomach and duodenal surgery	Recommended	Amoxicillin + Gentamicin + Metronidazole
Gastric bypass surgery	Recommended	Amoxicillin + Gentamicin + Metronidazole
Small intestinal surgery	Recommended	Amoxicillin + Gentamicin + Metronidazole
HEPATOBILIARY		
Bile duct surgery	Recommended	Amoxicillin + Gentamicin + Metronidazole
Gall bladder surgery - open	Recommended	Amoxicillin + Gentamicin + Metronidazole
Gall bladder surgery - laparoscopic	Not recommended but should be considered in high risk patients	If necessary: Amoxicillin + Gentamicin + Metronidazole High risk: intra-op cholangiogram, bile spillage, conversion to laparotomy, acute cholecystitis/pancreatitis, jaundice, pregnancy, immunosuppression, insertion of prosthetic devices
LOWER GI		
Appendicectomy	Highly recommended	Amoxicillin + Gentamicin + Metronidazole
Colorectal surgery	Highly recommended	Amoxicillin + Gentamicin + Metronidazole
ABDOMEN		
Hernia repair groin, inguinal/femoral with or without mesh	Not recommended	None
Hernia repair groin, laparoscopic with or without mesh	Not recommended	None
Hernia repair, incisional with or with out mesh	Not recommended	None
Open/laparoscopic surgery with mesh (e.g. gastric band or rectopiexy)	Not recommended but should be considered in high risk patients.	If necessary: Amoxicillin + Gentamicin + Metronidazole
Splenectomy	Not recommended but should be considered in high risk patients	If necessary: Amoxicillin + Gentamicin + Metronidazole High risk: immunosuppression Note, Not carried out as an elective procedure in Fife. If undertaken would be as part of a procedure where suitable prophylaxis would already be given.
Clean-contaminated procedures where no specific evidence is available	Recommended	Amoxicillin + Gentamicin + Metronidazole

Additional notes:

1. If a patient is on treatment and requires surgery the patient does not need additional prophylaxis if the antibiotic(s) they are on cover(s) the pathogens that would be expected to cause an SSI for that procedure. However, **it must be ensured that treatment antibiotics are not delayed/missed while the patient is in theatre**.

2. Patients who have **a true allergy to penicillin or who are MRSA positive** should be given **teicoplanin instead of amoxicillin**.

3. **Doses of prophylactic antibiotics:**

Antibiotic	Dose	Administration	Prolonged Surgery	>1.5L blood loss (redose after fluid replacement)
Amoxicillin	1g	IV bolus over 3-5 mins	If surgery >4 hours, redose 1g	Redose 1g
Gentamicin	See below	Doses up to 300mg - IV bolus over 3-5 mins. Doses above 300mg - IV infusion in 100ml of normal saline over 20-30 mins	If surgery lasts > 8 hrs AND eGFR > 60ml/min, then redose with full original dose	Redose with 50% of original dose
Metronidazole	500mg	IV infusion over minimum of 20 mins	If surgery >8 hours, redose 500mg	Redose 500mg
Teicoplanin	400mg	IV bolus over 3-5 mins	No repeat dosing required	Redosing not usually required

4. Prophylaxis should be given **≤30 minutes prior to skin incision**.

5. **Gentamicin Dosing for Surgical Prophylaxis:**

(i) Doses in the table below apply to patients whose **creatinine clearance is >10ml/min** (if BMI >30 or >20% over IBW see (iii)).

Actual Body Weight (ABW)	Recommended IV Bolus Dose
<40kg	Contact pharmacist or microbiologist
40-45kg	120mg
46-55kg	160mg
56-70kg	200mg
71-85kg	240mg
86-95kg	280mg
>95kg	Use IBW equation below

(ii) If **creatinine clearance < 10ml/min** use 2mg/kg (Actual Body Weight). (Rounded to nearest 10mg)

$$\text{Creatinine Clearance} = \frac{140 - \text{Age (years)} \times \text{Weight (kg)}}{\text{Serum Creatinine (µmol/l)}} \times 1.23 \text{ (males) or } 1.04 \text{ (females)}$$

(iii) If **> 20% over Ideal Body Weight or has a BMI >30** calculate the dose using the following equation:

Gentamicin Dose (mg) = 3 x (IBW + (0.4 x ABW - IBW)) (Rounded to nearest 40mg)

IBW = (Males: 50kg, Females: 45.5kg) + 2.3kg for every inch over 5ft

(iv) **Treatment of Infection.** If, after prophylaxis has been given, a decision is made that gentamicin is required for treatment of an infection this will no longer be classed as prophylaxis. In this situation the gentamicin level should be checked and confirmed as <2mg/l after which an appropriate gentamicin treatment regime should be commenced (see NHS Fife Antibiotic Guidance).

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MRSE/MRSA antibiotic prophylaxis

- Beta lactam drugs
- Glycopeptides

Benefits and risks of antibiotic prophylaxis

- Benefits of prophylaxis:1/ related to the severity of consequences of SSI e.g. in colonic anastomosis prophylaxis reduces the mortality. In total hip replacement reduces the long term morbidity, however in most operation reduces the short term morbidity.

2/ surgical wound infection increases the length of hospital stay depends on the type of the operation.

- Risks of prophylaxis:1/ Increased rates of antibiotic resistant bacteria. 2/ increased incidence of C. defficile carriage in patients received > 24 hours prophylaxis.
- The final decision depends on: 1/ The patient's risk of SSI. 2/The potential severity of the consequences of SSI. 3/ The effectiveness of prophylaxis in that operation. 4/ The consequences of prophylaxis in that patient (e.g. risk of colitis)

Administration of intravenous prophylactic antibiotics
The choice of antibiotics

- Usually a small number of pathogens need to be covered. The antibiotic used must reflect the local information about common pathogens.
- The choice should include economic considerations.
- Must be aware that if infection occurs, usually it remains sensitive to the antibiotic used for prophylaxis.
- Penicillin allergy(anaphylaxis, articaria and rash): Do not use penicillin, challenge test for cephalosporins and admit another antibiotic in the regime.

Timing of administration

- The risk begins at the time of incision so effective tissue concentration must be reached at that time.
- This depends on pharmacokinetic of the drug and the route of administration.
- Ideally 30 minutes within induction of anaesthesia.
- Considerations when use a tourniquet and in caesarian sections.

Elimination Half Lives

• Ampicillin	1-1.3h
• Amoxicillin	1h
• Cefuroxime	1.3h
• Ciprofloxacin	3-6.9h
• Flucloxacillin	46 min
• Gentamicin	1-3h
• Metronidazole	6-10h
• Piperacillin	39-72min
• Teicoplanin	70-100h
• Vancomycin	4-11h

Additional dose during the operation

- Using antibiotics of short half life(1_2 hours) it seems logical to give an additional dose during operations that last more than 4 hours.
- Controlled trials did not show any evidence to support this
- All antibiotics should be administered intravenously
- Additional doses may be needed if there is blood loss and dilution by fluid replacement
- Controlled trials did not show any benefit of further postoperative doses

Cost effectiveness

- Rule 1: The number of patients needed to treat to prevent one wound infection increases in operations with low risk of wound infection
- Rule 2: Prophylactic antibiotics are given if they are likely to reduce the overall antibiotics consumption (use NNT to compare the likely prophylactic and therapeutic consumption of antibiotics)
- Rule 3: Prophylactic antibiotics are given if they are likely to reduce the overall hospital costs

Factors to be considered in auditing practice

- Date and time of administration and surgical incision
- Operation performed (elective or emergency)
- Classification of operation
- Justification for prophylaxis
- Antibiotic name, dose and route
- Number of doses given and indications
- Duration of operation
- Previous adverse reactions to antibiotics

Antibiotics prophylaxis other than for SSI control

- Prevention of urinary tract or respiratory tract infections after surgery
- Prevention of endocarditis
- Topical antibiotics
- Treatment of anticipated infection in dirty emergency operations
- Oral antibiotics to achieve selective decontamination of the gut
- Patients with prosthetic implants undergoing surgery that may cause bacteraemia
- Transplant surgery

THE END