Antibiotic prophylaxis

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Abstract

Surgical site infection (SSI) is a common postoperative complication which leads to significant morbidity and mortality. The aim of antibiotic prophylaxis is to reduce the incidence of SSI by preventing the development of infection due to colonizing or contaminating organisms at the operative site. It is used as an adjunct to, rather than a replacement for, other evidence-based interventions to prevent wound infection, such as the use of skin antiseptics. The choice of antimicrobial agent(s) used is dependent on how clean the operation is, the operative site (which determines the likely organisms), and a variety of patient factors including the presence of allergies and colonization with resistant organisms such as meticillin-resistant *Staphylococcus aureus* (MRSA). The practicalities of antibiotic prophylaxis administration are discussed. Not all operations require antibiotic prophylaxis; use of antibiotics in any context, including as prophylaxis, can be associated with adverse effects, specifically an increased risk of *Clostridium difficile* infection (CDI) and resistance development. Prophylaxis should therefore be used responsibly. This article will address some of the common misconceptions about its use and special patient circumstances requiring deviation from the usual guidance.

Keywords Antibiotics; infection control; prophylaxis; surgical prophylaxis; surgical site infection

Surgical site infection

Surgical site infection (SSI) is infection arising in a wound created by a surgical procedure or postoperative infection of any cavity, bone, joint or tissue that was involved in the surgery. It includes infection of prostheses inserted during an operation.[1] SSI is diagnosed if infection occurs within 30 days of surgery (or within one year when an implant is affected), and is classified according to the tissues involved:[2]

- Superficial incisional – infection involving only skin or subcutaneous tissue at the incision site.
- Deep incisional – infection involving deep soft tissues (e.g. fascial and muscle layers) of the incision.
- Organ space – infection involving any part of the anatomy other than the incision that was opened or manipulated during the operation.

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SSI is a common postoperative complication, affecting nearly 5% of patients overall and accounting for 14% of healthcare-associated infections.[3] The true incidence of SSI may in fact be higher given the increasing proportion of surgery done on a day-case basis; many cases are now identified and treated in the community. Table 1 shows the variation in incidence of SSI with the type of surgery.

SSI can lead to increased length of stay and additional costs in the order of hundreds to thousands of pounds depending on the severity and site of infection.[5] Consequences for patients include the need for further surgery, additional antibiotic therapy and adverse effects associated with this, scarring, long-term discomfort, and impact on emotional wellbeing. SSI affecting anastomotic or graft sites can be life or limb threatening; SSI contributes to at least a third of all postoperative deaths.[6]

Risk of SSI occurs when there is bacterial contamination of the wound; the development of infection is then mediated by the virulence of the contaminating organism and the host's natural immunological defences. The organisms that cause SSI are usually endogenous to the patient and come from their skin or any viscus that is opened. Exogenous infection develops when the wound is contaminated preoperatively (e.g. a traumatic wound), perioperatively from instruments or the theatre environment, or postoperatively before the wound has healed. Surgery can also involve transient bacteraemia, which is an important mechanism

Surgical site infection incidence in England by type of surgery (adapted from national surveillance data[4]). These data take into account SSI diagnosed as an inpatient and on readmission to hospital

Type of surgery	Incidence of SSI (%)	Median time to infection (days)
Orthopaedic		
Hip prosthesis	0.7	15
Knee prosthesis	0.6	16
Repair neck of femur	1.4	14
Repair long bone fracture	1.2	16
Vascular		
Limb amputation	3.2	12
General vascular	2.8	11
Neurosurgery		
Cranial	1.5	17
Spinal	1.1	14
Gastrointestinal		
Large bowel	10.2	8
Small bowel	6.7	8
Cholecystectomy	4.7	7
Gastric	2.0	8
Bile duct/liver/pancreatic	6.0	8
Others		
Abdominal hysterectomy	1.4	9
Breast	0.9	12
Cardiac (non CABG)	1.2	12
Cardiac (CABG)	4.5	12

Table 1

in the development of infection at implant sites distant to the infection. Antimicrobial prophylaxis targets the perioperative risk of infection.

The rationale behind antibiotic prophylaxis

The aim of antibiotic prophylaxis in surgery is to prevent SSI whilst minimizing the collateral damage that occurs with all antibiotic use. This entails: (1) Using antibiotics for which there is evidence of effectiveness (i.e. a biologically appropriate agent which has, ideally, been shown in a high-quality trial to reduce infection rates); (2) minimizing the effect of antibiotics on patients' normal flora and host defences; and (3) minimizing other adverse effects.

The predominant target for prophylactic antibiotics is the *wound*; antibiotics are given to reduce the contaminating bacterial load so that it does not overwhelm natural host defences leading to infection. The targets of antibiotics therefore are skin/mucosal colonizing and contaminating organisms at the operative site. Generally, for operations above the waist this involves targeting Gram positive bacteria (staphylococci and streptococci), and for operations below the waist Gram positive and Gram negative bacteria (e.g. *Escherichia coli*). For trauma with open wounds and in oral or abdominal operations, anaerobic cover must also be considered.

Antibiotic prophylaxis should *not* be used to prevent postoperative complications which are unrelated to the wound or surgical site, e.g. catheter-related urinary tract infections following non-urological procedures, healthcare-associated pneumonia, and intravenous access device infections. Antibiotic prophylaxis should cover the most likely infecting organisms, not all potential pathogens, and should not be used to *treat* developing wound infection; in this case, a treatment course of antibiotics, the choice of agent for which may be different to prophylaxis, should be prescribed. Use of prophylactic antibiotics is not a replacement for optimal patient preparation, good surgical technique and theatre environment. These factors will not be explored here, but are at least as or more important than antibiotic prophylaxis; the 2008 SSI NICE guidance[7] and 2013 quality statements[8] provide further information.

The decision to administer prophylaxis should take into account national guidelines (e.g. SIGN/NICE), BNF advice, local patterns of drug resistance, local epidemiology of *Clostridium difficile* infection (CDI), and local consensus guidelines developed by anaesthetists, antibiotic pharmacists, infection specialists and surgeons. The decision must balance the individual's risk of SSI, potential severity of consequences of SSI, effectiveness of prophylaxis in that operation, and the potential adverse consequences such as colitis. The need for prophylaxis is not always as black or white as sometimes appears in local or national guidance. In our own Trust a patient died of recrudescent *C. difficile* infection triggered by, as recommended in local guidance, a single dose of co-amoxiclav prior to percutaneous endoscopic gastrostomy insertion. The fact the patient had recently had CDI was not considered when an alternative lower risk agent or no prophylaxis would have been more appropriate. Decisions about challenging patients must therefore be multidisciplinary with discussions between surgeons and infection experts occurring preoperatively.

Who is at risk of SSI and who needs prophylaxis?

Multiple factors determine the patient's risk of developing SSI, but predominantly risk is determined by the following:

- *Wound environment* — low haemoglobin, presence of necrotic tissue or foreign bodies, dead space, and patient colonization by MRSA (meticillin-resistant *Staphylococcus aureus*), Lancefield gp A/C/G *Streptococci* or other resistant organisms.
- *Patient characteristics including host defence* — extremes of age, presence of shock/hypoxia/hypothermia, glycaemic control, chronic illness, immunosuppressive agents, nutritional state, obesity, coexisting infection, ASA score (see below), previous SSI.
- *Pathogen exposure* — virulence of organisms, size of inoculum.
- *Operation factors* — length of scrub, skin asepsis, preoperative shaving and skin preparation, length of operation, theatre ventilation, equipment sterilization, foreign material at surgical site, surgical drains, surgical technique (haemostasis, trauma, closure).

The US Centre for Disease Control NNIS (National Nosocomial Infections Surveillance) risk index[9] is an internationally used scoring system based on:

- American Society of Anesthesiologists (ASA) score; this is calculated preoperatively by the anaesthetist and a score of >2 (3 = a patient with a severe systemic disease that limits activity but is not incapacitating) is associated with increased risk of SSI.
- Wound class, reflecting state of contamination of the wound.
- Duration of operation, reflecting technical aspects of the operation.

With an increasing score the risk of SSI increases

In the UK, the principal determinant in guidelines of whether to give antibiotic prophylaxis or not is how 'clean' the operation is. Four classes of operation exist, with an increasing rate of bacterial contamination and subsequent risk of SSI:[2,9]

Clean — an operation in which no inflammation is encountered. The respiratory, alimentary and genitourinary tracts are not entered. There is no break in aseptic operating theatre technique. Primary wound closure is undertaken e.g. sebaceous cyst excision.

Clean-contaminated — an operation in which the respiratory, alimentary or genitourinary tract is entered but there is no significant spillage (e.g. appendicectomy).

Contaminated — an operation in which acute inflammation (without pus) is encountered or where there is visible contamination of the wound. For example, gross spillage from a hollow viscus during the operation or open/compound injuries operated on within 4 hours. Operations in which there is a major break in aseptic technique also fall into this category; e.g. colorectal surgery.

Dirty — operations in the presence of pus or devitalized tissue, a previously perforated hollow viscus, or open/compound injuries more than 4 hours old.

Antibiotic prophylaxis should be administered to patients who are undergoing the following types of operation:[7,8]