POST-OPERATIVE INFECTIONS: PHYSICIAN'S PERSPECTIVES

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Infection is an important arbiter of success or failure of surgical practice and it is the most common form of postoperative morbidity and a major cause of mortality in all surgical specialties.

What should the physician also, not only the surgeon, look at?

WOUND INFECTION

A wound infection should have either a purulent discharge in, or exuding from, the wound or a painful, spreading erythema indicative of cellulitis. Bruising, haematoma formation, serous and lymph collections are complications which may predispose to the development of wound infection, and may lead to diagnostic difficulties. Infection should be considered to be present when there is fever, tenderness, oedema and an extending margin of the erythema. The discharge of clear fluid from a wound does not indicate an infection unless accompanied by cellulitis. The definition of wound infection should not be dependent on the results of bacteriological studies. False-negative cultures can occur and on other occasions organisms isolated from cultures may represent either secondary colonisation or merely contamination.

Wound infection may be classified according to aetiology, time, or severity. The infection should be considered primary unless there is a predisposing complication. Secondary infection may follow a complication which results in the discharge of serum, haematoma, cerebrospinal fluid, urine, bile, pancreatic juice, gastric or intestinal contents from the wound, contaminated by bacteria from within the patient or from the environment.

With regard to time, wound infection may be divided into: Early. Presenting within 30 days of operation. Intermediate. Presenting between 1 and 3 months of operation. Late. Presenting more than 3 months after operation.

Wound infection should be classified as minor when there is discharge of pus from the wound without lymphangitis or deep tissue destruction, and major when the purulent discharge is accompanied by partial or complete dehiscence of the fascial layers of the wound, or by spreading cellulitis and lymphangitis that requires antibiotic therapy.

POSTOPERATIVE SEPSIS

The diagnosis of sepsis should be made when rigors may occur together with one or more of the following signs: fever, higher than 38°C on more than one occasion in 24 h, and/or hypotension, and/or oliguria. Objective evidence of the source of infection and laboratory confirmation of viable microorganisms (bacteraemia) or their products (exo- or endo-toxins, antigen or antibody) in the blood are desirable to confirm the diagnosis. For a variety of reasons rigors may not be noted or detected and their absence does not exclude the diagnosis of sepsis. Patients with life-threatening sepsis require rapid identification and treatment if mortality is to be reduced and in these patients the presence of fever, shock, respiratory and multiple-organ failure may not be associated with positive blood cultures.
POSTOPERATIVE URINARY TRACT INFECTION

A postoperative urinary tract infection should be diagnosed in the presence of microorganisms in the urine accompanied by one or more of the following: dysuria, urgency, loin pain, tenderness, pyrexia or pyuria. A bacterial count greater than $10^5$ organisms/ml is generally considered significant in a midstream specimen of urine. A lesser number of organisms ($10^3$ organisms/ml) could be significant if a specimen is obtained by suprapubic puncture or where there is a pure growth of the common pathogens which can include Escherichia coli, Proteus mirabilis, coagulase negative staphylococci (CNS); Streptococcus faecalis, Klebsiella spp, Pseudomonas spp. and Acinetobacter. Interpretation of the laboratory results may need to be modified if the patient is already receiving antibiotics. A polybacterial culture may indicate contamination.

POSTOPERATIVE CHEST INFECTION

Pneumonia should be defined as new or increased production of purulent sputum, and/or a fever greater than 38°C persisting for more than 48 h together with the appropriate clinical signs. New or progressive radiological infiltrate may be apparent on chest radiograph and a positive sputum microscopy and culture may be available. A fresh sample of sputum should routinely be examined microscopically before starting antimicrobial therapy. In this way purulence can be confirmed and the significance of the organisms cultured can be evaluated. Lung abscess and empyema are defined as the collection of pus within the lung or pleural cavity respectively accompanied by clinical and radiological evidence (abscess cavitation or fluid in the pleural space), supported by positive bacterial culture.

POSTOPERATIVE GENERALISED PERITONITIS

Generalised peritonitis is a diffuse inflammation of the peritoneum caused by infective agents or by toxic substances associated with the clinical manifestations of abdominal pain, tenderness and guarding, and subsequently by impaired alimentary tract function. The latter may be absent under certain postoperative conditions, e.g. artificial ventilation, and it is accepted that clinical symptoms and signs may be difficult to interpret in the immediate postoperative period. It is desirable that the diagnosis of peritonitis due to infection is supported by positive bacterial culture of the peritoneal exudates.

POSTOPERATIVE PELVIC ABSCCESS

A pelvic abscess is characterized by the localised collection of infected fluid within the pelvic cavity, usually the rectouterine or rectovesical pouch. There will be evidence of infection (pyrexia in excess of 38°C) and a mass, which may be tender, is frequently apparent on abdominal or pelvic examination. The diagnosis can be supported by laboratory evidence including the isolation of bacteria from cultures of the aspirate and a raised WBC count (greater than $11 \times 10^9$/L). Appropriate imaging will usually confirm the location, and in gynaecological practice may help to differentiate the separate entities of tubo-ovarian abscess or pyosalpinx.

POSTOPERATIVE SUBPHRENIC ABSCESS

A subphrenic abscess is defined as a collection of infected fluid beneath the diaphragm with either clinical or laboratory evidence of infection. Clinical symptoms and signs include pain or discomfort, anorexia, weight loss, impaired diaphragmatic movement, pleural effusion or inflammatory swelling. Any of these together with a persistent pyrexia (greater than 38°C) and a raised WBC count greater than $11 \times 10^9$/L should alert the clinician to the possibility of this diagnosis. Laboratory confirmation by the isolation of bacteria from cultures of the aspirate, from drainage or using ultrasonographic or other guidance, should be sought.

ANASTOMOTIC LEAK

This is defined as a leak of luminal contents from a surgical join between two hollow viscera. The luminal contents may emerge either through the wound or at the drain site, or they may collect near the anastomosis, causing fever, abscess, sepsicaemia, metabolic disturbance and/or multiple-organ failure. The escape of luminal contents from the site of the anastomosis into an adjacent localized area, detected by imaging, in the absence of clinical symptoms and signs should be recorded as a subclinical leak.

POSTOPERATIVE INFECTION IN BONE

Surgically induced infection in bone and joints may present early or late. The diagnosis of early infection is based on the presence of pain at rest, a fever greater than 38°C persisting for more than 48 h supported by the isolation of bacteria from cultures when available. Late infection (defined as infection presenting more than 3 months after surgery) is indicated by the presence of pain at rest, a persisting elevation of the erythrocyte sedimentation rate greater than 30 mm/h above the preoperative level, radiological changes in bone indicative of infection and the isolation of bacteria from cultures when available. Deep cultures obtained by aspiration or surgical exploration are preferred since the results of superficial wound cultures may yield results that are difficult to interpret due to the presence of skin flora. These definitions may also be applied to traumatic (open) injuries and in this context the degree of associated soft tissue injury, periosteal stripping and vascular injury assumes considerable importance in subsequent management. Gram negative organisms assume greater significance when there is vascular impairment.

INFECTION AFTER IMPLANT SURGERY

Infection of an implant is indicated by the presence of one or more of the following: pain, persistent pyrexia greater than 38°C for 48 h, local signs of inflammation where the implant
Surgical site infection (SSI) is an important postoperative complication. It is second only to urinary tract infection as the most common nosocomial infection in hospitalized patients. Based on extensive epidemiologic surveys, it has been estimated that SSI develops in at least 2% of hospitalized patients undergoing operative procedures, although this is a likely underestimate because of incomplete post-discharge data. Other data indicate that SSI develops following 3% to 20% of certain procedures, and that the incidence is even higher in certain high-risk patients. There seems to be a perception among some surgeons that SSI is a relatively trivial infection. But the mortality rate was 3% among patients who developed SSI. There is also significant morbidity associated with SSI; a large number of patients develop long-term disabilities as a result of poor wound healing and overt tissue destruction following these infections. Finally, the economic costs of SSI to both the patient and the health care delivery system are high.

RISK FACTORS FOR DEVELOPING SSI

The risk of developing SSI varies greatly according to the nature of the operative procedure and the specific clinical characteristics of the patient undergoing that procedure. Ultimately, it is necessary to consider a broad range of risk factors for developing preventative measures.

In 1985, the Study on the Efficacy of Nosocomial Infection Control identified an abdominal operation, an operation of longer duration (2 hours or more), and a patient having three or more discharge diagnoses as being risk factors for the development of SSI in addition to CDC wound classification (contaminated or dirty-infected versus clean or clean-contaminated).

Subsequently, the National Nosocomial Infections Surveillance System (NNIS), the predecessor of the current NHSN, simplified risk stratification to three factors: (1) CDC wound classification (contaminated or dirty-infected); (2) a longer duration operation, defined as one that exceeded the 75th percentile for a given procedure; and (3) the medical characteristics of the patient, as determined by an American Society of Anesthesiology (ASA) score of III, IV, or V (presence of a severe systemic disease that results in functional limitations, is life threatening, or is expected to preclude survival from the operation) at the time of the operation.

MICROBIOLOGY

SSI is caused by microorganisms introduced into the surgical wound at the time of the operative procedure. Most of these microorganisms come from the patient’s endogenous flora, but occasionally the pathogenic organisms are acquired from an exogenous source, such as the air in the operating room, surgical equipment, implants or gloves, or even medications administered during the operative procedure. When there is an unexplained local outbreak of SSI, investigations performed by infection control personnel may be useful in uncovering an exogenous source. Large, cross-institutional surveys involving all surgical specialties have revealed that a small number of gram-positive cocci and gram-negative bacilli are responsible for most SSIs. The NNIS system categorized 17,671 isolates obtained from patients with SSI from 1986 to 1996. Over one half of the isolates were gram-positive cocci; Staphylococcus aureus was the most commonly isolated organism, followed by coagulase-negative staphylococci, and Enterococcus spp. Approximately one third of the isolates were gram-negative bacilli, with Escherichia coli, Pseudomonas aeruginosa, and Enterobacter spp being the most frequently encountered gram-negative organisms. About 5% of the isolates were anaerobic bacteria. More recent surveys involving multiple or single institutions have corroborated these general findings, although the specific distribution of organisms differs somewhat, probably reflecting different types of surgical practices at individual institutions.

This general pattern masks significant variability in the microbiology of SSI according to the type of operative procedure. Nonetheless, organisms derived from the skin may still contribute to these infections. In a recent trial of prophylactic antibiotics for subjects undergoing colorectal procedures, 11% of all isolates obtained from subjects with SSI were staphylococci, most of which were S aureus. With Class IV (dirty-infected) wounds, it is generally assumed that pathogenic organisms already present in the operative field will be responsible for a subsequent SSI. Finally, it should be noted that unique microbiological patterns may pertain to certain highly specialized procedures; for instance, enterococci are frequently found to be the pathogens causing SSI after liver transplantation.

The most significant change in the microbiology of SSI has been the increased involvement of resistant microorganisms.
in these infections. The number of SSI caused by methicillin-resistant S. aureus (MRSA) has increased dramatically. Anderson and colleagues found that MRSA was responsible for 17% of all severe SSIs developing in 1010 patients at 26 community hospitals in the Southeast, and accounted for 53% of the infections due to S. aureus. Naylor and colleagues documented MRSA in 40% of the severe postoperative SSIs developing in vascular surgery patients at 25 centers in Great Britain and Ireland. An increased occurrence of infections due to MRSA has also been recognized in studies of subjects undergoing cardiac, orthopedic, or plastic surgery procedures. The emergence of the USA300 clone of MRSA, commonly referred to as community acquired MRSA or CA-MRSA, may further impact the microbiology of SSI. This strain is recognized as being responsible for significant numbers of serious hospital-acquired staphylococcal infections; a preliminary report also suggests its frequent involvement as a cause of SSI.16

The gram-negative bacilli isolated from patients with SSI also demonstrate increased resistance. These resistant organisms likely result from prior exposure of the patient to the health care environment or broad spectrum antimicrobial therapy. The increasing resistance of gram-negative organisms causing SSI parallels their increasing resistance when they cause other nosocomial infections. Although infrequently identified in epidemiologic surveys, two infections, streptococcal gangrene due to Group A b-hemolytic streptococci and clostridial myonecrosis usually due to Clostridium perfringens, should be mentioned. These fulminant monomicrobial infections rarely develop following an operative procedure. The possibility of such an infection should be considered in a patient with clinical findings suggestive of severe sepsis or septic shock out of proportion to those expected in a patient with a typical postoperative SSI. Typically, soft-tissue infections due to these organisms manifest themselves early after an operative procedure, sometimes within the first 24 hours. Because of their rapidly progressive nature, early surgical management coupled with appropriate antimicrobial therapy is mandatory.17

Local signs of infection are usually apparent with superficial and deep SSI, although systemic signs are somewhat variable. In contrast, the presence of systemic signs of infection in the absence of local signs may indicate an organ/ space infection or an infection originating from a source other than the surgical site. The distinction between a superficial and a deep SSI may not be obvious on cursory examination; a necrotizing infection of the deeper tissues may progress if what was thought to be a superficial infection is neglected. Thus, the possibility of a necrotizing soft tissue infection should always be considered, especially when there is a particularly erythematous or painful wound, or patient appears more ill than would be expected with a relatively minor infection. The diagnosis of a necrotizing infection is best resolved by direct examination of the subcutaneous tissue and deeper layers.18

TREATMENT OF SSI

Treatment of SSI nearly always involves opening the incision and establishing adequate drainage. The blind use of antibiotics to treat what appears to be cellulitis of the wound without adequately determining the need for drainage is to be discouraged. For most patients who have had their wounds opened and adequately drained, antibiotic therapy is unnecessary. One recommendation is to use antibiotics only when there are significant systemic signs of infection (temperature higher than 38.5 degree C or heart rate greater than 100 beats/min) or when erythema extends more than 5 cm from the incision.

When antibiotics are used, selection should be based on the likely pathogens for a given operative procedure; thus, gram-positive organisms would be suspected following a clean orthopedic procedure, but involvement of gram-negative and anaerobic organisms would be expected if the infection followed a colorectal procedure. As with all soft tissue infections, the possibility that MRSA is involved in the infection needs to be kept in mind when choosing the empiric regimen. Although it has not necessarily been routine to culture most SSIs, this should be strongly considered in patients who will be treated with antibiotics, so that resistant microorganisms can be adequately treated.19

For patients with complicated skin and soft tissue infections, antibiotic therapy is generally used. Thus, most patients with deep SSI who have elements of tissue necrosis should be treated with antibiotics. Antibiotic selection should follow the general guidelines established for the treatment of complicated skin and soft tissue infections.

Patients who develop the rare early infections due to streptococcal or clostridial organisms are usually treated with penicillin with or without clindamycin, and aggressive surgical debridement.20

CONCLUSIONS

Recent improvements in antibiotic prophylaxis, including the timing of initial administration, appropriate choice of antibiotic agents, and shortening the duration of administration, have established the value of this technique in many clinical surgical settings. Future study designs should strongly consider risk factors for individual patients when new antibiotic agents are tested or administration techniques are refined. A concentrated effort should be made in areas of clinical surgery where the value of antibiotic prophylaxis has not been proven. A single-dose systemic regimen of an appropriately chosen cephalosporin given during the immediate preoperative period is safe and the indicated practice.
REFERENCES


