The Review Of
DIABETIC
STUDIES
OPEN ACCESS

An Overview Of Surgical Site Infection Treatment Guidelines

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Abstract: Surgical site infections are complications that develop post-surgery and often associated with high rates of morbidity and mortality in patients, especially in low- and middle-income countries. These infections are often fatal and thus require prompt and adequate care.
Aim: To objectively review the latest methodology for treatment guidelines regarding surgical site infections.
Materials and methods: This review is a comprehensive search of PUBMED from the year 2005 to 2025.
Conclusion: Surgical site infection is a serious condition that is associated with high mortality and morbidity. These conditions require prompt diagnosis and appropriate management to prevent the worsening of the patient's health and loss of life.

Keywords: Surgical site infections; Management; Vacuum-assisted closure; CiNPT.

Introduction

The WHO defines 'surgical site infections' (SSIs) as infections caused by bacteria that get into the body through incisions that are made during surgical procedures. Statistics show that 11% of patients from low- and middle-income countries, who undergo surgeries, can get infected. About 20% of the females undergoing caesarean section in Africa can contact would infection that could lead to both maternal and infant mortality.[1] An infection can be designated as an SSI if the wounds are infected or opened by a surgeon, within 30 days following surgery or within 1 year after implantation. [2] The postsurgical site infections can be classified as: superficial incisional infections, deep incisional infections, and organ/space infections by the Centers for Disease Control. [3]

Table 1: Classification of Postsurgical Wounds.[2]

Type of Postsurgical Infection	Description	Classification Criteria (at least one criterion should be met)
Superficial Incisional Infections	• Affects the skin and subcutaneous tissues • Accounts for 50% of all SSI	1. Presence of pus discharge from the site of incision 2. Identification of an organism from the surgical site

		3. Clinical diagnosis by a surgeon for SSI 4. Deliberate opening of the wound by the surgeon, accompanied by at least one associated infection symptom: swelling, erythema, or localized pain or warmth
Deep Incisional Infections	Affects soft tissues deep into the subcutaneous tissues- including muscles and fascial planes	1. Prescence of pus discharge from the site of infection 2. Wound dehiscence 3. Deliberate re-opening of the deep incision by the surgeon due to suspicion of infection or spontaneous dehiscence of the wound, and a positive wound culture along with at least one infectious symptom 4. Evidence of abscess formation or infection involving deep tissues, observed by computed tomography (CT) scan
Organ/ Space Infections	Involves any organ or anatomical space beyond the incisional site but deeper than the fascial or muscle layers, including implant-related infections	1. Prescence of pus discharge from a drain place in an organ, space, or cavity 2. Identification of an isolated organism from the involved organ, cavity, or related abscess 3. Evidence of abscess formation involving the organ, cavity, or anatomical space, as observed on a CT scan

Note: a wound is not considered infected if only a stitch abscess, localized cellulitis, or an infected superficial stab puncture is present.[2]

Causative Agents

Surgical site infections are commonly caused by the endogenous flora that is typically present on the mucous membranes, skin, or hollow viscera. The risk of surgical site infections increases when the concentration of the microbiological flora exceeds 10,000 microorganisms per gram of tissue.[4] The most common organisms associated with SSI are Staphylococcus aureus, Coagulase-negative staphylococci, Enterococcus faecalis, and Escherichia coli. Staphylococcus aureus and coagulase-negative staphylococci are most frequently implicated in cases of cardiac, breast, ophthalmic, orthopedic, and vascular surgeries. In contrast, anaerobes, Enterococcus, and gram-negative bacilli are responsible for infections following abdominopelvic surgeries. [5]

Young et al also reported on the role of exogenous microbes that originate from the operating theatre or its inhabitants, particularly being transmitted from airborne mediums, on instruments or material, or via hospital staff. Staphylococci and Streptococci are incriminated as exogenous organisms causing postoperative infections. There is a noted rise in infections caused by Methicillin-resistant Staphylococcus aureus (MRSA) and extended-spectrum β-lactamase microbes, attributed to the inappropriate use of broad-spectrum antibiotics.[4]

Etiopathogenesis

The risk factors for SSI are diverse and can be classified into patient risk factors and procedural risks.[2]

Table 2: Risk Factors For Surgical Site Infections [2]

Patient Risk Factors	Procedural Risk Factors
1. Advanced age 2. Malnutrition 3. Hypovolemia 4. Obesity 5. Steroid use 6. Poorly controlled diabetes 7. Immunocompromised state 8. Smoking 9. Trauma 10. Procedure site (intraabdominal, pelvic, or extremity) 11. Extended preoperative hospitalization 12. Inadequate preoperative skin hygiene 13. Existing infections at distant sites	1. Abnormal fluid collection such as hematoma or seroma 2. Contamination of the surgical site, equipment, or personnel 3. Utilization of drains 4. Presence of foreign material in the surgical site 5. Hypothermia 6. Improper hair removal 7. Inadequate antibiotic prophylaxis 8. Insufficient application of the skin prep 9. Short duration of surgical preoperative scrub 10. Prolonged surgical time 11. Poor operating room (OR) ventilation 12. History of prior infection or contaminated case 13. Prolonged perioperative inpatient stay 14. Unsatisfactory surgical practices and techniques

The symptoms of post-operative surgical infections usually manifest within 3-7 days postoperatively. The type of surgical interventions determines the timeframe of the appearance of the symptoms.[6] The typical symptoms of SSI include erythema and pain around the surgical wounds. Purulent discharge draining from the wound is another indicator of infection. Depending on the nature and extent of infections, additional symptoms vary.[7] Presentation of superficial and deep surgical site infections is in the form of a gradual onset of pain around the incisional site, along with general malaise or fatigue. There may be incisional discharge or saturation of the dressings. Patients with organ/deep space infections present with localized or generalized pain along with systemic symptoms of fever, chills, night sweats, fatigue, or chills. The physical examination reports incisional erythema, discharge that can be purulent or non-purulent, wound dehiscence, or delayed healing. On palpation, tenderness can be localized or diffuse.[2]

Diagnosis

The post-surgical wound infections are predominantly diagnosed clinically. Despite the clinical diagnosis, to isolate the causative agent for targeted antimicrobial therapy, wound cultures should be performed. In case of suspected deep space infections, imaging techniques such as ultrasound, CT scans, or magnetic resonance imaging (MRI) scans should be employed. Internationally recognized traditional risk assessment models such as the National Nosocomial Infection Surveillance System, Australian Clinical Risk Index, and the European System for Cardiac Operative Risk Evaluation can be used to predict the probability of developing infections based on the risk factors. The limitations of these models are due to the omission of certain risk factors from the calculations. In addition, some models lack the discriminatory abilities or the ability to risk-stratify for different surgical procedures.[2]

Table 3: Diagnosing Surgical Site Infections [2].

Type of Infection	Clinical Diagnostic Features
Superficial Incisional Infection	• Systemic signs of infections are not typically demonstrated • Fever and leukocytosis may be present • Limited utility for imaging and not recommended

Deep Incisional Infection	• Systemic signs of infection are seen • Laboratory evaluation demonstrates leukocytosis with a left shift, elevated procalcitonin, C-reactive protein levels • Ultrasound and CT scan be used to diagnose the depth, extent, and anatomical involvement. • Image-guided aspiration and discharge with culture can be used to guide antibiotic therapy
Organ/Space Surgical Site Infection	• Typical systemic signs and symptoms of inflammation and infection • Superficial incisions may appear unaffected • Imaging, demonstration of fluid collection or abscess in or around the surgical site • Image-guided aspiration and interventional radiology can be used

Surgical site infections can develop into necrotizing soft tissue infections, which increases risk of mortality and morbidity. The patients would present in a critical state within 48-72 hours following surgery and exhibit signs of sepsis. The examination would present with pain that is out of proportion to the typical postoperative course, skin appears dusky or erythematous, peri-incisional edema, ecchymosis, decreased blood supply, blistering, crepitus, or frank tissue necrosis. Incision would present with an excessive amount of drainage. Leukocytosis or leucopenia might be observed in laboratory evaluation.[8] These infections can involve any tissue- fascia and musculature, and proliferate rapidly along fascial or tissue planes. Surgical wound exploration and debridement should not be delayed in favor of imaging studies in suspected cases.[9] Fournier gangrene is a type of necrotizing soft tissue infection and is considered a medical emergency.[10]

During physical examination, all dressings must be removed, and the wound should be inspected for blisters, wound tension, edema, inappropriate tenderness, blackish-grey tissue, fluctuance, and evidence of ischemia or necrosis. Sterile techniques must be employed during palpation. If discharge is present, irrespective of its nature, should be sampled and cultured for microbiological assessment.[2]

Management

Risk Factor/Prevention Management

Before surgical procedures, some elective conditions can and should be optimized. These factors include smoking cessation, coagulation cascade normalization, glucose control optimization, weight loss, and stabilization of other comorbidities. [2] Peri-operative measures include preoperative shower, clipping of hair, and appropriate skin preparation. In addition, maintenance of optimal conditions during the procedure, such as temperature, air circulation, and sterility to prevent infections.[11]

Table 4: Intervention and Recommendation For Prevention Management.

Intervention	Recommendation
PRE-OPERATIVE INTERVENTION	
Nasal culture for MRSA/MSSA	Use of 2% muciprocin and shower with chlorhexidine soap [12]
Pre-operative showers with chlorhexidine	Beneficial in short duration procedures [13]
Antimicrobial surgical site preparation	Chlorhexidine is preferred over povidone-iodine [14]
INTRAOPERATIVE INTERVENTION	

Antimicrobial prophylaxis	Administration of 1g cefazolin approximately 2 hours prior to the surgery or earlier Clindamycin can be used alternatively [15]
Intraoperative warming	Intraoperative normothermia is optimal [15]
Vancomycin powder	Recommended use of vancomycin as a safe and inexpensive measure to prevent SSI [15]
POSTOPERATIVE INTERVENTION	
Wound drains	There is limited use in prevention but beneficial during SSI management [15]
Negative pressure wound therapy	Beneficial in prevention and management for SSI [15]
Traditional wound dressings	Use of dressings with silver and Aquaphor have antimicrobial properties and accelerate healing [15]
Delayed primary closure	No significant benefit observed clinically [16]

Shimane et al reported that the use of perioperative oral cleaning regimens leads to a significant decrease in surgical site infections. This regimen involves removal of tartar, plaque, and scaling, optimal denture care, and extractions if necessary.[17]

Treatment of Postsurgical Infection

The treatment is influenced by multiple factors such as the procedure performed, causative microbes, anatomical conditions, and the patient's characteristics. Removal is necessary in cases that involve foreign bodies such as mesh, stents, implants, or metalwork, due to contamination and biofilm formation.[18] Cultures are required for open wounds and drainage, especially in cases of purulent discharge, aids in antibiotic choices. Negative culture from the wound is suggestive of unconventional organisms such as acid-fast bacteria or fungi, especially in the case of immunocompromised patients.[2] For infections with systemic signs such as fever, skin erythema, and cellulitis, systemic antibiotics are prescribed. Blood cultures should be considered for such cases, and timely intervention is necessary to prevent sepsis. In case of superficial infections, limited local wound care is sufficient.[19] For superficial wound infections, the treatment of choice involves opening of the incision, examination, drainage of any infected fluids, and debridement of necrotic tissues. In case mechanical debridement is not possible, enzymatic agents can be employed.[2]

For deep surgical infections, especially those involving abdominal wounds, the risk of wound dehiscence is very common. It is recommended that the debridement of the wound be done in operating rooms. Percutaneous drainage can be considered for the collection of infected fluid. Imaging techniques such as ultrasound and CT can be used to ease the process of percutaneous drain placement to collect infected fluids and abscesses.[2] Wound irrigation is associated with a lowering of the contaminated bacterial population that could be associated with SSI. It is recommended to delay the closure of the wound after debridement and irrigation with antibiotic normal saline until the wound appears sufficiently clean for closure. There is a slight probability that instrumentation during irrigation might cause further diffusion of the bacteria in the surrounding tissue, unfortunately making infection control difficult.[20]

For infections involving orthopedic hardware, management can involve bone debridement, antibiotic wound care, long-term antibiotics, and removal of orthopedic implants and the cements used to adhere them, irrigation of wounds, and/or surgical debridement.[21] Use of polymer-coated intramedullary nails or antibiotic-impregnated cements has shown efficacy in preventing infections in the surgical sites.[22] For infections that are complex and non-healing, hyperbaric oxygen therapy can be administered.[23] Vacuum-assisted closure (VAC) is a therapeutic technique that is utilized in negative-pressure wound therapy.[24] This technique helps to minimize the number of dressing changes required, prevent excessive collection of fluid, and promote healing by granulation.[2] These dressings have been successfully used to accelerate healing in cases involving major trauma, orthopedic procedures, burn surgeries, and open abdomen surgeries.[25] Lu et al reported in their meta-analysis that the use of VAC is linked with lower instances of postsurgical wound infection in spinal surgeries and also decreases the probability of complications, along with the duration of postoperative hospital stay.[26] Armstrong et al also reported that they observed effectiveness and safety of VAC for patients undergoing partial diabetic foot amputation, along with a higher proportion of wound healing, with faster healing rates and fewer instances of reamputation.[27]

VAC is effective in wound healing, as when negative pressure is applied, microvascular blood flow around the wound edge changes gradually, which aids in accelerating the process of healing. VAC is found to promote capillary blood flow velocity, increasing capillary caliber and blood volume, stimulating proliferation of the endothelial and angiogenesis, narrowing endothelial spaces, along with restoration of the integrity of the capillary basement membrane. It was also reported that VAC influences the microenvironment of the wound as the negative pressure that is created, notably lowers the pro-MMP-9 levels and reduces the total MMP-9/TIMP-1 ratio. These combined factors aid in accelerating cell growth and wound healing. [24] Wounds that are treated with VAC dressings are required to receive intermittent mechanical debridement. Use of VAC requires specialized supervision, especially in cases where the underlying organs or major blood vessels are being exposed.[2] These VAC dressings use a negative pressure of approximately 120 mmHg as a baseline for most wounds.[20]

Closed incision negative-pressure therapy (CiNPT) is another novel technique being used to reduce the chances of SSI. CiNPT is a disposable, single-use system that has a replaceable canister, along with a variety of one-piece reticulated open-cell foam dressing options for incision lengths of various lengths and at different anatomical sites. This system is placed at a negative pressure of 125mmHg and in an operating room. These dressings can be used for up to a week, without requiring any change of dressings. This system acts as a barrier against the external environment, while holding together the incisional edges, and removing fluid or any infectious materials. Cooper et al reported in their meta-analysis that the use of CiNPT lowers the risk of SSIs, wound dehiscence, and skin necrosis. They also reported that the use of CiNPT helped in reducing the use of opioid pain control, decreased pain scores, and reduced readmissions and reoperations. [28] Gombert et al noted a significant reduction in SSI undergoing vascular surgeries with groin incision, using CiNPT compared to traditional methods of dressings.[29]

Self-care methods

Cleaveland Clinic suggests adhering to the surgeon's instructions along with wound care. They also recommend movement to ensure proper circulation of blood and oxygenation and nutrition. Another recommendation is proper nutrition involving protein, zinc, iron, and vitamins. [30]

Complications

The complications associated with surgical site infections involve: abscess, cellulitis, osteomyelitis, and sepsis.[30]

Conclusion

Surgical site infection is a serious condition that is associated with high mortality and morbidity. These conditions require prompt diagnosis and appropriate management to prevent the worsening of the patient's health and loss of life.

Author contributions

The literature review, editing, and creation of the table and figures were all completed by each co-author. The first author wrote the original text of the document. Each author must give their final approval before the manuscript is sent to a journal for publication.

Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

Ethical Approval
Not Applicable

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