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Epidemiology, Bacteriology and Risk Factors of Surgical Wound Infections: A Systematic Review

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ABSTRACT

Introduction: Surgical wound infections are a main cause of hospital associated infections in low income and the second most common cause in high income and resource rich countries. This review aiming at exploring epidemiology, bacteriology and risk factors associated with surgical wound infections.
Methods: The systematic search was conducted in the Medline, Science direct, CINAHL databases using search terms of (Wound Infection OR Nosocomial Infections OR Surgical Wound) AND (Epidemiology OR Bacteriology OR Risk Factors). The relevant information was extracted from eligible studies. The irrelevant, duplicated studies were excluded. The findings of the included studies were summarized in a narrative manner.
Results: Surgical wound infections have taken an alarming position as the third most common hospital acquired infection. SSIs continue to be a huge challenge to healthcare institutions where they add costly implications for surgery and health cost in general. Although gram-positive cocci hold the greater guilt for SSIs, there is an increased risk of SSIs from gram-negative bacilli after GI tract surgical procedures.
Conclusions: Detecting risk factors preoperatively, classifying patient's risk and using a multidisciplinary approach, all are of great importance to determine the appropriateness of the surgical procedure, designing a tailored education session for the patient on the risk of possible complications, and last but not least, determining an effective plan for expected postoperative complications.
Keywords: Bacteriology, Epidemiology, Wound Infections, Prevalence.

INTRODUCTION

A surgical wound is defined as a cut or an opening in the skin. However, it is usually caused during surgery, but it can be a result of a drain placed during surgery. Surgical wounds vary in respect to their size, and usually closed with stitching, but sometimes are left open so as to heal [(1)]. Wound infections are classified into two main groups, skin infections and soft tissue infections, and they often overlap as a result of disease sequence [(2,3)]. Since hospital-acquired wounds represent a major part of morbidity due to nosocomial infections and a rise in medical expenses, such wounds need to be routinely surveyed as recommended by the Centers for Disease Control and Prevention [(4)] as well as by the Surgical Infection Society [(5)].

One of the most common hospital acquired infections are surgical site infections (SSIs). They hold the third place among all hospital acquired infections, posing a great challenge to institutions as they have become a leading cause in hospital associated infections (HAIs) and have been found to have financially debilitating effects on surgical practices in both human and veterinary practice [(6,7,8)]. They have been linked to poor patients' outcomes with increased mortality, morbidity and a high healthcare expenditure [(9,10)]. SSIs are a main cause of HAIs in low income areas (low and middle-income countries 5.6%) and the second most common cause in high income and resource rich countries (USA 2.6% and Germany 1.6%) [(11,12,13)]. This review aiming at exploring epidemiology, bacteriology and risk factors associated with surgical wound infections.

METHODS

The systematic search was conducted in the Medline, Science direct, CINAHL databases using search terms of (Wound Infection OR Nosocomial Infections OR Surgical Wound) AND (Epidemiology OR Bacteriology OR Risk Factors). The relevant information was extracted from eligible studies. The irrelevant, duplicated studies were excluded. The findings of the included studies were summarized in a narrative manner. The protocol of the review was approved by the technical and ethical committee.
The study was done after approval of ethical board of King Faisal university.

RESULTS

The findings of the included studies revealed that surgical wounds classified according to level of contamination. They are classified into four classes

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which allow for better prediction of risk of infections and wound healing outcomes, thus allowing most favorable treatment for each type of surgical wound [14,15]. Class I represents clean surgical wounds: No inflammation signs detected and the respiratory, gastrointestinal or genitourinary tracts are not involved. Examples of such class are eye or vascular surgeries, laparoscopic surgeries, and biopsies. Class II represents clean-contaminated wounds, which are clean in this class but have a higher infection risk. Examples of such class include uncomplicated surgeries of the respiratory, gastrointestinal or genitourinary tracts. This class may also include chest and gynecologic procedures, ear surgeries and wounds opened to remove wires or pins. Class III represents contaminated wounds, which have come into contact with an external object (such as a bullet, knife or a blade). These are created when an outside object (such as bullet, knife, and blade). A large GIT spillage into the wound could also be a cause of contamination. Class IV represents dirty-infected surgical wounds, which have foreign objects (such as rubble or a bullet) lodged in. This class may also include traumatic wounds caused by unclean or contaminated objects, wounds that have become infected or have been exposed to fecal matter or pus.

As a stepping stone towards reducing SSI problems, surgical wound assessment and documentation is highly acknowledged. Hence several publications such as evidence based clinical practice guidelines (CPGs) are being made readily available and are being spread worldwide to shed light on recommended and effective practices in wound assessment and documentation. In this respect, NICE guidelines recommended that accurate wound assessment leads the process of medical treatment as well as identifies problems associated with the healing process. A complete wound assessment is believed to be the best way to conclude on the status of the wound, to find out whether the wound is progressing and attaining the desired objective. Among the most important factors upon which clinical decision-making depends are comprehensive individual assessment, clinical signs and symptoms of wound or systemic infection, risk factors and wound healing environment. One of the most accurate techniques was found to be direct observation of surgical wounds as a mean of SSI wound assessment [16, 17]. Treated wounds are usually assessed in order to verify the progress of healing. They may be inspected during a dressing change, however if the wound itself cannot be directly inspected, the dressing is inspected, beside assessing other data such as pain. Assessment of the surgical wound includes examining the size and severity of the wound, inspection for bleeding, checking foreign bodies, beside assessing associated injuries such as fractures, internal bleeding, spinal cord injuries, or head trauma [18]. Risk factors of SSIs have been widely studied [19]. They can be divided into: patient-related and procedure-related. The later comprises surgical procedures -related and operating room environment-related [20], as demonstrated in table1. Patient-related factors include older age, diabetes, malnutrition, obesity smoking, use of immune suppressive drugs, illness severity, pre-existing infection, and colonization with Staphylococcus aureus and other potential pathogens [20,21]. The microbiology of SSIs is directly associated with two factors: the type of surgery being carried out and to the normal flora of the organs to be operated or are involved in the procedure [24, 25]. The majority of SSIs are caused by gram-positive cocci, such as Staphylococcus aureus (S aureus) and Staphylococcus epidermis, which are organisms colonizing the skin of the patient [25, 26]. The chance of infection with gram-negative bacilli increases after a GI tract surgery. Enterococcus faecalis and Escherichia coli are commonly found to be causes of SSIs after a clean-contaminated surgery [25, 27], as shown in table 2.

Table (1): Factors that influence Surgical site infections (patient related and procedure related) [21]

Patient-related	Procedure-related
Age	Surgical scrub duration
Nutritional status	Skin antisepsis
Diabetes	Preoperative shaving
Smoking	Preoperative skin preparation
Obesity	Operation duration
Coexistent infection at a remote body site	Prophylaxis using antimicrobials
Colonization with micro-organisms (specially Staphylococcus aureus)	Ventilation of Operating Room
Immune response weak or altered	Surgical instruments in adequately sterilized
Preoperative hospital stay duration	Presence of foreign material in the surgical site

	Surgical drains
	Surgical procedure

Table (2): Pathogens commonly associated with different surgical procedures [25]

Operations	Likely Pathogens
Placement of grafts, prostheses, implants	*Staphylococcus aureus;* coagulase-negative or staphylococci
Cardiac	Staphylococcus aureus; coagulase-negative staphylococci
Neurosurgery	Staphylococcus aureus; coagulase-negative staphylococci
Breast Staphylococcus aureus	coagulase-negative staphylococci
Orthopedic	Staphylococcus aureus; coagulase-negative staphylococci;gram-negativebacill
Vascular Staphylococcus aureus	coagulase-negative staphylococci
Appendectomy	Gram-negative bacilli, anaerobes
Biliary tract	Gram-negative bacilli, anaerobes
Colorectal	Gram-negative bacilli, anaerobes
Gastroduodenal	Gram-negative bacilli; streptococci, oropharyngeal anaerobes (e.g. peptostreptococci)
Head and neck. (Major procedures with incision throughoropharyngeal mucosa.)	Staphylococcus aureus; streptococci; oropharyngeal anaerobes (e.g. peptostreptococci)
Obstetrics and gynecologic	Gram-negative bacilli; enterococci; group B streptococci; Anaerobes
Urologic (May not be beneficial if urine is sterile.)	Gram-negative bacilli

DISCUSSSION

Surgical procedures-related factors include factors related to patient preparation and surgical team preparation before the incision, which also includes poor surgical techniques, operation duration, preoperative skin preparation procedure quality and insufficient sterilization of surgical instruments [20, 21].

According to Florschutz ***et al.*** [22] when SSI risk factors are detected and the patient is stratified according to risk preoperatively, this greatly assists in several areas which include, judging appropriateness of the surgery, educating the patient on possible complication risks, and most importantly putting in place proper management schemes to any foreseen postoperative expectations. When early identification of such factors is achieved preoperative care planning and patient medical optimization is concomitantly also achieved and hence HAIs clinical and economic adverse effects in all related areas are greatly reduced [22]. According to **Weigelt *et al.*** [23] such efforts should focus on prevention of SSI which is a complex attempt requiring a multidisciplinary approach that based on the expertise of a range of professional groups.

There is a disturbing trend of antibiotic resistant pathogens (like Candid-albicans or Meticillin-resistant S. aureus (MRSA)) that are becoming a cause of an increasing number of SSIs. This could be indicative to the increasing number of immunocompromised surgical patients or even severely ill, as well as to the widespread overuse of broad-spectrum antibiotics [22, 27].

Pathogens of concern that cause SSIs (like Gram-positive organisms like staphylococci and streptococci) may be introduced to the site of wound or surgery via several routes like the patient's endogenous flora or preoperative infection sites remote from the operative, particularly in patients undergoing insertion of a prosthesis or other implant. Exogenous sources may also be a culprit, including the operating room, instruments materials used during surgery or even from members of the surgical team themselves [22]. The risk of SSI is considered to be significant when organisms in the tissue exceeds 105 organisms per gram of tissue [28]. An organism's virulence is its capability to produce toxins or the strength of its ability to invade or destroy tissue. 74% of mortality is among patients infected with highly virulent pathogens like MRSA [29]. When the balance between the patient's defense system and the number of pathogenic organisms is disrupted SSIs occur [29].

The attempt of reducing SSI and its complications has shown to be effective when guidelines that follow surgical wound assessment and documentation have been followed. The increasing number of antibiotic-resistant pathogens has also added to SSI, indicated greatly by the increasing number of immunocompromised surgical patients and the severely ill. The most distressing effect of SSIs included poor patient overall outcome, increased mortality, morbidity and debilitating healthcare associated spending. Surgical wound classes allow health care professionals to better predict the risk of infections and wound healing outcomes [27].

CONCLUSION

Surgical site infections (SSIs) have taken an alarming position as the third most common hospital acquired infection. SSIs continue to be a huge challenge to healthcare institutions where they add costly implications for surgery and health cost in general. Although gram-positive cocci hold the greater guilt for SSIs, there is an increased risk of SSIs from gram-negative bacilli after GI tract surgical procedures.

Risk factors of SSIs are patient-related and procedure-related. The dose and virulence of microbe at a surgical site and the strength of the patient's immune response determines the risk of developing an SSI and its severity. Detecting risk factors to SSI preoperatively, classifying patient's risk and using a multidisciplinary approach, all are of great importance to determine the appropriateness of the surgical procedure, designing a tailored education session for the patient on the risk of possible complications, and last but not least, determining an effective plan for expected postoperative complications.

CONFLICT OF INTERESTS

The authors declared no financial support and conflict of interests.

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