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A NARRATIVE REVIEW ON BACTERIA FROM SURGICAL WOUND

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Abstract

Surgical site infections are worldwide problems in the field of surgery contributing to increased mortality and morbidity. However, despite advances in the control of surgical site infections, the risk of acquiring these infections had not fully been eliminated due to the emergence and spread of resistant bacteria pathogens. The aim of this study was to isolate and identify bacteria from surgical wounds patient.

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Introduction:-

The incidence of surgical site infection is a major concern in many hospitals. It affects the patient's wellbeing as well as the healthcare personnel [1-3]. Therefore, surgical site infection (SSI) could be defined as an infection that occurs within 30 days of a surgical procedure or one year if an implant is left in place after the surgery and affects either the incision or the deep tissues at the surgical site. Infections involving organs or bodily space might be superficial or deep incisional infections [4].

Surgical site infections are a worldwide problem in the area of surgery; linked to longer hospital stays, higher treatment costs, and increased rates of morbidity and mortality [5]. SSIs are the second most common kind of nosocomial infection in hospitals in the United States, SSIs are linked to a 3.0% mortality rate, according to the Center for Disease Control and Prevention (CDC) [6]. Pre-existing medical disorders, the amount and type of resistant skin bacteria, and preoperative, intraoperative, and post-operative care are all factors that influence the risk of surgical site infection [7].

Deposition and multiplication of microorganisms create wound infections in surgical site of a susceptible host. Most infections of post- operative wounds are hospital acquired and vary from one hospital to another [8].

Lack of standardized criteria for diagnosis of SSIs present a challenge to monitor the global epidemiology of surgical site infection [5]. In addition to this, emergence of high antimicrobial resistance among bacterial pathogens has made the management and treatment of post-operative wound infection difficult [8].

Moreover, rapidly emerging nosocomial pathogens and the problem of multidrug resistance necessitates periodic review of isolation pattern and their sensitivity [9]. Many studies in different part of the world found that the most frequently isolated bacteria from surgical wound infections were Staphylococcus aureus, coagulase negative Staphylococcus (CoNS), Escherichia coli, Pseudomonas aeruginosa, Klebsiella pneumoniae, Proteus species [10].

Infected wounds are wounds that are colonized with bacteria or other microorganisms that cause its deterioration and a delay in wound healing. In other words, infected wounds result when immune defenses of the body are stunned or cannot withstand common bacterial growth. Wound infection caused by surgery is a severe health challenge and surgical wounds are mostly contaminated by bacteria, previous studies have revealed that about 70 percent of the deaths of patients who have undertaken surgical operations are triggered by surgical site infections [11-13].

Surgical antimicrobial prophylaxis can help prevent SSIs. In the hospital setting, 30- 50% of antibiotics are prescribed for surgical prophylaxis, and 30-90% of this prophylaxis is unnecessary. This incorrect use raises selection pressure, favoring the formation of pathogenic drug-resistant bacteria [14], complicating the selection of empirical antimicrobial drugs and thereby raising the risk of post-operative wound infections.

Surgical site infections: an overview

The varied nature of surgical site infections makes studies on their magnitude difficult. The rates of postoperative wound infections vary greatly depending on the surgery, hospital, surgeon, patient, and Geographic area. Although the link was not statistically significant, one study of 322 children surgical patients in Sub-Saharan Africa found a high SSI risk of 25.8% in emergency procedures compared to 20.8 percent in elective procedures. A comparable study found that dirty surgery has a higher rate of SSI (60%) than contaminated surgery (27.3%), clean contaminated surgery (19.3%), and clean surgery (14.3%), with the correlation being statistically significant [15-16]. The adoption of minimally invasive surgery, such as laparoscopic surgery, has been proven to reduce the incidence of SSI.

SSI prevalence and incidence rates in different parts of the world have been reported to range from 5.6 percent to 26 percent, according to several literature sources [17].In a study conducted by Mehdi et al in Indiaon 157 patients showed that the most common site of infection was the knee in 46 patients (29.3%) and that gram positive bacteria were detected in 55 patients (56.7%)while gram negative bacteria were found in 42 patients (43.3%),with vancomycin as the most effective antibiotic in staphylococcus infections [18-19].

Also a few African studies have also found that the severity of SSI varies based on the operations and specializations done. In one prospective multicenter study conducted at large hospitals in Lagos, Nigeria, a low prevalence rate of SSI of 9.6% was observed among women who had caesarian sections, with only those who had Pfannesteil incision included in the study[17]. The low frequency was speculated to be attributable to the removal of individuals having a sub umbilical midline incision [17].

Pathogenic organisms were found in 38.7% of patients with abdominal surgical wounds in a prospective trial at an Ethiopian teaching hospital; however surgical wound infection rates were only 21% on clinical grounds. This discovery highlights the need of confirming the diagnosis of potentially infected surgical wounds using laboratory techniques [20].

In sub-Saharan Africa, an overall incidence of 14.8% SSI has been reported; In Nigeria the prevalence of surgical sites infection is about 14.5% [21].Several studies had been conducted on the incidence of SSI in Nigeria. Majority of which involved a small number of patients admitted in a single healthcare facility and thus lack sufficient statistical power. As a result, findings fromsuch studies cannot be generalized, reliable and systematic data on the national prevalence and risk factors of SSI areneeded.

Epidemiology of SSI

It is generally acknowledged that surgical site infections are a major contributor to the number of hospital acquired infections recorded in healthcare facilities worldwide [22] and they cause a worldwide problem in the area of surgery; linked to longer hospital stays, higher treatment costs, and increased rates of morbidity and mortality [23] A lot of studies have previously been conducted on SSI for example a in a study conducted by Mehdi et al in India on 157 patients showed that the most common site of infection was the knee in 46 patients (29.3%) and that gram positive bacteria were detected in 55 patients (56.7%)while gram negative microorganisms were found in 42 patients (43.3%),with vancomycin as the most effective antibiotic in staphylococcus infections.

In the United States, SSI is currently the most common hospital acquired infection, with approximately 77% of the death of surgical patients being related to SSI and a large percentage as a result of serious infections involving organs or spaces accessed during the surgery.

An epidemiological study of SSI in Nigeria by Olowo-okereet al[21]using thirty two articles emanating from the six geo-political zones of Nigeria shows the cumulative incidence of SSIs was 14.5% (95% confidence interval [CI]:0.113-0.184) with the highest incidence reported in the north-eastern region of the country (27.3%,95%CI:0.132-0.481) .It was found to occur more following colorectal and abdominal surgeries ,among elderly patients and in patients with co-morbid factors .The most frequently reported was the superficial incisional SSIS occurring in 62.5%(95% CI: 0.333-0.848). A higher percentage was also observed among patients with dirty wounds (52.7%,95% CI:0.367-0.682).The highest incidence of SSI was reported in the North-eastern region (27.3%), followed by the North-central (26.3)with the lowest rate reported in the South-south region (8.0%) This is higher than 4.5% reported in China, 1.98% in the USA and up to 10% in Europe [21].

The increase in SSI among patients who had colorectal and abdominal surgeries is likely because the large bowel with addition of the rectum is loaded with a wide range of gram –negative bacteria and anaerobic bacteria which could easily spill over to contaminate the surgical site, these bacteria are usually resistant to common antibiotics thereby resulting in a higher rate of SSI compared to surgeries involving other organs [21].

Microbial Impact

Most instances of SSIs are due to bacteria, common bacteria causing SSI are Staphylococcus aureus,Pseudomonasaeruginosa, Corynebacterium spp.(diphtheroids), Serratiamarcescens, and anaerobic microorganism like Prevotella spp.andPeptoniphilus spp. Coagulase negativeStaphylococci and Enterococcus spp. also are vital causes of SSIs [24].

The microbial flora relies upon on the kind and location of surgical operation (Cheadle et al, 2006) these organisms are a part of thehost’s endogenous micro flora, but can also come from the operative room environment and the flora of healthcare givers.Staphylococcus aureus is the most common pathogen implicated in most SSIs, accounting for approximately 30% of all the instances[25].

Access into a hollow viscus by using some surgical techniques exposes the surrounding tissues to Gram negative bacterial pathogens like Escherichia colior Gram-positive bacteria consisting of Enterococcus spp., and, sometimes, anaerobes including Bacillus fragilis[26].

Risk Factors In Surgical Site Infections

The factors contributing to SSIs vary from patient to patient, depending on the associated morbidity. The variables could beintrinsic (patient related) or extrinsic factors (procedure related).

Intrinsic factors

These are patients related and they include the following factors.

Gender

According to several researches, surgical patients' gender is a significant factor in the development of surgical site infections [27]. This element may be connected to sex hormones by way of illustration, the hormones testosterone and estrogenhave the ability to disrupt the process of wound healing by altering genes in control of inflammatory responses and epithelization [28].According to research carried out by Chua et al on penile wounds, testosterone seems to stimulate a protracted inflammatory response which makes wound healing slower. On the other hand, estrogen triggers a fibrinopurulent assemblage early in the healing of a penile wound. While testosterone has a delayed effect, estrogen causes early collagen and fibroblast dispersion during general skin healingi.e., wounds heal faster[29], hence the slowing down of wound healing could increase the patient’s susceptibility to SSI.

Age

According to recent research, those who are young and older are more likely to develop surgical site infections (SSI) after surgery [30]. The cause of how being older makes surgical patients more susceptible to infection is not well known. However, a review of factors influencing the elderly's wound healing process found that altered inflammatory responses were to blame for the elderly's increased likelihood of wound infections [31].

Immunosuppressive disease conditions

In other instances, immune compromising conditions such as diabetes mellitus and anemia were discovered as factors linked with a higher risk of SSI. This is because patients with these conditions have reduced immunity which makes it very hard for the body to clear the infection at the wound site effectively [32].

Preoperative nasal colonization with Staphylococcus aureus

Recent literature shows that Staphylococcus aureus colonizes the anterior nares of about 30% of the human population [33]. Within the hospital setting, this bacterium has the ability to cause wound infections in immune-compromised surgical patients. This is because the bacteria can be transferred from the nostril to the patient skin and later into the wound during skin incision.

Poor nutritional status

A deficiency of micro and macro-nutrients such as vitamins, proteins, carbohydrates, iron, zinc and magnesium can have a profound effect on the healing process of the wound after surgery [34]. There is sufficient body of evidence to suggest that serum albumin levels below 3.5 g/dl can increase the susceptibility of surgical patients to SSI. This is because low levels of serum albumin in surgical patients are an indicator of a wide range of comorbid conditions that can impair patient immunity.

Obesity

On the other hand, surgical patients with a higher body mass index were seen to be at a greater risk of acquiring surgical site infection [35]. This is due to the high tissue mass in obese patients which lowers tissue vascularity, increases the complexity of the procedure, and reduces oxygen and antibiotics permeation to the surgical bed. Hence, all these events can increase SSI susceptibility.

Wound classification and American Society of Anesthesiologist (ASA) score

Classification of surgical wounds

1. **Clean wound**: A clean wound is an uninfected surgical wound in which there is no inflammation and no entry into the respiratory, gastrointestinal, genital, or uninfected urinary tracts.
2. **Contaminated wound**: A contaminated wound is an open, fresh, unintentional wound. A clean-contaminated wound is an operation in which the respiratory, alimentary, vaginal, or urinary tracts are entered without unusual contamination and under controlled conditions.
3. **Dirty wound:** A dirty wound is an old traumatic wound that has retained devitalized tissue, a wound with active clinical infection, or a lesion containing viscera that has been perforated [36].

Classification of surgical site infections

1. Superficial surgical site infection:This infection confines to the skin and subcutaneous tissue and it is characterized by the presence of either purulent drainage with or without laboratory confirmation of microbial isolates from superficial incision or the presence of signs and symptoms of infection at the site, or diagnosis of SSI by clinicians.
2. Deep surgical site infection: Is the presence of at least purulent drainage from the deep incision,spontaneous dehisces or a deliberately opened deep incision in a patient with at least one of the following signs or symptoms: fever (> 38 °C), localized pain, or tenderness.Unlessthe site is culture-negative, an abscess or other evidence of infection involving the deep incision, soft tissues or evendiagnosis of a deep incisional SSI by the attending clinician are all diagnostic of deep SSIs.
3.Organ/space SSI: Is an infection which involves any part of the anatomy other than the incision, which was opened or manipulated during an operation and at least purulent drainage from a drain that is placed through a stab wound into the organ/space.Isolate from an aseptically obtained culture of fluid or tissue in the organ/space, abscess or other evidence of infection involving the organ/space that is found on direct examination, during re-operation, or by histopathologic or radiologic examination, and diagnosis of an organ/space SSI by a surgeon or attending physician. All play major roles in identifying organ or space SSI.

Extrinsic factors

These are factors which are not part of the patient’s body

Types of procedures

Additionally, the type of surgery performed affects the likelihood that a patient may experience SSI; some studies have found abdominal surgeries like cesarean sections to have greater risks of infection [37-38]. These infection rates can be attributed to enteric rod contamination of the surgical site following an incision. Furthermore, it has been observed that surgical procedures that involve the placement of implants and drains increase the chance of surgical patients developing SSIs. This is because implant insertion causes tissue injury and blood clot production, which raises the possibility of biofilm development on the implant. Once the host's defenses have been breached by these circumstances, SSI may result [39].

Longer procedure durations

Additionally, surgical procedures lasting for long hours increase the chances of exposed tissues being contaminated with environmental bacteria. Moreover, long surgery durations can lead to tissue desiccation with the likelihood of tissue contamination and may also result in many technical errors as result of fatigue of the operating team; the reuse of medical devices during a long surgical procedure without the standard sterilization procedure exposes the patient to SSI [40].

Contaminated hospital surfaces

In addition to surgical procedures, the integrity of the hospital environment can also determine the outcome of surgery. Contaminated hospital surfaces can harbor pathogenic micro-organisms that have the potential to cause SSI. These grubby hospital surfaces are due to poor infection prevention and control programs, with most pathogens originating from the air, healthcare providers and can also be shed from the patient skin into the hospital environment [41].

Non-sterile equipment

Likewise is the use of surgical instruments contaminated with bacteria from the theater team. There have been a few documented cases of SSI arising from contaminated surgical instruments as a result of poor instrument handling and lack of proper inspection before surgery [42].

Hair removal

Hair removal is essential for ease of accessing the operative site, however shaving of the surgical site using a razor a day before an operation can result in minute skin cuts that can serve as sites for bacterial build-up and proliferation. The bacteria colonizing these sites may enter the surgical wound during skin incision and consequently cause post-operative wound infection [43].

Pathogenesis

A lot of clinical parameters could initiate SSIs after a surgery.

Pathogens that initiate SSI is obtained both internally from the patient’s own microbial flora on pores and skin, it may also come from an opened viscus or extraneously from the instruments used or the theatre environment. Microorganisms may gain entry to a wound after surgical procedure, before the skin has been sealed.

Less commonly, microbes from a far-away source of infection, mostly via haematogenous spread, can additionally cause SSI by adhering to a prosthesis or different implant or device that has been left inside the site of surgery. Extended time of surgery increases the danger of exogenous contamination [44]. In clean surgical procedures which no longer involve laparotomy or operation in genital tract, Methicillin resistantStaphylococcus aureus (MRSA) is the foremost microbe inflicting SSI; it is associated with a terrible clinical final outcome. Other Gram-positive bacteria like Coagulasenegative Staphylococci, Streptococcus spp. and Enterococcialso are incriminated, but less commonly.

SSIs may be monomicrobial orpolymicrobial. Polymicrobial infections are normally discovered at surgeries involving the oropharyngeal, axilla, perineum and GIT location due to a combined populace of cardioand anaerobic microorganisms. Yeasts of Candida speciescan also be the marketers of polymicrobial SSIs [45]. Occurrenceof SSI relies upon on the interplay of four elements as underneath: Inoculum of bacteria, virulence, microenvironment around surgical site and host’s immunity.

Virulence of bacteria

The more virulent the bacterial contaminating agent, thegreater is its probability of causing infection. It also dependsupon the type of exotoxins they release or the nature of lipopolysaccharide orendotoxins present in their cell walls. Bacterialike Staphylococcus aureus, Clostridium perfringens andStreptococcus pyogenes need only a small dose or inoculumto cause severe necrotizing infections at the surgical site.

Aerobic gram negative bacteria (like Escherichia.coli) and anaerobiccolonic bacteria like Bacteroides fragilis can have asynergistic relationship in vivo that leads to heightenedvirulence when the two species are concomitantly presentin critical inoculum counts at the surgical site [46]. Antibioticresistance can ideally be considered as a virulence feature of bacterial contaminants as well, since patients will hencehave more colonization by resistant bugs inside the coloniclumen or at the level of skin. Patients who have prolongedpreoperative hospitalization, recent hospitalization for otherpurposes, recent history of antibacterial agent consumptionfor the treatment of other infections, or those who are admitted inchronic care facilities will be colonized with more virulentmicrobes than any other patient having colon surgery. Theycan thus be expected to have more chances of developingSSI.

Innate and acquired host defenses

The tissue response of the host is very important. There can be two components of the host response. Firstly, there is the intrinsic, genetically programmed responsiveness that is poorly understood and possibly not affected by strategies for prevention [47]. Acquired derangement of the host immune and inflammatory response by many factors is also likely to be faced. These acquired factors may be chronic conditions like Diabetes mellitus, chronic kidney, chronic lung or chronic liver diseases. Also, there are acute conditions, namely hyperglycemia, hypoxemia, hypoalbuminemia, hypothermia or acute anemia that are associated with elevated rates of SSI. If wound contamination still continues or secondary infection occurs here, continuous activation of the complement system and other pathways can develop. It then provides a steady supply of chemotactic factors, leading to a greater influx of Polymorphonuclear Leucocytes into the wound. Monocyte takes up the role of a proinflammatory cell here with the release of many powerful cytokines. Serotonin is released from the mast cells, which cause vasodilation and enhanced vascular permeability. The combination of these two, that is intense vasodilation and increased blood vessel permeability then produces the classical clinical findings of inflammation like; rubor (redness), tumor (swelling), calor(heat), and dolor (pain).

Inoculum or load of bacteria

Procedures involving the sites which are heavily colonized with bacteria like the gut (10^3-10^4bacteria/ml of distal small bowel contents, 10^5-10^6 bacteria/ml in right colon, 10^{10}-10^{12} bacteria/gm. of stool in rectum and sigmoid colon having about 600 different species of bacteria) and the female genital tract (10^6-10^7bacteria/ml) are at higher risk of developing SSIs since large inocula of bacteria can harbor at the wound site during the course of operation [48].

Microenvironment around surgical site

Factors like hemoglobin and presence of hematoma in thesurgical incision site, foreign bodies or necrotic tissue fromoveruse of electro cautery procedure or wound trauma fromtoo much traction pressure also increase rates of infectioneven from lower load of bacteria [47]. Finally, presence ofdead space in the surgical incision serves as a dependentbasin for the accumulation of serosanguinous fluid afterthe closure of the wound. This drainage basin later harborsbacterial contaminants in a watery environment that cannotbe well tackled by host inflammatory or immune response.

Sources of surgical site infection

Pathogens which cause surgical site infections could either have exogenous or endogenous origin.

Endogenous sources

Most of the SSIs are due to bacterial contamination of the surgical wounds with endogenous flora of the host skin and viscera. This contamination occurs after the skin or hollow viscera has been incised [49]. These endogenous flora include skin micro-organisms for instance Staphylococcus aureus and enteric Gram-negative rods for example Escherichia coli. These pathogens can also originate from infective sites remote from the surgical site.

Exogenous sources

The sources include the operating room environment, surgical personnel-especially members of the surgical team, and all instruments brought to the operating room during an operation. Contamination occurs as a result of patient interaction with the surgical team or other healthcare providers colonized with pathogens and contaminated hospital surfaces with wounds serving as routes of infection [50]. Exogenous microbiota includes Staphylococcus aureus and Streptococci species.

Clinical features

Surgical site infections normally appear 2-7 days after the procedure, however, with any prosthetic device, they can also manifest later due to spread of bacteria from other sites. Physical examination could show localized sensitivity, erythema (redness of the skin), hotness and swelling (edema) at the site of the surgical procedure.Purulent wound drainage could be present [51].

Pus –filled wound drainage is seen in about two-third of cases of all SSI after instrumentation. Persistent infections usually presents with innate symptoms.

In rarer cases patients may experience extreme sepsis and organ failure.

Deep infections frequently lack obvious superficial signs making diagnosis difficult .An SSI of an organ or space may reveal a pus discharge out of a drain inserted into the bodily space through the skin or an organ.

A gathering of such noxious waste and deteriorating tissue surrounded by inflammation and epithelium is called an abscess.

Diagnosis of surgical site infections

Physically assessing the patient for indications of infection such erythema, localized swelling, discomfort, warmth, and purulent discharge is the initial step in the diagnosis of surgical site infections [52]. To determine the microbiological profile and antibiogram, the second and most crucial step is to perform a culture and sensitivity of pus either aerobically or anaerobically. Other tests that may be important include MRIs, C-reactive protein measurements, ultrasounds, computed tomography scans, sedimentation rates, and complete blood counts that screen for leukocytosis and neutrophilia, especially as the infection spreads to the systemic tissues.

Conclusion:-

Surgical site infections can be quite challenging to detect and then treat. Prevention necessitates meticulous patient care and all required interventions. Staphylococcus aureus is a leading causative organism of SSIs among surgical patients with Ciprofloxacin as the most sensitive antibiotic and Chloramphenicol, Cloxacillin and Erythromycin respectively as least sensitive, pointing to the necessity of clinicians and microbiologistsworking hand in hand forthe timely diagnosis and treatment of such infections.

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