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INFECTIONS AFTER ABDOMINAL SURGERY

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ABSTRACT

Objectives: To determine surgical site infection (SSI) rates, after abdominal Surgery and To determine risk factors associated with surgical site infections. **Settings:** AL-Jumhoori Teaching Hospital, Department of surgery, Mosul Medical City, Mosul, Iraq. Starting from October 2007-October 2008. **Patients and methods:** A prospective cohort study included 78 patients with surgical site infection after elective and emergency abdominal surgery. The dependent factors was abdominal surgical site infection, defined as redness, swelling, pain, warmth, pus discharge, during the 30 days after operation. The independent variables were age, sex, body mass index ,time, type of surgical operation, duration of hospital stay and risk factors promoting SSI. All four wound categories: clean, clean-contaminated, contaminated and dirty wounds were included. Surgical site infections are divided into superficial incisional, deep incisional and organ space SSI. **Results:** 485 patients Operated on for elective and emergency abdominal surgery, 78 (16%) developed SSIs, included 46 female (59%) and 32 male (14%). The peak age incidence was above sixty years (20%).SSI was associated with obesity. Superficial incisional infections founded in 45 (58%) , 21 (27%) for deep incisional and 12 (15%) was organ space SSI.SSIs incidence in complicated appendicitis (20.5%), penetrated injuries (15.38%), non-complicated appendicitis (10.259%), perforated duodenal ulcer (10.25%) and mesenteric ischemia (7.69%) .SSIs founded in (23%) elective operations, emergency atraumatic operations in (57%), penetrating operations (15%) and blunt trauma operations in (5%). Incidence of SSIs was (5%) in clean wounds, (12%) in clean- contaminated,(28%) in contaminated and (46%) in dirty wounds. Staphylococcus aureus was predominantly (80%) isolated from clean wounds, while polymicrobial flora in contaminated and dirty wounds. Important risk factors associated with SSI were systemic shock (30%), prolonged operation (22%), anemia (19.7%), associated chronic diseases (14%). The mean hospital stay for patients with SSI was 11 days. **Conclusions:** SSIs are frequent in elderly, obesity, emergency operations and dirty wounds. Shock, prolonged operation, anemia, chronic diseases are important risk factors Mean hospital stay was doubled and cost was elevated with postoperative infection.

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INTRODUCTION

Surgical site infections (SSls) are infections of the tissues, organs, or spaces exposed by surgeons during performance of an invasive procedure (Mangram, 1999). SSls is identified with redness, heat, pain, a temperature of 38 c, and septic drainage from the surgical site during the 30 days following operation (Brunicardi, 2005). SSIs are among the most common hospital acquired infections comprising 14-16 percent of inpatient infections (Skarzynska, 2000). SSI is a dangerous condition , a heavy burden on the patient and social health system (Troillet, 2001). Such infections lengthens bed stay for an average of seven days. Potential sources of infection are the patient (especially contamination by alimentary tract), hospital environment, food, other patients, staff, infected surgical instruments, dressings, and even drugs and injections (Burkih, 1963). In 1992, the US Center for Disease Control (CDC) revised its definition of wound infection, creating the definition surgical

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site infection (SSI) to prevent confusion between the infection of a surgical incision and the infection of a traumatic wound (Skarzynska, 2000). The surgical wound includes that area of the body internally and externally that involves the entire operative site Wounds are thus categorized into three general.

Categories

- Superficial, which includes skin and subcutaneous tissues.
- Deep, which includes fascia and muscles.
- Organ space, which includes the internal organs of the body if the operation includes that area (Courtney, 2005). Figure (1)

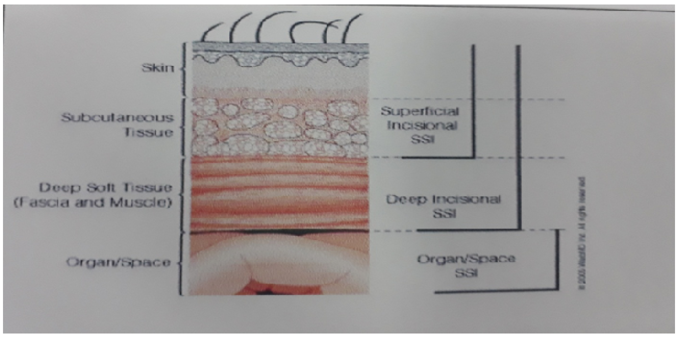

Fig. 1. Distribution of SSIs according to anatomical locations. (From ACS surgery: principles and practice)

CDC criteria for defining a surgical site infection (SSI)

- **Superficial incision:** infection less than 30 days after operation. Involves skin and subcutaneous tissue, only plus, one of following (purulent discharge, diagnosis by surgeon, symptoms of erythema, pain, local edema) (Courtney, 2006). Picture (1)
- **Deep incision:** Less than 30 days after operation with no implant, Infection less than 1 year after operation with implant Involves deep soft tissues (fascia and muscles)plus one of the following: (purulent drainage from the deep space but not extend into organ space, diagnosis by surgeon, symptoms of fever, pain, and tenderness lead to dehiscence of wound Picture (2)
- **Organ space:** Infection less than 30 days after surgery with no implant. Infection less than 1 year after surgery with implant Involves any part of the operation opened or manipulated plus one of the (purulent drainage from a drain placed into organ space ,cultured organisms from organ space aspirate ,abscess on direct or radiologic examination ,diagnosis by surgeon) (Courtney, 2005).

Etiology and risk factors: Wound infection occurs because of bacterial contamination of the surgical site (Courtney, 2005). One of the most common sources of bacterial contamination is transecting or entering the lumen of a hollow viscous in the abdominal cavity. A second source of bacteria is the skin flora. Third a break in the surgical technique may allow contamination from the operating surgeon, the equipment or the surrounding environment.

Three areas have been identified as risk factors for SSI: Bacterial factors, local wound factors, and patient factors .The interaction between these three is what determines the risk as a complication in surgery.

Picture(1) superficial incisional surgical site infection

Picture (2) deep incisonal surgical site infection

●Bacterial factors which includes remote site infection, duration wound class, ICU patient, prophylactic antibiotics, preoperative shaving, bacterial number virulence and antimicrobial resistance.
●Local wound factors includes: hematoma , seroma, necrosis , suture, drain, foreign body
● Patient factors includes: age, immunosuppression, steroids, malignancy, malnutrition, multiple comorbidities, transfusion, cigarette smoking, glucose control. A system of classification for operative wounds that is based on the degree of microbial contamination was developed at 1964 (Martone, 2001 and Berard, 1964). Four wound classes with an increasing risk of SSI were described: (clean, clean-contaminated, contaminated and dirty). Table (1)

Microbiology of surgical site infection: The pathogens isolated from infections differs, primarily depending on the type of surgical procedure (Nichols, 1984). In clean surgical procedures staphylococcus aureus from the exogenous environment or the patient skin flora is the usual cause of infection In other categories of surgical procedures including clean, contaminated dirty, the polymicroblial aerobic and anaerobic flora resembling the normal endogenous microflora of the surgically resected organ are the most frequent isolated pathogens (Nichols, 1984).

Prevention of surgical site infection: Most critical factor in the prevention of postoperative infection, although difficult to quantify, are the sound judgment and proper technique of surgeon and surgical team ,as well as general health and disease state of patient (Nichols, 1991 and Nichols, 1991). other factor influence the development of postoperative wound infection, especially in clean surgical procedures from which the infection rate is generally low, infection in these patients may be due to air born exogenous Microorganisms (Nichols, 1996).

Table 1. Classification of operative wounds based on degree of microbial contamination

Clean	Elective not emergency non traumatic primarily closed no break in technique, respiratory ,gastrointestinal .biliary, and genitourinary tracts not entered
Clean-contaminated	Urgent case , elective opening of respiratory, gastrointestinal ,biliary or genitourinary tract with minimal spillage, minor technique break
Contaminated	Non-purulent inflammation gross spillage from gastrointestinal tract, entry to biliary or genitourinary tract in the presence of infected bile or urine, major break in technique
Dirty	Purulent inflammation ,preoperative perforation of respiratory ,gastrointestinal biliary or genitourinary tract.(7,8)

Preventive techniques: The surgical technique used can affect the rate in various ways, for example in relation to skin preparation, shaving and wound closure (Altemeier, 1982). Skin preparation: evidence has shown that the use of a preoperative wash containing chlorhexidine decreases the bacterial count on skin by 80-90%, resulting in a decrease in preoperative wound contamination Prolonged washing releases organisms from deeper layers of the skin (Byrne, 1991). shaving: shaving damages the skin and the risk of infection increases with the length of time between shaving and surgery (Cruse, 1980). Wound closure: the healing of closed surgical wounds depends on many factors, one of the most complex of which is the influence of technique and expertise (Leaper, 1998).

Prophylactic antibiotic use in surgical patient: The use of antibiotic prophylaxis before surgery has evolved greatly in the last 20 years (Nichols, 1999). Quantitative and qualitative nature of the endogenous gastrointestinal flora in health and disease was appropriately defined (Antimicrobial prophylaxis in surgery, 1999). Many studies promoted definitive recommendations Concerning the proper approaches to antibiotic prophylaxis in Surgery (Nichols, 2001). Improvement in the timing of initial administration, the appropriate choice of antibiotic agent and short duration of administration have defined more dearly the value of this technique in reducing postoperative wound infection (Bennion, 1990). The pathologic state of the organ which operated on is the most important determinant of postoperative infections (Browder, 1989 and Nichols, 1984). It is generally recommended in elective clean surgical procedures and in clean contaminated procedures that a single dose of cephalosporin, such as cefazolin, administered intravenously just before incision. Additional doses are generally recommended only when the operation last longer than 2 to 3 hours (Nichols, 1984).

Presentation and Management

Postoperative wound infection present as redness, tenderness, edema, and occasionally drainage. The wound is often soft or fluctuant at the site of the infection Wound infections most commonly occur 5 to 6 days postoperatively but may present sooner or later than that, the patient may have a leukocytosis and a low grade fever. A number of studies have indicated that 80% to 90% of all postoperative infections occur within 30 days after the operation (Courtney, 2005). The cellulitic changes progress steadily if the wound is not opened. When the suspected wound opened, a culture should be obtained of the wound fluid. Gause, dressing is placed in the wound to allow fluid to evacuate with frequent dressing changes (Nichols, 1999). Surgical management of the wound is a critical determinant of the propensity to develop SSI (Troillet, 2001).

In healthy individuals clean and clean- contaminated wounds may be closed primarily , while skin closure in contaminated and dirty wounds is associated with high rate of incisional SSI. The superficial aspect of these wounds should be packed open and allowed to heal by secondary intention, although selective use of delayed primary closure has been with a reduction in incidence in SSl rate (Troillet, 2001).

Aims of the Study

- To identify the overall incidence of surgical site infections and in the four wound categories.
- To identify the incidence of risk factors promoting the development of SSI.

MATERIALSD AND METHODS

A prospective cohort study was conducted on 485 patients, male 190 (39%), females 295 (61%) whom underwent elective or emergency abdominal surgery, and were studied for SSI and factors affecting it in the second general surgical ward in AL-Jumhoori Teaching Hospital between October 2007-October 2008. The dependent factors in this study was abdominal surgical site infection, defined as redness, swelling, pain, warmth, pus discharge, during the 30 days after operation The independent variables were, age, sex, body mass index (BMI-body weight in kg/height in squared meter), time of shaving the site of operation, administration of antibiotics, type of surgical operation, duration of operation, duration of hospital stay and risk factors promoting SS!. Elective and emergency abdominal Surgical procedures were included in this study. Data were collected through a question are. Identification of patients, postoperative interview , frequent examination and follow up for 30 days after operation. The data collected and analyzed by Chi- square test.All four wound categories: clean, clean-contaminated, contaminated and dirty infected wounds were included in this study. Criteria of the US Centers for disease control and prevention (CDC) were used to diagnose SS where they classified as superficial incisional, deep incisional, and organ /space SSI. Bacteria infecting surgical wounds were identified by Swabbing the wound discharge for C&S test.

RESULTS

Of 485 patients who had undergone elective or emergency abdominal surgical procedures, 78 patients (16%) suffered from ssi, Fig (2). In this study the patients were grouped into 7 age groups from under 10 to above 60 years and the mean age was 47 years .The peak age incidence was noted in those patients above 60 years (20%) while only (3%) in patient below 10 years. Table (2). There were 32 male (41%) and 46 female (59%) whom suffered from surgical wound infection FIG.(3). The body mass index (BMI) for 14 patients (183%)

was above 30 indicating obesity and for 15 patients (19%) below 20 indicating malnutrition Fig.(4),According to CDC criteria for SSI there were 45 patients (58%) superficial incisional, ,21 patients (27%) deep incisional and 12 patients (15%) organ /space SSI.Fig.(5). Population distribution of SSl according to type of operation shows that SSI occur mostly after complicated appendicitis 16 (20.5%), penetrated abdominal injuries (bullets and shells) 12 (15.38%), non-complicated appendicitis 8(10.25%), perforated duodenal ulcer 8 (10.25%), mesenteric vascular ischemia 6 (10.25%) , blunt abdominal injuries 4 (5%), large bowl tumor 4 (5%) colostomy closure 4(5%) , hydatid disease 3(3.8%), Para umbilical hernia 3(3.8%), 3 (3.8%) laparoscopic surgery (2 cholecystectomy and 1 Para umbilical hernia repair) , pancreatic pseudocyst 2(2.5%) , incisional hernia 2 (2.5%) , elective cholecystectomy 2(2.5%), female hernia 1(1.2%). Table no. (3). There were 18 (23%) elective operation, 44 atraumatic operation (57&), 12(15%) penetrating traumatic operations, 6 (5%) blunt trauma. Fig. (6). As far as wound class was concerned, the incidence was(5%) for 126 clean wounds, (12%) for 140 clean-contaminated, (28%) for 114 contaminated, and (46%) for 107 dirty infected wounds. Fig. (7) Swab culture from wound site discharge after withholding antibiotics for 3 successive days, clarify that clean wounds were infected most commonly with staphylococcus aureus (80%) while E. coli and Bacteroides were mostly infecting contaminated and dirty wounds (24%), (21%) and (21%) respectively. 18% of contaminated and dirty wounds were infected with mixed aerobic pattern of pathogens :E.coli. and pseudomonas. OF many risk factors contributing to SSI this study shows that systemic shock 23(30%), operative time more than two hours 19(229%), anemia(Hb<10 mg/dl) 17(19.7%),chronic diseases 12(14%) of which diabetes mellitus was the most common and foreign body represented by multifilament suture material G(6.9%) were the most significant in promoting SSI, other risk factors included malignancy 3(3.4%), steroids intake 2(2.3%), jaundice 2(2.3%), wound hematoma 1(1%), and chemotherapy 1(1%) Table (4). The mean hospital stay was 11 days including both preoperative preparation and post operative care.

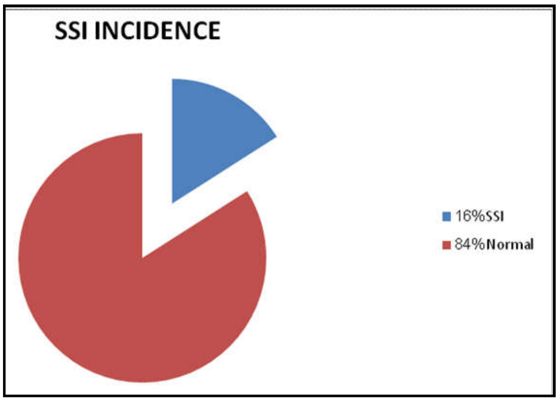

Figure 2. SSIs incidence

Table 2. SSIs Incidence according to age groups

AGE GROUP	NO. of patient	Percentage
< 10 years	3	3%
11_20 years	11	14%
21_30 years	13	16%
31_40 years	13	16%
41_50 years	11	14%
51_60 years	11	14%
> 60 years	16	20%
Total	78	100%

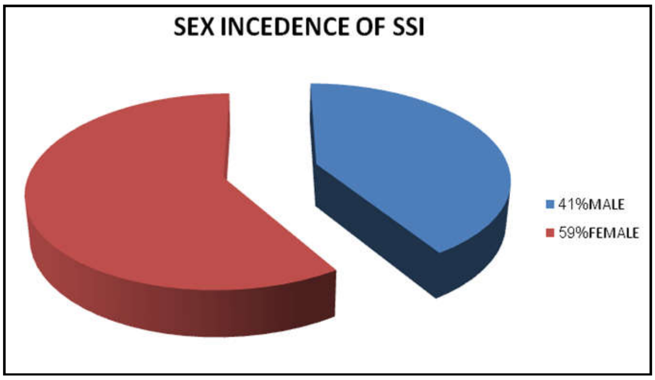

Fig. 3. Sex incidence of SSIs

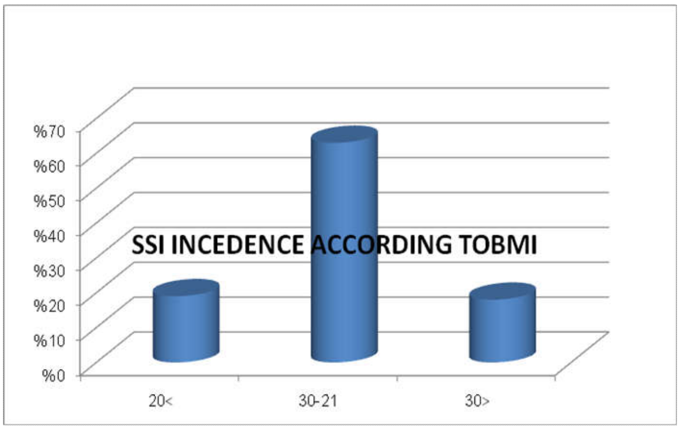

Fig. 4. SSIs incidence according to BMI

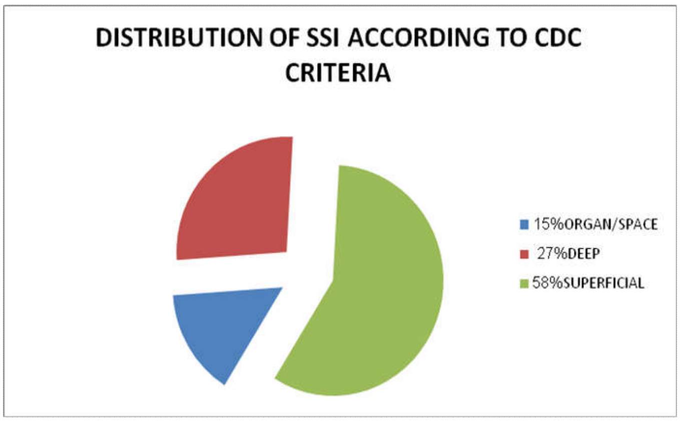

Fig. 5. Distribution of SSIs according to CDC criteria

Table 3. Population distribution based on type of operation

Operation	No of infected pts.	No of non-patient	Percentage of total infected pts.
Complicated appendicitis	16	26	20.5%
Non complicated appendicitis	8	98	10.25%
Bullet and shell injury	12	30	15.38%
Perforated duodenal ulcer	8	26	10.25%
Mesenteric vascular ischemia	6	8	7.6%
Blunt injury (hollow viscous)	4	16	5%
Large bowl tumor	4	22	5%
Closure colostomy	4	14	5%
Hydatid liver disease	3	24	3.8%
Para umbilical hernia repair	3	73	3.8%
Laparoscopic surgery	3	30	3.8%
Pseudocyst of pancreas	2	3	2.5%
Incisional hernia	2	13	2.5%
Cholecystectomy	2	22	2.5%
Femoral hernia	1	2	1.2%
Total	78	407	100%

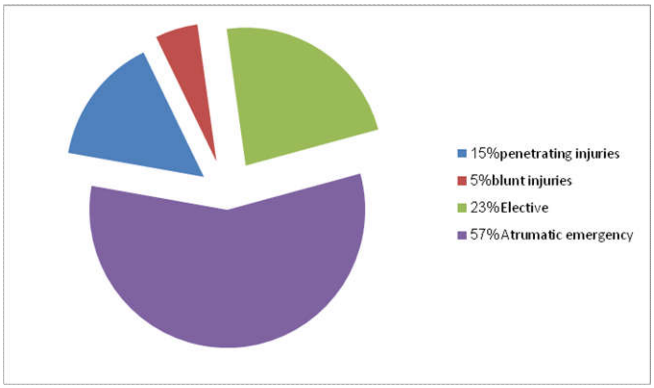

Figure 6. SSI incidence in elective and emergency operations

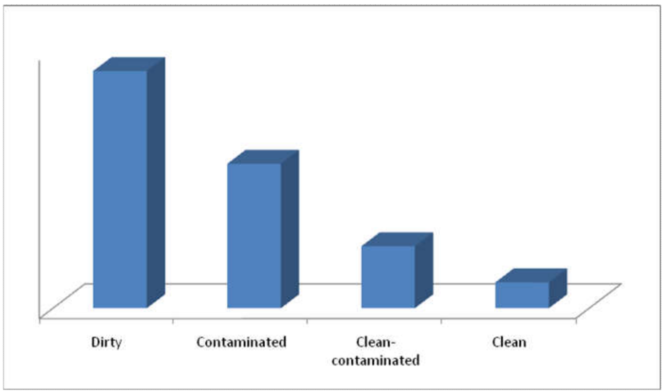

Figure 7. SSI incidence according to wound class

Table 4. Risk factors distribution in relation to SSI

RISK FACTER	No. of patients	%
Systemic shock	23	30%
Operation time > 2 hours	19	22%
Anemia	17	19.7%
Chronic disease	12	14%
Foreign body	6	6.9%
Malignancy	3	3.4%
Steroids	2	2.3%
Jaundice	2	2.3%
Haematoma	1	1%
Chemotherapy	1	1%
Total	86*	100%

Some patient had >1 factor.

DISCUSSION

SSIs Incidence

For 485 patients who had undergone elective or emergency operation the SSl incidence was reported in 78 patient (169%), Razavi and *et al* at reported17.4% in 2005 (Razavi, 2005). Nguyen D and *et al* stated 10.9% in a study done in Vietnam on elective and emergency operations (Nguyen, 1992). Sangrasi *et al* reported SSI incidence in 13% in a study done in Pakistan in 2006 (Sangrasi, 2006). In your study, the peak age incidence of SSI was above 60 years16 patient (20%) with mean age group of 47 years (p=0.01).This result coincide with the study done by Razavi (Razavi, 2005), in that SSI increases with ages above 60 years (P=0.001). Sangrasi AK (Sangrasi, 2006), stated that the mean age incidence was 38.8 years and age is a significant risk factor for increasing SSI (P<0.05). Increasing age is correlated with greater risk of certain chronic conditions, malnutrition and a fall in the body immunological efficiency causing more extensive SSI. A second peak of SSI was found in age groups 21-30 years (39%) and between 31-40 years (13%) The high incidence of SSls due to high number of patients with trauma and delayed presentation of patient in our hospital, this fact is of immense importance since they are young adults, the financial losses including not only the cost of care but also the cost due to losses of economic productivity. No significant relationship was found between sex and SS!(p>o.1), in agreement with the study done by Razav (Razavi, 2005) and the study conducted by Habet-gabr E who state the same finding in a study done in Ethiopia (Habte-Gabr, 1988). The literature shows that SSI increases with obesity (Burkih, 1963), one reason being a decrease in blood circulation in fatty tissues, Malnutrition is another factor predisposing to SSI (Norman, 2008). In this study we considered a BMI above 30 as obese (18%) and that below 20 as malnutrition (19%) significant relationship between the two ranges and SSI extensity (p<0.05). in a study done in Iran found only 9% of patients with SSl their body mass index was above 30 (Razavi, 2005).

Etiology and risk factors: In this study the finding proved the risk of SSl to be less in elective surgery 18 patients(23%) p=0.1 while in emergency surgery, atraumatic emergent procedures from 44 patients(57%), penetrating trauma in 21 patients (15%) and blunt trauma only 4 patients (5%) p<o.o5.this agreed with finding of Razavi (Razavi, 2005), in a study done in Iran at 2005.Lul Raka stated that 53.3% of SSI were emergency procedures (Lui Raka, 2007). This could result from lack of readiness for operation on the patient side Here we should reduce risk factors by preparing the patient for urgent operation as much as possible. According to CDC criteria for surgical site infection, 45 patients (58%) were superficial incisional, 21 patients (27%) were deep incisional and 12 patients (15%) were organ space. This coincide with the study of Lul Raka (Lui Raka, 2007) found that superficial incisional SSI was most common (55%). Leaper (Leaper, 1996) in 2004, and study of Dipiro TJ (Dioirio, 1998) *et al* where they stated that most SSis are superficial, but even so they contribute greatly to the morbidity and mortality associated with surgery. Akihiro (DAkihara, 2008) in a study done in japan in 2007 cited that superficial and deep incisional SSI occurred most frequently (46.2%) In this study the rate of wound infection was 5% in clean operations,12.8% in clean-contaminated. 8% in contaminated and 46% in dirty operation=0.012. The literature shows incidence of 1-3% in clean, 5-8% in clean- contaminated, 20-25% in contaminated and 30-40% in dirty infected wounds (Courtney, 2005). Sangrasi (Sangrasi, 2006). Stated 5.3% in clean, 12.4% in clean-contaminated , 36.3 %in contaminated and 40% in dirty wounds (p<0.01). Hernandez [(31)]. in a study for abdominal surgical site infection found high incidence 13.9% in clean 15.9% in clean-contaminated ,13.5% in contaminated and 47.2%in dirty infected wounds. The high incidence of SSIs in clean wounds in our country and other developed countries might be due to poor technique in sterilization in operative rooms, lack of supplies and poor education of working in these places. Pathogens isolated from infection differs, primarily depending on the type of surgical procedure Staphylococcus aureus was the predominant microorganism isolated from clean wounds (80%) while E.coli (20%) and Bacteroides (20%) were the most common pathogens isolated from clean-contaminated , contaminated and dirty wounds. This wounds agreed with the findings of Nichols RL (Nichols, 1982) in 1984 who stated that in clean wounds Staphylococcus aureus from the exogenous environment patients skin flora is the usual cause of infection while in clean- contaminated, contaminated and dirty wounds, the poly microbial aerobic and anaerobic flora closely resembling the normal endogenous microflora of surgically resected organ are the most frequently isolated pathogens. Erikson NH (Erikson, 1995). Who stated that the skin is colonized by various types of bacteria, but up to 50% of these are staphylococcus in 1995. whyte w (Whyte, 1991). Where they study the contamination rates after cholecystectomy, the main source of wound contamination was the skin of the patient. There were high incidence of SSI low risk cases (clean wounds 5.5%) this coincide with finding of Hernandez (Hernandez, 2005) in a study done in Peru in 1988. Correlation with the systemic shock 23 (30%), duration of operation 2hours 19 (22%), anemia (Hb<10 mg/d) 17 (19.7%) and associated chronic diseases 12 (14%) particularly DM, foreign body represented by multifilament sutures 6(6.9%),malignancy 3(3.4%) were found as the major risk factors (p=0.05).This agreed with the findings of Akihiro w (DAkihara, 2008), in Japan in 2007 who stated that strict asepsis and minimal blood loss were associated with a lower incidence of SSI following gastrointestinal surgery. Razavi (Razavi, 2005). Stated that over half the patients suffered from accompanying conditions such as diabetes, high blood pressure, kidney or liver failure, malignancy, chronic obstructive pulmonary disease, and immunological disorders (P<0.001). In a study done by Sangrasi in Pakistan (Razavi, 2006) stated that haemoglobin level and diabetes were not statistically significant risk factors (P>0.05). The literature shows that with the duration of operation above 2 hours the risk of SSI increases (Courtney, 2005). This supported by this study in which 30% of patients their operations lasted more than 2 hours .This agreed with findings of Haley RW (Haley, 1985), in 1985 and Jepsen OB (Jepsen, 1969)) in 1969. Sangrasi AK (Sangrasi, 2006). Study in Pakistan (P>0.05),Lul Raka (2007). Kosova (P>0.001) and Hernandez (2005) all stated that duration of operation longer than2 hours is an important risk factor contributing to SSl.

This may be related to desiccation or maceration of wound edges, increase in the number of bacteria that accumulate within the wound and decreased temperature and hypovolemia leading to peripheral vasoconstriction and therefore poorly perfused skin. Indeed fewer bacteria are required to produce an infection in the presence of necrotic tissue, foreign body, haematoma, seroma and poor tissue perfusion. The previously reported correlation between SSI and hospital stay (Troillet, 2001 and Burkih, 1963) was supported by this study in which the mean hospital stay was found to be 11 day (P=0.001). Lul RaKa (Lui Raka, 2007) stated that mean hospital stay was 9 days compared with 4 days for those without SSI(P> 0.001) Hernandez (Hernandez, 2005). *et al* stated that patient with SSI had a longer hospital stay than did non infected patients (14 vs 6 days) in a study In Peru(P>.001), SSI are associated with considerable morbidity and occasional morbidity, as well as substantial health care costs and patient inconvenience and dissatisfaction .For that reason surgeons strive to avoid SSI by using prophylactic antibiotics may serve to reduce the incidence of SSl rate during certain types of procedures. Other factors quoted in literature as the condition of operative theater, personal hygiene, accompanied diseases, immunological disorders, smoking, technique of surgeon, surgeon expertise, duration of surgical scrub, preoperative skin preparation, poor haemostasis, failure to obliterate dead space, tissue trauma and Inadequate sterilization of instruments, which were not included in this study might be considered as confounding factors.

Conclusions

- Postoperative surgical site infections were most frequent in elderly, obese patients, Emergency procedures and dirty wounds.
- Systemic shock, prolonged operation, anemia, malnutrition and associated chronic disease are important risk factors.
- Average hospital stay was doubled and cost of hospitalization was correspondingly elevated with postoperative infection.

Recommendations

- Meticulous technique must be applied in elderly patients, obese, emergency operations and dirty wounds.
- Good preparation of patients, reduction of operative time below two hours and control of chronic diseases are important in limitation of SSIs.
- Shortening of Hospital stay decreases occurrence of SSls.

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