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Role of Layer by Layer Irrigation by Povidone Iodine during Closure of Potentially Contaminated Wounds in Reduction of Surgical Site Infection

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ABSTRACT

Background: surgical site infection (SSI) is the infections occurring up to 30 days after surgery that affect the incision, deep tissue at the operation site or involve the organs or body space. Infection at the surgical site remains the second most common adverse event occurring to hospitalized patients and a major source of morbidity following surgical procedures.

Aim of the Work: this study was done to assess the role of irrigation of partially contaminated wounds by povidone iodine in reduction of surgical site infection.

Patients and Methods: this descriptive prospective study was carried out on 100 patients of potentially contaminated wounds at El-Hussein University Hospital and others, Patients divided into two groups A&B each group consisted of fifty patients, Group A: their wounds irrigated layer by layer with povidone iodine during closure, Group B: their wounds closed without irrigation with povidone iodine.

Results: total number of cases with SSI in our study is twenty cases 20% of the total count. In group A there was nine cases two of them showed pus formation. While, in group B there was eleven cases eight of them undergo pus formation.

Conclusion: from our study we concluded that The irrigation of the subcutaneous tissue during closure of potentially (clean) contaminated wounds layer by layer by povidone-iodine 10% solution did not significantly reduces the surgical site infection percentage but significantly reduced the formation of pus within the infected wound cavity and thus reducing the severity of surgical site infection.

Keywords: Surgical site infection (SSI), Potentially (clean) contaminated wound, Povidone-iodine (PVI), Irrigation.

INTRODUCTION

Surgical site infection (SSI) is the infections occurring up to 30 days after surgery that affect the incision, deep tissue at the operation site or involve the organs or body space[(1)]. Despite considerable research on best practices and strides in refining surgical techniques, technological advances and environmental improvements in the operating room (OR), and the use of prophylactic preoperative antibiotics, infection at the surgical site remains the second most common adverse event occurring to hospitalized patients and a major source of morbidity following surgical procedures [(2, 3)]. All surgical wounds are contaminated by bacteria, but only a minority actually demonstrates clinical infection. In most patients, infection does not develop because innate host defenses are quite efficient in the elimination of contaminants at the surgical site. The Centre for disease control and prevention (CDC) [(1)] has established four wound classes based on the degree of contamination with pathogens; Clean, Clean-contaminated, Contaminated and Dirty-infected wounds. The evidence reveals that the risk of SSI increases if the surgical wound is contaminated with more than 105 microorganisms per gram of tissue. However, this threshold is reduced when foreign bodies, such as detritus, sutures, and drains, are present in the surgical wound [(4)]. Clean-contaminated wound is an operative wound in which the respiratory, alimentary, genital, or uninfected urinary tract is entered under controlled conditions, including controlled contamination by the contents of the relevant tract(s), is rated clean contaminated or Class II. Specifically, operations involving the biliary tract, appendix, vagina, and oropharynx are included in this category, provided there is neither evidence of infection nor major break in technique. SSI rates in this class of procedures ranges from 4% to 10 % [(1)]. Most SSIs are caused by gram-positive cocci, including *Staphylococcus aureus* (*S aureus*) and *Staphylococcus epidermis*, organisms colonizing a patient's skin. Meanwhile, there is an increased likelihood of infection caused by gram-negative bacilli after surgery on the GI tract; *Enterococcus faecalis* and *Escherichia coli* are common pathogens after clean contaminated surgery [(5, 6)]. Intraoperative wound irrigation is the flow of a solution across the surface of an open wound to achieve wound hydration and it is widely practiced to help prevent SSI [(7, 8)]. It is intended to act as a physical cleaner by removing cellular debris, surface bacteria and body fluids, to have a diluting effect on possible contamination, and to function as a local antibacterial agent when an antiseptic or antibiotic agent is used. Up to 97% of surgeons state that they use intraoperative irrigation [(7)]. Evidence shows that the irrigation of the incisional wound with an aqueous povidone iodine (PVP-I) solution

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is beneficial with a significant decrease of the risk of SSI when compared to irrigation with a saline solution. There was no evidence for a dose-response effect with regard to the concentration of the PVP-I solution used [9]**.** The microbicidal activity of iodine appears to involve the inhibition of vital bacterial cellular mechanisms and structures, and oxidizes nucleotides fatty/amino acids in bacterial cell membranes, in addition to cytosolic enzymes involved in the respiratory chain, causing them to become denatured and deactivated [10]**.**

AIM OF THE WORK

The purpose of this study is to evaluate the role and efficacy of irrigating the potentially contaminated wounds by povidone iodine in reduction of surgical site infection.

PATIENTS AND METHODS

This descriptive prospective study was carried out on 100 patients of potentially contaminated wounds at El-Hussein University Hospital and others. Patient's selection for this study based on clinical diagnosis, ultrasonographic findings and laboratory findings suggesting the type of wound of the research. **The study was approved by the Ethics Board of Al-Azhar University.** The patients included in the group of the study underwent surgery under the category of potentially (clean) contaminated wound in which the alimentary tract was entered under controlled conditions without unusual contamination. Specifically, surgical procedures involving the biliary tract, appendix, and the intestine provided no evidence of infection is encountered and no major break in technique occurs. The following categories of patients were excluded from the studied groups:Patients with clean wounds, patients with contaminated or dirty wounds, patients with clean contaminated wounds irrigated with materials other than povidone iodine. Patients divided into two groups **A&B** (each group consisted of fifty patients)**: Group A:** all patients in this group their wounds irrigated layer by layer with povidone iodine during closure. **Group B:** all patients in this group their wounds closed without irrigation with povidone iodine. After approval of Local Ethics Committee, all patients included in the study or their relatives were informed well about the procedure and had an informed written consent before carrying the procedure, All the patients included in this study with potentially (clean) contaminated wounds were subjected to the following: **Proper history taking**: Patient demographics and clinical information including age, gender, comorbidities, medical history (hypertension, diabetes, cardiac), surgical history, personal history of smoking or alcohol intake. **Proper physical examination**: Proper physical examination to confirm the diagnosis of the condition**.** ***Preoperative preparation:*** Preoperative patient preparation included the correction of fluid and electrolytes imbalance. Routine preoperative laboratory investigations (CBC, coagulation profile, liver function tests and kidney function tests), abdominal ultrasound and CT were done if needed to confirm diagnosis. ECG and chest X-ray were done to assess the cardio-pulmonary condition. Written informed consent was obtained from all patients included in the study. ***Postoperative follow up:*** Postoperative analgesia was carried out during the first 24 hours and thereafter at the request of the patient. Patients were closely observed postoperatively for adequate pain control, urine output, care of drains, clinical examination and investigations were carried out regularly to follow up the patient general condition and to assess signs of surgical site infection. First wound inspection started after 24 hours post-operative and subsequently dressed and followed up for 30 days. All patients were discharged from the hospital by the second day except those with drains discharged after drain is removed. Later on, patients were followed up in the outpatient clinic up to one month later. ***Statistical methods:*** Qualitative data were described using number and percent. Quantitative data were described using mean and standard deviation for normally distributed data while abnormally distributed data were expressed using median, minimum and maximum. Comparison between different groups regarding categorical variables was tested using Chi-square test. When more than 20% of the cells have expected count less than 5, correction for chi-square was conducted using Fisher's Exact test or Monte Carlo correction.

RESULTS

The age of patients in group A ranged between 7-66 years old with a mean age of (26.86 ± 15.47) years, While that of the group B ranged between 6-60 years old with a mean age of (28.28

± 14.53) years and the statistical analysis revealed that there was no statistical significant difference between patients of both groups as regarding age (p = 1.145 (NS). 26 cases out of cases of the group A (26 /50, 52%) were males and 24 were females (24/50, 48%). While in group B 37 patients (37/50, 74%) were males and 13 of them (13/50, 26%) were females and the statistical analysis revealed that there was no statistical significant difference between patients of both groups as regarding sex p =0.09(NS). ***Operative data:*** The type of operation in group "A" was about 40 appendectomies, 9 surgical cholecystectomies and 1 case of obstructed umbilical hernia with gangrenous loop of ileum within it. While in group "B" the type of operation was 40 appendectomies, 9 surgical cholecystectomies and one case of intestinal obstruction in the form of sigmoid volvulus. The operative time in group A ranged between 25-120 min with a mean value of (48.3) min p=3.5752. While that of group B ranged between 20-120 min with a mean value of (46.9) min (p =7.9304). And the statistical analysis revealed that there was no statistical significant difference between patients of both groups as regarding time of operation (P=0.001) NS.

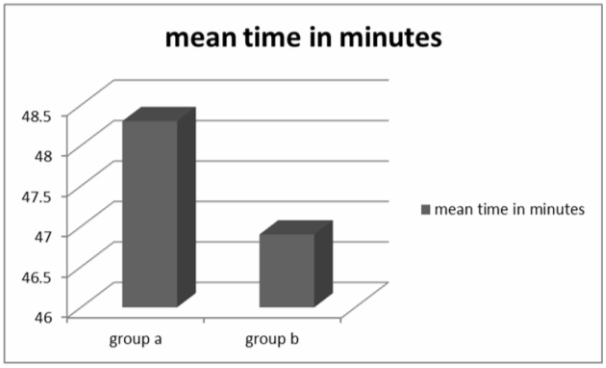

Fig. (1): time of operation in both groups.

23 cases in group A (46%) experienced surgical drain insertion in the form of 13tube drain and 10 rubber drains, 5 of them developed SSI and the remaining cases of this group passed without insertion of drains, while in group B 26 cases (52%) experienced surgical drain insertion 13 of both types, 7 of them developed SSI. The statistical analysis revealed that there was no statistical significant difference between patients of both groups as regarding SSI with inserted drains.

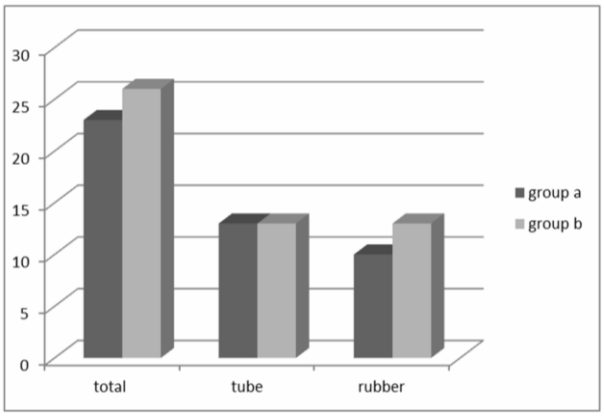

Fig. (2): surgical drains and type of them.

Intra-operative complications: 16 cases in group A (32%) experienced intra-operative complications in the form of suppurative inflammation and perforation of the appendix with spillage of abundant pus. Reaction intra-peritoneum in 10 cases (20%), bleeding at the bed after cholecystectomy in one case (2%), bleeding from slipped ligature of appendicular artery in one case (2%), meckeles diverticulum was found and wedge resection is done in one case (2%), right ovarian hemorrhagic cyst was found and marsupialization was done in one case (2%). A gangrenous ileum was found after opening of obstructed umbilical hernia then resection anastomosis was done in one case (2%), bile leakage after perforation of gall bladder in one case (2%), and the remaining cases of this group passed without complications. While in group B, 19 cases (38%) experienced intra-operative complications in the form of suppurative inflammation and perforation of the appendix with spillage of abundant pus and reaction intra-peritoneum in16 cases (32%), leakage after perforation of gall bladder in two cases (4%) and sigmoid volvulus with resection anastomosis in laparotomy due to intestinal obstruction in one case (2%).

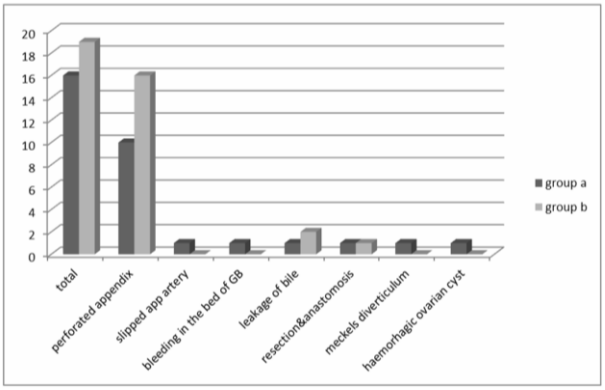

Fig. (3): Intraoperative complications in both groups.

Table (1): Operative data of the studied groups

Variable	Group A	Group B	P
Operative time	72.5	70	0.001
Insertion of surgical drains	(23/50, 46%)	(26/50, 52%)	0.841480581
Intra-operative complications	(16/50, 32%)	(19/50, 38%)	0.002699796

Follow-up Data: Post-operative hospital stay in patients of group A ranged between (24 hours – 6 days) with a mean value of (1.72 ± 1.1073) days. While in group B the hospital stay ranged between (24 hours - 7 days) with a mean value of (1.8 ± 1.069) days and the statistical analysis revealed that there was no statistical significant differences between both groups (p =0.995592541). **Surgical site infection:** Total number of cases with SSI in our study is twenty cases 20% of the total count. In group A there was nine cases two of them showed pus formation. While, in group B there was eleven cases eight of them undergo pus formation. Culture is taken from pus of all cases the most common microorganism was *Staphylococcus aureus* , *Escherichia coli* and *anaerobes* in nine cases which was susceptible to amoxicillin\clavulanate, ciprofloxacin, most cephalosporins and imipenem. Treated with iv ceftriaxone for one week, metronidazole orally and daily dressing. One case with *pseudomonas aeruginosa* which was resistant to amoxicillin\clavulanate and cefotaxime, treated with iv imipenem for 10 days with daily dressing. The surgical wound in both groups were examined up to 30 days post-operative and graded into five grades (0- 4) in accordance with Southampton wound grading system, as shown in figure (4).

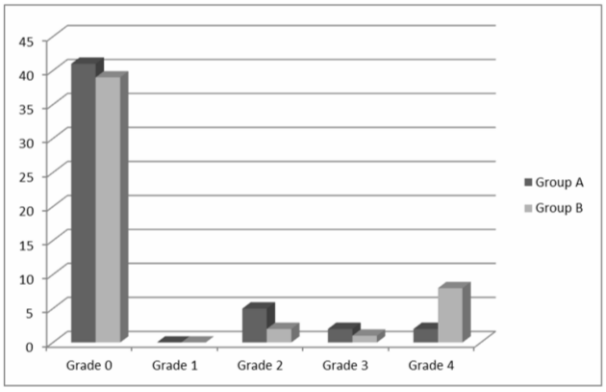

Figure (4): Southampton wound grading of clean contaminated wounds.

The frequency of patients in each Southampton grade was compared between two groups, as shown in table (2). A significantly higher number of patients (p <0.05) in control group B (eight patients) developed purulent discharge (pus) from wound site as compared to study group A (two patients).

Table (2): Comparison of wound infection between case and control group after irrigation of clean contaminated wound according to Southampton wound grading system.

Southampton Wound grade	Total patients n = 100	Group A Povidone irrigation n = 50	Group B No irrigation n = 50	P-Value
Grade 0: Normal healing	80/100 (80%)	41/50 (82%)	39/50 (78%)	0.823063274
Grade 1: Normal healing + mild bruising	0	0	0	0
Grade 2: Erythema/tenderness/heat	7/100 (7%)	5/50 (10%)	2/50 (4%)	0.256839258
Grade 3: Serous discharge	3/100 (3%)	2/50 (4%)	1/50 (2%)	0.563702862
Grade 4: Purulent discharge	10/100 (10%)	2/50 (4%)	8/50 (16%)	0.057779571

Southampton grade 2 and above was considered as surgical site infection. It was present in overall 20 patients (20%), nine patients (18%) from group A and 11 patients (22%) from group B. The difference of surgical wound infection in the two groups was statistically insignificant (p=0.654720846).

DISCUSSION

Patients were divided into two groups, Group A, which consisted of 50 patients with clean contaminated wound that was irrigated by povidone iodine 10% during closure. Group B consisted of 50 patients with clean contaminated wounds, which was closed without irrigation. This study showed that although wound infection rate was not significantly reduced after preoperative irrigation of povidone-iodine 10%; severity of infection was significantly less after subcutaneous irrigation by povidone-iodine 10%. The overall frequency of wound infection in our study was 20%, which is comparable to a wide range of clean contaminated wound infection of 4% to 10% from both local and international literature [11, 12, 13, 14]. In a study from Lahore, Shah demonstrated superficial infection rate of 13.1% in open appendectomy patients, which represents clean contaminated wound[15]. **Mughal and Soomro**[11] showed infection rate of 18%

among pediatric population**.** However, there are studies with low infection rates. **Ahmed *et al*.** [18] Reported wound infection rate of 5% from Lahore, **Chaudhry *et al*.** [16] showed infection rate of 6.4 %. One of the reasons for this varied presentation of wound infection after appendectomy is the inconsistent or non-standardized definitions of wound infection. In most of the local studies mentioned above the definition or criteria to label the wound as infected was not clearly mentioned [11, 12, 13, 16]**.** Since these studies compared laparoscopic with open appendectomy, infection rates of the two groups can be compared but not with other studies [12, 17]**.** In our study, we classified surgical wound according to Southampton wound grading system. This is the recommended classification of wound infection along with ASEPSIS score. CDC classification of surgical site infection has been used by various authors worldwide [17, 19]**.** Southampton grade 2 and above was considered as surgical site infection. Purulent discharge from the surgical wound is the hallmark of ongoing infective process. This purulent discharge (pus) occurred due to the persistent production of inflammatory mediators, metabolic wastes and toxins by the microbial pathogens and along with virulence of the microorganism is a predictor of continued proliferation and growth of the microorganism [20]**.** Antiseptics are agents that destroy or inhibit the growth of microorganisms on living tissue hence limiting the formation of pus in the wound cavity [20, 21]**.** In our study, the irrigation of subcutaneous tissue with povidone-iodine10% significantly reduced the formation of pus from the surgical wound; the infection rate was 4% in the treatment group and 16% in the control group ($p < 0.001$). The treatment group (povidone-iodine) did not experience any interference with wound healing or adverse reactions. **Sindelar and Mason** [22] also showed that local irrigation of abdominal and urological wound with 10% povidone-iodine solution significantly lowered the formation of pus. The infection rate was 2.9% in the treatment group and 15.1% in the control group ($p < 0.001$). The treatment group (povidone-iodine10%) did not experience any interference with wound healing or adverse reactions**. Hiramatsu and colleagues** [23] in their study also demonstrated the beneficial effect of povidone-iodine application on subcutaneous tissue. They randomly allocated 59 patients into two groups. In the treatment group povidone-iodine gel was administered to the subcutaneous tissue and the skin was closed. While in the control group no intervention was done. Wound infection occurred in 18 patients, 5 (16%) in treatment group and 13 (46%) in the control group ($p<0.05$)**.** Various other authors in their studies showed the effectiveness of povidone-iodine application for infection prophylaxis in abdominal, gynecological and ophthalmologic procedures [24, 25]**.** The diagnosis of surgical site infection was based on Southampton wound assessment scale which was observer-dependent and though observed by a single resident that had some degree of observer bias. No intervention was performed in the control group but irrigation with saline could be a possible solution for that.

CONCLUSION

From our study we concluded that The irrigation of the subcutaneous tissue during closure of potentially (clean) contaminated wounds layer by layer by povidone-iodine 10% solution did not significantly reduces the surgical site infection percentage but significantly reduced the formation of pus within the infected wound cavity and thus reducing the severity of surgical site infection.

CONFLICTS OF INTEREST

There are no conflicts of interest.

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