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Postoperative Wound Irrigation Using Distilled Water in Preventing Surgical Site Infection in a Tertiary Hospital: A Retrospective Cohort and Cost-effective Study

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Abstract

Introduction. The incidence of surgical site infections (SSIs) is reducing following the global campaign that requires all the stakeholder involvement. However, of all hospital-acquired infection prevention programs, wound irrigation is hard to be implemented in our hospital. There is a belief that the wound irrigation procedure leading to the spreading of infection. In contrast, the use of antiseptic and topical antibiotic, as well as systemic antibiotic, is uncontrolled high. Thus, we run a cost-effective study of wound irrigation to change the practice.
Method. We carried out a prospective cohort study comparing wound irrigation and the standard protocol in wound care in those underwent median laparotomy during the period of January to July 2018. A total of 80 subjects enrolled in this study, which divided into two groups, 40 for each group. The first group was those treated using antiseptics (povidone-iodine) and antibiotic contained paraffin tulle, while the second group was those treated using irrigation. This study performed in the digestive surgery division, which initiated irrigation protocol for wound irrigation. Stitch specimen taken for bacterial culture proceeded on 7th day postoperative and clinical signs of infection following CDC criteria was observed then statistically analyzed.
Results. The bacterial culture showed no significant difference (p = 0.82) between the two groups. Clinical signs are showing no significant difference between the two groups (p = 1.00). In the cost perspective, the application of wound irrigation saving IDR 57,500,00 or four USD per subject.
Conclusion: Wound irrigation using distilled water efficiently prevent SSIs.

Keywords: Surgical site infections, median laparotomy, wound irrigation, distilled water, bacterial culture, cost-effective

Introduction

Surgical site infections (SSIs) remains a serious problem in the surgical field worldwide. The Center for Disease Control and Prevention (CDC) report 2014 showing an improvement of prevention control as there a reduction of the incidence (up to 31% in 2011) compared to those reported in 1999 (up to 38%) of all hospital-acquired infections (HAIs).[1] The incidence is reduced by 2-5% annually (CDC report 2008), requiring a global effort involves the stakeholders for target achievement. At dr. Cipto Mangunkusumo General Hospital (CMGH) Jakarta, the prevalence of SSIs following abdominal surgery for pediatric surgery (2009-2011) was 7.2%,[2] while as in adult was 7.9%. This prevalence is much lower than those reported by CMGH (23.6% of the total HAIs following abdominal surgery) in 2017, which does not differ to 2014,[3] unfortunately, there were insufficient reports from another Indonesian center at the time. Thus, we have no accurate prevalence for Indonesia.

In infection control, prevention is better than treatment, particularly in SSIs. Some clinical practice guidelines (CPGs) of SSIs[4,5] including those released by the World Health Organization 2016[6,7] recommend the pre-surgical preparation, the use of antiseptics, monofilament threads including those containing antibiotics,[8] irrigation[9] including the intraabdominal cavity,[10,11] proper dressing,[12] the use of prophylactic antibiotics.[13,14] However, in the daily surgical practice at CMGH, wound irrigation is the procedure of low compliance for many reasons. Postoperative wound treatment was following the protocol using povidone-iodine,[15] and topical antibiotic added paraffined tulle[15] as the standard of wound management in addition to the systemic antibiotic. Wound irrigation is avoided as it believed responsible for the spreading of infection, particularly for hospital-acquired infections (HAIs). The success of SSIs reduction is costly, and this was leading to a more particular problem of financial, especially in the era of government insurance system (BPJS) in Indonesia. In addressing such an issue, we run a cost-effective study of wound irrigation using distilled water compared to the standard protocol at CMGH.

Method

A prospective cohort was carried out on adult subjects underwent elective abdominal surgery for any intestinal pathology requiring median laparotomy; with an exclusion, those with sepsis. The calculated minimum sample size was 32 subjects and an additional 10% applied in avoidance for a possible drop out; thus, each group consisting of 36 subjects with a total sample of 72 subjects enrolled. The study performed in dr. Cipto Mangunkusumo Hospital. Specifically, in digestive surgery division, where the wound irrigation (WB) first initiated despite the

standard protocol (SP) since January 2018. The wound in SP group was treated using standard manner in postoperative wound care, i.e., change dressing starting on the second day and continued in two days protocol using povidone-iodine, application of topical antibiotic added paraffined tulle and systemic antibiotic (intravenous gentamycin 80 mg and metronidazole 1.000mg) for five days. The wound in the treatment group (WB) were treated by daily wound irrigation using distilled water starting on the second day postoperatively; no povidone-iodine nor antibiotic added paraffined tulle applied.

We recorded subjects' characteristics (age, gender) including body mass index, classification of surgery (clean-contaminated vs. contaminated). On the seven postoperative days, a stitch was removed and sent to the lab for microbial culture. The clinical sign(s) of infection following the criteria of CDC (i.e. purulent discharge of superficial incision) and any growing microbes in the culture media well as microbial concentration were the object of investigators' interest. Both objects of interest subjected to statistical analysis — the cost of treatment in each group calculated in Indonesian Rupiah (IDR) with currency converter rate at 1 USD = 14253 IDR. The study carried out at CMGH from January to July 2018 and approved by the Committee of Ethics, Faculty of Medicine, Universitas Indonesia 7 May 2018 No. 0444/UN2.F1/ETIK/2018 with Protocol No. 18-03-0308 and 18-03-0313.

Results

During the period, a total of 80 subjects were enrolled in the study, exceeding the number calculated on the proposal; thus, each group consisting of 40 subjects. The subjects mean age was 43.57 years $\pm$ 15.505, and no differences between the two groups [SP, median 44.50 years (19–75) and WB, median 44.00 years (18–67)]. Males: females in the SP group equal (25%:25%) while as in WB group were 21.25%:28.75%. Mean of body mass index (BMI in kg/m^2) in SP group was 22.82 $\pm$ 1.837, whereas in WB group was 22.33 $\pm$ 1.94. The study predominated by clean-contaminated surgery (61.2%), both in the SP group (55%) and WB group (67.5%).

Table 1. Bacterial grow in the culture media and clinical sign(s) of infection in the study.

	Standard protocol	Wound irrigation	p-value
Microbial culture			
– Growing bacteria n (%)	23 (57.5)	22 (55)	0.82*
– No bacterial growth n (%)	17 (42.5)	18 (45)	
A clinical sign of infection			
– Positive sign(s) n (%)	2 (5)	2 (5)	1.00**
– Negative sign(s) n (%)	38 (95)	38 (95)	

* Chi-square analysis, ** Fischer test.

The important findings were the bacterial culture of the two groups, the infections, and clinical sign of infection, as shown in table 1. In the WB group, bacterial culture specified 57.5% bacterial grow in the culture media compared to 55% in SP group (p-value of 0.82; Chi-Square test). Meanwhile, in both groups, the clinical sign of infection was found negative result in up to 95% subjects. Two subjects in each group were showing clinical sign of infection, but no pus formation; thus, confirmed as a superficial type of SSI (p-value = 1.000; Fischer test). The growing bacteria in the culture media predominate by Staphylococcus epidermidis (17.5%) which was the common bacteria found on the human skin. Description of the growing bacteria in the culture media, as shown in table 2.

Table 2. The growing bacteria in the culture media

Bacteria	n (%)
Sterile	35 (43.75)
Staphylococcus epidermidis	14 (17.5)
Sphingomonas paucimobilis	2 (2.5)
Escherichia coli	4 (5)
Bacillus sp.	4 (5)
Micrococcus luteus	1 (1.25)
Staphyloccocus aureus	9 (11.25)
Escherichia hermannii	3 (3.75)
Enterococcus faecalis	4 (5)
Acinetobacter baumannii	2 (2.5)
Staphylococcus saprophyticus	2 (2.5)

Further analysis was performed to find out the effect of classification of surgery toward bacterial growth. We found the difference between contaminated– and clean-contaminated surgery (p-value of 0.01) with positive culture was more profound in contaminated surgery (table 3).

Table 3. The association between bacterial growth and the classification of surgery

	Positive culture	Negative culture	p
Clean–contaminated (n = 49)	22 (44.9%)	27 (55.1%)	0.01*
Contaminated (n = 31)	23 (74.2%)	8 (25.8%)	

In the study, the total cost for seven days postoperative wound care in WB group was IDR 385,500 or USD 27 for each subject, whereas in SP group was IDR 432,600 or USD 30.33; thus, saving IDR 57,500,00 per subject (1 USD =14253IDR). Cost-saving in WB group predominated from cutting of antibiotics dressing cost.

Table 4. The total cost of postoperative wound care for a subject (in IDR)

Items	Price per item	Cost			
		Pcs	Wound irrigation	Pcs	Standard protocol
Aquadest 500 mL	11,500	1	11,500	0	0
Sterile glove (pair)	10,000	5	50,000	3	30,000
Sterile gauze (pack)	6,000	3	18,000	3	18,000
Syringe 50 mL	15,000	1	15,000	0	0
Tulle dressing (sheet)	12,000	0	0	9	108,000
Transfer set for sterile fluids	4,000	1	4,000	1	0
Plaster	5,000	3	15,000	3	15,000
Culture*	250,000	1	250,000	1	250,000
Total			363,500		421,000

Discussion

The goal of the study is to find out the efficacy of wound irrigation using distilled water and addressed to replace the standard protocol in a natural

way to provide a suitable and conducive wound environment let the healing process proceeded. The basic concept is to provide cleanliness physiologically and prevent infection at a time. Irrigation the wound is proven to be useful to prevent infection as dilution is the solution for pollution, meanings, the number of microbes in the colony will never be achieved to meet the criteria of infection (namely, 10^5 per gram tissue, or centimeter cubic tissue). Irrigation is not aimed to provide a sterile environment, but cleanliness. A distilled water is chosen as it not containing the sodium of 154 milliequivalents per liter (and chloride of 100 milliequivalents per liter as well) as in abnormal nor physiologic saline of which, may lead to cellular/tissue hyperchloremic acidosis.[16,17] Compared to Ringer's lactate containing the sodium, which is equal to human serum (134 milliequivalents per liter), distilled water is less expensive.

The efficacy of dilutional process as shown through the assessment of colony-forming unit per milliliter or milligram (CFU/mL or CFU/mg) of which, unfortunately in this study enfacing the laboratory constrain. However, growing bacteria is shown in the culture media, indicating microorganisms that were not different from those treated using antibiotic contained paraffin tulle. Clinically, the assessment of infected wound is following the guideline provided by the CDC.[18]
The clean-contaminated wound is found predominate in the study (61.2%), and we found those with the positive sign of infection both in contaminated and clean-contaminated were two subjects in each group, indicating there was no difference between these two groups. What the interesting is, even though in a contaminated wound, the dilution is quite useful to control infection even in a contaminated one as the dirty wound has a higher risk to get infected (the chance in a clean wound is 2.9%, in a clean-contaminated wound 3.9%, contaminated wound 8.5%, and in a gross injury is 12.6%).[19,20]

There were studies focused on wound irrigation showing no difference with those, not in the occurrence of SSIs. A systematic review found studies showing no significant difference in the incidence of infection and healing process in wound irrigated with tap water and sterile saline. An RCTs on 121 subjects following hernia repair and abdominoperineal resection showing no significant difference in the occurrence of SSIs between those taking a shower on the first postoperative day and those proceeds in 2 weeks after surgery. Another study of 82 subjects also showing no significant difference between those taking a bath on the second postoperative day and those who did not (OR 0.53; 95% CI 0.09-3.05). Those two studies show that wound irrigation using tap water did not lead to SSIs. There was also an RCTs focused on the use of topical antibiotic and found no significant difference in the use of topical antibiotics to prevent the occurrence of postoperative SSIs in orthopedic patients (OR 0.43; 95% CI 0.12-1.54). Thus, whether using or topical antibiotics not, it does not impact the occurrence of SSIs.[21,22]

In this study, growing bacteria in the media was Staphylococcus epidermidis (17.5%), of which is a part of normal human skin flora. This finding quite differs to those reported during the bacterial pattern on the CMGH surgical ward (2016), namely Escherichia coli.[23] It is reasonable since the specimens in the study taken from stitch without a sign of infection, while as the report of bacterial pattern in CMGH taken from infected sites, particularly wherever there was pus.

Nevertheless, this study focused on the cost of wound care as well and found that wound irrigation using distilled water required a lower cost than the standard one, which is less IDR 57,500 or four USD per subject. However, in daily practice, the total cost will be reduced by culture (250,000). Thus, wound irrigation is efficient and may be implemented in the region, changing the daily practice.
However, the study enfacing the limitation, which is essential, namely the constrain to provide an assessment of colony-forming unit to provide the efficacy of dilution using distilled water.

Conclusion

Wound irrigation using distilled water efficiently prevent SSIs.

Disclosure

Authors declare no conflict of interests.

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