Effects of Chlorhexidine and Normal Saline Povidone Iodine as Interventions to Post- Operative Patients: Enhanced Wound Care Clinical Guidelines

Christian S. Tu, RN MSN
St. Dominic College of Asia
ctu@sdca.edu.ph

Abstract – *Surgery is a crucial event in any person's life. A wound that results from surgery is generally considered to be 'clean', and as a result is often judged as less of a clinical challenge than some other wound types. Many methods and techniques related to wound care exist, and using chlorhexidine is very rarely done in the Philippines. This study utilized an experimental research design with pre-test and post-test control group design. The respondents were post-operative patients with inclusion criteria. Simple random sampling was used to choose the respondents. The control group received standard treatment using normal saline povidone-iodine while the experimental group received treatment using chlorhexidine. Forty samples were randomly selected, each group has 20 samples. In terms of wound size measurement p value 0.046 < 0.05, skin integrity, p value 0.000 < 0.05, wound healing process p value 0.000 < 0.005, and risk of infection p value 0.000 < 0.05. Results show that there were significant differences and were notably documented between two groups. The results of the study revealed that there is a significant difference between using normal saline povidone-iodine and chlorhexidine as intervention to wound care of postoperative patients. Chlorhexidine was more effective than normal saline povidone-iodine in reducing the length of the wound size, showed an increase in skin integrity, gave an increased wound healing process, and prevented the risk of infection. On the other hand, normal saline povidone-iodine reduced the width of wound. An enhanced clinical guideline on wound care was developed and proposed.*

Keywords – *Wound Care, Povidone-Iodine, Normal Saline, and Post-Operative Patients.*

Introduction

Having a surgery is a major event in any person's life. Clients faced with surgery want to know that someone is there with them and will protect them during a time when they may have no control or any self-care abilities. The postoperative is the final stage of the perioperative period. The focus of this period is that care shifts from intense physiologic management and symptomatic relief of the adverse effects of anesthesia, to regaining independence with self-care and preparing for discharge. Despise these gains, the postoperative patient is still at risk from complications. Atelectasis, pneumonia, deep vein thrombosis, pulmonary embolism, constipation, paralytic ileus, and wound infection are ongoing threats for the postoperative patient (Smeltzer et.al. 2009).

According to Vermeulen et.al. (2008), a wound that results from surgery is generally considered to be "clean", and as a result is often judged as less of a clinical challenge than some other wound types. Most surgical wounds heal by primary intention, with the margins of the surgical incision closing up with either stitches or clips. These are left in place until the edges heal.

As said by Rainey (2008), studies have shown that after 24 hours the skin will have form a natural barrier at the suture or clip line, which means that a dressing may be unnecessary. Patients will require dressings if there is any leakage from the suture line, or to protect the wound from rubbing

on clothing. Some areas, such as the groin after varicose vein surgery, may be particularly prone to friction and may require a light dressing to absorb any perspiration and to reduce friction.

The most frequently used fluids are tap water, physiological "normal" saline, or antiseptics (Rainey, 2008). Physiological saline is a widely recommended wound dressing compatible with human tissue. It causes no damage to new tissue and does not affect the functions of fibroblasts and keratinocytes in healing wounds. Its effectiveness in preventing infection has not been ascertained (Salami, Imoseni and Owoeye, 2007).

Salami, Imoesene and Owoeye (2006), researched three groups of Wistar rats had 2 by 2 cm. Wounds with full thickness were made on their right dorsolateral flanks to compare the effect of chlorhexidine, tap water, and normal saline on healing wounds. The result showed an inhibitory effect of chlorhexidine on healing wounds. On day nine, the wound contraction in the antiseptic group was less than the tap water and saline group. The average number of days for wound healing to be completed in the antiseptic group was more than the other two. These results were statistically significant when compared with the other two groups. There was no statistical difference in the wound contraction values and rate of healing of the saline- and tap water-dressed wounds. All the wounds dressed with antiseptic also had greenish exudates on their surface with pale looking granulation tissue, and there was greater mortality in this group.

In the clinical study of Darouiche et.al (2010) they approximately compared the efficacy in preventing post-operative infection using chlorhexidine-alcohol vs. povidone-iodine (overall, 9.5% vs. 16.1%). Chlorhexidine-alcohol was significantly more protective than povidone-iodine against both superficial incisional infections (4.2% vs. 8.6%) and deep incisional infections (1% vs. 3%). The incidence of organ space infections was, however, not significantly different between the groups (4.2% vs. 4.5%). The team performing the study believed that, although both the antiseptic preparations possessed broad-spectrum antimicrobial activity, the more effective protection provided by chlorhexidine-alcohol may be due to its more rapid action, its persistent activity (even when exposed to bodily fluids), and some other residual effects.

Statement of the Problem:

The study aimed to compare the differences between chlorhexidine and normal saline povidone-iodine for the wounds of post-operative patient in selected hospitals in Bacoor City, Cavite.

1. What are the profile variables of the post-operative patients in terms of Age, Marital Status, Employee Status, Educational Attainment, and Reason for Surgery?
2. What is the status of post-operative patients' wounds pre- and post-therapy in two groups in terms of: Skin Integrity and Risk for Infection?
3. What is the difference in pre- and post- treatment of post-operative wound in terms of Skin Integrity and Risk for Infection?
4. Is there a significant difference in the wound healing process when using Chlorhexidine and Normal Saline Povidone-Iodine on post-operative patients when grouped according to demographic profile?
5. Based from the result of the study, what is the best intervention in the healing process of post-operative patients that would enhance wound care clinical guidelines?

Null Hypothesis

Ho. There is no significant difference in the wound healing process between using Chlorhexidine and Normal Saline Povidone-Iodine when grouped according to demographic profile.

Ho. There is no significant difference between the utilization of chlorhexidine and Normal Saline Povidone-Iodine as adjunct treatment for post-operative wounds.

Research Paradigm

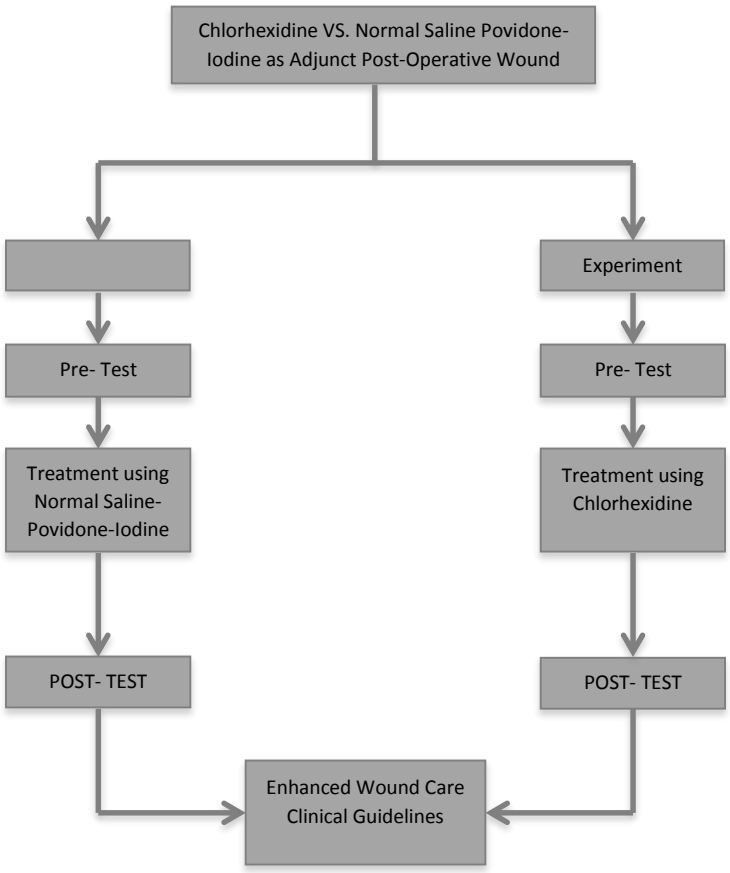

Figure 1. Research Paradigm

Research Methodology

The researcher utilized quantitative research and used the true experimental pretest-posttest design. In this design, the dependent variable is measured at two points in time: before and after the experimental intervention (Polit and Hungler, 1999). The independent variables of this study is wound care using Povidone-Iodine and Normal Saline, while the dependent variable is the wound healing process of postoperative patients.

The population in this study consists of postoperative patients in the selected hospital in Cavite.

The samples were chosen by inclusion criteria. The criteria for the sample selection are: 2 hours postoperative patients, the size of the wound is more than 5cm, the patients are conscious, they are

without another complication or disease, they are hospitalized, they have received antibiotic and analgesic medication, they are ages 30 to 35 years old, and they are without nutritional status disturbances. The researcher used an observation chart to measure skin integrity pre- and post-treatment in all groups. To find the difference between the postoperative patients profile and wound healing process using Povidone-Iodine and Normal Saline, a t-test (paired) was utilized.

Table 1. Profile of Respondents

PROFILE	FREQUENCY	PERCENTAGE
AGE (YEARS OLD)		
30 to 40	2	20%
40 to 50	6	60%
51 to 55	2	20%
LEVEL OF EDUCATION		
Elementary Undergraduate	6	60%
Elementary	1	10%
Junior High School	0	0%
Senior High School	3	30%
GENDER		
Male	7	70%
Female	3	30%
MARITAL STATUS		
Single	1	10%
Married	9	90%
EMPLOYEE STATUS		
Farmer	5	50%
Factory Worker	3	30%
Merchant	1	10%
Unemployed	1	10%
TYPE OF SURGERY		
BPH	3	30%
Fracture	5	50%
Appendicitis	2	20%
Illeus	0	0%

Each group had five (5) respondents, and the total number of respondents equal to ten (10). Based on an analysis made on twenty (20) respondents, which can be seen in Figure 2, the age of the respondents consisted of mostly 40 to 50 year olds, which amounted to six (6) (60%). The majority of the respondents graduated from elementary school, which includes six (6) of the respondents (60%). For the employment status of the respondents, the majority came from the Farmer category, consisting of five (5) respondents (50%). For the type of surgery, the most common among the respondents is due to Fractures, since five (5) of the respondents underwent surgery in relation to attaining a fracture (50%).

Table 2. Status of Postoperative Patients Pre and Post Treatment

CHARACTERISTIC	**SKIN INTEGRITY**				**RISK OF INFECTION**			
	WOUND SIZE (cm)		**CONDITION OF WOUND**		**LEUKOCYTE (mmk/L)**		**TEMP (C°)**	
Control Group	**Pre Test**	**Post Test**	**Pre Test**	**Post Test**	**Pre Test**	**Post Test**	**Pre Test**	**Post Test**
1	10.7	10.6	20	13	5500	5400	37.1	37.1
2	6.8	6.7	20	15	7300	7000	36.9	36.8
3	13.9	13.8	20	19	5400	5500	37.5	37.1
4	5.2	5.1	20	18	4700	5000	36.7	36.9
5	6.3	6.1	20	14	6700	7100	37.0	37.1
Experimental Group								
1	1.7	5.5	20	20	6100	6140	37.2	36.8
2	7.9	7.8	20	18	5900	6100	36.6	36.8
3	6.1	6.0	20	17	8200	8100	37.0	36.8
4	5.2	5.1	20	15	7360	7200	36.8	36.9
5	6.3	6.2	20	19	8300	8000	37.4	36.8

Table 2 describes the status of the respondents in their respective groups before and after the treatment was given. In the category of wound healing, it was split into two aspects: skin integrity and risk of infection. Skin Integrity includes the wound size and the condition of the wound, while Risk of Infection includes the number of leukocytes and the body temperature of the respondents.

Table 4. Difference between Control and Experimental Groups before Treatment

PRE TEST	WOUND HEALING	CRITERION	MEAN	SD	INTERPRETATION
Control Group	Skin Integrity	Wound Size (cm)	8.57	3.626	-
		Wound Condition	1.00	0.000	Very Good
	Risk of Infection	Leukocyte (mmk/L)	2.00	0.000	Normal
		Temperature (C°)	2.00	0.000	Normal
Experimental Group	Skin Integrity	Wound Size (cm)	7.48	2.346	-
		Wound Condition	1.00	0.000	Very Good
	Risk of Infection	Leukocyte (mmk/L)	2.00	0.000	Normal
		Temperature (C°)	2.00	0.00	Normal

Table 4 shows the status of the wound before being given treatment in the control and experimental group. In the control group, the skin integrity is normal, while the wound condition is very good. Based on the data above, the control group has no risk of infection, which was proven by the normal number of leukocytes and body temperature. In the experimental group, the skin integrity was also normal, wound condition was very good as well, and the experimental group was also not in risk of infection, also proven by the normal number of leukocytes and body temperature.

Table 5. Difference between Control and Experimental Group after Treatment

POST TEST	WOUND HEALING	CRITERION	MEAN	SD	INTERPRETATION
Control Group	Skin Integrity	Wound Size (cm)	8.51	3.636	-

		Wound Condition	1.60	0.000	Good
	Risk of Infection	Leukocyte (mmk/L)	2.00	0.000	Normal
		Temperature (C°)	2.00	0.000	Normal
Experimental Group	Skin Integrity	Wound Size (cm)	7.37	2.355	-
		Wound Condition	1.20	0.447	Very Good
	Risk of Infection	Leukocyte (mmk/L)	2.00	0.000	Normal
		Temperature (C°)	2.00	0.00	Normal

Table 5, shows the status of the wound after being given treatment in the control and experimental group. In the control group, the skin integrity is still normal, while the wound condition is reduced to a state of being very good to just good. But the control group still has no risk of infection, which is proven by the normal number of leukocytes and normal body temperature. In the experimental group, the skin integrity is still normal, wound condition is still very good, and the experimental group is still in no risk of infection, which is also proven by the normal number of leukocytes and body temperature.

Table 6. Difference between Control and Experiment Group in Terms of Size of Wound

Control Group	Pre Test (cm)	Post Test (cm)	Decreased Wound Size (cm)	Percentage

1	10.7	10.6	0.1	0.09%
2	6.8	6.75	0.05	0.07%
3	13.9	13.86	0.04	0.03%
4	5.2	5.12	0.08	0.02%
5	6.3	6.21	0.09	0.01%
Mean	**8.58**	**8.51**	**0.072**	**0.04%**

Experimental Group	**Pre Test (cm)**	**Post Test (cm)**	**Decreased Wound Size (cm)**	**Percentage**
1	5.7	5.53	0.17	3.00%
2	7.9	7.8	0.1	1.00%
3	6.1	6.02	0.08	1.00%
4	6.3	6.21	0.09	1.00%
5	11.4	11.3	0.1	0.90%
Mean	**7.48**	**7.37**	**0.108**	**1.00%**

Table 6, shows the comparison between the size of wound before and after treatment in both groups. In the control group the percentage for the decrease in wound size is 0.04%, while in the experimental group the percentage for the decrease in wound size is 1.00%. This means that in the experimental group the decrease in wound size was better than the progress made by the control group in terms of decrease in wound size.

Table 7. Difference Between Profiles and Wound Healing Using Povidone-Iodine and Normal Saline

VARIABLE	P VALUE	INTERPRETATION	DECISION
AGE	0.667	Not Significant	Accept Null Hypothesis
LEVEL OF EDUCATION	1.141	Not Significant	Accept Null Hypothesis
GENDER (Wound Healing)	0.483	Not Significant	Accept Null Hypothesis
MARITAL STATUS (Wound Healing)	0.316	Not Significant	Accept Null Hypothesis
EMPLOYMENT STATUS	1.197	Not Significant	Accept Null Hypothesis
TYPE OF SURGERY	0.789	Not Significant	Accept Null Hypothesis

There is no significant difference between profile and wound healing using povidone-iodine and normal saline. No significant differences were found between age and wound healing, which was divided into two groups: P value 0.667 > 0.05 means that, the null hypothesis is accepted. Level of education does not influence wound healing, P value 1.141 > 0.05 means that there is no significant difference between level of education and the healing process. Gender in terms of wound healing is also insignificant. Marital status is also insignificant in terms of wound healing, P value of 0.316 > 0.05 shows that the null hypothesis is accepted. Employment status has a P value of 1.197 > 0.05, which means there is no significant difference between employment status and wound healing. For the type of surgery the P value is 0.789 > 0.05, it means that the null hypothesis is accepted as well.

Table 8. Difference of Effects between Using Povidone-Iodine and Normal Saline to Postoperative Patients

DIFFERENCES	VARIABLE	P VALUE	INTERPRETATION	DECISION
Pre Test Control Group vs. Post Test Control Group	*Skin Integrity*			
	Size of Wound (cm)	0.043		
	Condition of Wound			
		1.000		
	Risk of Infection			
	Leukocytes (mmk/L)			Accept Null Hypothesis
	Temperature		Not Significant	
	(C°)	1.000		
		1.000		
Pre Test Experimental Group vs. Post Test Experimental Group	*Skin Integrity*			
	Size of Wound (cm)	0.042		
	Condition of Wound			
		0.317		
	Risk of Infection			
	Leukocytes (mmk/L)			Accept Null Hypothesis
	Temperature		Not Significant	
	(C°)	1.000		
		1.000		
Post Test Control Group vs. Post Test Experimental Group	*Skin Integrity*			
	Size of Wound (cm)	0.893		
	Condition of Wound			
		0.317		
	Risk of Infection			
	Leukocytes (mmk/L)			Accept Null Hypothesis

Temperature (C°)		1.000	Not Significant
		1.000	

Table 8, shows the difference of effects between using povidone-iodine and normal saline to postoperative patients and according to the table that in the control and experimental group, the use of either normal saline or povidone-iodine has no significant differences. Therefore the null hypothesis is accepted.

Wound healing, as a normal biological process in the human body, is achieved through four precisely and highly programmed phases: hemostasis, inflammation, proliferation, and remodeling. For a wound to heal successfully, all four phases must occur in the proper sequence and time frame. Many factors can interfere with one or more phases of this process, thus causing improper or impaired wound healing. Knowledge of the physiology of wound healing, in particular the recovery of the dermal and epidermal compartments and the coordination of these processes by the cytokine network, is of great importance to rational wound management. Various 'systemic factors' (endocrine and haematological diseases, nutritional deficiencies and medications) and 'regional disorders' (vascular and neural diseases) may impair wound healing. These complications occur more frequently in aged subjects. The factors include oxygenation, infection, age, sex hormones, stress, diabetes, obesity, medications, alcoholism, smoking, and nutrition. A better understanding of the influence of these factors on repair may lead to therapeutics that improve wound healing and resolve impaired wounds.

The wound-healing process consists of four highly integrated and overlapping phases: hemostasis, inflammation, proliferation, and tissue remodeling or resolution (Gosain and DiPietro, 2004). These phases and their biophysiological function must occur in the proper sequence, at a specific time, and continue for a specific duration at an optimal intensity (Mathieu et al., 2006). There are many factors that can affect wound healing which interfere with one of more phases in this process, thus causing improper or impaired tissue repair.

Wound healing is a dynamic process, and each phase must happen in a precise and regulated manner. Interruptions, aberrancies, or prolongation in the process can lead to delayed wound healing or a non-healing chronic wound. In adult humans, optimal wound healing involves the following the events: (1) rapid hemostasis; (2) appropriate inflammation; (3) mesenchymal cell differentiation, proliferation and migration to the wound site; (4) suitable angiogenesis; (5) prompt re-epithelialization (re-growth of epithelial tissue over the wound surface); and (6) proper synthesis, cross-linking, and alignment of collagen to provide strength to the healing tissue (Gosain and Dipietro, 2004). The first phase of hemostasis begins immediately after wounding, with vascular constriction and fibrin clot formation. The clot and surrounding wound tissue release pro-inflammatory cytokines and growth factors such as transforming growth factor (TGF)-β, platelet-derived growth factor (PDGF), fibroblast growth factor (FGF), and epidermal growth factor (EGF). Once bleeding is controlled, inflammatory cells migrate into the wound (chemotaxis) and promote the inflammatory phase, which is characterized by the sequential infiltration of neutrophils, macrophages, and lymphocytes (Campos et al., 2008).

The majority of the respondents belonged to the age group of 40 to 50 years old, 6 of the respondents come from this age group (60%). It means that the respondents are mostly middle-aged adults. The individual components of the wound healing process have been studied using various in-vitro and in-vivo models, comparing young, adult, and aged individuals. In the elderly, many of the processes involved in wound healing are impaired. However, the elderly patients not suffering from concomitant diseases, the rate of wound healing is normal or (initially slightly reduced). Failure of wound healing in the elderly is a chronic disabling condition, which occurs frequently in our society, requiring a major investment of medical care (Kerkhof et al., 2006)

The elderly population (people over 60 years of age) is growing faster than any other age and increased age is a major risk factor for impaired wound healing. Many clinical and animal studies at the cellular and molecular level have examined age-related changes and delays in wound healing. It is commonly recognized that, in healthy older adults, the effect of aging causes a temporal delay in wound healing, but not actual impairment in terms of the quality of healing (Gosain and DiPietro, 2004; Keylock et al., 2008). Delayed wound healing in the aged is associated with an altered inflammatory response, such as delayed T-cell infiltration into the wound area with alterations in chemokine production and reduced macrophage phagocyctic capacity (Swift et al., 2001). Delayed re-epithelialization, collagen synthesis, and angiogenesis have also been observed in aged mice as compared with young mice. Overall, there are global differences in wound healing between young and aged individuals. A review of the age-related changes in healing capacity demonstrates that every phase of healing undergoes characteristics age-related changes, including enhanced platelet aggregation, increased secretion of inflammatory mediators, delayed infiltration of macrophages and lymphocytes, impaired macrophage function, decreased secretion of growth factors delayed re-epithelialization, delayed angiogenesis and collagen deposition, reduced collagen turnover and remodeling, and decreased wound strength (Gosain and DiPietro, 2004).

Several treatments to reduce the age-related impairment of healing have been studied. Interestingly, exercise has been reported to improve cutaneous wound healing in older adults as well as aged mice, and the improvement is associated with decreased levels of pro-inflammatory cytokines in the wound tissue. The improved healing response may be due to an exercise-induced anti-inflammatory response in the wound (Emery et al., 2005: Keylock et al., 2008).

In this study there is no relationship between age and the wound healing process. It is maybe caused by the respondents being from the same age category, so the researcher cannot evaluate differences in wound healing in regards to age.

A majority of the respondents graduated elementary school, a total of six (6) respondents (60%). As many as five (5) respondents work as farmers (50%). These variables do not influence the wound healing process. Seven (7) respondents are males and three (3) are females. Differences in circulating sex steroid levels may underscore gender and age-related disparities in wound healing progression. Data from both human and rodent models indicate that Estrogen accelerates wound healing and dampens the local inflammatory response (Ashcroft et al., 2003). The regulatory roles of androgens are less well-characterized. Reports suggest that healing of incisional wounds is accelerated in castrated mice compared with controls, and is accompanied by reduced inflammation and an increase in wound collagen content (Ashcroft & Mills, 2002).

Some sex hormonal activity that influence healing process identified by (Gilliver et al. 2006) are:

Effects of Androgens on Macrophage Activity

Rat peritoneal macrophages were isolated by intra-peritoneal lavage with sterile ice cold sterile PBS and were pooled for subsequent studies. Cell viability was determined using Trypan Blue (Sigma). 2_106 cells/ml in suspension in serum-free Phenol-Red-Free DMEM medium that was treated for six (6) hours with DHT (10-8M) or testosterone (10-8M), or left untreated. For the final three (3) hours of the incubation period, one of the following inhibitors was added to the culture medium: 5_M actinomycin D, 10_M cycloheximide, 10_M PD 98059 (MAPK inhibitor) or 100 nM wortmannin (PI 3-kinase inhibitor) (all sigma). Additional macrophages were exposed for eighteen (18) hours to the following androgen concentrations: DHT (10-7 M or 10-8 M) or testosterone (10-7M or 10-8M).

Effects of androgens on fibroblast activity

Primary rat dermal fibroblasts were isolated by a previously-described explant technique (Freshney, 1987). Cells were maintained in phenol red-free DMEM supplemented with 5% (v/v) heat-inactivated fetal calf serum. At passage five, cells were seeded to 6-well plates and at 90% confluence were switched to a serum-free medium for a period of 24 hours. The fibroblasts were then treated for six (6) hours with or without DHT or testosterone and for three (3) hours with inhibitors as detailed above for macrophage culture.

Enzyme-linked immunosorbent assay (ELISA)

After the incubations described above the cells were pelleted by centrifugation and the supernatant was stored at -80°C for ELISA analysis of IL-6, TNF-_ (both Biosource International, Nivelle, Belgium) and active TGF-_1 (Promega). The assay was performed according to the manufacturers' instructions.

In this study, the researcher could not find any affectations of gender as to the wound healing process. This is perhaps due to the small amount of respondents the researchers utilized.

Fracture is the most common surgery performed in this study, five (5) respondents underwent surgery for fracture (50%). It falls under category of Class II. Class II (clean-contaminated wounds) refers to a surgical wound in which the respiratory, alimentary, genital, or urinary tracts are entered under controlled conditions and without unusual contamination. Specifically, surgical procedures involving the biliary tract, appendix, vagina, and oropharynx are included in this category, provided no evidence of infection is encountered and no major break in technique occurred (Chards, 2008).

The result of the pre-test showed that the wound conditions in both groups are very good. This is because the researchers determined the criteria that the respondents are clients who have undergone surgery with sterile wounds. After treatment, a change from very good condition to good condition occurred in the control group, while the very good condition was sustained in the experimental group. Based on the findings, there is a change in wound size in both groups. In terms of wound care using povidone-iodine, the percentage of decreased wound size is 0.04% in the control group, whereas the decreased wound size is 1.00% in the experimental group, therefore the decrease in wound size in the experimental group was better than that of the control group.

In comparison analysis, there is no significant difference between using normal saline and povidone-iodine for wound care to postoperative patients. The surgical wound signs assessment showed that the wound healing at the end of the study was similar in both groups. The result

became that way, perhaps due to the number of respondents used and the difference in the duration of wound care for each patient.

Alterations in the integrity of the skin leads to an organized healing process composed of four main phases. These phases are in sequential order: hemostasis, inflammation, proliferation and maturation or remodeling. While the hemostatic and inflammatory phases are critical for restoring tissue homeostasis, much of the wound fill process occurs during the proliferative phase. In this phase, the migration and proliferation of fibroblasts and the subsequent production of collagen and other extracellular matrix proteins are crucial for the formation of granulation tissue and resultant wound closure.

Wound dressings, as medical devices, should not, in the researcher's opinion, be judged as if they are pharmaceuticals; they are not. No regulatory authority in any developed nation currently regards them as such. This does not, however, reduce the need for the development of robust evidence to support and guide the use of dressing to gain the best outcomes for patients in the context of best value. The wider wound care community is now anxious to present their case for 'reasonable' and 'realistic' clinical trials. Wounds must be as clean as possible, but no attempt should be made to sterilize them. The goal is to clean the wound without damaging cells that survived the original trauma or cells that are important in the wound-healing process. Cleaning agents or antiseptics once considered safe are now known to be toxic to fibroblasts and other cells in the wound that enhance healing.

Fleicher and Reimer (1977) describe a main concern for clinicians prior to applying a topical agent on an open wound as safe. Agents that are cytotoxic or cause delay in wound healing are used with reservation. The strongest argument against the use of antiseptics on wounds is that antiseptics have been found, primarily using in-vitro models, to be cytotoxic to cells essential to the wound healing process, such as fibroblasts, keratinocytes, and leukocytes. However, this cytotoxicity appears to be concentration dependent, as several antiseptics in low concentrations are not cytotoxic, although they retain their antibacterial activity in-vitro. A second reason against the use of antiseptics on open wounds is that antiseptics are not as effective against bacteria that reside in wounds, as they are against bacteria in-vitro. The presence of exudate, serum, or blood seems to decrease their activity. However, in practice, several bacteriological studies have shown that antiseptics can decrease bacterial counts within wounds.

In a clinical study of Darouiche *et al.* (2010), the researcher approximately compared the efficacy in preventing postoperative infection of preoperative skin cleansing using chlorhexidine-alcohol versus povidone-iodine. The rate of surgical site infection was significantly lower in the chlorhexidine-alcohol group than in the povidone-iodine group (overall, 9.5% vs. 16.1%). Chlorhexidine-alcohol was significantly more protective than povidone-iodine against both superficial incisional infections (4.2% vs. 8.6%) and also deep incisional infections (1% vs. 3%). The incidence of organ-space infections was, however, not significantly different between the groups (4.4% vs. 4.5%). The team performing the study believes that although both the antiseptic preparations possess broad-spectrum antimicrobial activity, the more effective protection provided by chlorhexidine-alcohol may be due to its more rapid action, its persistent activity (even when exposed to bodily fluids), and some residual effect.

Normal sterile saline is regarded as the most appropriate and preferred cleansing solution because it is nontoxic, isotonic solution that does not damage healing tissues (Ovington, 2001). According to Sussman & Barbara (2007), for healthy wounds, clean wounds, cleanse with normal saline.

Normal saline appropriates for open wounds because approximately plasma that prevent cellular edema. What is appropriate for cleansing the skin is not appropriate for open wounds, because an open wound lacks the protection of an intact epidermis and provides direct access to the internal body structure.

The study conducted by Leung *et al.* (2010) is about the effects of normal saline instillation in conjunction with negative pressure wound therapy using reticulated open cell foam (NPWT/ROCF). The instillation of saline four times a day led to significantly increased wound fill at days six and seven. Not only was the wound fill increased, the quality of granulation tissue was also increased as evidenced by increased collagen content. Together, these data indicated an improved healing response in this model during treatment with saline instillation therapy. While Chan *et al.* (2009) found saline is as effective as diluted povidone-iodine in protecting metal-skin interfaces against infection, saline is recommended because it is cheaper, readily available and has a low risk of skin hypersensitivity in their study about diluted povidone-iodine versus saline for dressing metal-skin interfaces in external fixation.

Povidone-iodine is an iodophor of iodine and was created due to iodine's low solubility in water and irritations to the skin and mucosal membranes. A 10% povidone-iodine solution consists of 90% water, 8.5% polyvinylpyrrolidone, 1% available iodine, and an iodide. This solution was assumed to be superior because it was believed to have all the germicidal properties of iodine without the toxicity. However, current literature shows this to be false. Lineweaver *et al.* (2004), compared four different types of antiseptics and found that, at full strength, povidone-iodine hydrogen peroxide, acetic acid, and sodium hypochlorite were 100% toxic to fibroblasts. They also discovered that, after irrigating wounds in adult rats with povidone-iodine, wound epithelialization was significantly retarded 4 to 8 days later. Tensile strength of the wounds also was significantly weaker than those wounds irrigated with saline or not irrigate at all. In a separate study, Rodeheaver *et al.* also demonstrated that povidone-iodine solution had no effect on the rate of infection of a wound compared to a saline control group. Another form of povidone-iodine is povidone-iodine surgical scrub solution, which is povidone-iodine mixed with a detergent. Rodeheaver *et al.* also reported that wounds cleansed with this solution had a higher rate of infection than those cleansed with aqueous iodine and povidone-iodine. A povidone-iodine surgical scrub solution was also ineffective in reducing levels of bacteria in a contaminated wound.

Conclusions and Recommendation

Based on the findings of the study, the following conclusions were made after a careful analysis:

1. The majority of the respondents belonged to the age group of 40 to 50 years old and graduated from elementary school (60%). 7 of the respondents were male (70%) and 3 of the respondents were female (30%). 5 respondents worked as farmers (50%). Fractures was the most common cause for surgery and 5 of the respondents underwent surgery because of a fracture (50%).

2. Characteristics of the wound before being given treatment among the control group and the experimental group were both very good. After treatment was given the characteristic of the wound in the control group decreased from very good to good, while the experimental group sustained a very good status.

3. There is no significant difference between profile variable (age, gender, employment status, education, and type of surgery) and the wound healing process. Therefore the researcher accepted the null hypothesis.
4. There is no significant effect between using povidone-iodine and normal saline for wound care to postoperative patients.

Considering the abovementioned summary of findings and conclusions, the following are recommended:

1. Medical surgical nurses should upgrade their knowledge and information about new trends and method for wound care to improve nursing service to their patients.
2. Hospital should give opportunities to the staff by sending them to follow seminars, workshops, symposiums, or training regarding wound care.
3. The next researcher should involve a bigger number of respondents, and the long treatment for each respondent should be the same.
4. Developing research based on wound healing can be chosen with another method and variables. Alternative wound care and modern wound care is an advanced topic that can be studied.

References:

1. Darouiche, RO, Denton GW. Chlorhexidine. In: Block SS, editor. Disinfection, sterilization, and preservation. 5th ed. Philadelphia: Lippincott Williams & Wilkins; 2001. p. 321–36.

2. Darouiche RO, Wall MJ Jr, Itani KM, Otterson MF, Webb AL, Carrick MM, et al. Chlorhexidine-alcohol versus povidone-iodine for surgical-site antisepsis. N Engl J Med 2010;362(1):18–26.

3. Dumville JC, McFarlane E, Edwards P, Lipp A, Holmes A. Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. Cochrane Database Syst Rev 2013;(3):CD003949.

4. Ellenhorn JD, Smith DD, Schwarz RE, Kawachi MH, Wilson TG, McGonigle KF, et al. Paint-only is equivalent to scrub-and-paint in preoperative preparation of abdominal surgery sites. J Am Coll Surg 2005;201(5):737–41.

5. Gosain, TP, DiPietro, LP and Gottrup F. Prevention of surgical-wound infections. N Engl J Med 2000;342(3):202–4.

6. Hemani ML, Lepor H. Skin preparation for the prevention of surgical site infection: which agent is best? Rev Urol 2009;11(4):190–5.

7. Higgins JPT, Green S. Cochrane handbook for systematic reviews of interventions, version 5.1.0. The Cochrane Collaboration. 2011.

8. Kirkland KB, Briggs JP, Trivette SL, Wilkinson WE, Sexton DJ. The impact of surgical-site infections in the 1990s: attributable mortality, excess length of hospitalization, and extra costs. Infect Control Hosp Epidemiol 1999;20(11):725–30.

9. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR. Guideline for prevention of surgical site infection, 1999. Centers for Disease Control and Prevention (CDC) Hospital Infection Control Practices Advisory Committee. Am J Infect Control 1999;27(2):97–132, quiz 3–4; discussion 96.

10. Maiwald M, Chan ESY. The forgotten role of alcohol: a systematic review and meta-analysis of the clinical efficacy and perceived role of chlorhexidine in skin antisepsis. PLoS ONE 2012;7(9).

11. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. Ann Intern Med 2009;151(4):264–9, w64.

12. National Collaborating Centre for Women's and Children's Health. National Institute for Health and Clinical Excellence: guidance. Surgical site infection: prevention and treatment of surgical site infection. London: RCOG Press; 2008.

13. Ovington, IL. Chlorhexidine provides superior skin decontamination in foot and ankle surgery: a prospective randomized study. Clin Orthop Relat Res 2001;438:204–8.

14. Paocharoen V, Mingmalairak C, Apisarnthanarak A. Comparison of surgical wound infection after preoperative skin preparation with 4% chlorhexidine [correction of

chlohexidine] and povidone iodine: a prospective randomized trial. J Med Assoc Thai 2009;92(7):898–902.

15. Patil RA, Gaikwad VV, Kulkami RM. A comparative study of chlorhexidinealcohol versus povidone-iodine for surgical site antisepsis in clean & clean contaminated cases. J Med Thesis 2013;1(1):33–4.

16. Salami, Imoesene and Owoeye. Efficacy of surgical preparation solutions in shoulder surgery. J Bone Joint Surg Am 2006; 91(8):1949–53.

17. Sistla SC, Prabhu G, Sistla S, Sadasivan J. Minimizing wound contamination in a 'clean' surgery: comparison of chlorhexidine-ethanol and povidone-iodine. Chemotherapy 2010; 56(4):261–7.

18. Vermeulen, PL, Rodrigues AL, Simoes Mde L. Incidence of surgical site infection with pre-operative skin preparation using 10% polyvidone-iodine and 0.5% chlorhexidine-alcohol. Rev Col Bras Cir 2008;40(6):443–8.