Preoperative Skin Preparation: Which Is The Best Method?

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Citation

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Abstract

BackgroundPreoperative skin preparation is an integral part of patient preparation for surgery. Various methods of skin preparation have been developed. However, there is no single method which can be described as ideal. Hence the process of evolving an ideal method continues.AimsThe present study aims at determining the best method of skin preparation.Materials and methodsA series of 150 patients undergoing clean surgical operations were studied prospectively after randomizing them into three groups based on the technique used for preparation (Group A: 3 minute scrub plus paint, Group B: 5 minute scrub plus paint, Group C: paint only) The effect of each method of skin preparation on surgical-site infection rate was studied. Results were analyzed statistically.ResultsFour patients developed surgical-site infections. One in group A, one in group B and two in group C. However, results were not statistically significant.ConclusionPainting alone can be used for preoperative skin preparation.

INTRODUCTION

Pre-operative skin preparation is a very important part of pre-operative patient preparation. It has significant bearing on surgical outcome both in terms of morbidity and mortality. A variety of solutions and techniques have been developed. The evolution of these continues endlessly. Innumerable studies have been carried out to determine the best possible method. However, no consensus has been achieved as yet. The process of developing the best method therefore still continues; hence, the need to carry out the study to develop an optimum method of pre-operative skin preparation. The present study aims at evaluating the various methods of pre-operative skin preparation in order to identify the best one.

MATERIALS AND METHODS

One hundred fifty patients undergoing clear surgical procedures in a single unit over a 2-year period from June 2007 to July 2009 were studied prospectively. The patients were randomised into three groups. Each study group comprised of 50 patients. Different techniques of skin preparations were used in each group.

Group A: Iodophore scrubbing for 3 minutes followed by painting with povidone iodine

Group B: Iodophore scrubbing for 5 minutes followed by painting with povidone iodine

Group C: Iodophore painting only

Solutions used were:

Povidone iodine soap solution for scrubbing (7.5% povidone iodine + 0.75% iodine + detergent)

Povidone iodine aqueous solution for painting (90% water + 8.5% povidone iodine + 1% iodine)

After admission to hospital, a detailed pro-forma was completed during the course of treatment which included age, sex, duration of surgery, drain placement, days of hospital stay and infection of wound. All other factors including draping, pre-operative antibiotic usage and method of hair removal were kept constant. The only variable therefore was the method of pre-operative skin preparation.

Exclusion criteria:

All patients were admitted one day prior to surgery. Hair removal was done on the morning of surgery with the help of a clipper. The patients were made to take a bath on the day of surgery with non-medicated soap and water. They were instructed to shower with a non-medicated soap before surgery and given freshly laundered clothes before entering the operating room. The patients were randomised blindly into groups A, B and C with equal allocation to the 3 preparatory arms.

Patients in group A underwent rigorous 3 minutes scrubbing using gauze pieces soaked with povidone iodine detergent. The scrub solution was then mopped dry with cotton gauze flowed by painting with aqueous povidone iodine solution which was allowed to air dry.

Patients randomised to group B underwent an iodophore scrub for 5 minutes followed by painting with povidone iodine which was allowed to air dry.

Patients randomised to group C underwent only painting with aqueous povidone iodine solution which was allowed to air dry.

All patients were then draped with sterile autoclaved cotton drapes. All 150 patients included in the study were given perioperative (i.e. pre-operative, intra-operative, post-operative) antibiotic injections (Ceftriaxone 1g parenterally).

Criteria for surgical site infection: All check dressings were done on post-operative day 3. Surgical-site infection was defined by presence of any of the following factors within 3 days following the surgical procedure, in presence or absence of bacteria:

If the wound was found to be infected, swabs were taken for smear, culture and antibiotic testing followed by commencement of appropriate antibiotic therapy.

STATISTICAL METHODS

The observed results were analysed statistically. The three groups A, B and C were compared for variables such as age, sex, duration of surgery, drain inserted, days in hospital, and infection.

The ANOVA test was applied for quantitative variables and the chi-square test for qualitative variables. The impact of variables viz age, sex, duration of surgery, drain inserted, days in hospital and infection rate in the 3 groups was analysed by multiple logistic regression. The mathematical model was tested for significance and results analysed. Level of significance taken at the level of p=0.05 (S=significance, NS= non-significance)

RESULTS

One hundred fifty patients who underwent clean surgical procedures were studied prospectively.

The mean age of patients included in the study was 31.0+19.3. The distribution of age among the three groups was similar (Table 1A). Age did not have an effect on surgical site infection (Table 1B).

There were 94 males (62.7%), 56 females (37.3%) in the study. The distribution of sex in the three groups was similar (Table 2A). Sex did have an impact on surgical site infection (Table 2B)

Mean duration of surgery in various groups was as follows: in 31 patients (20.7%) it was 30 minutes, in 68 (45.3%) 60 minutes, in 50 (33.3%) 120 minutes and in one patient (0.7%) it was 180 minutes. This variable was similarly distributed in the three groups (Table 3A). The duration of surgery did not affect wound infection rates in the study (Table 3B).

Drains were inserted in 36 patients (24%) only. The usage of drains in the three groups was similar (Table4A). It did not affect the wound infection rate (Table 4B).

The hospital stay of the 150 patients was as follows: 67 (44.7%) for 2 days, 54 (36%) for 3 days and 29 (19.3%) for 4 days (Table 5A). The duration of hospital stay did not affect the surgical-site infection rate (Table 5B).

The 3 groups created in the study were well matched for all predictors of post-operative surgical-site infection. The variables were age, sex, duration of surgery, drain placement and number of days in hospital. After matching all the variables, it was concluded that the only variable which has confounding effect on surgical-site infection (SSI) rate was the method of skin preparation used.

INFECTION RATE

Out of 150 patients studied, 4 developed SSI (2.7%) (Table6):

As the p-value was 0.77, no significance of association between the method of skin preparation and development of surgical-site infection could be ascertained.

Figure 1

Table 1A: Distribution of age among the three groups

Age (yrs)	Infection	Not Infected	Total
<20yrs (n=52)	0	52 (35.6%)	52
20-40yrs (n=56)	1 (25%)	55 (37.6%)	56
>40yrs (n=42)	3 (75%)	39 (26.7%)	42
Total	4	146	150

Chi square value=5.04, DF=4, NS, p=0.28 (p>0.05), hence not significant

Figure 2

Table 1B: Analysis of age and infection

Age/Groups	A	B	C	Total
0-19yrs	15 (30%)	19 (38%)	18 (36%)	52
20-40yrs	23 (46%)	13 (26%)	20 (40%)	56
>40yrs	12 (24%)	18 (36%)	12 (24%)	42
Total	50	50	50	150

Chi square value=4.8, DF=2, p=0.09 (p>0.05), hence not significant

Figure 3

Table 2A: Analysis of sex distribution among the three groups

Sex	Infected	Not infected	Total
Male (n=94)	3 (75%)	91 (62.3%)	94
Female (n=56)	1 (25%)	55 (37.6%)	56
Total	4	146	150

Chi square value=0.40, DF=2, NS, p=0.82 (p>0.05), hence not significant

Figure 4

Table 2B: Analysis of sex and infection

Sex/Group	A	B	C	Total
Male	30 (60%)	33 (66%)	31 (62%)	94
Female	20 (40%)	17 (34%)	19 (38%)	56
Total	50	50	50	150

Chi square Yates correction=0.0, DF=1, p=1.00 (p>0.05), hence not significant

Figure 5

Table 3A: Distribution of duration of surgery among the three groups

Days in hospital	Infected	Not infected	Total
2 (n=67)	0	67 (45.8%)	67
3 (n=54)	2 (50%)	52 (35.6%)	54
4 (n=29)	2 (50%)	27 (18.4%)	29
Total	4	146	150

Chi square value=8.2, DF=6, p=0.22 (p>0.05), hence not significant

Figure 6

Table 3B: Analysis of days in hospital and infection

Duration(hrs)/Group	A	B	C	Total
0.5	7 (14%)	11 (22%)	13 (26%)	31
1	20 (40%)	23 (46%)	25 (50%)	68
2	23 (46%)	15 (30%)	12 (24%)	50
3	0	1(2%)	0	1
Total	50	50	50	150

Chi square value=4.1, DF=2, P=0.13 (p.0.05), hence not significant

Figure 7

Table 4A: Distribution of patients in whom drains were inserted among the three groups.

Days/Group	A	B	C	Total
2 days	18 (36%)	22 (44%)	27 (54%)	67
3 days	19 (38%)	17 (34%)	18 (36%)	54
4 days	13 (26%)	11 (22%)	5 (10%)	29
Total	50	50	50	150

Chi square value=4.61, DF=2, p=0.1 (p>0.05), hence not significant.

Figure 8

Table 4B: Analysis of drain placement and infection

Drain used	Infected	Not infected	Total
Yes (n=36)	2 (50%)	34 (23.2%)	36
No (n=114)	2 (50%)	112 (76.7%)	114
Total	4	146	150

Chi square Yates correction=+0.4, DF=1, NS, p=10.24 (p>0.05), hence not significant

Figure 9

Table 5A: Distribution of no. of days in hospital among three groups

Duration of surgery(hrs)	Infected	Not infected	Total
0.5 (n=31)	0	31 (21.2%)	31
1 (n=68)	1 (25%)	67 (45.9%)	68

Chi square value=+5.5, DF=4, NS, p=0.34 (p>0.05), hence not significant

Figure 10

Table 5B: Analysis of duration of surgery and infection

Duration of surgery(hrs)	Infected	Not infected	Total
0.5 (n=31)	0	31 (21.2%)	31
1 (n=68)	1 (25%)	67 (45.9%)	68
2 (n=50)	3 (75%)	47 (32.2%)	50
3 (n=1)	0	1 (0.7%)	1
Total	4	146	150

Chi square value +3.4, DF=3, NS, p=0.3 (p>0.05), hence not significant

Figure 11

Table 6: Analysis of incidence of infection among the three groups

Infection/ Group	A	B	C	Total
Infected	1 (2%)	1 (2%)	2 (4%)	4
Not infected	49 (98%)	49 (98%)	48 (96%)	146
Total	50	50	50	150

Chi square value=0.52, DF=2, p=0.77 (p>0.05), hence not significant

DISCUSSION

Skin is the most important body organ. It houses innumerable microorganisms which are called commensal bacteria. They also contribute to the protective function offered by the skin. These organisms tend to colonize deeper layers of the stratum corneum and hence not shed with desquamation. Understanding the characteristics of cutaneous flora is pivotal in devising methods aimed at reducing the surgical-site infections. [1] There are two types of micro-organisms on the skin:

The transient organisms are easily removed by improved hygiene whereas commensals cannot be removed completely. Commensal organisms are therefore a very important source of infection. The common commensals are Staphylococcus aureus and epidermidis, diphtheroids, pseudomonas and propionibacterium species. These can lead to serious and at times life -threatening infections, if they are allowed to multiply and invade the protective skin barrier. When the skin is incised during the course of a surgical

procedure, the protective function of skin is breached with likelihood of these commensals gaining entry to deeper tissues, giving rise to surgical-site infections.

A surgical site infection (SSI) is defined by the presence of discharge, either serous or purulent, with or without signs of redness, edema, raised temperature and tenderness. [2, 3] It is therefore very important before any surgical procedure to remove all transient bacteria and reduce the population of commensal organisms to such a low level that they are rendered incapable of causing surgical-site infections. Innumerable attempts have been made by using various combinations of antiseptic solutions as well as by use of different techniques to use these solutions. [4] The effectiveness of pre-operative skin preparation is thought to dependant on both the antiseptic used and the technique of application. An ideal antiseptic should satisfy certain criteria, viz eliminate all organisms as far as possible with spores, be non-toxic, be non-allergic, be safe to use in all body regions, it shouldn't be absorbed systemically, should have prolonged duration of action, and should be safe for repetitive use. Most of the antiseptic preparations available do not satisfy the aforementioned criteria. Hence a combination of various agents is advisable. Antiseptics exert action in two ways, mechanically and chemically. Mechanically, they remove both particulate matter and a significant number of micro-organisms, especially from contaminated areas. Chemically, they bind to the stratum corneum, thus exerting persisting anti-bacterial activity.

The advent of iodophores has revolutionized the method of skin preparation. [5, 6] An iodophore is a combination of iodine and solubilizing agent that liberates free iodine. Commercially available Povidone iodine contains 90% water, 8.5% povidone iodine and 1% iodine. Povidone iodine scrub contains 7.5% povidone iodine, 0.75% iodine and detergent. On application, the compound depolymerizes, which delivers bactericidal iodine to the cell membrane of the organism causing immediate antibacterial activity. However, the bactericidal activity of the compound may at times be impeded by organic material. Hence it is essential that all particulate organic matter be removed before the use of povidone iodine solution. The solution is allowed to dry for at least 3 minutes. [7] Povidone iodine has a potent and persistent activity against pathological microbes like methicillin-resistant staphylococcus aureus (MRSA). [8, 9] In the present study the two agents used were povidone iodine scrub solution for scrubbing and povidone iodine aqueous solution for painting. Many a times, antiseptic solutions themselves may be contaminated. It is therefore advisable to use single use disposable solution rather than using antiseptic solution stored in containers.

The technique of application also has significant bearing on the success of pre-operative skin preparation. [10, 11] Various methods have been described like scrubbing, painting or combination of both. The process of scrubbing involves rigorous cleaning of the incision site with a detergent containing solution in a circular manner from center to the periphery of the site for a predetermined time period ranging from 3 to 5 minutes. The process of painting involves single application of antiseptic solution on the incision site starting from the centre to the periphery and thereafter allowing it to air dry for at least 3 minutes.

Although for centuries it has been a practice to use various combinations of antiseptic methods in surgery, till date there is no consensus regarding the ideal method of preoperative skin preparation. The impact of the method of preoperative skin preparation on surgical-site infection rate therefore still merits further evaluation. [12] In the present study, only clean cases were included, thereby decreasing the chances of wounds getting infected from pre-existing pathogens. Antibiotic prophylaxis has become the standard care not only in operations characterized by high infection rate but also in the vast majority of clean surgical procedures, especially those involving the use of foreign materials such as grafts, prosthetic devices and implants. Hence, a course of perioperative antibiotics was given to all patients included in the study. Hair removal from the operative site was done by clipping on the morning of surgery in order to prevent damage to skin and infection thereafter. [13, 14]

Age has always been an attributable factor for surgical-site infection, the incidence of which increases with age. Diminished immunity and vitality of tissues associated with advancing age perhaps predisposes to wound infection.[11] In the present study age distribution was similar in the three groups (Table 1A). Three out of four patients who developed infection were above 40 years of age. However, this was statistically not significant (Table 1B).

The sex distribution in the three groups was similar (Table 2A). Of the 4 patients who developed wound infection, 3 were males and 1 was female. This observation did not attain statistical significance. Hence the sex of the patient could not be an attributable factor for wound infection (Table 2B).

Duration of surgery has a significant impact on the incidence

of wound infection. [11] Various factors have been postulated such as prolonged retraction of wound edges thereby decreasing viability, extensive handling of tissues and an inadvertent breach in aseptic technique during the course of a prolonged surgery. [12] In the present study the range of duration of surgery was similar in the three groups (Table3A). It was found that, as the duration of surgery increased, wound infection rate also increased. However, results were not statistically significant (Table 3B).

Every surgical procedure which involves dissection is always followed by a fluid collection consisting of tissue fluid and blood at the operated site. These natural body fluids are initially rich in anti-bacterial substances such as antibodies and opsonins. However, with time the concentrations of these substances decrease, thus providing an ideal medium for infection to develop. Hence it is necessary to remove these collections by the use of drains. If used judiciously, drains help in decreasing the wound infection rate. However, if they are kept for a prolonged period of time, there is high likelihood of increased wound infection rate. This is perhaps due to the availability of a direct path for microorganisms to enter. [15] In the present study drains were kept in 36 patients (Table 4A). Two patients developed surgical site infections in the category in which drains were kept. However, this was not statistically significant (Table 4B).

The duration of stay in hospital is seen to significantly impact the incidence of surgical-site infections. [11] These infections are usually caused by hospital strains of resistant organisms which do not respond to conventional antibiotic therapy necessitating higher antibiotics. In the present study the duration of hospital stay in the three groups was similar (Table 5A). Increased stay in hospital was associated with an increase in infection rate. However, this observation did not achieve statistical significance (Table 5B).

The impact of various factors influencing surgical site infections, viz. age, sex, duration of surgery, drain placement and the duration of hospital stay was studied and results were analyzed statistically. The results were not statistically significant. It was therefore inferred that surgical site infection rate in the present study could not be attributed to the aforementioned factors. Hence, the only attributable factor influencing surgical site infection rate in the present study was the method of preoperative skin preparation.

Preoperative skin preparation traditionally depends on two factors, namely the antiseptic used and the technique of preparation. [16] A number of solutions have been used for this purpose. [17] No single solution fits into the definition of an ideal antiseptic. Hence a combination of solutions is usually preferred. Despite the development of newer antiseptic agents, the problem of surgical-site infection continues to pose a challenge to the surgeon. In the present study, patients were divided into three groups based on the methodology of skin preparation to be used.

Group A comprised patients who underwent scrubbing for 3 minutes followed by painting.

Group B comprised patients who underwent scrubbing for 5 minutes followed by painting.

Group C comprised patients who underwent painting only.

Only one patient in Group A and one patient in Group B developed wound infection, whereas two patients in group C developed infection.

The pattern of preoperative skin preparation in Group A was a combination of a 3-minute scrubbing followed by painting. This method gives the advantage of both scrubbing as well as painting. Though statistically the results did not confer any advantage over the other methods ($p>0.05$), it can still be used as a method for skin preparation. Other studies have revealed similar results. [18] This method is specially recommended, if local hygiene is suboptimal.

In Group B, patients were scrubbed for 5 minutes, followed by painting. Duration of scrubbing was initially thought to be an attributable factor which could influence the incidence of surgical-site infection. Disturbingly, studies proved that the action of rigorous prolonged scrubbing may in fact cause release of organisms present at depths of skin layers, thus negating the very concept of skin preparation. Studies have shown that a 5-minute scrubbing is as effective as a 1-minute scrubbing in reducing the micro-organisms on the hand. [18] In the present study, one patient in Group B developed surgical site infection. The duration of scrubbing does not have an impact of the SSI rate as revealed by other studies. [18]

Group C patients were painted with povidone iodine solution. This was allowed to air dry for at least 3 minutes. Duration of contact of antiseptic with skin is an important factor which needs to be acknowledged. The antiseptic solution should be allowed to stay for at least 3 minutes or allowed to air dry, in order to permit its antibacterial effects. [19] This allows for optimum therapeutic action of povidone

iodine. Iodine forms complexes with large molecular compounds termed as carriers thereby releasing iodine slowly. 1-in-20000 solution kills most vegetative forms within 1 minute. Only 2 patients from group C developed wound infection. However, this was not statistically significant. Thus statistical analysis of the results of this study revealed that no method was superior to the others. Many other studies have also revealed similar observations. [20, 21, 22]

Thus painting alone can safely be used as a method of preoperative skin preparation thereby conferring other advantages of reduced time consumption, reduced cost and improved ease of application as compared to other methods.

CONCLUSION

Results of the statistical analysis of this study revealed that all 3 methods can safely be used for preoperative skin preparation in clean cases. However, painting alone as method of preoperative skin preparation could be good enough as it confers a few added advantages such as

The design of this equivalency study allows concluding that in patients undergoing clean surgical procedures, the three methods of preoperative skin preparation do not differ in efficacy.

Taken together with skin micro-biological studies and the data available from other randomized studies, it could be possible to eliminate the scrub part of skin preparation for surgical patients in future.

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References

1. Lilly HA, Lowbury EJ: Transient skin flora: their removal by cleansing or disinfection in relation to their mode of deposition. J Clinical Path; 1978; 31(10): 919-22.
2. Wilson AP, Gibbons C, Reaves BC, Hodgson B, Liu M, Plummer D, Krukowski ZH, Bruce J, Wilson J, Pearson A: Surgical wound infection as a performance indicator: agreement of common definition of wound infection in 4773 patients. BMJ; 2004; 329(7468): 720. Epub 2004 Sep 14.
3. Reilly JS, Baird D, Hill R: The importance of definition and methods in surgical wound infection audit. J Hosp Infect; 2001; 47(1): 64-6.
4. Lowbury EJ: Assessing the effectiveness of antimicrobial agents applied to living tissues. J Pharm Belg; 1981; 36(5): 298-302.
5. Connell JR Jr, Rousselot LM: Povidone Iodine. Extensive surgical evaluation of a new antiseptic agent. Am J Surg; 1964; 108: 849-55.
6. Zdeblick TA, Lederman MM, Jacobs MR, Marcus RE: Preoperative use of povidone iodine, a prospective randomized study. Clin Orthop Relat Res; 1986; 213: 211-15.
7. Kutarski PW, Grundy HC: To dry or not to dry? An assessment of a possible degradation in efficiency of preoperative skin preparation by wiping skin dry. Ann R Coll Surg Engl; 1993; 75(3): 181-5.
8. McLure AR, Gordon J: In vitro evaluation of povidone iodine and chlorhexidene against methicillin-resistant staphylococcus aureus. J Hosp Inf; 1992; 21(4): 291-9.
9. Lacey RW, Catto A: Action of povidone iodine against methicillin-sensitive and resistant cultures of staphylococcus aureus. Postgrad Med J; 1993; 69 Suppl 3: s78-83.
10. Lowbury EJ: Prevention of postoperative infection. Injury; 1985; 16(9): 583-4.
11. Mishriki SF, Law DF, Jeffery PJ: Factors affecting the incidence of postoperative wound infection. J Hosp Infect; 1990; 16(3): 223-30.
12. Reilly JS: The effect of surveillance on surgical wound infection rates. J Tissue Viabil; 1999; 9(2): 57-60.
13. Seropian R, Reynolds B: Wound infection after preoperative depilatory versus razor preparation. Am J Surg; 1971; 121(3): 251-4.
14. Reilly JS, Baird D, Hill R: the importance of definition and methods in surgical wound infection audit. J Hosp Infect; 2001; 47(1): 64-6.
15. Wiley AM, Ha'eri GB: Routes of infection. A study of using "tracer particles" in the orthopaedic operating room. Clin Orthop; 1979; 139: 150-155.
16. Warner C: Skin preparation in the surgical patient. J Natl Med Assoc; 1988; 80(8): 899-904.
17. Edwards PS, Lipp A, Holmes A: Preoperative skin antiseptics for preventing surgical wound infections after clean surgery. Cochrane Database Syst Rev; 2004; (3): CD 003949.
18. Deshmukh N, Kramer JW, Kjellberg SI: A comparison of 5 minute povidone iodine scrub and 1 minute povidone iodine scrub followed by alcohol foam. Mil Med; 1998; 163(3): 145-7.
19. Workman ML: Comparison of blot drying versus air drying of povidone iodine cleansed skin. Appl Nurs Res; 1995; 8(1): 15-7.
20. Moen MD, Noone MB, Kirson I: Povidone iodine spray technique versus traditional scrub paint technique for preoperative abdominal wall preparation. Am J Obstet Gynecol; 2002; 187(6): 1434-6.
21. Gilliam DL, Nelson CL: Comparison of a one step iodophore skin preparation versus traditional preparation is total joint surgery. Clin Orthop Relat Res; 1990; 250: 258-60.
22. Ellenhorn JD, Smith DD, Schwarz Re, Kawachi MH, Wilson TG, McGonigle KF, Wagman LD, Paz IB: Paint only is equivalent to scrub and paint in preoperative preparation of abdominal surgery site. J Am Coll Surg 2005; 201(5): 737-41. Epub 2005 Aug 31.

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