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Are Sterile Water and Brushes Necessary for Hand Washing before Surgery in Japan?

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Abstract

Purpose: To examine whether sterile water and brushes are necessary for hand washing before surgery.

Method: Twenty-two operating room nurses were randomly divided into two groups as follows: 11 nurses who used 7.5% povidone iodine (PVI group) and another 11 nurses who used 4% chlorhexidine gluconate (CHG group) to wash their hands using the rubbing method. All the nurses were examined for bacterial contamination of their hands before and after surgical hand rubbing. We used tap water to wash the hands at the sink used for washing surgical instruments in the operating room and non sterilized plastic brushes.

Results: No bacteria were detected in the tap water. Before washing the hands, the number of bacteria detected was 5.0×10^3 cfu/H in the PVI group and 4.0×10^3 cfu/H in the CHG group, which were similar in both groups. After washing the hands, the median value of the bacteria decreased to 8.7×10^2 cfu/H in the PVI group and 0 cfu/H in the CHG group.

Conclusions: Sterile water and brushes are not necessary for preoperative scrubbing up. When using tap water for surgical hand washing, 1) the hand-rubbing method should be used; 2) a quick-alcohol-based disinfectant scrub should be used; 3) the concentration of free chloride in the water should be maintained at over 0.1 PPM; 4) the bacterial contamination of the water should be checked; and 5) the faucet should be routinely cleaned and sterilized.
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Key words: surgical hand washing, sterilized water, sterilized brush, tap water

Introduction

Although tap water or drinking water is routinely used in Europe and the United States for hand washing before surgery[1], the Water Supply Law prohibits this practice in Japan[2,3]. However, Fujii et al. performed a multi-center trial on the preoperative scrubbing method and reported that there was no need to use sterile water when washing hands before surgery[4].

In 2003, we changed hand washing before surgery from scrubbing with brushes for 6 minutes to rubbing the hands together for a shorter time as one of the measures to control hospital infection[5].

In the current study we examined whether sterile water and brushes are necessary for preoperative scrubbing method using the hand rubbing method

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with non-sterile brushes and tap water, comparing to the previously reported method with sterile water[5] as a control.

Methods and Objects

1. Disinfectant Scrub Agent

7.5% povidone iodine (PVI; Isodine®, Meijiseika Co. Ltd.) and 4% (W/V) chlor-hexidine gluconate (CHG; Hibiscrub®, Sumitomo Pharmaceutical Co. Ltd) were compared as disinfectant scrub agents.

2. Object

Twenty-two operating room nurses were randomly divided into two groups as follows: the PVI group (n=11) and the CHG group (n=11). All the nurses were examined for bacterial contamination of their hands before and after surgical hand washing.

3. Survey Period

December 27th 2002.

4. Tap Water Used

We used running tap water for surgical hand washing at the sink used to wash surgical instruments in the operating room (**Fig. 1**).

Fig. 1 We used running tap water for surgical hand washing at this sink used to wash surgical instruments in the operating room.

5. The Surgical Hand Washing Method

The technique for scrubbing up before surgery involves scrubbing all the nails with brushes for 30 seconds followed by rubbing both forearms together from elbows to hands twice for 70 seconds each time, as previously described[5]. The plastic brushes are commercially available for hand washing, and they are cleansed and dried for reuse. The duration of hand washing was accurately measured.

6. Detection of Bacteria

(1) Tap water

We took water samples from 4 faucets just before hand washing and 1 m*l* of each sample was injected onto Brain-Heart infusion bouillon plates (Eiken K. K) and cultured at 37℃ for 48 hours for bacterial detection.

(2) Hands and fingers

The samples were collected and pre-treated according to the Glove Juice method[5]. In detail, the sample liquid was taken from the right glove just before hand washing and from the left glove after hand washing. The liquid was added to a neutralizer to make original samples. A 10-fold dilution series was made from the original sample and 1 m*l* of each concentration was injected onto Brain-Heart infusion bouillon plates, and cultured at 37℃ for 48 hours, whereafter the number of bacterial colonies was counted. The number of bacteria (cfu; colony forming unit) was expressed as the number on each hand (cfu/H). Minimal bacterial detection was 25 cfu/H. No bacteria (n=0) was logarithmically expressed as $\log_{10}(0+1) = 0$ cfu/H.

7. Statistics

The chi-square test or Fisher's exact test was used to detect the differences between the two groups, and the Mann-Whitney test was used to compare changes in the bacterial number.

P values less than 0.05 were considered significant.

Results

1. Bacterial contamination of faucets

No bacteria were detected from the faucets.

2. Bacterial contamination of the hands

(1) Before hand washing

The number of bacteria detected in the PVI group ranged from 1.0×10^2 cfu/H to 4.8×10^5 cfu/H, with a median of 5.0×10^3 cfu/H. The mean bacterial

number logarithm was 3.6 ± 1.2.

The number of bacteria detected in the CHG group ranged from 3.0×10^2 cfu/H to 5.4×10^4 cfu/H, with a median of 4.0×10^3 cfu/H. The mean bacterial number logarithm was 3.5 ± 0.9, which was not statistically different from the PVI group (**Fig. 2**).

(2) After hand washing

The number of bacteria detected in the PVI group ranged from 0 cfu/H to 3.5×10^3 cfu/H. The median bacterial count decreased from 5.0×10^3 cfu/H (before) to 8.7×10^2 cfu/H (after), and the mean bacterial number logarithm decreased from 3.6 ± 1.2 (before) to 2.4 ± 1.3 (after) in the PVI group.

The number of bacteria detected in the CHG group ranged from 0 cfu/H to 2.5×10 cfu/H. The median bacterial count decreased from 4.0×10^3 cfu/H (before) to 0 cfu/H (after), and the mean bacterial number logarithm decreased from 3.5 ± 0.9 (before) to 0.1 ± 0.4 (after) in the CHG group (**Fig 2, Table 1**).

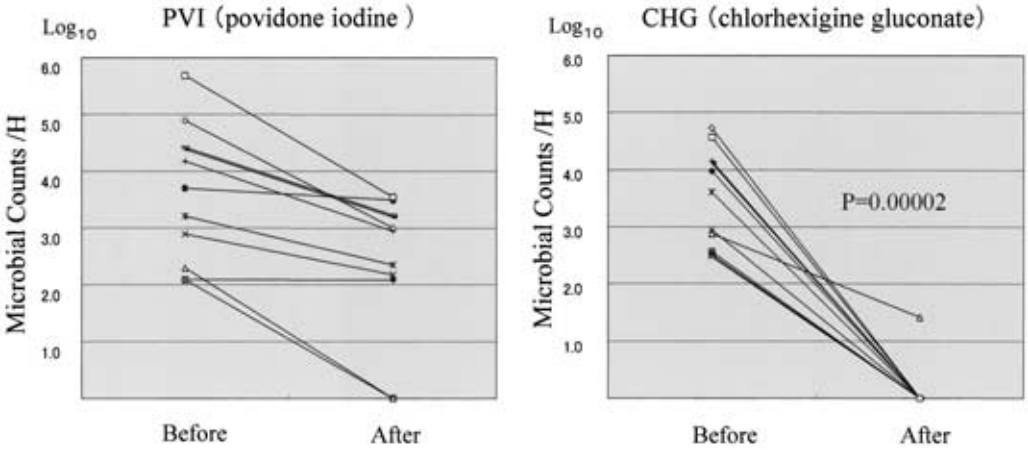

Fig. 2 Before preoperative hand rubbing, the number of bacteria detected in the PVI group ranged from 1.0×10^2 cfu/H to 4.8×10^5 cfu/H, and from 3.0×10^2 cfu/H to 5.4×10^4 cfu/H in the CHG group. After hand rubbing, the number of bacteria detected in the PVI group ranged from 0 cfu/H to 1.5×10^4 cfu/H, and from 0 cfu/H to 2.5×10 cfu/H in the CHG group.

Table 1 The chlorhexidine gluconate (CHG) scrub agent was significantly more effective at controlling bacteria than the popidone-iodine (PVI) scrub agent (P = 0.001). The median bacterial count was 8.7×10^2 cfu/H in the PVI group, and 0 cfu/H in the CHG group. The mean bacterial number logarithm was 2.5 ± 1.4 cfu/H in the PVI group and 0.1 ± 0.4 cfu/H in the CHG group. The mean bacterial number logarithm was significantly positive in the povidone-iodine compared with the chlorhexidine gluconate agent (P = 0.0003). Chlorhexidine gluconate was bacteriologically superior to povidone-iodine after hand antisepsis

No of positive bacteria	PVI	9/11 (81.8 %)[a]
	CHG	1/11 (9.1 %)[b]
Median bacterial count (cfu/H)	PVI	8.7×10^2
	CHG	0
Mean of logarithm (cfu/H)	PVI	2.5 ± 1.4[c]
	CHG	0.1 ± 0.4[d]

PVI: Povidone-iodine CHG: Chlorhexidine gluconate
0: < 25 cfu/H a vs b = 0.001, c vs d = 0.0003

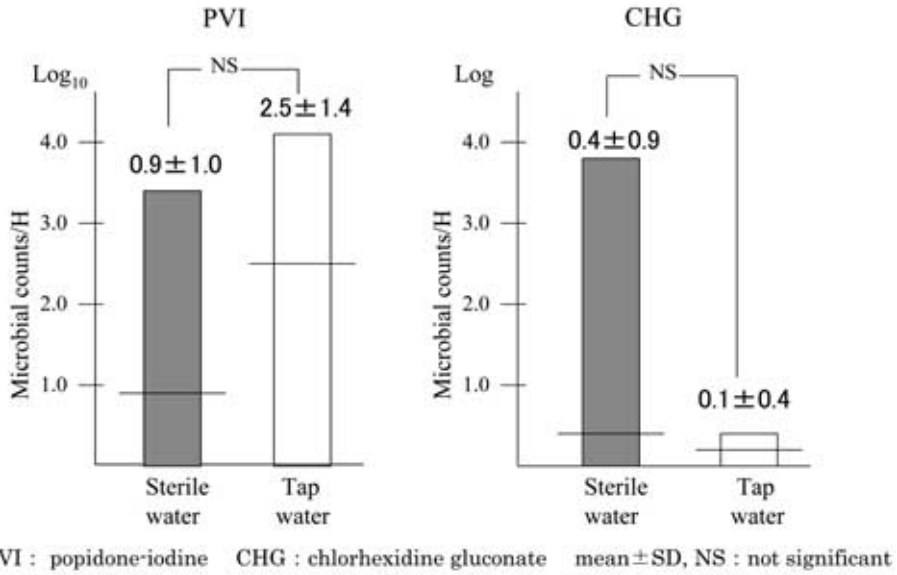

Fig. 3 There was no difference in the bacterial counts with sterile water (0.9±1.0 cfu/H) and with tap water (2.5±1.4 cfu/H) in the PVI group. Moreover, in the CHG group, there was no difference between sterile water (0.4±0.9 cfu/H) and tap water (0.1±0.4 cfu/H). The results were similar in surgical hand washing with tap water or with sterile water.

Discussion

Recently, there has been a great concern about using tap water instead of sterile water for hand washing before surgery. In North America, sterile water is reportedly not necessary for hand washing before surgery, because the incidence of post-operative infection has not increased in spite of using drinking water of a quality standard below 200 cfu/m*l* of general bacteria. This is more lenient than the rules laid down by the Japanese Water Supply Law (general bacteria below 100 cfu/m*l*, and no *E. coli* detected.)

However, in Japan, the Enforcement Regulation of the Medical Service Law dated November 5th 1948, and the Health Policy Bureau (HPB) /Guidance of Medical Service Division (GMSD) Notification No. 46 dated June 26, 1991, insist on the use of sterile water for hand washing before surgery, as both laws define the purpose of presurgical scrubbing up as being for sterilization rather than disinfection.

On the other hand, Fujii[4] reported in 2002 that sterile water was not necessary for presurgical scrubbing up on the basis of a multi-center trial which compared sterile water and tap water by the Glove Juice method, which resulted in no differences between them. According to those reports, the results of hand washing with tap water and non-sterile brushes were similar to those with sterile water and brushes which were examined and reported in the same period, and so the current study was designed with the previous study as a control. Because the use of tap water for hand washing before surgery is prohibited, we examined the counts of bacteria detected from the hands just after hand washing. As shown in **Fig. 3**, in the PVI group there was no difference in the bacterial counts when rubbing with sterile water (0.9±1.0 cfu/H) and rubbing with tap water (2.5±1.4 cfu/H). Moreover, in the CHG group, there was no difference between sterile water (0.4±0.9 cfu/H) and tap water (0.1±0.4 cfu/H). As indicated above, since the results of hand washing with tap water were similar to those with sterile water, tap water is clean enough for hand washing before surgery, and we could not find any superiority with sterile water. The brushes are useful to remove dirt around the nails, the use of which is recommended by the Centers for Disease Control (CDC)[6], and the brushes

do not need to be sterilized as long as they are cleansed and dried adequately.

On the other hand, an interesting report has appeared about the use of sterile water and tap water. Oie et al.[7] performed a bacteriological investigation of sterile water and tap water from 10 hospitals in Yamaguchi prefecture. The report showed that whereas bacterial levels were detected at no more than 10 cfu/m*l* in all of the tap water samples, levels of more than 100 cfu/m*l* of bacteria were detected from sterile water in 47.2% of the institutions and levels of more than 10^3 cfu/m*l* of bacteria were detected in 14%. The authors concluded that sterile water could be more easily contaminated than tap water containing a certain concentration of chloride.

These results suggest that it is not easy to keep water sterile and to supply it from sterilized equipment to a faucet through a pipe, and there is less possibility of contamination in tap water containing chloride than sterile water. In other words, appropriate maintenance of the water supply and correct scrubbing techniques are more important than the inherent sterility of the water used.

Incidentally, the Water Supply Law in Japan mandates that tap water should contain more than 0.1 PPM of free chloride. In our institution, we measure the chloride concentration of tap water every week (**Table 2**).

What techniques will enable the use of tap water for scrubbing up? First of all we recommend a gentle rubbing method for washing hands and forearms. In our previous study, wach lower levels of residual bacteria were found with the rubbing method than scrubbing with brushes[5]. Also we recommend adding the use of a quick-drying alcohol-based disinfectant scrub agent for a prolonged effect in case the number of bacteria is still high after scrubbing up. A periodical check of the chloride concentration of the tap water and bacterial examination of the faucets are necessary. We should directly supply water from the mains as far as

Table 2 We measure the free chloride concentration of tap water every week. The tap water contains a free chloride concentration of more than 0.1 PPM

The date	chloride concentration
2002.12 25	0.20 PPM
2004.3 3	0.24 PPM
10	0.20 PPM
17	0.24 PPM
24	0.27 PPM
31	0.34 PPM
2004.4 7	0.21 PPM
14	0.17 PPM
21	0.22 PPM
28	0.25 PPM

Table 3 We check the sterile water quality annually

An examination item	Reference value	Measured value
Nitrate nitrogen and nitrite nitrogen	Less than 10 mg/*l*	Less than 0.1 mg/*l*
Chlorine ion organic matters (potassium permanganate consumed)	Less than 200 mg/*l*	34.6 mg/*l*
A chlorine ion	Less than 10 mg/*l*	0.6 mg/*l*
General bacteria	Less than colony 100 in 1 m*l*	0
Coli-aerogenes group	What is not detected	0
PH value	Less than 8.6 more than 5.8	8.1
Chromaticity	5 degrees following	Less than one degree
Turbidity	2 degrees following	Less than 0.5 degree
Odor	The thing that is not abnormal	No particular
Taste	The thing that is not abnormal	No particular
Chloroform	Less than 0.06 mg/*l*	Less than 0.001 mg/*l*
The bromo chloromethane	Less than 0.1 mg/*l*	Less than 0.001 mg/*l*
Bromo dichloromethane	Less than 0.03 mg/*l*	Less than 0.001 mg/*l*
Bromoform	Less than 0.09 mg/*l*	Less than 0.001 mg/*l*
Total trihalomethane	Less than 0.1 mg/*l*	Less than 0.001 mg/*l*

possible to prevent stagnation of tap water in holding tanks. The sterilization and disinfection of the faucets are indispensable. When tap water is supplied from a very large reservoir tank on the roof, the risk of lowering the chloride concentration and increasing bacterial contamination is higher, so sterile water may be safe, in those institutions where a direct supply from the water mains is not provided.

In our institution, ten sterilization systems were fitted in the operating room, which cost approximately 30 million yen, and the annual running cost is 5.25 million yen for changing the pre-filter 4 times a year, the main filter every year, and checking water quality annually (**Table 3**). If we could use tap water for scrubbing up like Western countries, most of the maintenance cost of the sterile water would be cut, the budget for protection against hospital infection could be increased, and it would contribute to a lower incidence of hospital infection. Urgent discussion with the Ministry of Health, Labour and Welfare is desired.

Conclusions

There is no merit in using sterile water for preoperative scrubbing up, which requires expensive equipment with costly maintenance and administration. Sterile brushes are also unnecessary. When using tap water for surgical hand washing, the technique of rubbing the hands together is adequate; a quick-drying alcohol-based disinfectant scrub can be added if necessary; the chloride concentration should be maintained at more than 0.1 PPM; bacterial examinations should be routinely carried out; and thorough washing and sterilization of faucets are all more important than the sterility of the water.

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