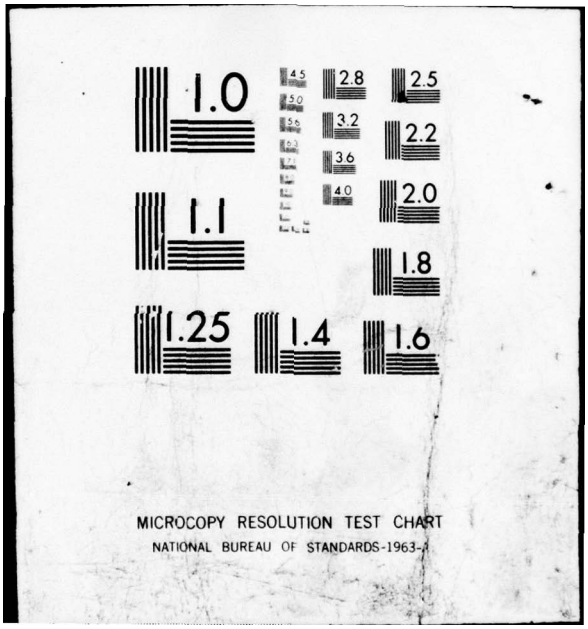
AD-A056 628 ARMY INST OF DENTAL RESEARCH WASHINGTON D C F/G 6/5
THE EFFECT OF SURGICAL SCRUB ON MICROBIAL POPULATION UNDER THE --ETC(U)
JUN 78 A GROSS, D E CUTRIGHT

UNCLASSIFIED NL

| OF |
AD
A056628

END
DATE
FILMED
8-78
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

LEVEL

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
The Effect of Surgical Scrub on Microbial Population Under the Fingernails

5. TYPE OF REPORT & PERIOD COVERED
Manuscript for publication
15 Nov 77 - 15 Jun 78
Rept. for

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Arthur Gross, Duane E. Cutright
Sandra M. D'Alessandro

8. CONTRACT OR GRANT NUMBER(s)
62110A 3A162110A825
Task 00 [illegible]36, Work Unit 115

9. PERFORMING ORGANIZATION NAME AND ADDRESS
U. S. Army Institute of Dental Research
Walter Reed Army Medical Center
Washington, DC 20012

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
23p

11. CONTROLLING OFFICE NAME AND ADDRESS
U. S. Army Medical Research & Development Command
HQDA (SGRD-RP)
Washington, DC 20314

12. REPORT DATE
15 Jun 78

13. NUMBER OF PAGES
20

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
UNCLASSIFIED

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
This document has been approved for public release and sale; its distribution is Unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

DDC
RECEIVED
JUL 19 1978
F

18. SUPPLEMENTARY NOTES
None

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Surgical Scrub

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
The effectiveness of two methods of presurgical hand preparation - 10 min. routine scrub and 90 sec. Hydroscrub - in reduction of microbial numbers under fingernails was determined. Bacteriological cultures of 292 subungual areas of 20 subjects revealed prescrub microbial counts of up to 9.5×10^5 colony forming units (CFU) per area. Following the surgical scrub, bacterial concentrations were reduced to a different degree among the individuals tested. The means of 3.0×10^3 - 3.2×10^4 CFU immediately after scrub indicated that neither of the

over

'78 07 10 117

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED 038 670
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

AD A056628

DDC FILE COPY

BLOCK 20. continued.

two methods tested reduced the microbial population under fingernails of most individuals to "acceptable" levels. The finding of high postscrub microbial counts under fingernails is of particular interest and significance in view of the results relating to the relatively low counts on fingertips. The extremely high number of microorganisms remaining in the subungual areas should alert every member of the surgical team to the possible danger of (until now) unrecognized failure of proper hand degerming prior to surgery. On the basis of the results of this study, it is concluded that: (1) Degerming of the areas under the fingernails by present methods is not satisfactory; (2) Evaluation of the efficacy of various antiseptic agents and scrub techniques should include determination of the microbial counts in the subungual areas in addition to the assays of microbial population on the skin of hands; and (3) The possible implication of the subungual microorganisms in the development of postsurgical infection should be investigated; and (4) A modification of the methods currently used or, possibly, a new approach to the effective reduction of microbial population under the fingernails is necessary.

THE EFFECT OF SURGICAL SCRUB ON MICROBIAL POPULATION UNDER THE FINGERNAILS

Arthur Gross, D.D.S., M.S.

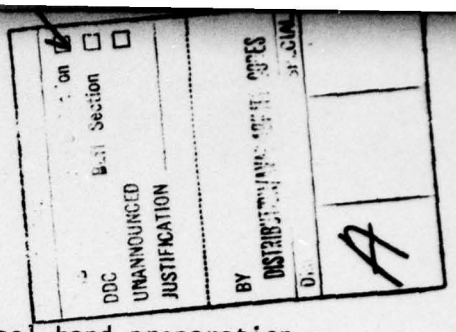
Duane E. Cutright, D.D.S., Ph.D.

Sandra M. D'Alessandro, B.S.

U. S. Army Institute of Dental Research
Walter Reed Army Medical Center
Washington, D. C.

Reprint Requests to:

COL Arthur Gross, DC
Chief, Division of Oral Biology
U. S. Army Institute of Dental Research
Walter Reed Army Medical Center
Washington, D. C. 20012



ABSTRACT

The effectiveness of two methods of presurgical hand preparation - 10 min. routine scrub and 90 sec. Hydroscrub - in reduction of microbial numbers under fingernails was determined. Bacteriological cultures of 292 subungual areas of 20 subjects revealed prescrub microbial counts of up to 9.5×10^5 colony forming units (CFU) per area. Following the surgical scrub, bacterial concentrations were reduced to a different degree among the individuals tested. The means of 3.0×10^3 - 3.2×10^4 CFU immediately after scrub indicated that neither of the two methods tested reduced the microbial population under fingernails of most individuals to "acceptable" levels. The finding of high postscrub microbial counts under fingernails is of particular interest and significance in view of the results relating to the relatively low counts on fingertips. The extremely high number of microorganisms remaining in the subungual areas should alert every member of the surgical team to the possible danger of (until now) unrecognized failure of proper hand degerming prior to surgery. On the basis of the results of this study, it is concluded that: (1) Degerming of the areas under the fingernails by present methods is not satisfactory; (2) Evaluation of the efficacy of various antiseptic agents and scrub techniques should include determination of the microbial counts in the subungual areas in addition to the assays of microbial population on the skin of hands; and (3) The possible implication of the subungual microorganisms in the development of postsurgical infection should be investigated; and (4) A modification of the methods currently used or, possibly, a new approach to the effective reduction of microbial population under the fingernails is necessary.

INTRODUCTION

Dissemination of pathogenic bacteria to patients by the hands of medical personnel was recognized by Semmelweis and Lister more than 100 years ago. Since that time various antiseptic agents have been introduced for the purpose of cleansing the hands before patient care, especially prior to invasive surgical procedures. To further insure that bacteria would not gain access to surgical wounds from surgeons' hands, in 1889 Halsted recommended the use of rubber gloves. Although several modifications of the methods of presurgical preparation of hands have been made, and newer, more effective, and non-irritating surgical scrub preparations evaluated and accepted, the surgical scrub has not changed significantly since those early days. Only recently a new, rapid method for surgical preparation of hands has been developed and shown to be at least as effective as conventional scrub.[6]

Any accepted method should not be followed blindly, but re-examined from time to time, and possible fallacies and misconceptions recognized and, if possible, rectified. Indeed, during the surgical scrub studies in this laboratory we have observed and reported one such misconception pertaining to the use of sodium thiosulfate. This iodine inactivating agent has been frequently incorporated into the culture media in the investigations of the effectiveness of the iodine-containing scrub preparations. In spite of the fact that we have shown sodium thiosulfate to have an inhibitory effect on bacterial growth, and have indicated that use of this neutralizer may have led to misleading

results;[12] and although our results have been confirmed[11] and considered to be important enough to warrant caution when evaluating iodine preparations,[21] there is still insistence by some[16] to continue the use of sodium thiosulfate. It should be pointed out again that povidone-iodine preparations are water soluble and any residual iodine on the skin can be effectively removed by rinsing the hands thoroughly.[14] Therefore, incorporation of iodine inactivators is not necessary.

There is voluminous literature concerning surgical scrub. Comparison of results is rather difficult because of the different techniques and sampling methods used. Most frequently used methods for determination of the extent of microbial contamination on the skin include the multiple basin technique,[19] glove juice technique,[6,17] swabbing technique,[10] fingertip impression method,[6,14] combination of fingertip impression and Rodac plate method,[13] tape stripping method,[23] fingertip impression with drawing fingers across the contact plate,[20] glass cup method,[18] and modification of these techniques. Most of these methods have been discussed by Ulrich.[22]

It is apparent from the extensive literature review that the evaluation of the efficacy of surgical scrub has been based on determination of microbial counts on the skin of either the fingertips or of the palmar or dorsal parts of the hand, or the total area of the hands.

It appears that no attempt has been made to assess the microbial

contamination of an area of the hand with possibly the most abundant microbial flora, namely, the subungual areas. It was, therefore, the purpose of this study to determine the microbial counts underneath the fingernails and to evaluate the effectiveness of two methods of pre-surgical preparation of hands in an attempted elimination or reduction of the microorganisms from the subungual areas.

METHODS AND MATERIALS

Part 1.

Members of the U. S. Army Institute of Dental Research laboratory staff participated in this study. Prior to the beginning of the tests they were taught the conventional scrub technique. They then scrubbed their hands using the following two methods.

The first method was a conventional surgical scrub of 5 min. duration using individually packaged E-Z Scrub surgical scrub brush-sponge with nail cleaner and containing a detergent with iodophor. Eleven individuals scrubbed this way on three different days.

The same individuals also used another method developed at this institute, and shown to be at least as effective as routine 10 min. surgical brush scrub.[6,7] The device employed for this purpose, and referred to as Hydroscrub, utilizes the high pressure pulsating water jet principle, and delivers water with an appropriate antiseptic scrub preparation at 120 psi (Fig. 1). It has been described in more detail earlier.[7] Eight individuals had their hands and arms lavaged for 90 sec. on two different days using this device with a 200X dilution of Betadine Solution.

Prescrub cultures of the subungual areas of the first (index) and second fingers (all areas cultured are shown in Table 1) were obtained using sterile small swabs that were made by wrapping cotton tightly around the end of a flat wooden toothpick. The cotton tip was moistened with sterile 0.1% peptone water, placed under the nail, and brought across the nail three times. Each tip was then cut off and dropped into a test tube containing 10 ml of 0.1% peptone water. The tube was agitated with Vortex for 30 sec., serial dilutions were made, and 0.1 ml aliquots of each dilution were spread on Brain heart infusion agar plates.

Immediately after the scrub by either method, the hands and arms were rinsed thoroughly under tap water, dried with a sterile towel, and cultures of the hands were obtained using the fingertip impression method and Brain heart infusion agar as a culture medium as described earlier.[6,13] Postscrub cultures of the subungual areas were taken in the same manner as before the scrub.

All cultures were incubated at 37°C for 48 hours; then the colony forming units (CFU) on the surface of the agar plates were counted.

Part 2.

Since the majority of the subjects tested in the first part of this study were laboratory personnel without previous experience in the routine surgical scrub techniques and, therefore, the resulting bacterial counts following the routine 5 min. scrub could be attributed in part to the poor scrub technique, it was considered appropriate to

extend the testing to the additional group of participants. This group consisted of nine staff dentists who did have previous instruction and experience in proper surgical scrub procedures. They used both methods of presurgical preparation of hands on three separate occasions, in the same manner as described in Part 1, except that duration of the routine scrub was changed from 5 to 10 min.

Bacteriological cultures were obtained as described above; but in addition to postscrub fingertip counts, prescrub counts of fingertips were also determined. All areas cultured are shown in Table 2.

RESULTS

Part 1.

Postscrub microbial counts on hands and counts underneath the fingernails before and after surgical preparation of hands are shown in Table 1.

Following the routine 5 min. surgical scrub microorganisms could be recovered from the hands of all eleven subjects. Colony forming units (CFU) counts ranged from 4 - 41 with a mean of 14.3 per hand. After 90 sec. Hydroscrub the same individuals yielded somewhat lower counts ranging from 0 to 8.5 with a mean of 2.8 CFU/hand. These results indicate that scrubbing by either method did not consistently degerm hands as effectively as would be desired.

The prescrub microbial counts of the subungual areas showed great variability. The lowest value of 0.5×10^3 (Subj. #6) differed markedly from the highest of 756×10^3 (Subj. #1).

The data relating to the effectiveness of both methods in reducing

subungual levels of microorganisms is shown in Table 1. The postscrub counts were decreased to different degrees in different individuals. While in some subjects the microbial counts were relatively low (ranging from 0.05×10^3 - 7.0×10^3 in Subj. #6), in others, postscrub cultures yielded 99.0×10^3 (Subj. #8) and even 447.7×10^3 (Subj. #9).

Part 2

In this part both prescrub and postscrub microbial counts on five fingertips of both hands were determined. The mean counts before presurgical preparation of hands of 114.0 and 113.7 and postscrub counts of 8.3 and 9.0 CFU for both groups were almost identical (Table 3) indicating both methods to be equally efficient or deficient in hand degerming. The values for each subject in Table 3 also show that concentration of microorganisms on the hands vary among individuals and that the degerming of hands, although not complete, is not necessarily dependent on the prescrub levels but appears to be due rather to some other factors controlling the ease of removal of microorganisms from skin.

Microbial counts underneath the fingernails of participating dentists (Table 3) were found to be lower than in the group participating in the first part of the study. However, great differences in counts among individuals were again observed. The low prescrub counts in Subjects 2, 4, and 7 contrasted sharply with much higher counts in Subjects 3, 5, and 8. The microbial concentrations following the scrubs differed not only among the individuals but also among subungual areas of

different fingers in the same individual.

As shown in Table 4, the means for prescrub counts of 13.0×10^3 for 10 min. routine scrub group and 20.7×10^3 for Hydroscrub group were decreased to 3.0×10^5 (76.9%) and 7.8×10^3 (62.3%) respectively, by the two methods tested.

DISCUSSION

We have obtained convincing evidence that surgical scrub does not reduce the microbial population under fingernails of most individuals to "acceptable" levels. It is obvious that the microbial counts in subungual areas remained very high, particularly in some individuals. The mean microbial counts after scrub in both groups ranged from 3.0×10^3 - 3.2×10^4 CFU/area which, in comparison with the prescrub counts, represents 62.3 - 86.5 percent reduction. This percent reduction however, should not be considered an indication of the effectiveness of scrub techniques, since the counts, although reduced, must be considered excessive.

Only very scanty information is available in the literature on this aspect of hand degerming in spite of the fact that Arnold, et al.,[1] in the study of the self-disinfecting power of the skin almost half a century ago, showed that the fingernail region was an area of the hand and fingers with the least efficient capability to disinfect itself. These investigators considered the fingernail area from the standpoint of body defense to be a very interesting region of the body surface, with an almost inexhausbible reservoir of bacteria. They also pointed out

that experienced surgeons harbor many bacteria under fingernails after a thorough scrub.

In another study, Connell, et al.,[4] obtained cultures from under the physicians' fingernails following the scrub; unfortunately the results of this procedure were not reported in the paper. Also, the following points of interest were not explained: The methods of obtaining the cultures from under the nails and from the palmar surfaces which were dried while still lathered; and procedures necessary for inactivation of the residual antiseptic agents.

The finding of high postscrub microbial counts under fingernails is of particular interest in view of the results relating to the relatively low counts on fingertips which resembled those reported earlier for nonclinical personnel,[6,13] medical obstetric personnel,[7] and for operating room nurses and other operating room personnel (unpublished data). It may be assumed, on the basis of these last two reports with data from studies on clinical personnel experienced in scrub techniques, that similar high postscrub counts under fingernails could have been present.

The counts on fingertips cannot be compared directly with those under fingernails, because of different methodology used for their determination and the surface areas cultured. The surface areas under fingernails from which bacteriological cultures were obtained were considerably smaller than the areas of the fingertips, yet the subungual counts exceeded those on fingertips. This finding is due to the

variability in bacterial concentrations on different areas of the hand. The microbial numbers on the palms and dorsa of the hands are normally rather low, being higher on the arms, and much higher under fingernails and in the recesses of the nail folds.[15]

During our investigations dealing with the effectiveness of the surgical scrub,[6,7,13] including this study, we have observed repeatedly that the extent of microbial colonization of the skin of hands varies among individuals. Generally, individuals exhibiting high numbers of organisms did so from day to day, while others regularly yielded low numbers. This observation is in agreement with findings of Price[19] and Blank.[2] The factors that regulate the bacterial colonization of the cutaneous surfaces are not completely understood; however, pH, extent of hydration, presence of microbial growth inhibitory substances, and inorganic salt concentrations are thought to be involved in the regulation of the survival of organisms on the skin.

In this laboratory, we are presently investigating the possible role of cutaneous fatty acids in the regulation of microbial flora, in an attempt to correlate the microbial numbers on hands with the presence and concentration of endogenous fatty acids on skin.

Similar to the differences in the degree of microbial concentrations on fingers of various individuals we have also observed individual differences in difficulty with which microorganisms on the skin of fingers and subungual areas could be reduced by degerming methods used. The reduction in the microbial population on fingers following

the scrub did not generally appear to be correlated with the prescrub counts, since in some subjects with consistently high prescrub count the bacterial numbers were decreased effectively and possibly eliminated (Subj. #2, 3, and 6 in Part 2). In others, (Subj. 7) relatively low numbers of microorganisms, although reduced by the scrub, could not be diminished as effectively.

Even greater variability in results was evident from the data of subungual areas. While in some individuals the scrubs markedly reduced the microbial concentrations, in others no such effect could be observed. Occasionally, the postscrub counts even exceeded the prescrub counts.

We can only speculate about the implication of our findings, since no studies have been reported on the infectious potential of subungual microorganisms remaining following the surgical scrub. There is not even general agreement on main sources of the wound infections after various surgical procedures. While some postsurgical wound infections are attributed to infecting microorganisms from the operating room personnel[9] and to the neglect of strict adherence to aseptic techniques, including proper presurgical preparation of hands of operating room personnel, in other postsurgical complications an endogenous source of infecting bacteria from the patient himself has been implicated.[3,8]

There is no doubt that strictly aseptic techniques are necessary during surgical procedures. Preparation of surgeons' hands is an important link in the chain of asepsis and rendering the hands of surgical personnel as free of bacteria as possible is absolutely essential. Contaminated hands are the source of wound infection, and

prevention of wound contamination by wearing of gloves is not always effective since puncture or tear occurs in about 25% of gloves.[9] The danger associated with the glove puncture is supported by the finding of three times higher infection rate following operations accompanied by glove tears than after those without glove breaks.[5]

In view of finding excessive microbial concentrations under the fingernails following the presurgical scrub, we believe that evaluation of the effectiveness of various antiseptic agents and scrub techniques should include determination of the microbial numbers in the subungual areas in addition to the assays of microbial population on the skin of hands.

Additional studies by other investigators, preferably in a clinical environment, are needed; and the possible implication of the subungual microorganisms in the development of postsurgical infection should be investigated.

Also, a new approach to the effective reduction of microbial levels under fingernails should be considered in order to eliminate or minimize the potential danger of complications arising from the neglect of strict adherence to aseptic techniques.

* * * * * * *

Commercial materials and equipment are identified in this report to specify the investigative procedures. Such identification does not imply recommendation or endorsement or that the materials and equipment are necessarily the best available for the purpose. Furthermore, the opinions expressed herein are those of the authors and are not to be construed as those of the U. S. Army Medical Department.

Table 1. MICROBIAL COUNTS ON HANDS AND UNDER THE FINGERNAILS BEFORE AND AFTER SURGICAL PREPARATION OF HANDS

	Surgical Scrub (5 Min)					Hydroscrub (90 Sec)								
		CFU x 10^3 / Subungual Area*				CFU / Hand† Post		CFU x 10^3 / Subungual Area†						
	CFU/* Hand	Finger #1		Finger #2				Finger #1 (R)§		Finger #2 (R)		Finger #1 (L)ξ		Finger #2 (L)	
Subject	Post	Pre	Post	Pre	Post	Right	Left	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	41.0	103.1	23.4	218.5	46.0	8.5	4.0	732.0	50.0	756.0	41.5	950.0	38.0	690.0	83.3
2	17.0	6.4	0.3	28.2	5.1	2.0	0	11.2	0.05	211.5	44.4	67.0	27.7	200.0	2.3
3	8.0	40.7	13.9	28.7	14.7	2.5	0.5	287.0	83.0	263.0	35.9	87.0	0.4	136.0	12.1
4	16.7	12.7	12.3	12.3	6.5	0	0.5	12.1	38.2	1.1	17.8	22.0	5.9	51.0	10.0
5	28.3	23.3	11.2	69.7	33.9	1.0	1.5	143.0	0.8	185.0	26.0	50.3	2.4	245.0	4.6
6	4.3	12.7	1.3	0.8	0.5	0	1.0	0.5	0.05	39.5	7.0	31.2	0.1	11.1	1.3
7	4.0	95.0	11.0	124.1	4.8	4.5	8.5	283.0	70.5	212.5	51.5	228.1	14.0	345.0	72.5
8	12.0	7.8	3.3	25.5	5.5	8.5	2.0	236.0	82.0	360.0	99.0	144.0	25.7	550.0	71.8
9	Confluent	25.0	7.3	112.0	447.7#										
10	6.7	11.2	0.8	27.1	2.5										
11	5.5	14.6	11.5	25.4	6.7										
MEAN	14.3	32.0	8.8	61.1	12.6	3.4	2.3	213.1	40.6	253.6	40.4	197.5	14.3	278.5	32.2

*Average of three tests
†Average of two tests
§R = Right hand
ξL = Left hand
#Not included in calculation of the Mean

TABLE 2. EFFECT OF PRESURGICAL PREPARATION OF HANDS ON MICROBIAL CONCENTRATION UNDER THE FINGERNAILS (CFU/AREA)

	SURGICAL SCRUB (5 Min)		HYDROSCRUB (90 Sec)	
No. Subjects	11		8	
No. Subungual Areas	66		64	
	Pre	Post	Pre	Post
Microbial Count	4.6×10^4	1.1×10^4	23.6×10^4	3.2×10^4
Percent Reduction	76.1		86.5	

TABLE 3. MICROBIAL COUNTS ON HANDS AND UNDER THE FINGERNAILS BEFORE AND AFTER SURGICAL PREPARATION OF HANDS

	SURGICAL SCRUB (10 Min)										HYDROSCRUB (90 Sec)									
	CFU/Hand				CFU x 10^3 / Subungual Area*						CFU/Hand				CFU x 10^3 / Subungual Area					
Subject	R† Pre	L§ Post	R Pre	L Post	Finger Pre	#2 (L) Post	Finger Pre	#1 (R) Post	Finger Pre	#2 (R) Post	R Pre	L Post	R Pre	L Post	Finger Pre	#2 (L) Post	Finger Pre	#1 (R) Post	Finger Pre	#2 (L) Post
1	250.0	250.0	39.0	31.0	17.9	10.5	72.1	1.6	32.0	23.7	187.5	204.0	9.0	52.0	5.5	4.0	16.1	0.6	15.6	0
2	158.0	152.5	1.0	0	0.02	0	0.02	0	0.2	0	79.0	109.0	0	1.0	0.3	0.2	7.1	1.1	1.1	0.3
3	37.5	72.0	1.0	0.5	20.4	0.1	19.0	0.01	0.2	23.4	91.5	145.5	0.5	0	18.5	0.005	21.6	0.9	0.4	0.5
4	104.0	98.5	8.5	11.0	0.1	0	0.7	0.1	0.1	0.02	76.0	83.0	1.0	11.0	0.2	0.3	1.0	1.7	0.5	0.2
5	38.0	51.0	9.5	6.5	0.9	0.3	2.7	2.0	14.7	16.6	103.5	51.5	44.0	11.0	17.2	10.6	18.1	30.2	149.2	4.0
6	131.0	46.0	1.5	2.0	0.1	0.4	0.5	0.1	0.5	0.1	131.0	46.0	1.5	2.0	8.4	0.4	5.0	4.0	7.6	0.2
7	26.0	27.5	6.0	12.0	0.1	0.2	0.5	0.05	1.05	0.1	8.5	16.0	2.5	7.5	2.0	4.3	0.5	0.2	0.5	0.8
8	203.0	160.0	4.5	7.5	11.3	0.03	1.1	0.4	14.0	0.1	155.5	149.5	13.0	2.0	37.9	0.7	39.7	100.6	170.8	43.8
9	142.0	116.0	5.0	3.5	138.2	0.8	0.2	0.01	2.4	0.5	197.5	213.0	2.0	1.5	10.7	1.0	1.9	0.3	0.2	0.9
MEAN	119.9	108.2	8.3	8.2	21.0	1.4	10.8	0.5	7.2	7.2	114.4	113.1	8.2	9.8	11.2	2.4	12.3	15.5	38.4	5.6

*Avg. of 3 tests
†R = Right hand
§L = Left hand

TABLE 4. EFFECT OF PRESURGICAL PREPARATION OF HANDS ON MICROBIAL CONCENTRATION UNDER THE FINGERNAILS (CFU/AREA)

	SURGICAL SCRUB (10 Min)		HYDROSCRUB (90 Sec)	
No. Subjects	9		9	
No. Subungual Areas	81		81	
	Pre	Post	Pre	Post
Microbial Count	13.0×10^3	3.0×10^3	20.7×10^3	7.8×10^3
Percent Reduction	76.9		62.3	

REFERENCES

1. Arnold, L., Gustafson, T.G., Hull, B.E., Singer, M. and Singer, C.: The Self-Disinfecting Power of the Skin as a Defense Against Microbic Invasion. Amer. J. Hyg. 11:345, 1930.

2. Blank, Irvin H.: Survival of Bacteria on the Skin. In Skin Bacteria and Their Role in Infection, Maibach, H.I. and Hildick-Smith, G. (ed.), New York, McGraw-Hill Book Company, p. 43-47, 1965.

3. Burke, John F.: Factors Predisposing to Infection in the Surgical Patient. In Skin Bacteria and Their Role in Infection, Maibach, H.I. and Hildick-Smith, G. (ed.), New York, McGraw-Hill Book Company, p. 143-155, 1965.

4. Connell, J.F.Jr. and Rousselot, L.M.: Povidone-Iodine, Extensive Surgical Evaluation of a New Antiseptic Agent. Amer. J. Surg. 108:849, 1964.

5. Cruse, P.J.E. and Foord, R.: A Five-Year Prospective Study of 23,649 Surgical Wounds. Arch. Surg. 107:206, 1973.

6. Cutright, D.E., Bhaskar, S.N., Gross, A. and Mulcahy, D.M.: A New Method of Presurgical Hand Cleansing. Oral Surg. 33:2, 162-167, 1972.

7. Decker, L.A., Gross, A., Miller, F.C., Read, J.A., Cutright, D.E. and Devine, J.: A Rapid Method for the Presurgical Cleansing of Hands. Obstet. Gynecol. 51:1, 115-117, 1978.

8. Drake, C.T., Goldman, E., Nichols, R.L., Piatruszka, K. and Nyhus, L.M.: Environmental Air and Airborne Infections. Ann. Surg. 185:219, 1977.

9. Devenish, E.A. and Miles, A.A.: Control of Staphylococcus aureus in an Operating-Theatre. Lancet 1:1088, 1939.

10. Evans, C.A. and Stevens, R.J.: Differential Quantitation of Surface and Subsurface Bacteria of Normal Skin by the Combined Use of the Cotton Swab and the Scrub Method. J. Clin. Microbiol. 3(6):576, 1976.

11. Green, B.L. and Litsky, W.: The Use of Sodium Sulfite as a Neutralizer for Evaluating Povidone-Iodine Preparations. Health Lab. Sci. 11:3, 188-194, 1974.

12. Gross, A., Cofone, L. and Huff, M.B.: Iodine Inactivating Agent in Surgical Scrub Testing. Arch. Surg. 106:175, 1973.

13. Gross, A., Selting, W.J., Cutright, D.E. and Bhaskar, S.N.: Evaluation of Two Antiseptic Agents in Surgical Preparation of Hands by a New Method. Am. J. Surg. 126:49, 1973.

14. Joress, S.M.: A Study of Disinfection of the Skin: A Comparison of Povidone-Iodine with Other Agents used for Surgical Scrubs. Ann. Surg. 155:296, 1962.

15. Kligman, A.M.: The Bacteriology of Normal Skin. In Skin Bacteria and Their Role in Infection, Maibach, H.I. and Hildick-Smith, G. (ed.), New York, McGraw-Hill Book Company, 13-31, 1965.

16. Kundsin, R. B.. and Walter, C.W.: The Surgical Scrub - Practical Consideration. Arch. Surg. 107:75, 1973.

17. Lowbury, E.J.L., Lilly, H.A. and Bull, J.P.: Disinfection of Hands: Removal of Resident Bacteria. Br. Med. J. 1:1251, 1963.

18. Pachtman, E.A., Vicher, E.E. and Brunner, M.J.: The Bacteriologic Flora in Seborrheic Dermatitis. J. Invest. Dermatol. 22:389, 1954.

19. Price, P.B.: The Bacteriology of Normal Skin: A New Quantitative Test Applied to the Study of the Bacterial Flora and the Disinfectant Action of Mechanical Cleansing. J. Infect. Dis. 63:301, 1938.

20. Smylie, H.G., Webster, C.U. and Bruce, M.L.: "Phisohex" and Safer Surgery. Br. Med. J. 2:606, 1959.

21. Tucci, V.J., Stone, A.M., Thompson, C., Isenberg, H.D., Wise, L.: Studies of the Surgical Scrub. Surg. Gynecol. Obstet. 145:415, 1977.

22. Ulrich, J. A.: Technics of Skin Sampling for Microbial Contaminants. Hosp. Topics 43:121, 1965.

23. Updegraff, D.M.: A Cultural Method of Quantitatively Studying the Microorganisms in the Skin. J. Invest. Dermatol. 43:129, 1964.

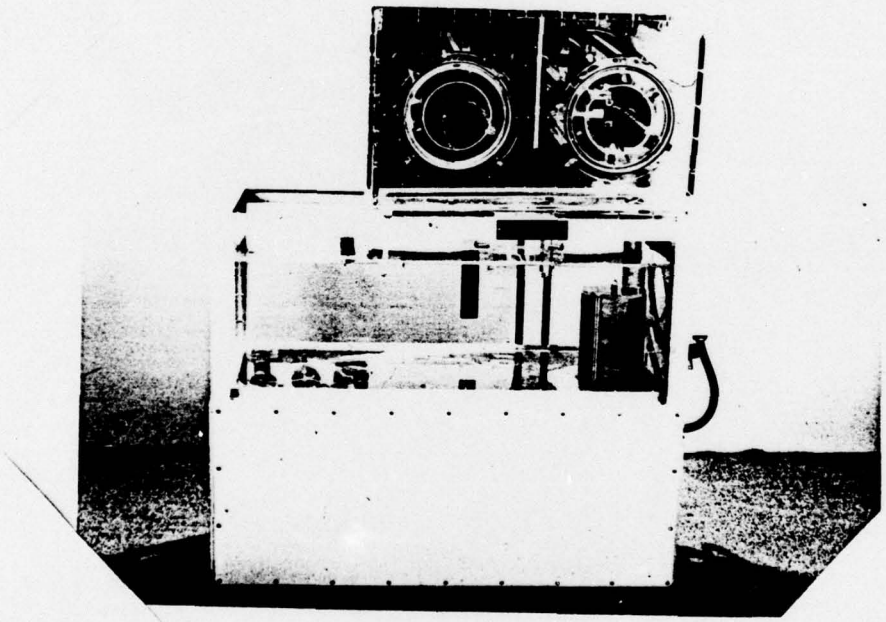


Figure 1. Hydroscrub Device