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Detergents compared with each other and with antiseptics as skin 'degerming' agents

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SUMMARY

Three detergent preparations (bar soap, 'Hibiscrub' base and 'LIC 76'), two antiseptic preparations (0·5% chlorhexidine in 95% ethyl alcohol and an alcohol jelly, 'Alcogel'), and one antiseptic-detergent solution (4% chlorhexidine gluconate in a detergent base, 'Hibiscrub') were compared for their effectiveness, on a single use, in reducing the yield of bacteria from the hands of volunteers. The antiseptic and antiseptic–detergent preparations were more effective than the detergents, with a mean reduction in yield of skin bacteria of 96·0% after use of alcoholic chlorhexidine and of 81·2% after use of Hibiscrub. One of the detergents, LIC 76, appeared more effective than the others, causing a mean reduction in the yield of skin bacteria of 41·5%, compared with reductions of 4·6% by the Hibiscrub detergent base and an increase of 3·2% with bar soap; unlike the other detergents, LIC 76 was found to have appreciable bacteristatic and bactericidal properties.

INTRODUCTION

The numbers of bacteria on the skin, as judged by quantitative sampling from the surface, can be reduced by *detergent cleansing*, i.e. physical removal with a detergent and water, or by *disinfection*, i.e. killing the bacteria on the skin with a bland bactericidal agent ('antiseptic'), or by a combination of both processes. The reduction in the natural skin bacteria (including 'residents') is found to be much greater after various forms of disinfection than after washing with soap and water (Price, 1957; Lowbury & Lilly, 1973; Lowbury, Lilly & Ayliffe, 1974). Some antiseptics are shown to be more effective in this respect than others, but we are not aware of any published information on the relative efficiency of different kinds of detergent in reducing the bacteria by physical removal.

We report here a comparison of two antiseptic preparations, one antiseptic detergent preparation and three preparations which were supplied as detergents, though one was found to have some bactericidal properties. We use the word 'degerming' to cover reduction of skin flora by either or both of the mechanisms mentioned above.

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MATERIALS AND METHODS

Preparations tested

Antiseptic. (1) 0·5% chlorhexidine gluconate in 95% ethyl alcohol, with 1% glycerine (Lowbury *et al.* 1974). (2) 'Alcogel' (LIC), a Swedish preparation containing 70% ethyl alcohol in a jelly.

Antiseptic-detergent. 4% chlorhexidine gluconate in a detergent solution ('Hibiscrub').

Detergent. (1) Bar soap. (2) The detergent base used in Hibiscrub ('Hibiscrub Base'). (3) 'LIC 76', a Swedish detergent solution containing ethanolamine lauryl sulphate, coconut oil, sodium chloride and other compounds in water. This preparation has been claimed to reduce the yield of skin flora as effectively as the antiseptic detergent preparation Hibiscrub (Lars Jonsson, personal communication).

Methods of using the preparations

The detergent and antiseptic detergent preparations were applied to the hands and moistened with running warm water from a tap. Hibiscrub was rubbed consistently over all surfaces for about 20 sec before further additions of water to enhance the detergent effect. Washing continued for 2 min, with a standard attention to all surfaces, including the wrists, the tips of fingers and spaces between fingers. After washing, the hands were rinsed thoroughly under running water and dried on a sterile towel.

The alcoholic chlorhexidine solution was applied in two lots of 5 ml poured into the cupped hands, and then rubbed in vigorously until the skin felt dry (Lowbury *et al.* 1974). The Alcogel was applied in the same way as the alcoholic chlorhexidine, i.e. 2×5 ml lots into the cupped hand and rubbed until dry.

Assessments of effectiveness in reducing natural skin flora

The procedure was that used in previous assessments of skin disinfection (e.g. Lowbury, Lilly & Bull, 1960; Lowbury *et al.* 1974), the socially clean hands of volunteers being sampled for yield of bacteria by a standard rinsing technique before and again immediately after cleansing and/or disinfection. The hands were sampled in bowls containing 100 ml Ringer's solution with a mixture of neutralizers (Lubrol W, 1%, Lecithin, 0·5% and Tween 80, 1%) by moistening thoroughly and rubbing vigorously 3 times palm to palm, 3 times right palm over left dorsum, 3 times left palm over right dorsum and 3 times with fingers interlaced, rinsing thoroughly after each of these manoeuvres. Tenfold dilutions of the washings were made in sterile sampling fluid and pour plates were prepared, from 1 ml amounts of each dilution, in nutrient agar containing the same neutralizers. After 48 h aerobic incubation at 37 °C, total colonies were counted (Lowbury & Lilly, 1960). Hands were rinsed under running water and dried on a sterile towel before each sampling, and after disinfection or cleansing. Tests for carry-over of antiseptic to culture plates were made by a standard technique in which a diluted culture of *Staph. aureus* (Oxford strain) was inoculated, for viable counts, on pour plates to which hand washings were transferred and on control uninoculated plates.

A Latin-square design was used, each method of cleansing and/or disinfection

being tested on each of the volunteers. One week was allowed to elapse between experiments, so that the skin flora could return to its normal equilibrium level before each experiment.

Statistical analysis

An analysis of variance was made, using the logarithmic reduction factors (RF) from the Latin-square experiment (Rotter, Mittermayer & Kundi, 1974). The significance of the difference between the mean log. RF's was assessed by calculating t, as the ratio of difference between the two means to the standard deviation of the difference, the latter calculated from the residual variance.

RESULTS

Table 1 shows the viable bacterial counts per ml in skin sampling fluid used before and after skin 'degerming' treatments in each subject and in each experiment. It can be seen that after the use of soap and of the detergent used in Hibiscrub there was a small reduction or, sometimes, an increase in viable counts; LIC 76, however, caused a larger reduction, similar to that obtained with Alcogel. Greater reductions were obtained with alcoholic chlorhexidine and with the 4% chlorhexidine detergent preparation, Hibiscrub. The means of the percentage reductions and the mean of the log reduction factors (log RF) are shown in Table 2. Log reduction factor (log RF) is the logarithim of the viable count of the pre-treatment sample minus the logarithm of the viable count of the post-treatment sample; a log RF of 1·00 corresponds with a 90% reduction, and a log RF of 2·00 corresponds with a 99% reduction.

The significance of differences between mean log reduction factors caused by different methods of treatment is shown in Table 3. Alcoholic chlorhexidine was significantly more effective than all the other methods, and Hibiscrub was signicantly more effective than Alcogel, LIC 76 and the detergent base of Hibiscrub; there was no significant difference between Alcogel and the three detergent preparations, though the log RF with Alcogel and LIC 76 was greater than with the detergent base of Hibiscrub or with bar soap (Table 2).

Because of the apparently better effect obtained with LIC 76 than with the other detergents (bar soap, 'Hibiscrub' base, Table 2) tests were made for bacteriostatic and bactericidal action against a strain of *Staphylococcus aureus* by this product and by the detergent base of Hibiscrub. Doubling dilutions of both preparations in nutrient broth were inoculated with 0·02 ml of an overnight broth culture of *S. aureus* (Oxford strain). After overnight incubation at 37 °C the tubes were examined. The Hibiscrub detergent base showed no bacteriostatic or bactericidal properties in these tests. Subcultures of tubes containing dilutions of LIC 76 from 1/16 to 1/1024 showed no growth up to 1/256; the bacteria which had grown initially in these tubes had, presumably, been killed on continued exposure to an antimicrobial component of LIC 76. This preparation should therefore be grouped with the antiseptic detergents rather than with the simple detergent preparations.

Table 1. *Viable counts of bacteria per ml. skin samplings*

Subject	Sampling before or after treatment	'Degerming' treatment of skin: Bar soap	LIC 76	'Hibiscrub' base	'Hibiscrub'	'Alcogel'	0·5% chlorhexidine in 95% ethanol
A.K.	Before	12400	20400	9900	21600	11100	21700
	After	14900	9800	8100	3410	8900	1290
B.D.	Before	20900	22100	22100	38700	15500	37400
	After	16600	15200	19800	2740	6300	59
K.B.	Before	28400	18300	18000	4000	4210	16100
	After	30400	13800	12100	470	1930	1090
B.G.	Before	2230	5200	6800	12600	14800	4000
	After	2000	3600	8300	3900	5400	59
S.B.	Before	13600	23700	22800	16600	52200	94000
	After	17300	9300	20300	7300	27900	2830
C.R.	Before	37100	15100	4800	16700	42900	15800
	After	35500	7600	5900	590	24100	1010
Mean	Before	19105	17467	14066	18367	23452	31500
	After	19450	9883	12416	3068	12421	1056

Table 2. *Mean reduction in viable counts of skin bacteria*

Treatment of skin with	Mean of percentage reductions	Mean of log reduction factors
Bar soap	−3·2	−0·008
'LIC 76'	41·5	0·245
'Hibiscrub' base	4·6	0·0302
'Hibiscrub'	81·2	0·867
'Alcogel'	47·9	0·298
0·5% chlorhexidine in 95% ethanol	96·0	1·624

Table 3. *Significance of differences between treatments* (P)

	Alcoholic chlorhexidine	Hibiscrub	Alcogel	LIC 76	Hibiscrub base
Hibiscrub	< 0·001 (S)	—	—	—	—
Alcogel	< 0·001 (S)	< 0·01 > 0·001 (S)	—	—	—
LIC 76	< 0·001 (S)	< 0·01 > 0·001 (S)	> 0·01	—	—
Hibiscrub base	< 0·001 (S)	< 0·001 (S)	> 0·1	> 0·1	—
Bar soap	< 0·001 (S)	< 0·001 (S)	> 0·1	> 0·1	> 0·1

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DISCUSSION

Alcoholic chlorhexidine and the 4% chlorhexidine detergent solution Hibiscrub were shown in these, as in previous studies, to cause a large immediate reduction in the yield of bacteria from the skin. The alcohol jelly, Alcogel, had a similar effect which was not significantly greater than that obtained with LIC 76. This result was surprising, as LIC 76 had been described as a detergent preparation; however, tests showed that LIC 76 had antimicrobial properties *in vitro*. Hibiscrub detergent base showed no antimicrobial properties *in vitro*, and its skin degerming properties were similar to those of bar soap. The use of soap and of the Hibiscrub detergent base was sometimes associated with an increase in the yield of bacteria – in the case of soap the mean showed an increase. The antiseptic preparations always caused a reduction in the yield of skin bacteria.

Detergents might be expected to have a more important role against transient skin flora than against the resident flora. Recent studies (Lilly & Lowbury, 1978) have shown that bacteria allowed to dry on the skin were as effectively reduced in numbers by soap and water as by an antiseptic detergent preparation, but treatment of the skin with 70% ethyl alcohol, in the manner described above, was more effective than a simple detergent wash. Bacteria which had been rubbed on to the skin were more effectively reduced by an antiseptic–detergent preparation than by a simple detergent, but against such transients, too, ethyl alcohol rubbed on until dry was more effective than detergent or antiseptic-detergent treatment.

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