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The intermittent use of hexachlorophene soap—a controlled trial

By J. A. C. WEATHERALL and H. I. WINNER
Department of Bacteriology, Charing Cross Hospital, W.C. 2

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Hexachlorophene has been used as a skin disinfectant during the last 18 years. Various workers have shown that under specified conditions the use of toilet soap containing 2% hexachlorophene reduces the number of bacteria which can be isolated from the skin (Traub, Newhall & Fuller, 1944; Fahlberg, Swan & Seastone, 1948; Price & Bonnet, 1948; Best, Coe, McMurtrey & Henn, 1950; Cade, 1950; Lawrie & Jones, 1952; Hurst, Stuttard & Woodroffe, 1960; Lowbury & Lilly, 1960; Lowbury, Lilly & Bull, 1963). Lowbury & Lilly (1960) showed that the exclusive use of 2% hexachlorophene soap for several days reduced the bacterial flora of the skin of nurses' hands, but its use only during periods of duty was of much less value. Nurses now often live out of the hospital and although it is easy enough to make hexachlorophene soap the only available toilet soap in the hospital, it is impracticable to require all the nursing staff to use hexachlorophene soap when not on duty. However, it is of practical importance to know whether the use of 2% hexachlorophene soap only while on duty does reduce the number of bacteria on the surface of the nurses' hands, and the present controlled experiment was undertaken to settle this point.

There are various techniques for making quantitative estimations of bacteria on the hands and they differ in the depth of the bacterial population sampled. It is probable that only the surface flora of the nurses' hands are likely to be transmitted to patients and therefore are potentially dangerous (Lowbury, Lilly & Bull, 1960). We have therefore used a method by which only surface bacteria are sampled. Other methods such as those which involve washing either the hands or the insides of rubber gloves with sterile solutions from which counts are made (Lowbury & Lilly, 1960; Price, 1938) sample both the superficial and deep bacterial flora. The relevance of the latter is doubtful and these methods are also technically more complicated than the surface sampling method we have used.

METHODS AND DESIGN OF EXPERIMENT

The investigation was conducted in four surgical wards each of thirty beds, in a general hospital of some 400 beds. All the regular nursing staff of the surgical wards were observed during a period of 8 weeks, during which they were required to use either hexachlorophene soap or a control soap while on duty in the hospital. Nurses were told about the experiment, but no nurse knew which periods were the test periods, nor what soaps were being used at any given time during the experiment.

The bacteria on the palms of the hands were counted using the following technique (modified from Lawrie & Jones, 1952). Eight-inch lengths of sterile gauze bandage were embedded in blood agar plates while the medium was still molten. When the medium was cold the disk of agar (approximately 10 cm. in diameter and 0·5 cm. in thickness) was lifted out of the Petri dish and the under side of the disk, which was smooth, was laid on the palm of the hand to be tested. Contact was made for 45 sec. Pressure over the palm was maintained by applying a weight (340 g.) to the upper surface of the blood agar disk. Pressure was distributed uniformly by having a soft rubber inflated bag between the disk and the weight. The surface of the rubber bag under the weight was cleaned by wiping it with a 1:1000 solution of benzalkonium chloride and drying with a sterile swab. This did not interfere with the growth of organisms on the opposite side of the plate.

The blood agar disk was replaced in a Petri dish, contact side uppermost. This was incubated aerobically at 37° C. overnight. Next day a metal template with four square holes, each of 1 cm.^{2} area, was placed on the surface of the medium and the colonies within each of the four squares were counted. Replicate counts of a plate counted by this method showed little variation in the mean for the four squares counted.

The experiment was conducted over 8 consecutive weeks during February and March 1962 in four surgical wards. During the experimental period any nurse on duty in the surgical wards used experimental soap when washing her hands or when washing a patient. While off duty, nurses used whatever soaps or detergents they pleased. Nurses were on duty for 42 hr. a week, usually spread over 6 days, with a maximum of 8 hr. on any one day. While on duty the number of times a nurse washed depended on her duties. For example, nurses handling bedpans washed frequently; those doing dressings scrubbed up before and washed their hands after attending to each patient, and those making beds washed less frequently.

Soap for the experiment was provided by Messrs Bibby and Co. Control soap and soap containing 2% hexachlorophene were each made in two colours, pink and blue, to be distinct from soap used in other wards not in the experiment. Control and hexachlorophene soap of one colour were indistinguishable.

The soaps used were tested *in vitro* before the experiment. Dissolved control or hexachlorophene soap was incorporated in a nutrient agar medium to achieve final concentrations of 1:1000 or 1:10,000 soap. The nutrient agar plates were inoculated with serial dilutions of a strain of *Escherichia coli* or of a strain of *Staphylococcus aureus*. They were then incubated overnight. The growth of *E. coli* was not inhibited by either 1:1000 control soap or 1:1000 hexachlorophene soap (1:50,000 hexachlorophene). The growth of *Staph. aureus* was slightly inhibited on nutrient agar containing 1:1000 control soap and completely inhibited on the medium containing 1:10,000 hexachlorophene soap (1:500,000 hexachlorophene). No differences were observed *in vitro* between pink and blue hexachlorophene soap or between pink and blue control soap.

Soaps were used according to the programme in Table 1. During the 8 weeks the right hand of each nurse was sampled twice a week. The number of hours a nurse had worked since coming on duty was noted. As the concentration of hexachloro-

phene on the surface of the hands was likely to be changing in the first 2 and third 2 weeks the results during these weeks were discarded. Weeks 3 and 4, and weeks 7 and 8 were taken as test periods. The maximum number of estimates for any one nurse during each test period was therefore four. No nurse contributed less than three estimates.

Table 1. *Programme of experiment*

Colour and type of soap by week and by ward

		Equilibration period	First test period	Equilibration period	Second test period
Week of expt.		1, 2	3, 4	5, 6	7, 8
Ward	Type of surgery				
I	Gynaecological and orthopaedic, female	Hexachlorophene (pink)	Hexachlorophene (blue)	Control (pink)	Control (blue)
II	General, male	Control (blue)	Control (pink)	Hexachlorophene (blue)	Hexachlorophene (pink)
III	General, female	Control (pink)	Control (blue)	Hexachlorophene (pink)	Hexachlorophene (blue)
IV	General, genito-urinary and orthopaedic, male	Hexachlorophene (blue)	Hexachlorophene (pink)	Control (blue)	Control (pink)

The changes from pink to blue soap and blue to pink soap were made to allow easy estimation of the amount of soap being used in each ward, to ensure that soaps did not migrate from control to hexachlorophene wards during the experiment, and to check that the colour of soap did not influence the amount of soap used.

RESULTS

Only nurses remaining attached to one ward for at least $3\frac{1}{2}$ weeks of the first or second half of the experiment were included. In spite of excellent co-operation from administrative staff, only four out of ten nurses attached to each ward fulfilled these criteria. Altogether twenty-five nurses were included in the experiment. Of these, seven remained attached to one ward for all 8 weeks of the experiment.

The amount of soap used varied from ward to ward but in any one ward the consumption was remarkably constant. Since each ward contained different types of patient according to the specialities of the consultant surgeons, and since each ward was run on different regimens, the results from all wards for each control or for each hexachlorophene period have been combined, so that each ward contributes equally to the results.

The number of bacteria isolated from the hands of nurses varied widely from day to day, as is shown in the data from two wards in Table 2. The overall variation was not apparently different in the control and hexachlorophene periods. As some nurses were examined only three times and some four times in each test period, the results have been expressed as the mean number of colonies counted in 4 cm.^{2} for each nurse. Therefore for any one test period each of the four wards contributes mean counts from each of four nurses.

Table 3 shows the mean values for each nurse for all four wards in the experiment. The difference between mean counts obtained during the hexachlorophene period and during the control period is not significant ($P > 0{\cdot}4$).

Of the seven nurses who did not move from one ward to another during all

Table 2. *Number of colonies in 4 cm.² from fifty-eight contact samples from palms of nurses' hands (two wards only)*

Soap used	Ward	Nurse	Days after exposure to soap: 16	20	23	27
Control	III	A	8	6	8	24
		B	23	5	137	11
		C	16	—	418	3
		D	215	3	2	5
Control	IV	I	2	1	0	16
		K	45	61	35	5
		L	7	12	18	—
		M	3	2	185	25
2% hexachlorophene soap	III	E	6	1	14	83
		C	19	30	8	105
		D	509	19	11	9
		F	4	206	4	28
2% hexachlorophene soap	IV	G	66	31	10	0
		H	22	30	1	20
		I	0	3	5	2
		J	9	421	51	—

Table 3. *Mean of counts in 4 cm.² for each nurse from all four wards during control period and during hexachlorophene period*

	Control period			Hexachlorophene period		
Ward	Soap colour	Nurse	Mean count	Soap colour	Nurse	Mean count
I	Blue	T	2	Blue	T	31
		X	18		U	31
		Y	46		V	21
		W	56		W	9
II	Pink	N	13	Pink	R	67
		O	9		O	41
		P	30		S	24
		Q	22		Q	42
III	Blue	A	12	Blue	E	26
		B	44		F	61
		C	146		C	41
		D	56		D	137
IV	Pink	I	5	Pink	I	3
		K	37		G	27
		L	12		H	18
		M	54		J	160
	Mean = 35·13 ± S.E. 9·07				Mean = 46·18 ± S.E. 11·92	

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8 weeks of the experiment, the mean during the control period was 42·3 ± S.E. 19·3 colonies in 4 cm.² which did not differ from the mean value of 43·4 ± S.E. 16·7 colonies per 4 cm.² obtained during the hexachlorophene period.

It was thought that the length of time on duty before the hands were sampled might affect the number of organisms on the hands. Table 4 shows the mean of colonies per 4 cm.² analysed by time on duty. In fact mean counts obtained were higher after duty in the hexachlorophene periods than during the control periods, but the differences were not significant. Similarly, and equally without significance, there were less organisms on the hands of nurses arriving on duty in the hexachlorophene periods than on the hands of nurses arriving on duty during the control period.

Table 4. *Mean number of colonies and standard error in 4 cm.² from all nurses' hands after being on duty for varying periods*

(Number of observations in brackets)

	Hours on duty						
	0	1	2	3	4	5	6
During control period	61·4 ± 16·56 (16)	13·7 (1)	17·5 (2)	3 (3)	36·7 ± 27·39 (15)	15·1 ± 5·08 (18)	14 (3)
During hexachlorophene period	28·5 ± 8·63 (13)	10 (3)	96·3 (6)	Nil	57·2 ± 6·64 (21)	36·8 ± 13·76 (16)	15 (2)
Difference between means. Hexachlorophene minus control	−32·9	—	—	—	+20·5	+21·7	—
Probability of difference being due to chance	$0·3 < P < 0·4$	—	—	—	$0·5 < P < 0·6$	$0·1 < P < 0·2$	—

Table 5. *Number of nurses carrying coagulase positive staphylococci in wards using hexachlorophene soap and control soap*

	Nurses carrying coagulase positive organisms	Nurses not carrying coagulase positive organisms	Total
Control soap	5	9	14
Hexachlorophene soap	9	6	15

For the difference between these proportions: $\chi^2 = 1·71$ $\quad 0·2 > P > 0·1$

At the beginning of the experiment a number of staphylococci which had been isolated from the hands of nurses in hexachlorophene wards and in control wards were tested for coagulase. The few results shown in Table 5 indicate no significant difference in the incidence of coagulase positive staphylococci on nurses' hands between the control and hexachlorophene wards. Apart from this, no attempt was made to identify the organisms recovered from nurses' hands during the experiments.

DISCUSSION

In this experiment the effects of 2 % hexachlorophene soap on the bacteria on the surface of nurses' hands have been studied by contact sampling and it was found that this soap did not reduce the number of viable bacteria on the skin. Both Best *et al.* (1950) and Lowbury & Lilly (1960) studied bacteria on the hands of nurses. Although their sampling methods differed, both sets of workers found that regular and exclusive use of 2 % hexachlorophene soap resulted in a reduction of viable bacteria on the hands. However, Lowbury & Lilly (1960), in their broad study which is not directly comparable to the limited controlled experiment reported here, showed that the intermittent use of hexachlorophene soap by nurses was of doubtful value in reducing bacteria on the hands.

Fahlberg *et al.* (1948) have shown that an ether soluble substance which inhibited the growth of *Staph. albus* was present on the skin of subjects who had used hexachlorophene soap for several days, and the concentration of this substance decreased during 72 hr. after hexachlorophene soap had been last used. It seems probable that the substance which accumulated was hexachlorophene and that the effectiveness of hexachlorophene soap depends on the accumulation of hexachlorophene on the skin.

In the present investigation nurses used hexachlorophene soap only while at work. Any washing with other soaps or detergents while not at work probably removed any hexachlorophene which had accumulated during work, so that no effective antibacterial concentration of hexachlorophene was ever reached.

This work shows that the intermittent use of hexachlorophene soap has no effect in reducing the number of superficial bacteria on the hands.

SUMMARY

The number of bacteria on the hands of nurses using 2 % hexachlorophene soap intermittently was compared with the numbers of bacteria on the hands of nurses using ordinary soap. No significant differences were observed.

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