*Papers and Originals***DISINFECTION OF HANDS: REMOVAL OF RESIDENT BACTERIA**

BY

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Price (1938) drew attention to the difference between "transient" and "resident" bacteria of the skin. The latter are characterized by persistence, with variable diminution, even after prolonged washing and treatment with antiseptics. They include relatively few types of bacteria and appear to colonize the skin; most of them are harmless, but among them may in some individuals be found strains of *Staphylococcus aureus* (Evans, Smith, Johnston, and Giblett, 1950; Hare and Ridley, 1958; Lowbury, Lilly, and Bull, 1960).

In a comparison of alternative methods for disinfection of the surgeon's hands (Lowbury and Lilly, 1960), a detergent emulsion containing 3% hexachlorophane was found to be one of the most effective agents for the removal of resident bacteria from the skin. Although some other measures—for example, rinsing for three minutes after the scrub in 0.5% alcoholic chlorhexidine—had a similar effect, hexachlorophane emulsion used instead of soap had the advantage of convenience and speed. Its value has been widely recognized (Hufnagel, Walter, and Howard, 1948; Walter, 1948; Smylie, Webster, and Bruce, 1959; Beilby and Thompson, 1961), and in many hospitals it has been introduced for routine use by medical and nursing staff.

Various antiseptic soaps, detergent emulsions, creams, and jellies for disinfection of the hands have become available during the last few years. In three series of experiments described below a Latin square design was used for the comparative study of 12 antiseptic preparations; this method of assessment takes into account possible interfering effects of personal variation and of day-to-day changes of conditions. The effects of a single application and of repeated use of the antiseptic preparations have been separately assessed. In two additional experiments the removal of staphylococci and the value of a more recently available preparation were examined.

Materials

The following preparations were studied:

(1) A detergent emulsion (cream) containing 3% hexachlorophane ("phisohex").

(2) Compound hexachlorophane cream (Royal Free Hospital) containing:

Exonic (26% dispersion) extra	...	500 g.
Simple ointment	...	150 g.
Collone N.I.	...	20 g.
Hexachlorophane (B.P.C.)	...	30 g.
Water	...	to 1,000 ml.

(3) A liquid soap containing 2% hexachlorophane ("ster-zac").

(4) A liquid soap containing 3% hexachlorophane, prepared by adding the appropriate amount of hexachlorophane dissolved in ether to ster-zac liquid soap.

(5) A liquid soap containing 2% dichlorophene.

(6) A liquid soap containing a mixture of five halogenated alkyl/aryl phenols ("hycolin" liquid soap; see Larkin, Bridson, Grieve, and Gibson, 1961).

(7) An emulsion containing a mixture of N-dodecyl-1, 3-aminopropyl-aminobutyric acid and O-dodecyl-1, 3-oxypropyl-aminobutyric acid ("tegolan" emulsion; see Schmitz and Harris, 1958; Frisby, 1959).

(8) A bar soap containing 2% hexachlorophane ("derl").

(9) A cream containing similar ingredients to (6) (hycolin cream).

(10) Chlorhexidine (1%) hand cream.

(11) A jelly containing hexachlorophane (0.01%), orthophenylphenol (0.01%), and isopropyl alcohol (45%) ("steriloderm").

(12) A jelly containing hexachlorophane (0.5%), orthophenylphenol (0.25%), and isopropyl alcohol (45%) ("steriloderm forte").

(13) Polyvidone iodine (povidone iodine, U.S.A.; "betadine") surgical scrub, containing polyvinylpyrrolidone-iodine complex, which, like other iodophors, is claimed to have the antibacterial properties of iodine without its irritant and sensitizing properties (Joress, 1962; Zintel, 1956).

(14) Unmedicated bar soap and water (control treatment).

Preparations 1 to 8 and 13 were used instead of soap, a small amount being deposited on one hand at the beginning of an ablution. Preparations 9 to 12 were applied to both hands and rubbed in thoroughly each time after the hands had been scrubbed or washed (according to the stage of the experiment) with ordinary bar soap and water and dried with a sterile towel.

First Series of Experiments

In this series of experiments seven preparations (Nos. 1, 3, 6, 7, 9, 10, and 11) and the control (14) were compared; the mean viable counts of hand-washings and glove-content washings were estimated after a single use, after repeated use of the preparation, and also after no treatment.

Methods

Eight subjects (laboratory staff) were chosen for the experiments. The preparations, including the inert control, were allotted to the subjects in a Latin-square design (Fisher, 1942). Eight experiments were made in alternate weeks, allowing about 10 days for a complete return of resident flora (Price, 1957). In every experiment all preparations were tested and all subjects used, each preparation being tested once by each subject.

The plan of the experiment was as follows. On day 1 (Monday) and day 4 (Thursday) of each test week the subjects scrubbed up for two minutes with a nylon brush under running warm water, and used the antiseptic or control preparation allotted to them in the Latin square. On each of days 2 and 3 (Tuesday and Wednesday) the antiseptic or control preparation was used six times with, or after, two minutes' washing (not scrubbing) under running warm water. In this way the effects of single and repeated applications could be studied.

After drying their hands with a sterile towel on days 1 and 4, the subjects wore rubber gloves for an hour. At the end of this time the gloves were removed carefully and washings were taken with 100 ml. of sampling fluid (see below) from the inside of the gloves for viable counts as described elsewhere (Lowbury and Lilly, 1960). The hands were then washed with sampling fluid in a standard way (an initial rinse, three strokes palm to palm, a rinse, three strokes right palm over left dorsum, a rinse, three strokes left palm over right dorsum, a rinse, three strokes with fingers interlaced, and a final rinse). The sampling fluid was Ringer's solution containing "lubrol W" (1%), lecithin (0.5%), and "tween 80" (1%) to neutralize the antiseptics. Viable counts were made in pour-plates with undiluted glove-content washings and tenfold dilutions of hand-washings; the medium was nutrient agar containing the neutralizers at the same concentration as in the sampling fluid. In the earlier tests 2.5% serum was added to the sampling fluid and culture medium to neutralize the phenols in hycolin preparations. This component was not used in the later tests because viable counts were not noticeably different when the serum was omitted from replicate tests. Colonies were counted after 48 hours' incubation at 37° C. Tests for the transfer of inhibitory amounts of antiseptic to the sampling fluid and to plates were made in the manner described elsewhere (Lowbury and Lilly, 1960; Lowbury *et al.*, 1960).

Hand-washings of the experimental subjects were examined in alternate weeks between tests of antiseptics for a record of the flora when no antiseptic was being used; for these tests gloves were not worn.

Results

The counts from hand-washings at the sampling on the first day immediately after wearing gloves for one hour and the further sampling on day 4 are shown in Table I. It will be seen that each preparation was tested on each individual, so that eight readings are available for assessment of the effects of the different treatments. The distribution of these counts is skewed, as commonly

occurs in such data; for the purposes of statistical analysis logarithms of the counts have therefore been taken. This converts the distribution to a near-normal shape and has the further advantage that a difference of logarithms on, say, day 4 as compared with day 1 measures the proportional reduction in bacteria, which is usually of more interest than the absolute counts. Analysis of variance of the readings on day 1, the readings on day 4, and the difference between day 1 and day 4 is summarized in Table II. It is interesting to note

TABLE II.—*Analysis of Variance of Log Bacterial Counts from Hand-washings on First and Fourth Days of Application of Different Agents (First Series)*

	Degrees of Freedom	Mean Squares		
		Day 1	Day 4	1-4
Persons ..	7	0.7507 NS	1.0628 S	0.2395 NS
Experiments ..	7	0.3388 NS	0.6029 NS	0.2703 NS
Treatment ..	7	2.2997 S	7.5423 S	1.6342 S
Residual ..	42	0.4369	0.2818	0.2996

that the variance attributable to differences between experimental days and differences between persons was slight in comparison with that attributable to the different treatments. Taking the contributions of the different treatments to this highly significant treatment effect, it is clear that most of the benefit is attributable to preparations Nos. 1 and 3. None of the other preparations showed a significant difference from the control in respect of day 1; on day 4, preparations Nos. 6 and 7 showed barely significant difference from the control, and in the comparison of day 1 and day 4 only the preparations Nos. 1 and 3 were significantly effective.

As a further check on the validity of these comparisons, analysis has also been made by ranking order of the preparations for each experimental subject. This method leads to an identical conclusion, preparations Nos. 1 and 3 leading on day 1, day 4, and in the day 1/day 4 comparison. Third place was shared between preparations Nos. 6 and 7, as was concluded from the analysis of variance.

TABLE I.—*Logarithms of Viable Counts of Bacteria from 0.1 ml. of Hand-washings (First Series of Experiments)*

Experiment	Day	Code Number of Preparation Used for Hand Treatment							
		1	3	6	7	9	10	11	14 (Control)
1	1	(A.K.) 1.41	(C.L.) 1.54	(M.W.) 2.90	(J.D.) 2.46	(J.B.) 3.21	(E.L.) 2.49	(B.C.) 2.34	(R.J.) 3.44
	4	0.72	1.32	2.86	2.06	3.16	2.48	3.23	3.29
2	1	(J.D.) 2.49	(R.J.) 2.01	(C.L.) 2.99	(E.L.) 2.81	(B.C.) 3.30	(A.K.) 2.79	(M.W.) 3.44	(J.B.) 3.11
	4	1.79	0.30	2.75	1.84	3.28	2.57	3.60	3.16
3	1	(R.J.) 1.08	(J.B.) 2.86	(J.D.) 2.38	(M.W.) 2.83	(C.L.) 3.50	(B.C.) 2.86	(A.K.) 2.86	(E.L.) 3.60
	4	0.00	0.90	2.25	2.51	4.05	3.55	1.76	3.28
4	1	(E.L.) 1.62	(A.K.) 1.80	(B.C.) 2.68	(J.B.) 3.16	(J.D.) 2.70	(C.L.) 3.95	(R.J.) 2.78	(M.W.) 2.81
	4	0.48	0.48	2.47	2.48	3.03	4.04	3.29	2.95
5	1	(J.B.) 1.87	(M.W.) 2.34	(E.L.) 2.34	(R.J.) 2.26	(A.K.) 3.18	(J.D.) 2.20	(C.L.) 3.89	(B.C.) 2.13
	4	0.30	1.40	1.08	2.39	3.13	2.26	4.00	2.11
6	1	(B.C.) 1.26	(E.L.) 0.95	(J.B.) 2.58	(A.K.) 2.36	(R.J.) 2.72	(M.W.) 3.25	(J.D.) 3.17	(C.L.) 3.77
	4	0.00	0.85	2.10	2.06	3.13	2.12	3.16	3.48
7	1	(C.L.) 2.37	(J.D.) 0.70	(R.J.) 2.72	(B.C.) 1.73	(M.W.) 3.52	(J.B.) 2.85	(E.L.) 1.68	(A.K.) 2.57
	4	0.48	0.15	2.35	0.70	2.51	2.32	2.04	2.44
8	1	(M.W.) 1.92	(B.C.) 2.41	(A.K.) 3.15	(C.L.) 3.32	(E.L.) 2.94	(R.J.) 3.03	(J.B.) 2.89	(J.D.) 3.05
	4	1.52	1.23	1.36	3.57	2.95	1.86	3.03	2.37
Mean counts of 8 experiments (not logs)	1	100	177	629	704	1,683	1,784	1,792	2,022
	4	14	10	267	289	2,441	1,793	2,526	1,235

* Initials of subjects in parentheses.

A further approach is possible from comparison of the counts obtained from the glove contents. The mean counts with the corresponding analysis of variance are shown in Table III. Again the difference due to experiments and to persons is not a prominent source of variance, but that due to treatments is significant in the analyses on day 1 and day 4, though not in the difference between the two days. Of the different preparations,

TABLE III.—*Viable Counts of Bacteria from 1 ml. of Glove-content Washings (First Series of Experiments)*

	Day	Code Number of Preparation Used for Hand Treatment							
		1	3	6	7	9	10	11	14 (Control)
Mean counts of 8 experiments	1 4	18 8	11 6	33 14	34 19	179 77	47 16	91 130	46 43
<i>Analysis of Variance (Log Counts)</i>									
	Degrees of Freedom	Mean Squares							
		Day 1	Day 4	1-4					
Persons ..	7	0.3689 NS	0.3008 NS	0.1585 NS					
Experiments ..	7	0.2407 NS	0.3912 S	0.4706 NS					
Treatment ..	7	1.3393 S	1.9578 S	0.2646 NS					
Residual ..	42	0.2371	0.1566	0.3286					

Nos. 1 and 3 show significant effects on day 1, and Nos. 1, 3, 6, and 7 show significant effects on day 4, though the observed effect of Nos. 6 and 7 is appreciably less than that of Nos. 1 and 3. The mean count for No. 10 was lower on day 4 than on day 1, but this reduction was not significant.

We would conclude, therefore, from this experiment that of the preparations tested Nos. 1 and 3 were outstandingly more effective in reducing the number of organisms both on the day of first application and after continued use for four days under the specified conditions of testing. Of the other preparations, Nos. 6 and 7 showed some useful effects, but the other preparations were of doubtful value.

Second Series of Experiments

In these experiments we compared a commercial hexachlorophane detergent emulsion (preparation No. 1) with a similar mixture prepared in a hospital pharmacy (No. 2), a liquid soap containing the same proportion of hexachlorophane (No. 4), and the control preparation, soap and water (No. 14).

Methods

Four subjects were chosen, and a Latin-square design was used as in the first series of experiments. The effects of a single application and of repeated use were again studied by tests after scrubbing with the preparation on days 1 and 4, the preparation being used for six hand-washes on day 2 and again on day 3.

The sampling procedure was different from that used in the first series of experiments. No gloves were worn, and three samples were taken: (1) on day 1, after a "social wash" with soap and water immediately before the first treatment with the preparation; (2) immediately after scrubbing up for two minutes with the preparation; and (3) on day 4, immediately after scrubbing with the preparation. The hands were thoroughly rinsed under a tap after the first sampling to remove neutralizers from the skin.

The sampling technique for the hands and the counting of bacteria were the same as in the first series of experiments.

Results

The mean counts obtained from the hands before and after single treatment with each of the preparations tested and after continued treatment for four days, together with the corresponding analysis of variance, are shown in Table IV. It is interesting to note that by this method of experimentation in which samples were taken soon after the application of the agent no significant effect of treatment was found at this stage. However, at four days there was a very significant effect of treatment, and this was apparent whether the result at four days was compared with the initial control or

TABLE IV.—*Viable Counts of Bacteria from 0.1 ml. of Hand-washings (Second Series of Experiments)*

	Day	Code Number of Preparation Used for Hand Treatment			
		1	2	4	14
Mean counts of 4 experiments	1a (before treatment) 1b (after " ") 4	855 683 17	791 471 43	2,520 1,831 12	1,096 619 890

Analysis of Variance (Log Counts)

	Degrees of Freedom	Mean Squares		
		Day 1 (1a-1b)	Day 4 (1b-4)	Day 4 (1a-4)
Persons ..	3	0.0202	0.2864	0.2739
Experiments ..	3	0.0293	0.2336	0.1674
Treatment ..	3	0.0379 NS	3.3691 S	3.6089 S
Residual ..	6	0.0299	0.2321	0.1904

with the count after the first application. On all occasions the variance due to experiments and persons was not significant. Comparison of the different preparations shows that all were significantly more effective than the control treatment. Though there was not a great deal of difference between the performance of the agents tested, in the comparison of the control counts and the final count after four days preparation No. 4 was significantly more effective than either No. 1 or No. 2.

Third Series of Experiments

From previous studies (e.g., Lowbury and Lilly, 1960) and from the experiments reported above it appeared that 3% hexachlorophane detergent cream was superior as a hand-cleansing agent to 2% hexachlorophane bar soap; the new experiments also showed that the detergent cream was about as effective as 2% hexachlorophane liquid soap.

In this experiment we have compared the value of a solid (derl) and a liquid (ster-zac) soap containing 2% hexachlorophane; in the same experiment we have examined the value of a liquid soap containing 2% dichlorophene and a jelly containing 0.5% hexachlorophane.

Methods.—The methods were the same as those used in the second series of experiments; in view of the absence of an appreciable reduction in bacterial flora immediately after the first application of hexachlorophane in the second series, however, we omitted this sampling in the third series of experiments.

Results.—Mean counts of organisms from hand-washings, corresponding to those of the first and second experimental series, together with analysis of variance, are shown in Table V. The most informative analysis of these results is that of the comparison between the

result on the first and fourth days. Again the variation attributable to experiments and to persons is not significant. The variance due to treatment, however, is

TABLE V.—*Viable Counts of Bacteria from 0.1 ml. of Hand-washings (Third Series of Experiments)*

	Day	Code Number of Preparation Used for Hand Treatment				
		3	5	8	12	14
Mean counts of 5 experiments	1 4	2,352 52	1,382 318	2,068 742	2,790 2,227	1,373 914
<i>Analysis of Variance (Log Counts)</i>						
		Degrees of Freedom		Mean Squares (Day 1-Day 4)		
Persons	..	4		0.4587		
Experiments ..	..	4		0.1377		
Treatment .. .	..	4		2.5407 S		
Residual .. .	..	12		0.1626		

highly significant. Of the preparations tested, No. 3 was significantly better than all the remainder. No. 5 showed an effect which was barely significantly better than the control; none of the other agents showed a significant effect.

Comparison of Polyvidone Iodine with Hexachlorophane Liquid Soap

Polyvidone iodine surgical scrub (preparation No. 13) was reported by Jorress (1962) to have greater disinfecting power than a hexachlorophane detergent cream. As this preparation became available to us after the three experiments reported above, we have compared its disinfectant action on the hand flora with that of one of the two preparations found most effective in those experiments (the hexachlorophane liquid soap, preparation No. 3).

Methods.—Bacterial counts were obtained from hand-washings by the method described above: (1) immediately before the antiseptic scrub (in all six subjects); (2) in two subjects, immediately after a two minutes' scrub; (3) in two other subjects, one hour after a two minutes' scrub; and (4) in two other subjects, immediately after the seventh in a series of two-minute hand ablutions during a 24-hour period, the first of these being a scrub with a nylon brush. Before sample 1 was taken the hands were given a brief social wash with soap and water. One subject in each pair used preparation No. 3 and one used No. 13; in a replicate experiment a week later the subjects exchanged antiseptic preparations. To neutralize iodine which might be carried over from the hands, sodium thiosulphate (1%) was included with the other neutralizers in the rinsing fluid and in the nutrient agar used for the pour plates. The whole experiment was repeated with six other subjects.

Results.—Table VI shows the mean percentage reduction in viable counts of hand-washings following single

TABLE VI.—*Comparison of 2% Hexachlorophane Liquid Soap with Polyvidone Iodine Surgical Scrub*

Hands Cleansed with	Mean % Reduction in Viable Counts of Hand-washings		
	Immediately after 2 Minutes' Scrub	1 Hour after 2 Minutes' Scrub	After 7 Applications (the First with a Brush)
2% hexachlorophane liquid soap (preparation 3) ..	38.2 ± 14.8	63.3 ± 10.8	83.6 ± 10.8
Polyvidone iodine surgical scrub (preparation 13) ..	60.4 ± 10.7	71.6 ± 7.2	89.9 ± 6.0

and repeated applications of the two antiseptic preparations. The effects of the two agents were similar; the mean effect of polyvidone iodine surgical scrub was slightly greater than that of the hexachlorophane soap, but in the numbers tested this difference was not statistically significant.

Numbers of Staphylococci on Skin During Use of Hexachlorophane

Six nurses in the burns unit whose hands were found to be carrying *Staph. aureus* were chosen for a test of the effect of hexachlorophane, used at all ablutions, on the carriage of staphylococci.

Experiment.—A bar soap containing 2% hexachlorophane (preparation No. 8) was used by the nurses while on duty—a method shown to have limited value in earlier studies (Lowbury and Lilly, 1960). Samples were taken from their hands by the standard washing method described above on one or two occasions before they were supplied with a hexachlorophane detergent emulsion (phisoex) and asked to use this for all ablutions, on or off duty, for one week. Daily samples of hand flora were examined during this week and when possible on several successive days after the return to the previous hand-washing routine. Counts of presumptive *Staph. aureus* were made on the hand-washings by surface inoculation on plates of phenolphthalein diphosphate agar (Barber and Kuper, 1951).

Results.—In each subject (see Table VII) at least one of the samples taken during the week when phisoex was being used showed no colonies of presumptive *Staph. aureus*, and there was a tendency for counts to fall during this period and to rise again afterwards. In

TABLE VII.—*Mean Counts of Presumptive Staph. aureus per ml. Washings Taken on Successive Days from Nurses' Hands*

Nurse	Before Phisoex*	During Use of Phisoex (1 Week)	After Phisoex*
H	647, 650	575, 0.93, 119, 4	118, 86, 28, 375
W	2, 2,550	50, 6, 2, 2, 0	4, 32
F	58	275, 30, 8, 0, 2	54, 32, 325
G	303	615, 52, 127, 0, 0	0, 28, 30, 475, 300
A	33, 104	386, 10, 10, 1, 0	200, 70, 175
S	102, 515	120, 287, 28, 0	—

* Hexachlorophane bar soap was used by nurses on duty; during the week when phisoex was used this was used for all ablutions on or off duty.

each case, however, some samples showed large or moderate counts of *Staph. aureus* in spite of the use of phisoex—an expected finding in view of the frequent recontamination that was likely to occur in nurses working without gloves in a burns ward.

Sensitivity to Hand-cleansing Preparations

No sensitization was found in the limited use of hexachlorophane detergent cream or polyvidone iodine described above, but the repeated use of hexachlorophane liquid soap was occasionally found to cause redness and discomfort of the hands. As this occurred in some individuals who had previously used hexachlorophane detergent creams without ill effect, the reaction to the liquid soap was apparently due not to hexachlorophane but to some other component; it seems probable that repeated washing with the liquid soap was responsible for this effect.

Tests for Transfer of Antiseptic and Neutralizer

There was no evidence in these experiments of bactericidal or bacteriostatic effects of antiseptic carried over to sampling fluids or culture-plates.

In a comparison of sampling with Ringer's solution and the neutralizer solutions, approximately the same immediate effect of hexachlorophane liquid soap on skin flora was found with the two sampling fluids; there appeared, therefore, to be no inactivation of hexachlorophane by traces of neutralizer carried on the skin following the pretreatment sampling.

Discussion

The experiments reported here illustrate the value of applications of hexachlorophane with soap or detergents, and, in a more limited study, of an iodine-polyvinylpyrrolidone complex (polyvidone iodine) as antiseptics for removal and suppression of the resident bacteria of the hands. They also show the absence of any such effect following the use of several preparations which might have been expected to suppress the hand flora. With hexachlorophane preparations the immediate disinfecting action of a single application was slight, but there was a progressive reduction in hand flora, which was appreciable one hour after the first application, and considerably greater after one or two days of repeated use (cf. Price, 1951). With polyvidone iodine there appeared to be a larger initial effect, but also some cumulative action following repeated use.

The vehicle in which an antiseptic is applied appears to be important. As in previous experiments, a detergent emulsion containing 3% hexachlorophane (preparation No. 1) was found to be superior to bar soap containing 2% hexachlorophane (No. 8); in the new study, however, a liquid soap containing 2% hexachlorophane (No. 3) was no less effective in reducing the skin flora than phisohex, and the same liquid soap enriched to contain 3% hexachlorophane was found to cause a significantly greater reduction of skin flora than the detergent emulsion. When applied, after washing or scrubbing the hands, in a jelly containing 0.01%, or even 0.5%, of the antiseptic, hexachlorophane had little or no effect on the skin flora. This result was surprising; one might have supposed that a larger amount of hexachlorophane would be left on the skin after rubbing in such a jelly than after washing the skin with a soap or cream, the excess of which is washed away. It is possible that the process of scrubbing with a detergent and water helps to bring the antiseptic into closer contact with bacteria, especially in the deeper layers of the epidermis, than occurs after rubbing a jelly into the dry skin. The action of other antiseptics on skin flora was also affected by the vehicle in which they were applied—for example, hycolin soap caused a small but significant reduction in the counts of hand-washings, but there was no similar effect with hycolin cream.

Glove-washings gave results very much like those obtained from hand-washings; there was, however, a small difference in the experiments with chlorhexidine cream, which showed a fall (though not a significant one), following repeated use, in counts from glove-washings but not from hand-washings. This recalls the more striking effect of chlorhexidine cream reported by Murray and Calman (1955) when viable counts were taken from finger-stalls which were moistened with broth before they were worn. It seems likely that the glove count in these experiments with creams was showing bactericidal and perhaps bacteriostatic action on organisms deposited on the moist inner surface of the glove rather than an effect on bacteria in the skin. The reduction of glove-content flora, even if the skin flora

is unaffected, may well be useful in preventing contamination of surgical wounds by organisms emerging through holes in gloves, but it is irrelevant to the transfer of bacteria from the ungloved hands (of nurses on duty in wards, for example).

The hygienic value of a skin disinfectant depends on its ability to reduce or remove pathogens. Previous studies have shown that the use of hexachlorophane soap by nurses led to a significant reduction in the carriage of *Staph. aureus* on the hands (Lowbury and Lilly, 1960), and that ethyl alcohol caused, in some nurses, a comparable reduction in the numbers of staphylococci and of total organisms (Lowbury *et al.*, 1960). The transient removal of staphylococci from the hands of nurses when they used hexachlorophane detergent cream was again shown in this study. Other pathogens, including coliform bacilli and *Pseudomonas pyocyanea*, may be carried as superficial or transient organisms: while one can remove a large proportion of these by washing with soap and water, it is sometimes impossible to remove all of them even with antiseptics. A study of this problem, which differs in various ways from that of the resident organisms, is in progress and will be reported later.

Summary

A Latin square design was used in the comparison of seven antiseptic preparations used for disinfection of the hands; mean viable counts of hand-washings after wearing gloves for one hour after a two-minute scrub with 3% hexachlorophane detergent cream and with 2% hexachlorophane liquid soap were, respectively, 4.9% and 8.7% of the mean count obtained after comparable use of unmedicated bar soap; after repeated use of these preparations during three days the mean counts fell respectively to 13.8% and 5.9% of the levels reached one hour after a single application, compared with a fall of 38.9% in the mean count from hands washed with the control preparation (unmedicated soap). In contrast with these highly significant effects there was no apparent reduction in skin flora after the use of two antiseptic creams and a hexachlorophane jelly applied after scrubbing or washing with ordinary soap. Similar results were obtained from washings from the inside of gloves worn during the experiment. The proportional reduction in flora was best shown by log counts, and these were used in the statistical comparisons; there was, however, a fairly close agreement between the results of these analyses and the numerical means.

In other similar experiments the immediate effect of a single application of hexachlorophane detergent cream or soap was shown to be negligible, and a liquid soap containing 3% hexachlorophane caused a greater reduction of skin flora than two detergent creams, one of them made in a hospital pharmacy, containing 3% hexachlorophane; 2% hexachlorophane was much more effective in a liquid soap than in bar soap, and 2% dichlorophene was less effective than 2% hexachlorophane.

In a comparison of a polyvinylpyrrolidone-iodine complex (polyvidone iodine surgical scrub) with 2% hexachlorophane liquid soap, these preparations were shown to cause a similar reduction in skin flora.

Repeated use of 3% hexachlorophane detergent cream was followed by transient elimination of *Staph. aureus* from the hands of six nurses who carried the organism.

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NITROGEN MUSTARD THERAPY WITH AORTIC OCCLUSION IN NASOPHARYNGEAL CARCINOMA

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The incidence of malignant disease of the head and neck area, relative to other parts of the body, is higher in hospital patients in Kenya than in Europe or America (Clifford, 1961). In the five-year period 1956–60, patients with a primary neoplastic growth in this area constituted one-third of all those with malignant disease admitted to the King George VI Hospital, Nairobi. Undifferentiated growths of the post-nasal space formed the largest group. The patients admitted were classified as follows:

Total number suffering from malignant disease (1956–60)	1,048 (100%)
Patients with a primary head and neck malignancy	368 (34.3%)
Patients with a post-nasal space malignancy	94 (11%)

Digby, Fook, and Che (1941) drew attention to the prevalence of carcinoma of the nasopharynx in Hong Kong, and the clinical picture as described by them is similar to that seen in Kenya. Histologically the tumours are very poorly differentiated and the commonest presenting symptoms are those associated with enlarged secondary neck glands. The disease affects patients of both sexes from the ages of 15 to 55 years, mean about 30 years.

Surgery has no place in the treatment of malignant disease of the post-nasal space (Lederman, 1961), and, as radiotherapy is not available in Kenya, nitrogen mustard (HN2) has been used since 1956 in this department. Initially the recommended pharmacopoeial dose (0.1 mg./kg. body weight, daily for five days) was given, the aim being palliation. Experience suggested that tumour response was proportional to the dose administered (Clifford, Clift, and Duff, 1961), and consequently attention was directed to the development of methods designed to allow larger doses of the drug to be given with safety to the patient. By using auto-

logous marrow infusion to counteract bone-marrow toxicity, 2 mg. of HN2/kg. body weight was given without fatality (Clifford *et al.*, 1961); although the immediate palliative results were satisfactory, the tumour and symptoms recurred.

Miller and Lawrence (1961) developed a method of protecting the pelvic bone-marrow by temporarily occluding the abdominal aorta, but noted that a dose of 1.2 mg. of HN2/kg. produced auditory-nerve damage. To avoid this and other cerebral complications, it was decided to fractionate the dose of HN2, at the same time protecting the pelvic bone-marrow by aortic occlusion. Duff, Dennis, Clift, Clifford, and Oettgen (1961) have described this technique and reported the immediate effects of administering 1.5–3 mg. of HN2/kg. body weight by this method to 10 patients with anaplastic carcinoma of the post-nasal space or mid-third of the oesophagus. The present paper describes the developments and modifications in technique introduced as the result of further experience with this form of therapy, and the method is evaluated with reference to the complications and therapeutic effects noted in 18 patients with anaplastic carcinoma of the post-nasal space.

Assessment and Investigations

Prior to treatment the following investigations were carried out in each case.

1. *Nature and Extent of Disease.*—The diagnosis in all cases was confirmed by a positive biopsy from the post-nasal space. Negative clinical examination of this area may be misleading and patients suspected of having a growth were examined under general anaesthesia. The post-nasal space was carefully palpated by a finger