

CONTROL OF CROSS-INFECTION BY MEANS OF AN ANTISEPTIC HAND CREAM

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From the early days of antiseptics the problem of bacterial cross-infection has attracted increasing attention; first in maternity work, and more recently in burns, accident, and plastic surgery units.

Control of this cross-infection is concerned with the prevention of organisms reaching patients from their environment, which includes all persons attending them. Methods of control of infection due to droplet airborne particles, dust, ward utensils, linen, and contaminated dressings have been extensively investigated, and methods of prevention are well described (Medical Research Council, 1951). A recent appraisal of the use of dust-free air in special units has been made by Lowbury (1954).

The purpose of this paper is to describe attempts to reduce the incidence of cross-infection by treatment of the hands of persons attending patients.

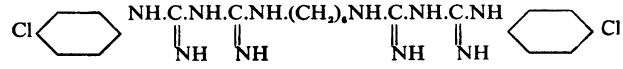
The commonest and most important organisms encountered in cross-infection in maternity hospitals are pyogenic staphylococci and streptococci. Nowadays infection with the β haemolytic streptococcus is confined to relatively rare single cases and small outbreaks, and the measures for its control are well understood. *Staphylococcus aureus* produces a large variety of minor infections in a considerable percentage of babies, and a much smaller number of more serious infections in both mothers and babies.

Hospitals are then faced with the problem of a pool of pyogenic organisms which not only is circulating in the personnel but is spread throughout the buildings in the form of contaminated dust, fluff, bedding, towels, etc. At this hospital we have found that about 60% of nurses carry pyogenic staphylococci in their noses. This figure is similar to that reported by Barber *et al.* (1949) from another maternity unit, and contrasts with the lower incidence in the general population found by the same authors, and also by Rountree and Thomson (1949).

We are convinced that these nasal carriers provide a substantial reservoir for hospital infections, and that the main method of transfer of these organisms is by way of the nurse's or doctor's hand. This view is in agreement with the observations of Moss *et al.* (1948), who established that the nose was the predominant source of *Staph. aureus* on the hands.

In the course of our general investigation into modern antiseptics we became impressed by the possibility of utilizing the persistent antibacterial action of certain antiseptics applied to the skin, as suggested for the control of streptococci by Colebrook and Maxted (1933).

It became clear that these antiseptics might provide a method of interrupting the cycle of transfer of organisms. Amongst a group of antiseptics tested in an investigation to be described elsewhere, we were struck by the high antibacterial levels attainable in therapeutic concentrations, using a new compound (10,040) described by Davies *et al.* (1954) having the basic formula



the diacetate and dihydrochloride of which we have had the opportunity of testing.

As a result of satisfactory experience using an obstetric cream incorporating 1% of this substance, we persuaded the manufacturers to prepare a hand cream with the same comparatively high concentration. This cream ("hibitane") when spread thinly on the hands is capable of suppressing the majority of normal hand bacterial flora, and, as we shall show, renders the hands resistant to bacterial contamination for a considerable period.

Methods

Finger Sampling Technique.—Initial experiments showed that if sterile surgical gloves or fingerstalls were worn on "socially clean" hands for periods up to two hours the number of organisms which could be recovered from the interior varied according to the amount of sweating which occurred.

Thus, if dry gloves were worn for two hours, during which the subject sat still, and then the gloves were rinsed out with nutrient broth, very few colonies indeed were found on plate culture. Whereas if sterile gloves were moistened with broth before being put on, and worn for 30 minutes, very large numbers of organisms could be recovered on culturing the interior of the gloves. Based on these observations, a method of culturing the skin of fingers was therefore devised.

Sampling of Normal Untreated Fingers.—The hands were washed with soap and water, rinsed, and dried on clean towels. Sterile rubber fingerstalls moistened inside with 0.5 ml. of nutrient broth were slipped on and worn for 30 minutes. On removal, 1 ml. of broth was placed inside and shaken so as to rinse the interior thoroughly. Then 0.5 ml. of the broth rinse was withdrawn with a pipette and added to 9.5 ml. of 25% sterile serum water. A further tenfold dilution was then made, giving a final dilution of 1/200. From this last dilution 1 ml. was withdrawn and a poured plate prepared. Colonies were counted after 48 hours' incubation at 37° C.

Normal "Resident" Skin Bacteria.—Results of a typical experiment are shown in Table I, where it can be seen that the variation in the number of colonies recovered from adjacent fingers of the same hand is on the whole not very great.

TABLE I.—Normal "Resident" Finger Organisms

Subject	Control Test of Adjacent Untreated Fingers		
	Index	Middle	Ring
A	368	121	2,548
B	662	670	2,984
C	696	1,292	1,088

Colonies counted on plate (1/200 dilution).

Sampling of Treated Fingers.—Fingers treated with antiseptic creams were sampled in a similar manner, starting at various times from immediately after application, up to two hours afterward. In each experiment untreated fingers of the same hand were used as controls.

Quantity of Antiseptic Creams Used.—The weight of antiseptic cream used was limited to the amount which could be

rubbed into the skin so that no excess cream remained. Quantities of 0.1 to 0.25 g. were tried for each finger, and ultimately 0.15 to 0.2 g. was used in most of the experiments. The results obtained with varying amounts of cream were remarkably similar.

Preliminary Tests

To exclude the possibility of the fingerstall tests being vitiated by the carry-over of antiseptic into the culture plates, blank tests were done.

For these 0.1 and 0.2 g. quantities of cream were emulsified in tubes containing 1.5 ml. of nutrient broth. From each of these tubes 0.5 ml. was transferred to 9.5 ml. of 25% serum peptone water and was allowed to stand for ten minutes as in the tests proper.

A final dilution to 1/200 was made and a poured plate prepared containing 1 ml. of this dilution and seeded with a weak suspension of an overnight culture of *Staph. pyogenes*. At the same time control plates were poured containing the same inoculum of bacteria but no dilution of cream.

The precise dilution of inoculum of *Staph. pyogenes* necessary to give countable colonies on the control plates was first determined, and at a culture dilution of 1 in 1,000,000 the control plate gave 62 colonies. With the use of the same inoculum, plates containing the dilutions from 0.1 and 0.2 g. of antiseptic cream gave 55 and 60 colonies respectively. It is therefore clear that no antiseptic activity could be carried over on to the test plates with this technique.

Results

In these experiments the tests were carried out simultaneously on the same finger of three subjects—A, B, and C.

Suppression of "Resident" Skin Bacteria

The reduction of recoverable bacterial flora is demonstrated well by Tables II and III, in which control and test

TABLE II.—Suppression of "Resident" Organisms by Antiseptic Cream (0.1 g. of 10,040 Diacetate Cream was Rubbed Into Each Test Finger)

Subject	Fingerstalls on for			
	30 Minutes		60 Minutes	
	Test (Index Finger)	Control (Middle Finger)	Test (Index Finger)	Control (Middle Finger)
A ..	8	1,336	32	204
B ..	3	58	12	53
C ..	0	233	305	610

Colonies counted on plate (1/200 dilution).

TABLE III.—Suppression of "Resident" Organisms by Antiseptic Cream (0.2 g. of 10,040 Dihydrochloride Cream Rubbed Into Each Test Finger)

Subject	Fingerstalls Worn for 30 Minutes	
	Test (Middle Finger)	Control (Index Finger)
A ..	1	333
B ..	5	324
C ..	2	1,330

Colonies counted on plate (1/200 dilution).

ingers are compared. It can be seen that similar results are obtained with either the diacetate or the dihydrochloride of 10,040 as the antiseptic in the cream.

A similar experiment to that shown in Table II was made, using 0.25 g. of antiseptic cream, and the results may be seen in Table IV, where the figures for both controls and tests are very low in the two-hour experiment. The most probable reason was that all the fingers used had had 0.2 g. of antiseptic cream applied five hours previously for a different experiment. The hands had, however, been washed several times and used for normal laboratory duties in the interval.

TABLE IV.—Suppression of "Resident" Organisms by Antiseptic Cream (0.25 g. of 10,040 Diacetate Cream Rubbed Into Each Test Finger)

Subject	Fingerstalls on for			
	1 Hour		2 Hours	
	Test (Index Finger)	Control (Middle Finger)	Test (Index Finger)	Control (Middle Finger)
A ..	3	4,000	1	20
B ..	17	387	1	59
C ..	3	1,450	0	18

Colonies counted on plate (1/200 dilution).

Finger-tip Contamination Technique

For the contamination tests a strain of *Bact. coli* was chosen, because these organisms are more resistant to contact with antiseptics than staphylococci.

Test fingers were treated with 0.2 g. of 10,040 cream, which was rubbed in completely, leaving no surplus to be seen on the surface. Contact was then made after periods of 30 minutes and one hour by pressing the fingers for 30 seconds on to filter paper moistened with a culture of *Bact. coli*. For this purpose to sterile 5-cm. filter papers in Petri dishes were added 1-ml. quantities of a 1/100 dilution of an 18-hour culture of *Bact. coli*. This dilution contained approximately 25,000,000 organisms per ml.

The fingers were allowed to dry in the air for one minute and then pressed on to horse-blood-agar plates for 30 seconds. These plates were examined at 24 and 48 hours, and the colonies in the fingerprints were counted.

A remarkable reduction was found in the number of bacteria which could be transferred by "creamed" fingers as compared with control untreated fingers. Table V shows the results of an experiment using the finger-tip contamination technique.

TABLE V.—Finger-tip Contamination

Subject	Test Fingers (0.2 g. of 10,040 Cream Rubbed into Each Test Finger)			Control
	Index Finger		Middle Finger	Ring Finger
	30 Minutes	Recontaminated after further 30 Minutes	Contaminated after 1 Hour	Not Creamed
A ..	1	1	6	65
B ..	1	4	7	64
C ..	0	0	0	42

The figures represent number of colonies counted in each fingerprint on blood-agar plate.

Included in the second column of Table V are the results of contaminating the same finger twice—first, 30 minutes after application of antiseptic cream, and, secondly, after a further 30 minutes—and they indicate the excellent persistent qualities of the antiseptic.

Clinical Use in the Hospital

When the laboratory investigations were completed it was decided to try the effect of 10,040 hand cream throughout the hospital.

For this purpose tubes of the antiseptic cream were placed beside each wash-basin in wards and nurseries. The nursing and medical staffs were encouraged to rub about 1.5 to 2 g. of the cream on to their hands after washing. While the concentration of antiseptic cream was maintained at 1%, the formulation of the base was altered from time to time in order to find a compatible formulation which was cosmetically attractive and which therefore would be freely used by the staff. The preparation of acceptable emollient hand creams is made difficult by the fact that many of the modern antiseptics are inhibited by the presence of some of the bases of the popular commercial creams.

The 10,040 cream has been in use in the hospital for more than 18 months, and has proved successful. The antiseptic incorporated in the cream was originally used in

the form of the diacetate of 10,040, and latterly in the form of the dihydrochloride, laboratory tests having shown no difference between these two salts. Throughout the 18 months that the cream has been in use, no cases of idiosyncrasy to the antiseptic have occurred.

During the period of this clinical trial not only have the number of clinical cases been reduced, but there have been no patients with serious staphylococcal infections in the hospital: but possibly of greater significance is the observation that those staphylococcal infections which did occur no longer appeared as groups in particular wards, but were scattered sporadically throughout the hospital. It may well be that other factors played a part in the remarkable results achieved and that the use of the antiseptic hand cream was not alone responsible. Nevertheless, the improvement was very real.

Discussion

In a maternity hospital staphylococcal lesions of the newborn are by far the commonest forms of cross-infection, although minor infections of mothers are by no means rare. We have stressed our view of the importance of the hands as a vehicle for transfer of organisms. Our experimental results show beyond doubt the ability of a suitable hand cream to provide a bactericidal layer of prolonged activity against this type of organism, and they have also shown that hands so treated will not readily transfer even more resistant organisms, such as coliform bacilli, from heavily contaminated material.

A possible fallacy of the fingerstall technique was the carry-over of antiseptic into the final poured plates. It was calculated that in the unlikely event of all the antiseptic becoming dissolved in the broth with which the fingerstalls were lubricated the quantity reaching the final dilution would be too small to have any inhibitory action. As an additional precaution, however, 25% serum peptone water was used in the first dilution. The preliminary-blank tests amply confirmed the absence of carry-over to the final plates.

While our work has been carried out largely with 10,040 cream, we have no doubt that other antiseptics might be used in the same way, and that a variety of formulations could be employed for application of the antiseptic to the hands. For example, the particular preparation which we have tried most extensively throughout the hospital is in the form of an emollient hand cream for use after washing, in order not only to render the hands antiseptic but also to assist in the prevention of "chapped" hands. This formulation would not be satisfactory for application before putting on surgical gloves. For such purposes powders or quick-drying lotions might be more suitable.

We have had the opportunity of trying a number of hand preparations of different antiseptics, and, while some are active, in others a base was employed by makers which inactivated the original antiseptic. For example, one of the creams had so little antibacterial activity that staphylococci could be recovered abundantly from cream inoculated and incubated for 48 hours. There were others again which, although very active against skin bacteria, were unsatisfactory from the point of view of repeated application to the hands.

It is not our intention to specify these unacceptable preparations, as they were in most cases specially prepared by the manufacturers for our experimental work, and are not at present available for general use.

Our experience with antiseptic hand creams in the laboratory and in practical hospital use leads us to conclude that a considerable contribution to the control of cross-infection can be achieved by the wide use of such creams. We therefore recommend that in departments where cross-infection is likely to occur each wash-basin should be provided with a "dispenser" or tube of antiseptic cream, and that the nursing and medical staff should be encouraged to use the hand cream as often as possible after washing between cases.

Summary

The incidence of staphylococcal infection in babies born in a maternity hospital is shown to be related to the prevalence of carriers of the staphylococcus among nurses, the organism often being conveyed by the hands. The use of an antiseptic hand cream would to a large extent prevent this transfer of bacteria from nurse to baby.

A new antiseptic compound—1:6-di-4'-chlorophenyl-diguanidohexane 10,040—was incorporated in a cream ("hibitane") and its effectiveness in keeping the skin free from bacteria tested in the laboratory, two new methods being used. Both methods showed that this cream was capable of greatly reducing the bacterial count of the skin.

Use of the cream in the wards led to a marked decrease in the number of clinical cases of staphylococcal infection; during the period of trial no groups of infection were seen in any ward or nursery.

Recommendations for the regular use of antiseptic hand cream are made.

We would like to thank our obstetric colleagues and the nursing staff of the hospital for their co-operation in the clinical trials, and we are glad to thank Mr. E. Clark for technical assistance. We are grateful to Imperial Chemical (Pharmaceuticals) Limited for generous supplies of materials, and in particular to Dr. K. G. Green, without whose continued interest and help the investigation would have been impossible.

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RUPTURE OF A COLD ABSCESS INTO THE BRONCHUS

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According to Cleveland (1940) a cold abscess is the most common complication of tuberculous spondylitis and occurs in 68–86% of cases. Ruptures of these abscesses to the body surface, with fistula formation, are less common, while rupture of cold abscesses into the pleural cavity or into the bronchopulmonary system or oesophagus is rare.

Review of Literature

Loeffler (1922) cites Ideler, who by 1911 had seen six cases of cold abscess communicating with a bronchus or pleural cavity. He does not state how many cases were pleural, and how many were bronchial, or a combination of the two. Nor does he say anything about the outcome of these cases.

Cameron (1925) reported a case of long-standing tuberculous spondylitis in which a cold abscess developed in the inguinal region. During an iodoform injection into the abscess the patient tasted iodoform in his mouth, and after several minutes expectorated iodoform. Coughing lasted for several days, then gradually lessened and stopped completely after six weeks. Evidently an old bronchial fistula