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Comparison of Barrier Creams and Germicides for Hand Hygiene

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ABSTRACT

Germicidal hand wash agents and two barrier creams for use on hands were compared to determine their ability to reduce the number of microorganisms released from finger tips. Use of the barrier creams resulted in a significant decrease in the number of microorganisms released, equivalent to the reduction achieved when effective germicidal agents were used, such as 4% chlorhexidine gluconate or iodophor containing 0.75% available iodine. The persistence of the effect of barrier creams on the skin was also studied, and it was found that an initial increase in number of microorganisms released occurred after rinsing with water or washing with non-germicidal soap. Sequential rinsing of hands with tap water, after treatment with the barrier creams or with the effective germicidal agents, gave similar results. Barrier creams can perform a useful adjunct role in hygienic hand disinfection. In this study, they were equivalent to effective hand germicides.

Considerable emphasis is placed on hand hygiene in hospitals, nurseries and food handling establishments (*4,12,15,21*). Hand washing with ordinary soap (*9,18,19*) as well as hygienic hand disinfection (*2,11,16*) are recommended to reduce the number of microorganisms on hands and to prevent cross-contamination or infection (*3*). Germicidal hand wash agents containing 4% chlorhexidine gluconate or iodophor with 0.75% available iodine effectively reduce the number of bacteria released from hands (*11,16,17*). Frequent use of germicidal hand wash agents has caused skin problems, including dry skin, irritation, chapping and dermatitis (*6,13*). As a result, alternatives to these agents have been sought, such as emulsion-type soaps (*12*) or sterile plastic gloves (*8,14*). The latter are not considered satisfactory because the skin becomes occluded by the glove, leading to increased bacterial counts on the skin and increased chances of contamination from punctured or cracked gloves (*5,8,14,20*).

Barrier creams are widely used for skin protection (*7,22*). Hydrophobic barrier creams create a thin, water repellant layer over the skin (*22*). This prevents aqueous liquids from contacting the skin, and may prevent microorganisms from being released from the skin. Some barrier creams are formulated with germicidal agents, e.g., benzalkonium chloride (*22*), to reduce bacterial contamination of hands. Barrier creams are generally applied to clean, dry hands following regular hand washing with ordinary soap (*1,7,22*). Although barrier creams are removed by hand washing, their use is considered a useful adjunct to hand washing (*22*).

The object of this study was to compare the ability of two commercial barrier creams to reduce the number of microorganisms released from hands with selected germicidal hand wash agents.

MATERIALS AND METHODS

Two separate experiments using a replicated 4 × 4 and a single 7 × 7 Latin Square design were done. The sequence in which agents were used by subjects was randomly assigned by a specified procedure (*10*). Each subject was exposed to each agent over the period of the experiment according to the designs shown in Table 1. The agents used in Experiment I included: (A) non-germicidal liquid hand soap; (B) iodophor containing 0.75% available iodine ("Tamed Iodine" Scrub, West Chemicals Ltd., Montreal); (C) Protective Hand Cream #311 (West Chemicals Ltd., Montreal; barrier I); and (D) "Debba" Wet Work Barrier Cream (Deb Swarfega Ltd., Waterford, Ontario, Canada; barrier II). Agent D was specially prepared by the manufacturer without the addition of 0.5% quaternary ammonium compound (QAC) as a bacterial inhibitor. The agents for Experiment II included agents A, B, C and D (above), (E) chlorhexidine gluconate (4%) liquid detergent (Hibitane, Ayerst Laboratories Ltd., Montreal); (F) iodophor hand wash containing 0.005% available iodine; and (G) an antibacterial skin cleanser containing 0.3% Irgasan DP 300 in gel.

Washing procedures in both experiments were identical and followed the methods previously described by Sheena and Stiles (*16*) using 15-s exposure time. Barrier cream was applied as an adjunct treatment to non-germicidal hand washing. Hands were washed for 15 s with non-germicidal soap, dried, and approx. 0.3 g of the barrier cream was applied to the clenched finger tips of each hand. In a procedure resembling the 15-s hand wash technique, the cream was spread over the hand and allowed to dry for an additional 15 s.

Sampling was done by finger imprint technique onto separate letheen agar (LA; Difco) plates for each hand (*16,17*). Samples were taken before treatment (Y_0), and after treatment (Y_1). The inocula were spread using a sterile, glass "hockey stick", and the plates were incubated at 35°C for 24 h. The mean number of microorganisms released from the finger tips

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TABLE 1. *Latin square designs used for this study*[a].

Experiment I (replicated 4 × 4 design)

Subjects \ Day	I	II	III	IV
	Agents			
11 and 21	B	D	C	A
12 and 22	A	C	B	D
13 and 23	D	B	A	C
14 and 24	C	A	D	B

Experiment II (7 × 7 design)

Subject \ Day	I	II	III	IV	V	VI	VII
				Agents			
1	C	D	B	F	E	G	A
2	D	B	A	G	C	E	F
3	E	C	D	A	B	F	G
4	G	F	C	B	D	A	E
5	F	G	E	D	A	B	C
6	B	A	G	E	F	C	D
7	A	E	F	C	G	D	B

[a]Hand wash agents and barrier creams: A, non-germicidal liquid hand soap; B, iodophor (0.75% available iodine); C, Protective Hand Cream #311 (barrier I); D, "Debba" Wet Work Barrier Cream (barrier II); E, chlorhexidine gluconate (4%) liquid detergent (Hibitane); F, iodophor hand wash (0.005% available iodine); and G, 0.3% Irgasan DP 300 in gel.

was calculated from the plate counts for the left and right hands after each treatment.

The persistence of the effect of barrier creams was measured by finger tip sampling after two additional treatments: (a) after a 15-s rinse under running tap water (Y_2); and (b) after a 15-s wash with non-germicidal soap (Y_3). Based on the results of these experiments, an additional study was done to determine the persistence of barrier cream and germicide treatment effects. Hands were exposed to agents A to E above, and subjected to 12 consecutive 15-s rinses under running tap water. Finger tip imprints on LA were done after each rinse. The plates were handled as described above and changes in the counts were determined relative to the initial number of microorganisms released from the finger tips. A total of ten subjects was involved in this experiment. Each subject used each agent on one occasion during the experiment.

Data were calculated as the ratio of the number of microorganisms released from finger tips after treatment compared to the number released before treatment. Mean counts and the mean percentage of microorganisms released from finger tips were based on the individual changes in count for each subject. Data were analyzed using $\log_{10}$ transformed ratios in a statistical computer package for Latin Square designs (BMDP2V, Biomedical Computer Programs, P-series, 1979, University of California Press).

RESULTS

The mean number of microorganisms released from finger tips and the percentage released after treatment with the barrier creams or germicidal hand wash agents are shown in Table 2. In both experiments a significant effect ($P<0.001$) was attributed to treatments. The barrier creams, iodophor (0.75% available iodine) and 4% chlorhexidine gluconate treatments resulted in a significant decrease in microorganisms released. This is illustrated by the results for Duncan's multiple range test shown in Table 3. The other agents, including non-germicidal soap, iodophor hand wash containing 0.005% available iodine and the Irgasan DP 300 gel resulted in an increase in the number of microorganisms released from the finger tips.

TABLE 2. *Mean change in number of microorganisms released from finger tips after 15-s hand washing or barrier cream application*[a].

Agent	Initial	After treatment
	No. of microorganisms × 10 (%)[b]	
Experiment I		
A Control soap	14.6	21.4(155)
B Iodophor	12.2	4.8(42)
C Barrier cream I	7.9	1.7(41)
D Barrier cream II	6.4	3.7(59)
Experiment II		
A Control soap	8.9	13.1(148)
B Iodophor	11.9	6.5(54)
C Barrier cream I	9.2	4.5(48)
D Barrier cream II	9.8	6.0(56)
E Chlorhexidine	7.7	3.3(42)
F Iodophor wash	6.8	7.5(116)
G Irgasan gel	8.7	10.5(126)

[a]Explanation of product codes given in Table 1.
[b]Mean counts and mean percentage survivors calculated from individual changes in count for each subject after 15-s hand washing or barrier cream application (Y_1) compared to first sampling, before treatment (Y_0).

TABLE 3. *Summary of Duncan's multiple range test (95% confidence level) for differences among treatment means for 15-s hand washing or barrier cream application*[a,b].

Experiment I:	C	B	D	A			
	———	———	———				
Experiment II:	E	C	B	D	F	G	A
		———	———	———	———	———	———
	———	———					

[a]Explanation of product codes given in Table 1.
[b]Agents underlined with an unbroken line are not statistically different at 95% confidence level.

Persistence of the barrier creams measured by release of microorganisms from the finger tips after a water rinse and a subsequent wash with non-germicidal soap are shown in Table 4. The analysis of variance indicated a significant effect ($P<0.01$) attributable to treatments (water rinse and soap wash). The effect of the barrier creams was diminished after rinsing with water, and after washing with soap the number of microorganisms released was markedly increased. This was confirmed by the results for Duncan's multiple range test shown in Table 5. There was a significant increase in number of microorganisms released as a result of the water rinse and soap wash.

Persistence of the barrier creams and effective germicides was studied by determining the change in number of microorganisms released from finger tips after each of the twelve consecutive water rinses. The mean percentages of the number of microorganisms released from the finger tips of the ten subjects are plotted in Fig. 1 and 2. The non-germicidal soap caused an increase in number of microorganisms released from finger tips. Subsequent water rinses gave counts greater than the initial number released (Y_0). In contrast, a marked reduction in count was observed after

TABLE 4. *Persistence of barrier cream effect tested by water rinse and soap washing after treatment*[a].

Agent	Initial number released (× 10)	Percentage of microorganisms released: After treatment	Water rinse	Soap wash
Experiment I				
Barrier cream I	7.9	41	67	86
Barrier cream II	6.4	59	86	106
Experiment II				
Barrier cream I	9.2	48	73	92
Barrier cream II	9.8	56	83	96

[a]See footnotes for Table 2.

TABLE 5. *Summary of Duncan's multiple range test (95% confidence level) for presistence of treatment effects*[a,b].

Experiment I:	Y_1	Y_2	Y_3
Experiment II:	Y_1	Y_2	Y_3

[a]Explanation of codes: Y_1, application of barrier cream; Y_2, hand rinse with tap water for 15-s; Y_3, hand wash with non-germicidal soap for 15-s.

[b]Treatments underlined with an unbroken line are not statistically different at 95% confidence level.

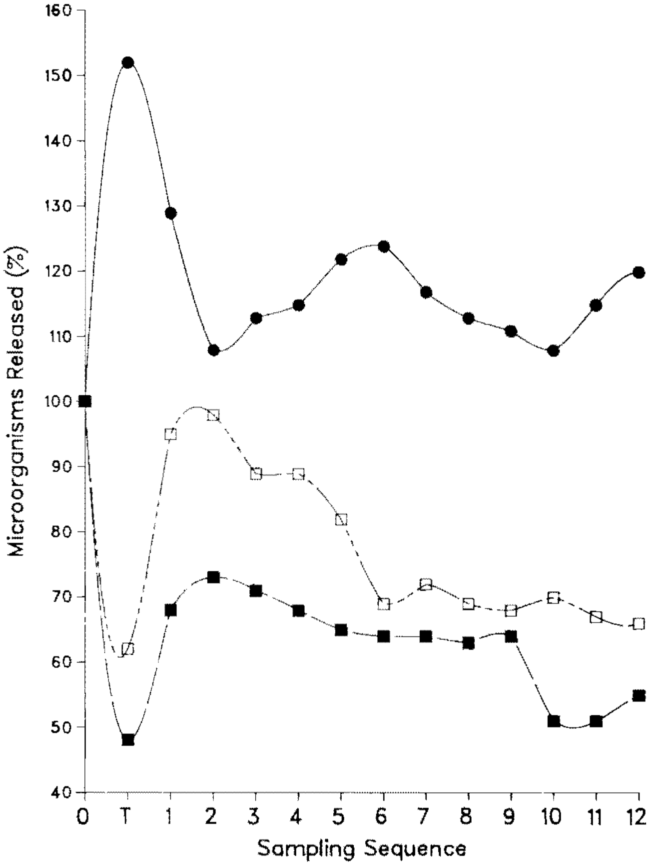

Figure 1. *Microorganisms released (%) from finger tips as a result of initial non-germicidal hand wash and barrier cream application, followed by successive water rinses. ●, non-germicidal liquid hand soap; ■, Protective Hand Cream #311 (barrier I); □, "Debba" Wet Work Barrier Cream (barrier II); O, initial sample in sampling sequence; and T, sample taken after treatment, before the sequence of water rinses.*

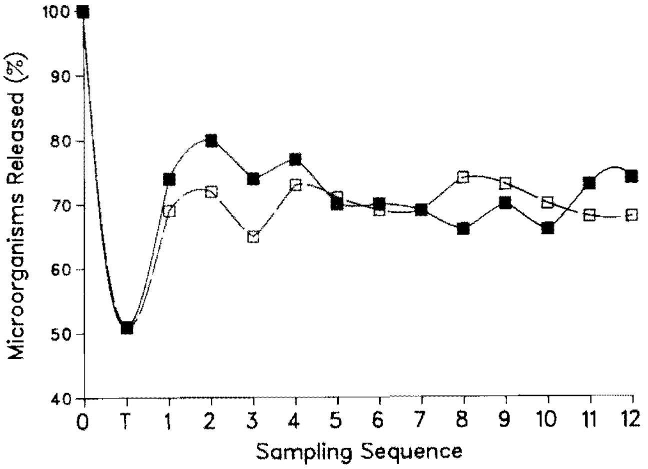

Figure 2. *Microorganisms released (%) from finger tips after treatment with germicidal hand wash agents followed by successive water rinses. ■, iodophor (0.75% available iodine); □, chlorhexidine gluconate (4%) liquid detergent (Hibitane); O, initial sample in sampling sequence; and T, sample taken after treatment, before the sequence of water rinses.*

adjunct treatment with the barrier creams. The reduction of this effect was confirmed by the increase in number of microorganisms released after rinsing with water. This was more marked with barrier II than with barrier I. However, after six rinses the number of microorganisms released from finger tips using either barrier creams was equivalent.

This apparent loss of the "barrier" effect prompted a similar study of the persistence effect of iodophor (0.75% available iodine) and 4% chlorhexidine gluconate during successive rinses (Fig. 2). The marked decrease in microorganisms released is apparent, however, with both germicides a subsequent increase in counts was observed. This was equivalent to the increase in count observed for barrier cream I.

DISCUSSION

Previous studies indicated only a limited number of germicidal hand wash agents that were likely to reduce the number of microorganisms released from hands after short exposure (15-s) hand washes (*16,17*). The barrier creams used in this study were designed to protect hands from direct contact with moisture. It was assumed that they might also prevent or reduce the release of microorganisms from hands. Since these products are intended to protect hands from dryness, chapping and dermatitis (*7*), if the release of microorganisms is reduced, a dual protective effect of skin and foods might be achieved.

The barrier creams reduced the number of microorganisms released from finger tips equivalent to the most effective germicide products (iodophor with 0.75% available iodine or 4% chlorhexidine gluconate) reported in our previous studies (*16-18*). Further evaluation of the efficacy of the barrier creams depended on their continued prevention of microorganism release from finger tips. Water rinsing was selected as the treatment to challenge the persistence of the "barrier". This was predicated on successive water rinses simulating handling of foods.

The water rinses revealed an unexplained difference between the barrier creams, suggesting that differences might occur as a result of product formulation. However, the two barrier creams gave an equivalent protective effect after the sixth successive water rinse, and their effect was similar to that of the effective germicidal agents.

Wedderburn (*22*) used barrier cream as an adjunct to hand hygiene and noted that a valuable antiseptic effect could be achieved with 0.5% benzalkonium chloride in the cream. In our study, barrier creams were selected that specifically excluded antiseptic agents such as QACs. The marked reduction in microorganisms released from finger tips suggests the possibility that effective hand hygiene and skin protection might be achieved for food handlers with specially prepared barrier creams. Transient bacteria were not specifically included in this study, however, our earlier report (*18*) indicated that transient bacteria on hands are more readily reduced than resident bacteria.

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