J. Hyg., Camb. (1979), **82**, 463
Printed in Great Britain

Evaluation of products for treating babies' napkins

By H. GAYA, J. THIRLWALL
Departments of Bacteriology and Computing, St Mary's Hospital Medical School, London W2 1PG

ELIZABETH J. SHAW and ZERHA HASSAM
Bacteriology Department, St Bartholomew's Hospital, London EC1A 7BE

(*Received* 26 *July* 1978)

SUMMARY

A test is described for assessing the sanitizing effect of napkin treatment products on naturally urine-wetted and faecally-contaminated napkins. This test defines in-use conditions which closely resemble typical domestic situations. One napkin treatment product ('Napisan'), tested at two different concentrations and with challenges of different numbers of babies' napkins, performed satisfactorily under the conditions used.

INTRODUCTION

As infants may require many changes of napkin each day, it is impracticable to wash each napkin separately, and it is usual for napkins to be stored until they can be laundered in a suitably-sized batch. Used napkins are normally soaked with urine and are often soiled with faeces, even if the bulk of the faecal deposit has been removed. Consequently solutions for storing napkins should be designed to minimize bacterial cross-contamination in the home or hospital. Such solutions must be bactericidal and must be active in the presence of organic matter and textiles. In addition they should also have deodorant, detergent and bleaching properties.

Solutions for sanitizing napkins have been in widespread use for many years. One such preparation, 'Napisan', employs potassium monopersulphate which oxidizes chloride ions to hypochlorous acid and the manufacturers claim that the antibacterial and bleaching properties are reduced much more slowly by organic matter such as urea than the corresponding solutions of sodium hypochlorite and sodium dichloroisocyanurate.

Conventional tests for disinfectants are not appropriate to solutions for soaking napkins because they are not designed to measure the effects of repeated challenges with bacteria-laden organic matter over a long period of time (Kelsey & Sykes, 1969; Mallman & Hanes, 1945; AOAC, 1950; Weber & Black, 1948). One attempt to produce a realistic in-vitro assessment of these soak solutions has already been published (Prosser-Snelling, Duke & Rodger, 1977). However, we consider that all these methods are unrealistic from the point of view of domiciliary practice.

0022-1724/79/0095-1978 $01.00

We now report on a test which uses naturally urine-wetted and faecally-soiled napkins taken from babies in hospital.

MATERIALS AND METHODS

Napkins

New Harrington 'Blue Seal' quality napkins of nominal size 61 × 61 cm and dry weight 90–115 g were used. Initially they were rinsed twice, to remove any chemical applied as fabric softener, and dried. Each napkin was indelibly marked with its measured dry weight after laundering.

The napkins were supplied to the Paediatric wards of St Bartholomew's, Edgware General and Westminster Hospitals for use on in-patient infants aged between 10 days and 2 years. Used napkins were removed by nursing staff and placed in individual waterproof bags (Sterilin) which were sealed and marked with the time of removal. These bags were collected at regular intervals and taken to the test centre where they were stored at 4 °C until used. Napkins not used within 12 h of removal from the baby were discarded.

Materials

'Napisan' was supplied by the manufacturers (Vick International, Slough, formulated to Australian Patent No. 419785), and packed for this study in sealed containers of 21 g or 28 g, with potassium monopersulphate 16·0% (w/w) and sodium chloride 36·5% (w/w) in a detergent base.

The neutralizing solution for 'Napisan' was 0·1% w/v 'Analar' grade sodium thiosulphate (BDH) in distilled water distributed in 45 ml volumes and sterilized at 121 °C (15 lb/in^2) for 15 min.

Cultures were made on previously dried agar plates with 8% v/v added horse blood.

Test solutions

Solutions of 'Napisan' were prepared immediately before the start of the test each day in 2 gal capacity covered plastic buckets, using 21 g or 28 g of the product dissolved in 7 l of World Health Organization standard hard water to give final concentrations of 0·3% (w/v) or 0·4% (w/v) respectively. For every three buckets containing 'Napisan' one control bucket containing only WHO standard hard water was prepared. This ratio of 3 to 1 was convenient as four buckets were normally processed at one time.

Treatment of napkins before addition to the soak solutions

Wet napkins. Wet napkins were weighed to estimate their urine content, which is the natural urea load for test and control buckets.

Soiled napkins. Faecal material from at least 5 napkins was pooled. Faecally soiled napkins were prepared in a standard fashion by spreading, with a spatula, 4 g of pooled faeces over the central area of a clean dried napkin. The total colony

count of the pooled faeces was measured by culturing serial dilutions on blood and MacConkey's agar and the number of bacteria per soiled napkin was estimated.

Addition of napkins to the soak solutions

Napkins were added at hourly intervals to the test and control bucket and swirled to ensure that each napkin was thoroughly soaked with the test or control solution. In the first series of tests the solutions, both 0·3 and 0·4 % respectively, were challenged with six napkins, the first five being only urine soaked and the sixth and last carrying the standard faecal load. In the second series the challenge was eight napkins, seven being urine soaked and the eighth faecally soiled as before.

Microbiological assay of the soak solutions

Sampling. At 55 min after the addition of the penultimate napkin and at 120 min after the addition of the last (faecally soiled) napkin, the contents of the buckets were swirled and a 5 ml sample taken with a sterile pipette from the middle of the soak solution for estimation of total bacterial count (c.f.u. per ml).

Sample treatment. The samples of soak solutions were transferred aseptically to 45 ml of sterile 0·1 % (w/v) sodium thiosulphate solution and after thorough shaking the mixtures were allowed to stand for 5 min. Serial dilutions of the test and control solutions were made in sterile 1/4-strength Ringer's solution. Bacterial counts were made by spreading 0·5 ml of each dilution on blood agar plates which were incubated overnight at 37 °C, colonies were counted and the number of colony forming units (c.f.u.) per ml of soak solution calculated.

RESULTS

Table 1 shows the results obtained using 0·3 % w/v 'Napisan' with a challenge of 8 napkins; table 2 the results using 0·4 % w/v 'Napisan' with 8 napkins; table 3 the results using 0·4 % w/v 'Napisan' with 6 napkins; and table 4 the results using 0·3 % w/v 'Napisan' with 6 napkins. The results are shown for each individual test and control bucket and the results for each run of corresponding test and control buckets are grouped together within each table.

The urine loads show some variation from bucket to bucket but they all fall within the range one would expect for the daily urinary output (and urea load) of a normal infant.

The faecal load added to each bucket on the final napkin is the same for the test and control buckets in each group, and the small variations between groups of buckets represent the day to day variations in bacterial count in the collected pools of faeces.

Bacterial count 1 for each bucket is calculated from the sum of the residual bacterial count in the solution before the addition of the last napkin (from the contaminated napkins which have been partially disinfected) and the faecal load of bacteria distributed (theoretically) throughout the 7 l volume of each bucket. These counts vary from $1{\cdot}4 \times 10^5$ to $2{\cdot}6 \times 10^7$ c.f.u. per ml, but within each group of

Table 1. *Results with 0·3% w/v 'Napisan' and eight napkins*

Bucket no. (*a*)*	Urine load (g) (*b*)	Faecal load c.f.u. (*c*)	Bact. count 1 (c.f.u./ml) (*d*)	Bact. count 2 (c.f.u./ml) (*e*)	Log reduction (c.f.u./ml) (*f*)	Reduction (%) (*g*)
1	401·5	4×10^{10}	$5{\cdot}7 \times 10^{6}$	3×10^{5}	1·2632	94·5455
2	493·5	4×10^{10}	$5{\cdot}7 \times 10^{6}$	$7{\cdot}5 \times 10^{3}$	2·8653	99·8636
3	427·5	4×10^{10}	$5{\cdot}7 \times 10^{6}$	$3{\cdot}6 \times 10^{2}$	4·1841	99·9935
4C	174·3	4×10^{10}	$5{\cdot}7 \times 10^{6}$	$5{\cdot}5 \times 10^{6}$	—	—
5	602·7	$1{\cdot}2 \times 10^{11}$	$1{\cdot}7 \times 10^{7}$	$9{\cdot}0 \times 10^{3}$	3·3468	99·9550
6	571·5	$1{\cdot}2 \times 10^{11}$	$1{\cdot}7 \times 10^{7}$	$5{\cdot}3 \times 10^{4}$	2·5768	99·7350
7	428·3	$1{\cdot}2 \times 10^{11}$	$1{\cdot}7 \times 10^{7}$	$8{\cdot}3 \times 10^{4}$	2·3820	99·5850
8C	734·4	$1{\cdot}2 \times 10^{11}$	$1{\cdot}7 \times 10^{7}$	2×10^{7}	—	—
9	481·0	8×10^{9}	$1{\cdot}14 \times 10^{6}$	1×10^{4}	3·4624	99·9655
10	475·3	8×10^{9}	$1{\cdot}14 \times 10^{6}$	$2{\cdot}6 \times 10^{4}$	3·0474	99·9103
11	431·0	8×10^{9}	$1{\cdot}14 \times 10^{6}$	$8{\cdot}1 \times 10^{4}$	2·5539	99·7207
12C	465·0	8×10^{9}	$1{\cdot}14 \times 10^{6}$	$2{\cdot}9 \times 10^{7}$	—	—

* (*a*) C (after bucket number) denotes control bucket for preceding buckets of group. (*b*) Total weight of urine contained in napkins added to each bucket. (*c*) Total number of colony forming units (c.f.u. = viable bacteria) added in 4 g faeces. (*d*) Calculated total number of c.f.u./ml soak solution after addition of last napkin; (sum of c.f.u. in soak solution 55 min after addition of penultimate napkin and measured c.f.u. in faecal load). (*e*) Measured c.f.u./ml soak solution 2 h after addition of last napkin. (*f*) 'Log reduction' in c.f.u./ml calculated from $\log_{10}$ Bacterial count 2 (control bucket) – $\log_{10}$ Bacterial count 2 (test bucket). (*g*) Percentage reduction in c.f.u. in test bucket 2 h after addition of last napkin compared with c.f.u. in control bucket (for that test bucket) 2 h after addition of last napkin.

Table 2. *Results with 0·4% w/v 'Napisan' and eight napkins*

Bucket no. (*a*)*	Urine load (g) (*b*)	Faecal load (c.f.u.) (*c*)	Bact. count 1 (c.f.u./ml) (*d*)	Bact count 2 (c.f.u./ml) (*e*)	Log reduction (c.f.u./ml) (*f*)	Reduction (%) (*g*)
1	278·2	$3{\cdot}2 \times 10^{10}$	$4{\cdot}57 \times 10^{6}$	$1{\cdot}8 \times 10^{5}$	1·2499	94·3750
2	252·0	$3{\cdot}2 \times 10^{10}$	$4{\cdot}57 \times 10^{6}$	$1{\cdot}3 \times 10^{5}$	1·3912	95·9375
3	206·0	$3{\cdot}2 \times 10^{10}$	$4{\cdot}57 \times 10^{6}$	$2{\cdot}4 \times 10^{3}$	3·1249	99·9250
4C	155·0	$3{\cdot}2 \times 10^{10}$	$4{\cdot}57 \times 10^{6}$	$3{\cdot}2 \times 10^{6}$	—	—
5	338·3	$2{\cdot}2 \times 10^{10}$	$3{\cdot}1 \times 10^{6}$	20	5·9031	99·9999
6	360·6	$2{\cdot}2 \times 10^{10}$	$3{\cdot}1 \times 10^{6}$	$1{\cdot}1 \times 10^{3}$	4·1627	99·9931
7	414·6	$2{\cdot}2 \times 10^{10}$	$3{\cdot}1 \times 10^{6}$	8×10^{2}	4·3010	99·9950
8C	183	$2{\cdot}2 \times 10^{10}$	$3{\cdot}1 \times 10^{6}$	$1{\cdot}6 \times 10^{7}$	—	—
9	376·4	4×10^{10}	$5{\cdot}7 \times 10^{6}$	$3{\cdot}2 \times 10^{5}$	3·4949	99·9680
10	399·1	4×10^{10}	$5{\cdot}7 \times 10^{6}$	$7{\cdot}8 \times 10^{2}$	6·1079	99·9999
11	372·5	4×10^{10}	$5{\cdot}7 \times 10^{6}$	$6{\cdot}4 \times 10^{3}$	5·1938	99·9994
12C	—	4×10^{10}	$5{\cdot}7 \times 10^{6}$	1×10^{9}	—	—

* See footnote to Table 1.

buckets there is little variation in this figure because the standardized faecal load of bacteria is the major component.

Bacterial count 2 is the measured number of c.f.u./ml of test or control solution 2 h after addition of the last napkin. This is used for calculation of the reductions in bacterial counts in the test buckets compared with the corresponding control buckets.

https://doi.org/10.1017/S0022172400053985 Published online by Cambridge University Press

Table 3. *Results with 0·4% w/v 'Napisan' and six napkins*

Bucket no. (*a*)	Urine load (g) (*b*)	Faecal load (c.f.u.) (*c*)	Bact. count 1 (c.f.u./ml) (*d*)	Bact. count 2 (c.f.u./ml) (*e*)	Log reduction (c.f.u./ml) (*f*)	Reduction (%) (*g*)
1	347	$2·4 \times 10^{10}$	$3·4 \times 10^{6}$	$5·5 \times 10^{3}$	3·1941	99·9360
2	306	$2·4 \times 10^{10}$	$3·4 \times 10^{6}$	$8·0 \times 10^{2}$	4·3014	99·9907
3	369	$2·4 \times 10^{10}$	$3·4 \times 10^{6}$	$1·2 \times 10^{6}$	0·8553	86·0465
4C	317	$2·4 \times 10^{10}$	$5·6 \times 10^{6}$	$8·6 \times 10^{6}$	—	—
5	353	$6·4 \times 10^{10}$	$9·1 \times 10^{6}$	$8·0 \times 10^{1}$	5·6410	99·9998
6	360	$6·4 \times 10^{10}$	$9·1 \times 10^{6}$	$6·0 \times 10^{1}$	5·7659	99·9998
7	340	$6·4 \times 10^{10}$	$9·1 \times 10^{6}$	$2·0 \times 10^{1}$	6·2430	99·9999
8C	353	$6·4 \times 10^{10}$	$2·6 \times 10^{7}$	$3·5 \times 10^{7}$	—	—
9	364	$8·0 \times 10^{10}$	$1·1 \times 10^{7}$	$1·2 \times 10^{2}$	5·0969	99·9992
10	354	$8·0 \times 10^{10}$	$1·1 \times 10^{7}$	$4·1 \times 10^{2}$	4·5633	99·9973
11	364	$8·0 \times 10^{10}$	$1·1 \times 10^{7}$	$2·0 \times 10^{1}$	5·8751	99·9999
12C	383	$8·0 \times 10^{10}$	$1·6 \times 10^{7}$	$1·5 \times 10^{7}$	—	—
13	341	$1·4 \times 10^{11}$	$2·0 \times 10^{7}$	$2·0 \times 10^{1}$	5·7404	99·9998
14	319	$1·4 \times 10^{11}$	$2·0 \times 10^{7}$	$2·0 \times 10^{1}$	5·7404	99·9998
15	320	$1·4 \times 10^{11}$	$2·0 \times 10^{7}$	$1·6 \times 10^{2}$	4·8373	99·9985
16C	388	$1·4 \times 10^{11}$	$2·0 \times 10^{7}$	$1·1 \times 10^{7}$	—	—
17	317	$3·5 \times 10^{10}$	$4·9 \times 10^{6}$	$1·3 \times 10^{5}$	2·3632	99·5667
18	325	$3·5 \times 10^{10}$	$4·9 \times 10^{6}$	$2·5 \times 10^{2}$	5·0792	99·9992
19	319	$3·5 \times 10^{10}$	$4·9 \times 10^{6}$	$2·0 \times 10^{1}$	6·1761	99·9999
20C	226	$3·5 \times 10^{10}$	$2·3 \times 10^{7}$	$3·0 \times 10^{7}$	—	—
21	380	$6·4 \times 10^{9}$	$9·1 \times 10^{5}$	$2·0 \times 10^{1}$	5·0414	99·9991
22	376	$6·4 \times 10^{9}$	$9·1 \times 10^{5}$	$2·0 \times 10^{1}$	5·0414	99·9991
23	345	$6·4 \times 10^{9}$	$9·1 \times 10^{5}$	$2·0 \times 10^{1}$	5·0414	99·9991
24C	358	$6·4 \times 10^{9}$	$4·6 \times 10^{6}$	$2·2 \times 10^{6}$	—	—
25	348	$2·1 \times 10^{9}$	$2·9 \times 10^{5}$	$2·0 \times 10^{1}$	6·0792	99·9999
26	340	$2·1 \times 10^{9}$	$2·9 \times 10^{5}$	$5·1 \times 10^{3}$	3·6726	99·9788
27	351	$2·1 \times 10^{9}$	$2·9 \times 10^{5}$	$2·0 \times 10^{1}$	6·0792	99·9999
28C	254	$2·1 \times 10^{9}$	$7·7 \times 10^{6}$	$2·4 \times 10^{7}$	—	—
29	315	$4·2 \times 10^{9}$	$6·1 \times 10^{5}$	$2·0 \times 10^{1}$	4·6580	99·9978
30	267	$4·2 \times 10^{9}$	$6·1 \times 10^{5}$	$2·0 \times 10^{1}$	4·6580	99·9978
31	310	$4·2 \times 10^{9}$	$6·1 \times 10^{5}$	$2·0 \times 10^{1}$	4·6580	99·9978
32C	409	$4·2 \times 10^{9}$	$7·8 \times 10^{5}$	$9·1 \times 10^{5}$	—	—

* See footnote to Table 1.

'Log reduction' in c.f.u./ml is calculated from: $\log_{10}$ control bacterial count 2 – $\log_{10}$ test bacterial count 2, and is analagous to the logarithm of the Inactivation Factor used in tests of sterilization and disinfection (Rubbo & Gardner, 1965). It is a figure which means more to many bacteriologists than Percentage Reduction in bacterial count which is arithmetically more appropriate as a measure of the disinfection process. In Table 1 four buckets of a total of nine test buckets achieve better than 99·9% reduction ('Log reduction' > 3·0) while in Table 2 seven of nine buckets achieve better than 99·9% reduction in bacterial count. The corresponding figures for Tables 3 and 4 are 22 and 8 buckets respectively out of 24.

Table 5 compares the bacterial counts, 2 h after addition of the last napkin, in the control buckets in each part of the study and shows that there are no significant differences between them.

https://doi.org/10.1017/S0022172400053985 Published online by Cambridge University Press

Table 4. *Results with 0·3% w/v 'Napisan' and six napkins*

Bucket no. (*a*)	Urine load (g) (*b*)	Faecal load (c.f.u.) (*c*)	Bact. count 1 (c.f.u./ml) (*d*)	Bact. count 2 (c.f.u./ml) (*e*)	Log reduction (c.f.u./ml) (*f*)	Reduction (%) (*g*)
1	357·5	$2·4 \times 10^{10}$	$3·4 \times 10^{6}$	20	1·7404	99·9982
2	348·4	$2·4 \times 10^{10}$	$3·4 \times 10^{6}$	20	4·7404	99·9982
3C	179·2	$2·4 \times 10^{10}$	$3·4 \times 10^{6}$	$1·1 \times 10^{6}$	—	—
4	263·0	$5·6 \times 10^{10}$	8×10^{6}	40	4·5119	99·9969
5	336·4	$5·6 \times 10^{10}$	8×10^{6}	$2·6 \times 10^{3}$	2·6990	99·8000
6	254·0	$5·6 \times 10^{10}$	8×10^{6}	40	4·5119	99·9969
7C	347·3	$5·6 \times 10^{10}$	8×10^{6}	$1·3 \times 10^{6}$	—	—
8	351·9	$9·6 \times 10^{10}$	$1·37 \times 10^{7}$	$6·6 \times 10^{3}$	2·8794	99·8680
9	311·2	$9·6 \times 10^{10}$	$1·37 \times 10^{7}$	$1·3 \times 10^{4}$	2·5850	99·7400
10	352·0	$9·6 \times 10^{10}$	$1·32 \times 10^{7}$	$9·7 \times 10^{4}$	1·7122	98·0600
11C	265·8	$9·6 \times 10^{10}$	$1·3 \times 10^{7}$	5×10^{6}	—	—
12	382·8	$6·4 \times 10^{10}$	$9·1 \times 10^{6}$	$4·8 \times 10^{4}$	1·5975	97·4737
13	356·7	$6·4 \times 10^{10}$	$9·1 \times 10^{6}$	$1·6 \times 10^{4}$	2·0746	99·1579
14	390·7	$6·4 \times 10^{10}$	$9·1 \times 10^{6}$	6×10^{3}	2·5006	99·6842
15C	352·2	$6·4 \times 10^{10}$	$9·1 \times 10^{6}$	$1·9 \times 10^{6}$	—	—
16	366·1	$4·8 \times 10^{10}$	$6·9 \times 10^{6}$	$9·6 \times 10^{3}$	2·6512	99·7767
17	365·2	$4·8 \times 10^{10}$	$6·9 \times 10^{6}$	8×10^{4}	1·7304	98·1395
18	352·0	$4·8 \times 10^{10}$	$6·9 \times 10^{6}$	$1·84 \times 10^{3}$	3·3687	99·9572
19C	353·9	$4·8 \times 10^{10}$	$6·9 \times 10^{6}$	$4·3 \times 10^{6}$	—	—
20	344·9	1×10^{9}	$1·4 \times 10^{5}$	$1·2 \times 10^{5}$	2·1996	99·3684
21	365·3	1×10^{9}	$1·4 \times 10^{5}$	$1·1 \times 10^{4}$	3·2374	99·9421
22	345·5	1×10^{9}	$1·4 \times 10^{5}$	$4·4 \times 10^{3}$	3·6353	99·9768
23C	376·5	1×10^{9}	$1·4 \times 10^{5}$	$1·9 \times 10^{7}$	—	—
24	354·2	$7·2 \times 10^{10}$	$1·03 \times 10^{7}$	1×10^{7}	0·3010	50·0000
25	340·3	$7·2 \times 10^{10}$	$1·03 \times 10^{7}$	$1·6 \times 10^{5}$	2·0969	99·2000
26	341·5	$7·2 \times 10^{10}$	$1·03 \times 10^{7}$	$1·6 \times 10^{4}$	3·0969	99·9200
27C	334·0	$7·2 \times 10^{10}$	$1·03 \times 10^{7}$	$2·0 \times 10^{7}$	—	—
28	362·7	$1·2 \times 10^{11}$	$1·7 \times 10^{7}$	$1·5 \times 10^{4}$	3·2711	99·9464
29	357·0	$1·2 \times 10^{11}$	$1·7 \times 10^{7}$	$3·2 \times 10^{5}$	1·9420	98·8571
30	360·8	$1·2 \times 10^{11}$	$1·7 \times 10^{7}$	$1·4 \times 10^{4}$	3·3010	99·9500
31	360·5	$1·2 \times 10^{11}$	$1·7 \times 10^{7}$	$5·6 \times 10^{4}$	2·6990	99·8000
32C	365·4	$1·2 \times 10^{11}$	$1·7 \times 10^{7}$	$2·8 \times 10^{7}$	—	—

* See footnote to Table 1.

Table 6 shows a comparison of the mean percentage reductions in bacterial counts in the test buckets, 2 h after addition of the last napkin, in each part of the study. One bucket from each of two parts of the study has been excluded from this part of the analysis according to the usual procedures for dealing with 'outliers' (extreme and unlikely results) (Davies & Goldsmith, 1972). These are bucket number 3 from Table 3 and bucket number 24 from Table 4. With 0·4% (w/v) 'Napisan' and six napkins the mean percentage reduction in bacterial count is 99·977% and this result is significantly better than those obtained in the other parts of the study. No other statistically significant differences are evident.

https://doi.org/10.1017/S0022172400053985 Published online by Cambridge University Press

Table 5. *Summary of control buckets*

	Test concentration (%)	No. of challenge napkins	No. of control buckets	Mean bact.* count 2 (c.f.u./ml)	Significances† a with	b with	c with
a	0·3	8	3	$1{\cdot}817 \times 10^7$	—	—	—
b	0·4	8	3	$3{\cdot}397 \times 10^8$	0·4	—	—
c	0·4	6	8	$1{\cdot}562 \times 10^7$	0·8	0·4	—
d	0·3	6	8	$1{\cdot}008 \times 10^7$	0·4	0·4	0·4

* Mean bacterial count (c.f.u./ml) in control buckets 2 h after addition of last napkin.
† *P*-values measured by unpaired *t*-test.

DISCUSSION

None of the accepted methods for the evaluation of disinfectants is appropriate for the evaluation of napkin soak solutions because they fail to allow for repeated insults by bacteria and organic matter such as urea and faeces, nor do they take into account any possible inactivation of the solution by the napkin itself. One laboratory test designed specifically for napkin soak solutions, the serial urea insult test (Prosser-Snelling *et al.* 1977), uses small pieces of napkin, urea rather than urine, an artificial bacterial inoculum, and is carried out in 500 ml volumes in glass jars over a short time period. These conditions are unrealistic from the point of view of the 'urine' and 'faecal' loads and it is possible that the extrapolation of results obtained with pieces of napkin in small volumes of solution to full-sized napkins in buckets in domiciliary practice is not warranted and may in reality be over-demanding on the product.

These authors consider that a product passes the Serial Urea Insult Test if the number of bacteria surviving in the soak solution is less than 100 c.f.u./ml 2 h after the addition of the last piece of napkin in the laboratory, while Burn *et al.* (1969) regarded less than 10000 c.f.u./ml of soak solution to be satisfactory in domiciliary practice. We doubt whether any absolute bacterial count at any time following the addition of any specified number of napkins to a soak solution can have real meaning as a standard for safety.

It is important first to define what is required of a solution for sanitizing babies' napkins. We believe it should not damage fabrics, nor should it be harmful even if applied to babies' skin. However, it should be bactericidal, though not necessarily rapidly so, even in the presence of large amounts of organic matter such as faeces and urine. In normal domestic or hospital circumstances all that should be required of a napkin soak solution, from the microbiological point of view, is that bacteria do not multiply and preferably are killed during the time recommended for use of the solution thus reducing the potential hazard of cross-contamination.

The test which we describe here uses naturally urine-wetted napkins and faeces taken from babies in hospital. It uses a heavy urine and faecal load compared with that found in the average domestic situation where the manufacturer's instructions are followed and excess faeces are removed either on a napkin-liner, by scraping off, or by rinsing thoroughly.

Table 6. *Summary of test buckets*

	Test concentrations (%)	No. of challenge napkins	No. of test buckets*	Mean log reduction (c.f.u./ml)	Mean % reduction†	Significances‡ a with	b with	c with
a	0·3	8	9	2·854	98·573	—	—	—
b	0·4	8	9	3·881	98·914	0·740	—	—
c	0·4	6	23	5·024	99·977	0·003	0·022	—
d	0·3	6	23	2·947	99·482	0·074	0·265	0·002

* Extreme results removed from computations: see text.

† Mean percentage reduction in bacterial count in test bucket compared with corresponding control buckets 2 h after addition of last napkin.

‡ *P*-values calculated from unpaired *t*-tests on percentage reductions.

In the four parts of this trial there were no significant differences between the bacterial counts in the control buckets (containing standard hard water only) 2 h after the addition of the last (sixth or eighth) napkin (Table 5) and this allows comparison of results between the four parts (Table 6). With 0·3 % (w/v) 'Napisan' and eight napkins bacterial counts were reduced by 98·57 % and with 0·4 % (w/v) 'Napisan' and a similar number of napkins counts were reduced by 98·91 %. With six napkins and 0·3 or 0·4 % (w/v) 'Napisan' counts were reduced by 99·48 and 99·98 % respectively. The last result is significantly better than the other three in the statistical sense and it is clear that the degree of bactericidal activity is influenced both by the concentration of the solution and the number of napkins (the 'inactivating load') added to the system.

However, as even the 0·3 % (w/v) solution with a challenge of eight napkins reduced bacterial counts significantly, and as the function of napkin sanitizing solutions is not to sterilize but rather to reduce the numbers of faecal and other organisms, we are of the opinion that the concentration of the solution and the number of napkins added, under all the conditions tested, is not critical. Provided that a concentration of 'Napisan' similar to those we tested is used and the number of napkins added is not excessive (a maximum of eight in our tests), the sanitizing solution performs satisfactorily and provides hygienic storage conditions when used under the variable conditons to be found in the 'average' domestic environment.

We are grateful to the nursing staff of the paediatric wards of St Bartholomew's, Edgware General and the Westminster Hospitals for willingly collecting napkins; to Miss A. M. Duke and Mr K. Prosser-Snelling for expert technical assistance; to Vick International Division of Richardson-Merrell Inc. for supplies of 'Napisan'; to Miss G. Kearney and Mr D. Brennan for help with data processing; and to Miss L. Gleave for patient and excellent secretarial assistance.

REFERENCES

ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS (1950). *Official Methods of Analysis*, 7th ed. Washington.

BURN, J. L., LAMB, D., ABBOTT, J. D. & WATKINSON, J. M. (1969). Domiciliary standards of napkin hygiene: a field survey. *Medical Officer* **122**, 249–51.

DAVIES, O. L. & GOLDSMITH, P. L. (1972). *Statistical Methods in Research and Production* 4th ed. Edinburgh: Oliver and Boyd.

KELSEY, J. C. & SYKES, G. (1969). A new test for the assessment of disinfectants with particular reference to their use in hospitals. *Pharmaceutical Journal* **202**, 607–9.

MALLMAN, W. L. & HANES, M. (1945). The use-dilution method of testing disinfectants. *Journal of Bacteriology* **49**, 526.

PROSSER-SNELLING, K. R., DUKE, A. M. & RODGER, M. N. (1977). A test for the assessment of disinfectant/sanitizers used for napkin storage. *Journal of Hygiene* **79**, 315–19.

RUBBO, S. D. & GARDNER, J. F. (1965). *A review of Sterilization and Disinfection*, 1st ed. London: Lloyd-Luke.

WEBER, G. R. & BLACK, L. A. (1948). Laboratory procedure for evaluating practical performance of quaternary ammonium and other germicides proposed for sanitizing food utensils. *American Journal of Public Health* **38**, 1405–17.