Alternatives to hexachlorophene bathing of newborn infants

S.I. HNATKO, MD, FRCP[C]

In controlled trials newborn infants were bathed with Lactacyd, pHisoHex, Hibitane, Lanohex or tap water. Bacteriologic samples were taken from three sites (groin, axilla and cord) immediately after birth, following an initial bath with one of the test agents, and on day 3 or 5 after a water bath. Initial bathing with all agents, including water, reduced the concentration of bacteria on the skin to a similar extent. However, comparisons of bacterial flora at birth versus those on days 3 and 5 indicated differences in the actions of the various agents on pathogenic and nonpathogenic organisms. Lactacyd and Hibitane appeared to be suitable alternatives to hexachlorophene in the control of pathogenic bacteria on the skin of newborns. However, their absorption and toxicity in the newborn are unknown and, unless use of a skin disinfectant is warranted, routine bathing of newborns with tap water appears to be satisfactory.

Dans des études contrôlées, des nouveaux-nés ont été lavés avec du Lactacyd, du pHisoHex, de l'Hibitane, du Lanohex ou de l'eau du robinet. Des prélèvements bactériologiques ont été pris de trois endroits (l'aîne, l'aisselle et le cordon) à la naissance, après un premier bain avec un des produits testés, et au jour 3 ou 5 après un bain avec de l'eau du robinet. Un premier bain avec un ou l'autre des agents, y compris l'eau, a diminué de façon similaire la concentration bactérienne sur la peau. Toutefois, la comparaison des flores bactériennes à la naissance et aux jours 3 et 5 a indiqué des différences d'action des divers produits sur les organismes pathogènes et non pathogènes. Le Lactacyd et l'Hibitane semblent des alternatives acceptables à l'hexachlorophène pour contrôler les bactéries pathogènes de la peau chez le nouveau-né. Néanmoins, leur absorption et leur toxicité chez le nouveau-né ne sont pas connues et, à moins que l'utilisation d'un désinfectant de la peau ne soit justifiée, le lavage systématique des nouveaux-nés à l'eau du robinet semble satisfaisant.

From the division of medical microbiology, department of laboratory medicine, Royal Alexandra Hospital, Edmonton

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Reprint requests to: Dr. S.I. Hnatko, Department of laboratory medicine, Royal Alexandra Hospital, 10240 Kingsway, Edmonton, Alta. T5H 3V9

Following studies showing that hexachlorophene can be absorbed through an infant's skin[1] and warnings against the use of hexachlorophene preparations for routine total body bathing of newborn infants because of its toxicity to the central nervous system,[2,3] many hospital nurseries adopted alternative disinfectant regimens.

At the Royal Alexandra Hospital, Edmonton, repeated pHisoHex bathing was replaced in February 1972 by an initial pHisoHex bath and subsequent daily water bathing. The infection rate among newborns remained unchanged until July–August 1972, when the rate increased after the regimen was changed to daily bathing with Savlon (chlorhexidine gluconate, 7.5% volume per volume, and cetrimide, 15% weight per volume [w/v]) (Tables I and II). With immediate reintroduction of pHisoHex bathing the infection rate decreased sharply.

Others have reported a similar pattern of sudden outbreak of skin disease in healthy newborns following discontinuation of routine hexachlorophene bathing.[4-7] One group cited these outbreaks as proof of the protective value of hexachlorophene in the hospital nursery.[5] The others, however, thought that scrupulous aseptic technique was far more important than hexachlorophene bathing in preventing infectious skin disease in newborns.[4,6,7]

Because of the continuing controversy about hexachlorophene the study reported below was undertaken to answer the following questions:

1. Was the transient increase in incidence of infection at the Royal Alexandra and other hospitals due to discontinuation of hexachlorophene bathing?
2. Is there an effective substitute antiseptic?
3. Is it necessary to use any antiseptic in bathing newborns?

Methods

Test groups

As infants were born at the Royal Alexandra Hospital between January and May 1974 they were assigned randomly to four groups of 25 each, to receive initial baths with one of the following antiseptic agents:

Group 1: Lactacyd (lactoserum, 2.115 g; lactic acid, 2.351 g)

Group 2: pHisoHex (3% hexachlorophene: 2,2′-methylenebis[3,4,6-trichlorophenol])

Group 3: Hibitane skin cleanser (chlorhexidine gluconate, 4% w/v: 1,6-bis-[*p*-chlorophenyldiguanido]hexane.

Group 4: Lanohex (phenoxyethanol, 1%; Phenonip, 1% [solution of mixed parahydroxybenzoates in phenoxyethanol in lanolin base])

A control group consisted of 50 newborns selected at random and bathed with only tap water.

Table I—Rate of nosocomial infection in relation to changes in bathing procedure for newborns, 1971 to 1975

Period	No. of babies discharged	Infection rate (%)	Bathing procedure
1971	4338	0.5	Initial pHisoHex bath, then daily sponge bath with water and repeated pHisoHex bath on days 3 and 5
1972, Jan	354	0.6	Initial pHisoHex bath, then daily sponge bath with water and repeated pHisoHex bath on day 4
1972, Feb - June	1729	0.2	Initial pHisoHex bath, then daily sponge bath with water until discharge
1972, July	346	0.6	Daily bath with Savlon 1:3000 until discharge
1972, Aug	349	7.7	
1972, Sept - Oct	646	1.1	Initial pHisoHex bath on doctor's order, then daily sponge bath with water until discharge
1972, Nov - Dec	681	1.3	pHisoHex, Lactacyd or Hibitane on experimental basis
1973, Jan - July	3381	1.0	Initial pHisoHex bath on doctor's order, then daily sponge bath with water until discharge
1973, Aug - Dec	561	0.3	Lactacyd or Hibitane on experimental basis
1974, Jan - May	150	0	Lactacyd, pHisoHex, Hibitane or Lanohex on experimental basis
1974, June	196	0	Daily sponge bath with water until discharge
1974, Jan - Sept	2266	0.5	Initial pHisoHex bath on doctor's order, then daily sponge bath with water until discharge
1974, Sept - 1975, Dec	5914	0.3	Initial Hibitane bath, then daily sponge bath with water until discharge

Table II—Nosocomial infections following discontinuation of initial pHisoHex bath

	Area; no. of infections							
Organisms isolated*	Groin†	Axilla†	Neck†	Face†	Cord†	Skin†	Arm, breast or skin‡	Total no.
Staphylococcus aureus	2	6	1	—	1	2	3	15
Staph. aureus Nonhemolytic streptococci *Escherichia coli*	—	1	—	—	1	—	—	2
Staph. aureus *Strep. faecalis*	—	1	—	—	3	—	—	4
Staph. aureus *Staph. albus*	—	3	—	1	—	—	—	4
Staph. aureus *Enterobacter aerogenes*	1	1	—	—	—	—	—	2
Total no.	3	12	1	1	5	2	3	27

*Staphylococcal phage types isolated: GP1-9, GP2-7 and GP3-8; three untypable.
†Three to five pustules in each case (stay, 4 to 6 days).
‡Abscess of arm in one (hospital stay, 13 days) and of breast in one (stay, 24 days), and dermatitis in one (stay, 19 days).

Bathing procedure

After the baby was received in the nursery the following procedure was followed for those being bathed with one of the test antiseptic agents.

1. The face was washed with tap water and a Chix towel (Johnson & Johnson Ltd.).
2. The baby was wetted with the hands.
3. About 4 mL of one of the test agents was lathered in the palms of the hands.
4. The lather was spread gently over all parts of the baby's body, including axillae, creases, groins and folds.
5. With a Chix towel soaked in tap water the lather was sponged off.
6. The baby was wrapped in a towel and patted dry.
7. The scalp was lathered with the same agent, washed off with a Chix towel and patted dry.
8. The eyes were washed with sterile distilled water.
9. A diaper and a shirt were put on and the baby moved to a bassinet.

From the 2nd day all babies were sponge-bathed daily with tap water and a Chix towel. In addition, the cord remnant was dabbed with Savlon 1:30 in 70% isopropyl alcohol two to four times daily if the remnant appeared wet or once daily if it appeared dry.

Bacteriologic examination

Three sites — left groin, left axilla (area, 5 x 5 cm) and surface of cord remnant — were bacteriologically sampled immediately after birth, after the initial bath, and after the bath on day 3 or 5. Sampling was done with moistened swabs, which were then placed in Stuart's transport medium, sent to the laboratory and inoculated onto sheep blood agar and MacConkey agar plates. The cultures were read in 24 and 48 hours and the organisms identified by the usual laboratory methods. The skin and nose were sampled for staphylococcal colonization at the same time by similar procedures.

Follow-up

While in hospital all newborns in the study were observed daily for evidence of skin infection. After discharge the physician in charge of the infant was asked to report any evidence of infection.

Study with premature infants

Since premature infants may be particularly susceptible to the toxic effects of hexachlorophene,[8] a group of 61 premature infants was studied; initial baths were with Lactacyd in 23, Hibitane in 21 and Savlon in 17.

Results

The organisms isolated from samples from the study groups are listed in Table III. In the 100 newborns (groups 1 to 4) from whom samples were taken immediately prior to the initial bath with an antiseptic, bacteria were grown from 34% of the groin, 41% of the axilla and 21% of the cord swabs. In the 50 newborns bathed with water initially, bacteria were grown from 38% of the groin, 36% of the axilla and 20% of the cord swabs. For all 150 babies the cord remnant yielded significantly fewer ($P \leq 0.05$) positive cultures than either the groin or the axilla. In all areas the flora were primarily *Escherichia coli* and *Staphylococcus albus*.

Following the initial bath bacterial

Table III—Bacterial flora of 150 babies at birth (A), after initial bath (B) and after bath on day 3 or 5 (C)

Group; agent of initial bath; organisms isolated	Area sampled; time; no. of isolations of organisms											
	Groin			Axilla			Cord			Total no.		
	A	B	C	A	B	C	A	B	C	A	B	C
1: Lactacyd (n = 25)												
E. coli	8	1	10	9	3	9	2	0	9	19	4	28
Staph. aureus	1	0	2	1	0	1	0	0	2	2	0	5
Strep. faecalis	1	0	0	1	0	1	0	0	1	2	0	2
Proteus	0	0	0	0	0	0	0	0	2	0	0	2
Subtotal	10	1	12	11	3	11	2	0	14	23	4	37
Staph. albus	5	5	17	6	6	21	5	3	14	16	14	52
Total	15	6	29	17	9	32	7	3	28	39	18	89
2: pHisoHex (n = 25)												
E. coli	4	1	16	7	2	12	1	0	13	12	3	41
Staph. aureus	2	0	0	1	0	0	0	0	3	3	0	3
Strep. faecalis	0	0	4	0	0	3	0	0	0	0	0	7
Proteus	0	0	0	0	0	0	0	0	3	0	0	3
Subtotal	6	1	20	8	2	15	1	0	19	15	3	54
Staph. albus	8	4	17	11	7	16	5	2	11	24	13	44
Total	14	5	37	19	9	31	6	2	30	39	16	98
3: Hibitane (n = 25)												
E. coli	4	2	11	2	2	4	2	0	3	8	4	18
Staph. aureus	2	1	0	1	0	0	0	0	0	3	1	0
Strep. faecalis	0	0	2	0	0	0	0	0	0	0	0	2
Proteus	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	6	3	13	3	2	4	2	0	3	11	5	20
Staph. albus	1	0	14	5	0	2	2	0	8	8	0	24
Total	7	3	27	8	2	6	4	0	11	19	5	44
4: Lanohex* (n = 25)												
E. coli	2	0	16	2	0	6	2	0	11	6	0	33
Staph. aureus	0	0	1	0	0	0	0	0	0	0	0	1
Strep. faecalis	0	0	1	0	0	0	0	0	0	0	0	1
Proteus	1	0	0	1	0	0	0	0	0	2	0	0
Subtotal	3	0	18	3	0	6	2	0	11	8	0	35
Staph. albus	5	1	15	4	4	20	2	2	10	11	7	45
Total	8	1	33	7	4	26	4	2	21	19	7	80
Control: water (n = 50)												
E. coli	4	1	17	4	2	12	0	0	7	8	3	36
Staph. aureus	1	0	2	1	0	2	1	0	2	3	0	6
Subtotal	5	1	19	5	2	14	1	0	9	11	3	42
Staph. albus	14	10	30	15	12	31	7	5	14	36	27	75
Strep. viridans	1	0	0	0	0	0	2	0	0	3	0	0
Nonhemo. strep.	1	1	0	1	1	0	1	1	0	3	3	0
Total	21	12	49	21	15	45	11	6	23	53	33	117
All babies (n = 150)												
E. coli	22	5	70	24	9	43	7	0	43	53	14	156
Staph. aureus	6	1	5	4	0	3	1	0	7	11	1	15
Strep. faecalis	1	0	7	1	0	4	0	0	1	2	0	12
Proteus	1	0	0	1	0	0	0	0	5	2	0	5
Subtotal	30	6	82	30	9	50	8	0	56	68	15	188
Staph. albus	33	20	93	41	29	90	21	12	57	95	61	240
Strep. viridans	1	0	0	0	0	0	2	0	0	3	0	0
Nonhemo. strep.	1	1	0	1	1	0	1	1	0	3	3	0
Total	65	27	175	72	39	140	32†	13	113†	169	79	428

*For this group, C = day 5.
†Significantly fewer ($P \leq 0.05$) than for groin or axilla.

counts were reduced to a similar extent in all groups (Tables III and IV). There were no significant differences in the effect of the antiseptic agents in single areas of the body. When isolations from groin, axilla and cord were grouped (Table IV), chi-square analysis demonstrated the best reduction in number of isolations of pathogens (i.e., *E. coli, Staph. aureus, Streptococcus faecalis* and *Proteus*) in the Lactacyd group ($P \leq 0.05$), there being only four positive cultures from swabs taken after the bath. Significant ($P \leq 0.05$) effectiveness against pathogens was also shown by pHisoHex and Lanohex. Bathing with tap water also reduced the number of isolations of pathogens, but the decrease was not as pronounced as with the other agents. Hibitane proved significantly less effective ($P \leq 0.05$) than the other agents in reducing the total number of isolations of pathogens; however, it reduced the number of *Staph. albus* cultures from 8 to 0, a highly significant decrease. The decrease in number of isolations of nonpathogens (i.e., *Staph. albus, Strep. viridans* and nonhemolytic streptococci) was significantly less with the other agents.

Swabs taken on day 3 or 5 (Table III) yielded an increased number of positive cultures from all three areas of the body. The most striking finding was the increased number of isolations of *E. coli* from the three sites. The greatest increase followed initial bathing with pHisoHex; increases were smaller with Lanohex, Lactacyd, water and Hibitane, in that order. The main organisms isolated from the groin were *E. coli* and *Staph. albus;* from the axilla, *Staph. albus,* with a decrease in the number of *E. coli* isolates; and from the cord, *E. coli* and *Staph. albus.* The total number of positive cultures from cord swabs was significantly less ($P \leq 0.05$) than that from the axilla or the groin; however, this may have resulted from the daily care of the cord with Savlon and alcohol.

Staphylococcal colonization of the skin after the initial bath was detected in the following proportions of each group: Lactacyd, 20%; pHisoHex, 4%; Hibitane, 0%; Lanohex, 12%; and water, 12%. For nasal colonization the proportions were as follows: Lactacyd, 16%; pHisoHex, 7%; Hibitane, 3%; Lanohex, 8%; and water, 12%. Repeated studies showed that staphylococcal colonization of the skin was similar on day 3 compared with day 5, except in the Hibitane group, where a decrease was seen.

Important differences between the agents were noted in their effect on bacteria generally considered pathogenic (*E. coli, Staph. aureus, Strep. faecalis* and *Proteus*), compared with their effect on those usually considered nonpathogenic (*Staph. albus, Strep. viridans* and nonhemolytic streptococci). The Lactacyd and Hibitane groups showed a relatively small increase in number of isolates of pathogens as compared with the large increase for nonpathogens (Fig. 1). The reverse was true for the water and pHisoHex groups. The Lanohex group did not appear to follow the pattern of the other agents, in that it showed a 400% increase for both pathogens and nonpathogens. The relatively small numbers in the study prevent statistically valid comparisons of these findings.

In the study of 61 premature infants about 28% of the swabs collected before the initial bath yielded bacteria. The proportion decreased to about 15% among those bathed with Lactacyd or Hibitane, but Savlon produced no decrease. The organisms isolated were primarily *E. coli* and *Staph. albus.* Staphylococcal colonization of the skin,

Table IV—Number of isolations of organisms from swabs taken before and after initial bath

Group	Organisms	At birth	After initial bath	% reduction
1: Lactacyd	Pathogens	23	4	82.6*
	Nonpathogens	16	14	12.5
2: pHisoHex	Pathogens	15	3	80.0*
	Nonpathogens	24	13	45.8
3: Hibitane	Pathogens	11	5	54.5†
	Nonpathogens	8	0	100.0
4: Lanohex	Pathogens	8	0	100.0*
	Nonpathogens	11	7	36.4
Control: water	Pathogens	11	3	72.7
	Nonpathogens	42	30	28.6
All babies	Pathogens	68	15	78.0
	Nonpathogens	101	64	36.6

*Significant ($P \leq 0.05$) by chi-square analysis, the best reduction being with Lactacyd.
†Significantly less effective ($P \leq 0.05$) than the other agents in reducing the total number of isolations of pathogens, but decrease in number of isolations of *Staph. albus* was highly significant and that for nonpathogens was significantly greater ($P \leq 0.05$) than with the other agents.

studied at 7, 14 and 21 days, was similar in each of the three groups and did not differ significantly from that of the term newborns bathed with tap water alone. Colonization took longer in the premature newborns (7 to 21 days) compared with the term newborns (3 to 5 days).

Discussion

All the agents tested in this study, including tap water, effectively reduced the number of gram-positive and gram-negative bacteria on the skin of newborns. Lactacyd and pHisoHex proved more effective against pathogens than Hibitane; pHisoHex was more effective against nonpathogens but the results did not differ significantly from those for water.

These findings must be tempered by the observation that, for an undetermined reason, the newborns washed with Lactacyd carried significantly more ($P \leq 0.05$) pathogens at birth; 23 isolates of pathogens were obtained from the 25 babies later washed with Lactacyd, as against 11 from the 50 babies in the water group. Thus, the groups were not perfectly randomized. Varying degrees of sterility in the delivery rooms and contamination of newborns during delivery may have caused these differences.

In terms of the questions motivating this study, analysis of the entire sample of term and premature newborns indicates that the transient increase in rate of nosocomial infection following the discontinuation of hexachlorophene bathing was most probably not due to ineffectiveness of the substituted antiseptic agents. The rate increased to 7.7% when newborns were bathed with Savlon, and it decreased within 2 months to 1.1% upon reinstitution of hexachlorophene bathing. However, when a control sample of newborns were carefully bathed with water the rate was no different from that encountered with other disinfectants.

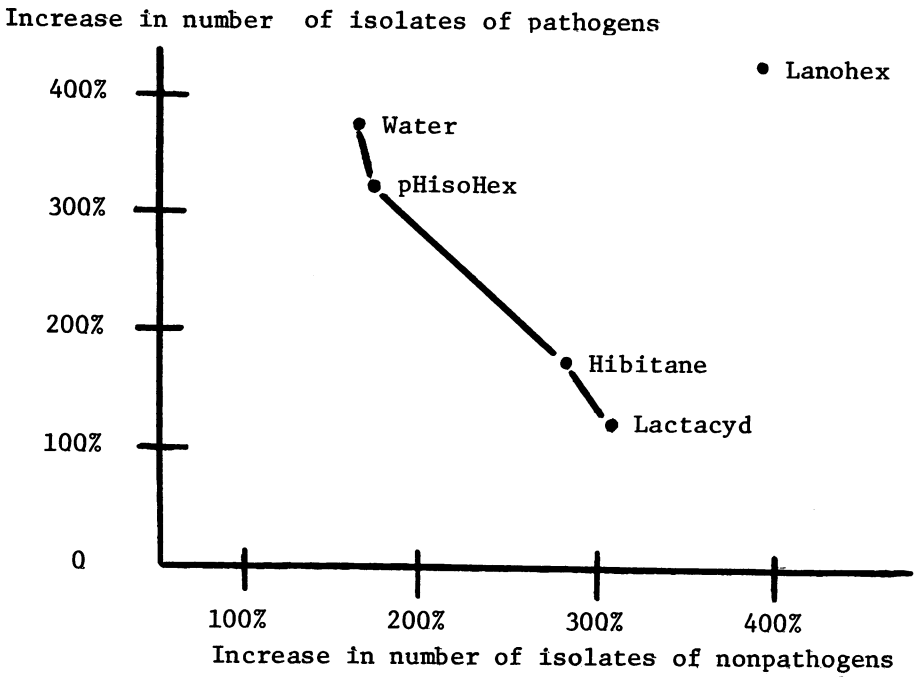

FIG. 1—Increase in number of bacterial isolates on day of discharge over that on day of birth.

As McHattie and colleagues[6] found, Lactacyd appears to be a reasonable replacement for hexachlorophene, as does Hibitane, although their toxicity in newborns has not been investigated. Observation of 6475 newborns bathed with Lactacyd or Hibitane, or both, supports this view (Table I). Further study of the interaction of pathogens and nonpathogens may demonstrate important differences between these possible alternatives to hexachlorophene.

In the light of recent evidence of vacuolar encephalopathy related to hexachlorophene exposure in newborns,[9,10] the long-standing practice of bathing newborn infants with disinfectants should be examined closely once more. Routine daily skin care with water, by good sanitary methods, appears to be preferable. Skin disinfectants should be reserved for situations in which the incidence of staphylococcal and other infections appears to be increasing. In many instances the selection of a disinfectant for initial bathing of newborns is made not on the basis of need but on the basis of esthetic value. This practice should be discouraged.

References

1. Curley A, Hawk RE, Kimbrough RD, et al: Dermal absorption of hexachlorophene in infants. *Lancet* 2: 296, 1971
2. American Academy of Pediatrics, committee on fetus and newborn: Hexachlorophene and skin care of newborn infants. *Pediatrics* 49: 625, 1972
3. *Hexachlorophene and Newborns*, Food and Drug Administration drug bull, US Dept of Health, Education, and Welfare, public health service, Dec 1971
4. Gehlbach SH, Gutman LT, Wilfert CM, et al: Recurrence of skin disease in a nursery: ineffectuality of hexachlorophene bathing. *Pediatrics* 55: 422, 1975
5. Hyams PJ, Counts GW, Monkus E, et al: Staphylococcal bacteremia and hexachlorophene bathing: epidemic in a newborn nursery. *Am J Dis Child* 129: 595, 1975
6. McHattie JC, Crossan M, Talukdar C, et al: A comparison of hexachlorophene and Lactacyd on growth of skin flora in healthy term newborn infants. *Can Med Assoc J* 110: 1248, 1974
7. Najem GR, Riley HD, Ordway NK, et al: Clinical and microbiologic surveillance of neonatal staphylococcal disease: relationship to hexachlorophene whole-body bathing. *Am J Dis Child* 129: 297, 1975
8. Powell H, Swarner O, Gluck L, et al: Hexachlorophene myelinopathy in premature infants. *J Pediatr* 82: 976, 1973
9. Shuman RM, Leech RW, Alvord EC jr: Neurotoxicity of hexachlorophene in the human: I. A clinico-pathologic study of 248 children. *Pediatrics* 54: 689, 1974
10. Idem: Neurotoxicity of hexachlorophene in the human: II. A clinico-pathologic study of 46 premature infants. *Arch Neurol* 32: 320, 1975