NASAL STAPHYLOCOCCI AND SEPSIS IN NEWBORN BABIES

BY

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In a previous study in this hospital an attempt was made to trace the pathways by which staphylococci spread in a nursery (Cook *et al.*, 1958). The method used was based on the finding that, in the absence of special measures, all the newborn babies carried *Staphylococcus aureus* in the nose by the twelfth day of life. Certain measures, and in particular the application of triple dye to the umbilical stump, reduced the nasal colonization rate. This work has been continued. Air disinfection with ultra-violet light and bathing with hexachlorophane have been assessed as a means of preventing nasal carriage. Williams *et al.* (1959) have shown that adult patients in this hospital who are nasal carriers are more likely to suffer staphylococcal sepsis than those who are not carriers. We have found a similar relationship between sepsis and the carriage state in newborn babies. If this is a general finding it provides a practical reason for attempting to prevent the colonization of newborn babies by *Staph. aureus*.

Methods

Babies.—The babies were full-term and breast-fed. Where breast-feeding did not become established, the babies were nevertheless taken to the mothers for either a breast-feed with complement or a bottle-feed. Babies and mothers normally went home on the 12th day.

Nurseries and Staff.—These were as described by Cook *et al.* (1958). Masks and gowns were not worn.

Bacteriology.—Noses were examined daily, except on Sundays, by rubbing dry cotton-wool swabs six times round the inside of each nostril. Staphylococci which coagulated plasma were regarded as *Staph. aureus*.

Results

Carriage of *Staph. aureus*

Throughout the trial, triple dye* was applied at birth and thereafter daily to the umbilical stumps of all the babies in each group.

Babies Treated with Triple Dye Only.—One hundred and ten babies were treated with triple dye to the umbilical stump, without any other special measure. Of these, 38 (35%) were still not carriers of *Staph. aureus* by the 12th day of life (Table I). In the previous trial of this method 17 out of 55 babies (31%) were found not to be nasal carriers by the 12th day.

Effect of Air Disinfection with Ultra-violet Light.—As it is possible that staphylococci reach babies through the air, the effect of air disinfection with ultra-violet light was tested. The apparatus used was designed to circulate 1,000 cu. ft. (28.3 cu. m.) of air a minute past four ultra-violet-light tubes. This rate meant that in the large nursery the air was passed through the

*Triple dye=brilliant green, proflavine hemisulphate, and crystal violet.

disinfectant approximately seven times an hour, and more often in the small nursery. The 30-watt low-pressure mercury tubes, each 3 ft. (90 cm.) long, had an ultra-violet output of approximately 6 watts at 2537Å. They were placed parallel to the direction of air-flow at the corners of a square of side 12 in. (30 cm.) set symmetrically in a 3 ft. 6 in. (107 cm.) length of square section duct approximately 23½ by 23½ in. (60

TABLE I.—Nasal Carriage of *Staph. aureus* by Newborn Babies. Babies Becoming Carriers on Successive Days of Life

Day of Life	Triple Dye	Triple Dye and Ultra-violet Light	Triple Dye and Hexachlorophane
1	1	2	1
2	3	2	3
3	11	6	8
4	9	18	10
5	9	10	13
6	10	8	8
7	6	5	2
8	6	7	4
9	4	4	5
10	5	0	2
11	4	0	1
12	4	0	0
Negative on 12th day	38 (35%)	35 (36%)	48 (46%)
Total ..	110	97	105

TABLE II.—Bacterial Air Counts in Babies' Nurseries in Varying Circumstances

Nursery	Treatment	Quiet			Activity			
		No. of Samples	Mean Counts/cu. ft.		No. of Samples	Mean Counts/cu. ft.		
			<i>Staph. aureus</i>	General		<i>Staph. aureus</i>	General	
Small	{ (1)	Triple dye ..	52	0.031	9.9	23	0.091	26.6
		T.D.+ ultra-violet ..	64	0.020	5.8	18	0.038	20.5
		T.D. ..	35	0.031	5.9	11	0.106	15.4
Large	{ (2)	T.D.+air circulation	35	0.020	7.2	8	0.140	12.1
		T.D.+ ultra-violet ..	82	0.014	7.1	22	0.026	9.2
		T.D.+ hexachlorophane ..	177	0.026	8.5	31	0.059	13.7

(1) Triple dye with air circulation by the disinfectant, but ultra-violet not on.
(2) Hexachlorophane, either as soap ("cidal") or "phisohex."

by 60 cm.) inside dimensions. The average number of staphylococci in the nursery air was reduced, especially during periods of activity, when the disinfectant was in use (Table II), but, despite reduction in the air counts, we could find no appreciable differences in the nasal colonization rates. Of 97 babies, 35 (36%) were still negative on the 12th day (Table I).

Effect of Washing the Babies with Hexachlorophane.—Hexachlorophane, after the first few babies, was used as "phisohex," a proprietary preparation containing amongst its ingredients a detergent and 3% hexachlorophane. Babies were bathed daily. A lather was produced with phisohex, which was then rinsed off in the bath. There was some indication of a reduction in the air counts of staphylococci during the period of hexachlorophane treatment, though this reduction was less than that seen when air was disinfected by ultra-violet light. Nevertheless triple dye and hexachlorophane were more successful than triple dye alone or triple dye and ultra-violet light in preventing nasal colonization. There were 105 babies in this group, and 48 (46%) of them were still negative on the 12th day.

Sepsis

A record was made of sepsis as it occurred in the 312 babies involved in this study. The figures presented here are only for sepsis due to *Staph. aureus*, or, in

cases where no swab was taken, for sepsis thought on clinical grounds to be due to staphylococci.

In all, 24 babies (7.7%) suffered staphylococcal sepsis. In 12 of these the diagnosis was made by isolation of the staphylococcus; in 12 the diagnosis was presumptive. Sepsis was distributed almost equally between the three groups of babies—7 cases among the 110 babies treated with triple dye only, 11 cases among the 97 babies treated with triple dye in conjunction with air disinfection, and 6 cases in the 105 babies treated with triple dye and hexachlorophane.

Sepsis in Relation to Nasal Carriage of Staph. aureus.—It has been shown that adult patients in this hospital are more likely to develop staphylococcal sepsis if they are nasal carriers of *Staph. aureus* than if they are not (Williams *et al.*, 1959). It was therefore of interest to see if the same trend was present in the babies. Of the 312 babies, 191 carried staphylococci by the 12th day. In this group there were 20 babies (10.5%) with staphylococcal sepsis during their stay in hospital. The remaining 121 babies were not found to be carriers by the 12th day of their life in hospital. Of these, only 4 (3.3%) developed staphylococcal sepsis. In 16 babies who were carriers and developed sepsis, staphylococci were isolated from the nose before the onset of sepsis. In a further two babies the isolation was made from the nose and septic lesion at the same time.

Discussion

In our previous work in these nurseries we found two measures that appreciably affected the nasal colonization rate of newborn babies. These were the application of triple dye to the umbilical stump, and the use of individual gowns for each baby. Combination of these two methods was no more successful than either method alone. This should be borne in mind when assessing the present results. The failure of air disinfection by ultra-violet light to alter the nasal rate despite an undoubted effect on the number of bacteria in the air clearly shows that a reduction in the number of bacteria in the environment is not necessarily followed by a reduced rate of staphylococcal spread. If, however, the ultra-violet light had been used uncombined with triple dye, a result due to it alone might have been seen. The failure may have been observed because the aerial transfer of staphylococci was not important in the circumstances, though other explanations are possible.

Hexachlorophane is used in many North American nurseries. Baldwin *et al.* (1957), for instance, found that it reduced the rate of infants' nasal colonization below that reported in other investigations. Our results support these findings in that, though the difference was not statistically significant, the nasal colonization rate was lowest with hexachlorophane bathing in conjunction with triple dye to the umbilical stump.

But there is still a long way to go. Even with our best regimen more than half the babies became nasal carriers before leaving hospital. That this phenomenon was of clinical and not only academic importance was strongly suggested by the analysis of sepsis. Staphylococcal sepsis occurred three times as often in babies who became carriers of *Staph. aureus* as it did in those who remained negative, and in most cases carriage preceded sepsis. This ratio is very close to that reported for adults. If it means, as it apparently does, that carriage of staphylococci conduces to sepsis, it provides

a further incentive and justification for attempts to prevent the colonization of newborn babies by *Staph. aureus*.

Summary

An attempt has been made in a hospital nursery to prevent the colonization of newborn babies' noses by *Staph. aureus*. When triple dye was applied to the umbilical stump 35% of babies were still not carriers by the 12th day of life. Air disinfection of the nursery with ultra-violet light combined with triple dye produced almost identical results. With triple dye and hexachlorophane 46% of babies reached the 12th day free from nasal staphylococci.

Staphylococcal sepsis occurred three times as often in babies found to be carriers as in those who were not.

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MEGALOBlastic ANAEMIA DUE TO PHENOBARBITONE THE CONVULSANT ACTION OF THERAPEUTIC DOSES OF FOLIC ACID

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Megaloblastic anaemia may develop in patients treated with the anticonvulsant drugs phenytoin sodium and primidone (Badenoch, 1954; Hawkins and Meynell, 1954; Fuld and Moorhouse, 1956) and in patients receiving large doses of barbiturates (Hobson, Selwyn, and Mollin, 1956; Calvert, Hurworth, and MacBean, 1958). Though Hawkins and Meynell (1958) observed mild macrocytosis in about a third of the patients receiving phenobarbitone, megaloblastic anaemia due to this very widely used barbiturate has not been recorded.

The purpose of this paper is to describe a patient who presented with a megaloblastic anaemia on two occasions while taking large doses of phenobarbitone, and to report observations on the pathogenesis of the anaemia and the unusual response to treatment with folic acid.

Case Report

The patient, a known epileptic aged 43, was first seen in 1955 with rheumatoid arthritis. He was uncooperative, refused to attend for treatment, and developed permanent contractures of both knees and the left arm.