

A Study of Staphylococcal Infection in the Maternity Ward of Ratnapura Hospital

by

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INTRODUCTION

In the past cross infection with pyogenic organisms in surgical and obstetric wards was a common occurrence. The introduction of aseptic surgery and antibiotics saw the incidence of hospital cross infection decline abruptly. But during the last two decades, due to the widespread use of antibiotics and the acquisition of resistance by the staphylococci, the increasing incidence of sepsis due to antibiotic resistant staphylococci has posed a problem. Unfortunately we do not know the actual magnitude of this problem in our hospitals.

On 29.3.67 when we visited Ratnapura Hospital, the Medical Superintendent and the Obstetrician brought to our notice that there was an increasing incidence of staphylococcal infection amongst the new born infants, since December 1966. It was therefore decided to carry out an investigation to determine the extent of the problem. This paper outlines the investigations that were undertaken, the results and the remedial measures adopted.

MATERIAL AND METHODS

Bacteriological and Epidemiological investigations were carried out at Ratnapura Hospital during the period 22.4.67 to 14.5.67 by a Bacteriologist and a Medical Laboratory Technologist. Bacteriological investigations were carried out even after 14.5.67 when the specimens were despatched to Colombo for processing. This report gives only the results of the investigations carried out at Ratnapura.

During this period perineal and nasal swabs were taken from mothers on admission to the maternity ward and the proportion of these who proceeded to delivery were again

swabbed on admission to the labour room. No examinations were carried out on mothers post-partum. Nasal and umbilical swabs were taken from infants. The swabs were first taken three hours after delivery and subsequently every morning approximately at 24, 48 and 72 hours after delivery. 68 members of the staff including pupil midwives working in this unit were also examined by taking nasal swabs and swabs from hands and garments. The environment too was studied by examining swabs from beds, cots, lockers, curtains and other equipment in 16 sections of the maternity unit. Settle plates or culture plates were also exposed in various sections for a period of six hours to determine the degree of aerial contamination.

LAYOUT OF THE MATERNITY UNIT

A sketch map of the Maternity Unit is shown in Fig. 1. This is a section of the first floor in the Hospital. The Maternity Unit consists of two blocks opening into a long corridor through which it is continuous with other sections of the Hospital. Block A is the 'clean block' while B is the 'septic block'. The two sections are kept almost completely isolated. Separate staff work in the two sections. For block A the antenatal section consists of rooms 1 and 17 of which the former is always overcrowded. At the onset of labour the mothers are sent to room 16 for preparation and then to the labour room (room 15). After delivery the normal babies and mothers are transferred to the post natal room (room 10) while premature babies are sent to room 18. Baby washing and dressing is carried out in room 11 and those who develop pustules or any other infectious condition are isolated in room 3.

CLINICAL MANIFESTATIONS

In babies the lesions were mainly seen in the skin, as tiny pustules either single or few in number. They were mostly seen in the flexures or folds of skin as in the neck, groin, axilla, face, etc. There were only a few cases of conjunctivitis and in some, multiple sites were affected. The infection was mild and there were no constitutional disturbances or complications. The period of incubation was 2-10 days with a median of 5 days.

INCIDENCE OF INFECTION IN THE UNIT

The Obstetrician of the unit had observed an increasing incidence of staphylococcal skin lesions amongst the new born since December 1966, but a record of such cases had only been maintained since March 1967. Table 1 shows the number of live births occurring in the unit in 1967 and the number of cases of skin infection recorded since March. If all the infants born in the unit were considered as those at risk, the attack rate during March was 11.6%. But as the average duration of stay of infants is about 2-3 days, it is only those who stay longer that would manifest the disease. Perhaps a certain number would have developed symptoms after discharge from hospital.

Before the investigations were undertaken it was reported that a certain number of infants delivered at the hospital had been readmitted to the paediatric section of the hospital with staphylococcal meningitis and pneumonia, but no figures are available.

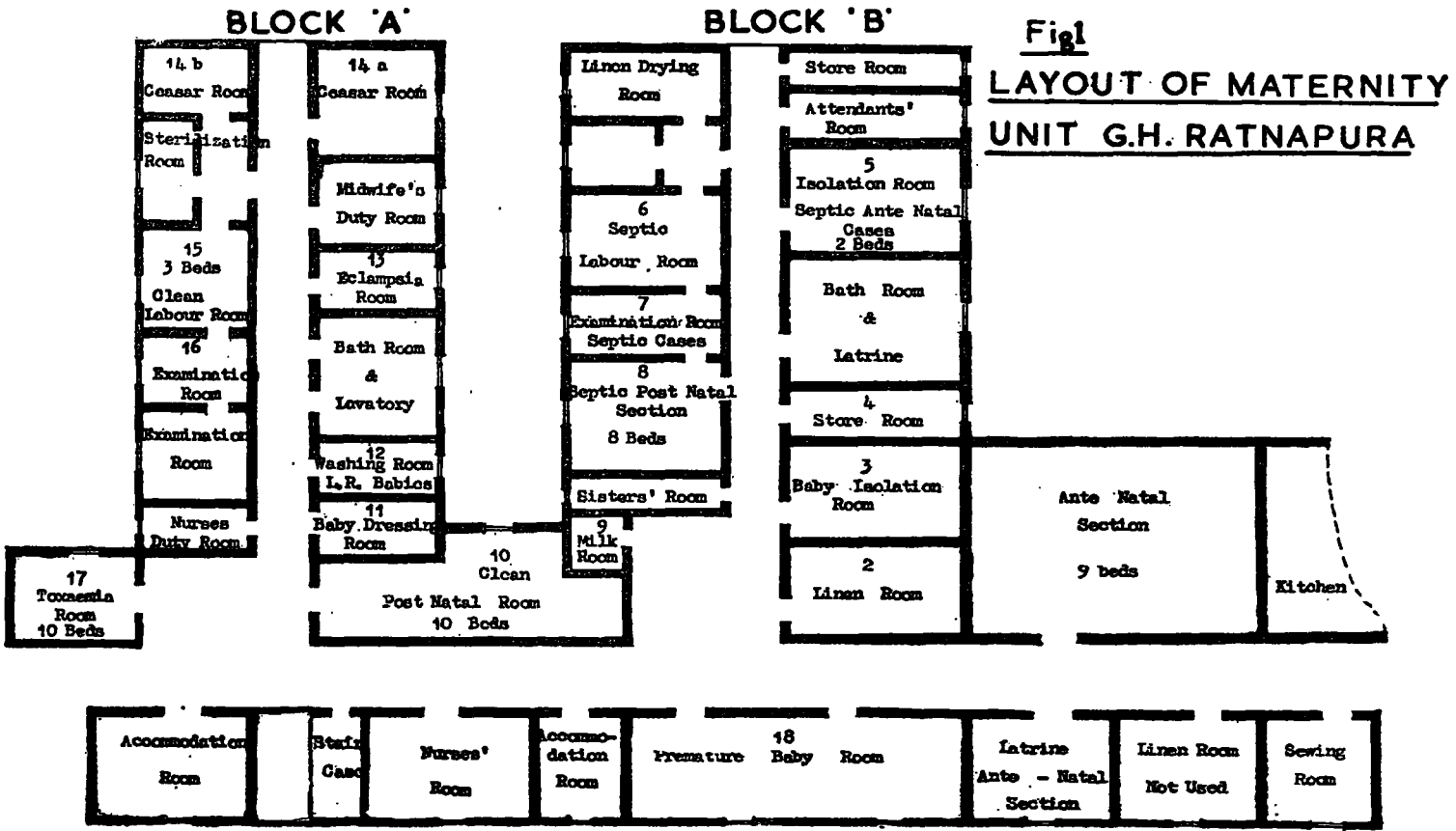


TABLE 1

Incidence of Neonatal skin Infections in Maternity Unit—1967.

1967	No. of Live Births	No. of skin lesions	No. of % affected
January	174	Not known	—
February	242	Not known	—
March	259	30	11.6
April	241	20	8.3
May	223	11	4.9
June	169	9	5.3
July	180	6	3.3
August	186	4	2.1
September	193	6	3.1
October	262	4	1.5
November	258	1	0.4
December	293	4	1.4

RESULTS

(a) *Expectant Mothers.* Table 2 shows the incidence of colonization amongst mothers on admission and at labour. It is seen that the incidence of colonization at both sites, the nose and the perineum is about 13% on admission. But at commencement of labour, nasal carriage rate is slightly increased, while there is decrease in colonization at the perineum. This is perhaps due to better personal hygiene practised while awaiting delivery in hospital.

TABLE 2

Incidence of Staphylococcal Colonization among Expectant Mothers.

Site of Culture	On admission			At Commencement of Labour		
	No. examined	No. +	% +	No. examined	No. +	% +
Nasal swab	169	22	13.0	64	10	15.6
Perineal swab	169	23	13.6	64	3	4.7

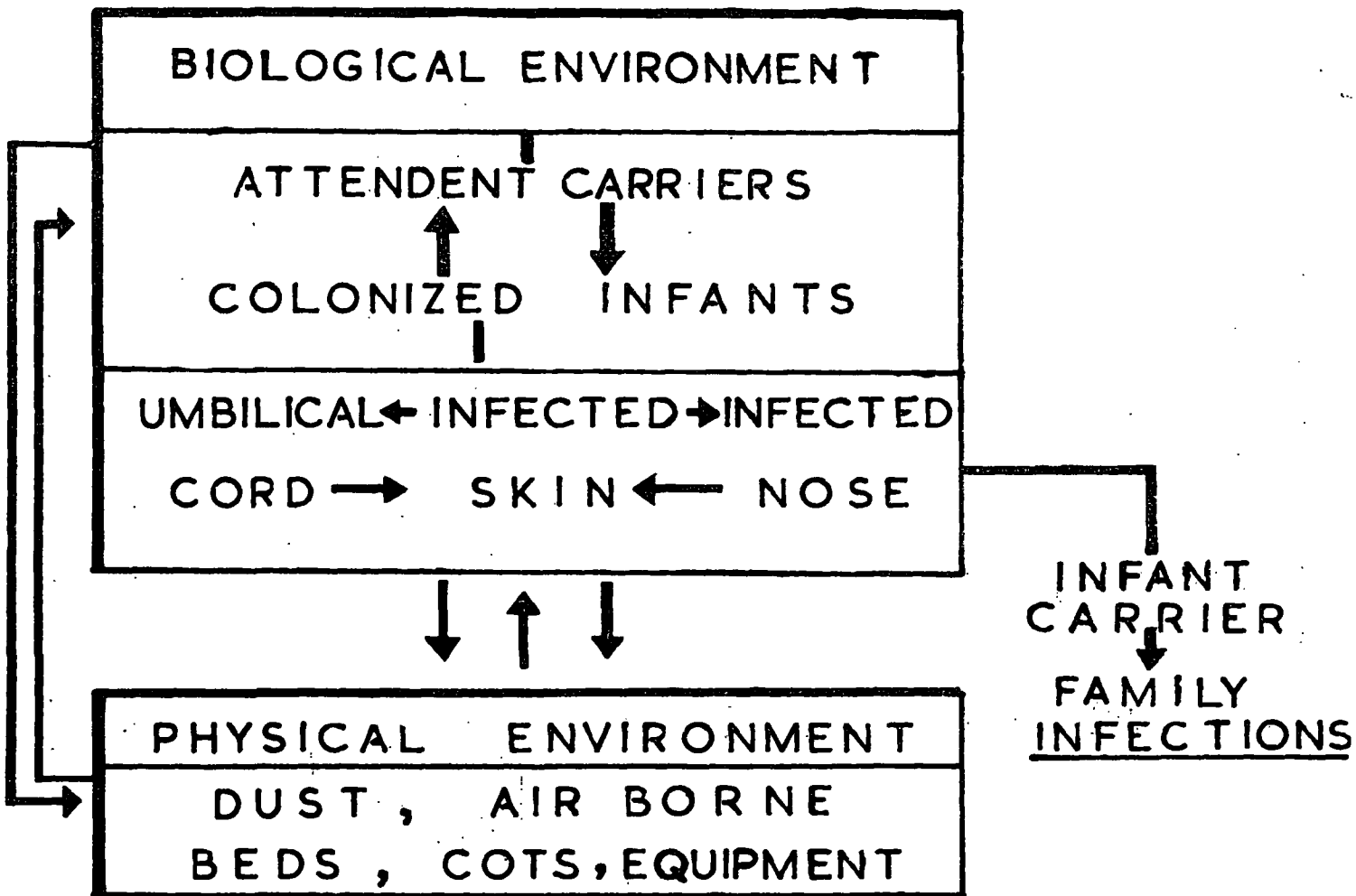


FIG. 2. PATHWAYS OF SPREAD OF STAPHYLOCOCCAL INFECTION IN MATERNITY WARDS.

(b) *Newborn Babies.* Staphylococcal carriage rate amongst neonates is shown in Table 3. It is seen that 16.3% are positive at 3 hours after birth, 32.9% at 24 hours, 39.4% at 48 hours and 62.2% at 72 hours, showing a very rapid rate of colonization. With regard to the site of colonization, there is no significant difference in the two sites, but after 24 hours the nose appears to be colonized faster than the umbilicus.

TABLE 3

Incidence of Staphylococcal Colonization among New Born Babies.

Site of Culture	Period after Birth											
	3 hrs.			24 hrs.			48 hrs.			72 hrs.		
	No. examined	No. +	% +	No. examined	No. +	% +	No. examined	No. +	% +	No. examined	No. %	% +
Nasal Swab	86	6	7.0	88	20	22.7	66	16	25.7	45	21	46.6
Umbilical Swab	86	9	10.4	88	17	19.3	66	14	21.2	45	15	33.3
Babies	86	14	16.3	88	29	32.9	66	26	39.4	45	28	62.2

(c) *Environment.* Results of examination of the environment is shown in Table 4. The larger number of swabs have been taken from the principal sections of the maternity unit. It is seen that positive swabs have been obtained from many sections of the unit, but the highest contamination appears to be the clean post-natal section (room 10) of the ward, where there is the largest turnover of mothers and babies.

TABLE 4

Environmental Contamination with Staphylococci—Swabs examined and Number positive.

Site of Culture	Ante Natal Section (Room 1)		Block A Rooms (11—17)		Post Natal Section (Room 10)		Block B	
	No. examined	No. +	No. examined	No. +	No. examined	No. +	No. examined	No. +
Beds	9	—	19	1	16	9	13	4
Cots	—	—	8	2	16	7	3	1
Lockers	5	2	5	0	16	7	—	—
Settle Plates	3	—	9	3	4	0	6	1
Others	—	—	22	3	6	0	14	1
All Sites	17	2	63	9	58	23	36	7
		(11.8%)		(14.3%)		(39.6%)		(19.4%)

(d) *Staff.* Results of examinations of swabs from the staff is given in Table 5. It is seen that 14.7% of the staff were nasal carriers of staphylococci while none of the swabs taken from the hands were positive.

TABLE 5
Staphylococcal Carrier Rate among Staff.

Site of Culture	No. examined	No. +	% +
Nasal Swab	68	10	14.7
Swab from Hands	68	—	—
Aprons	68	1	1.5

(e) *Phage Typing.* 103 strains were phage typed of which 74 were typable and 29 untypable. Of the typable ones two belonged to Group I, two to Group II and 68 to Group III. Of the Group III staphylococci, the commonest phage types were 5, 54 and 6/54. The phage pattern shown by staphylococci isolated from mothers on admission was significantly different from the staphylococci isolated from the rest.

(f) *Antibiotic Sensitivity.* Pattern of antibiotic resistance of the staphylococci is shown in Table 6. 47.4% of strains are resistant to penicillin, 25.7% to streptomycin and 24.7% to tetracycline. It is seen that the antibiotic resistance pattern of the hospital strains isolated from babies, staff and environment is significantly different from that of the strains isolated from expectant mothers at admission and at commencement of labour.

TABLE 6
Antibiotic Resistance of Staphylococci Isolated in the Maternity Unit.

Site of Isolation of Staphylococci	No. tested	Resistant to Penicillin		Resistant to Streptomycin		Resistant to Tetracycline	
		No.	%	No.	%	No.	%
Mothers	21	6	28.6	1	4.8	3	4.8
Babies	51	27	52.6	16	31.4	15	29.4
Environment	19	10	52.6	5	26.3	5	26.3
Staff	6	3	50.0	3	50.0	1	16.6
	97	46	47.4	25	25.7	24	24.7

CONTROL OF INFECTION

General control measures were adopted along with the commencement of the investigations. These included—

1. Early detection and isolation of babies with lesions :
2. Application of 3% hexachlorophene detergent ("phisohex") to the skin of babies shortly after delivery and every morning thereafter up to the time of discharge.

In addition to the above procedures the following recommendations were made :—

- (a) A separate towel to be used on each baby at cord dressing;
- (b) All soiled linen to be received into a vessel containing 1% lysol;
- (c) Bed linen to be changed more frequently;
- (d) Walls and floor to be mopped with 3% lysol.

DISCUSSION

A study of the clinical features of the infection in babies showed that the lesions were mostly confined to the skin with a very few cases of conjunctivitis. In this respect this outbreak differs from those reported in other countries where most authors have observed a high incidence of conjunctivitis and umbilical sepsis along with skin lesions.

It was seen that the incidence of infection among babies has been 11.6 and 8.3 per cent during the two months March and April respectively. These figures do not appear to be unusually high as according to Williams, Blowers, Garrod and Shooter (1966), the incidence of staphylococcal infection as seen in skin lesions and sticky eye (staphylococcal ophthalmia) is 10—20% during normal times, while in epidemics, the figure reaches 30—40%. We should be cautious in comparing our figures with the statistics of developed countries, because the average duration of stay of babies in our hospitals is about 2—3 days while in the more economically advanced countries it is much longer and the observed incidence of sepsis has a direct relationship to duration of stay. The phage type encountered here belongs to Phage Group III, while outbreaks reported in other countries are usually caused by so called epidemic strains like 79, 52A/79 and 80/81 which belong to Phage Group I. However Plueckhahn (1961) found that in the maternity wing of an Australian Hospital, Phage Group III predominated next to non-typable strains both in sick children and carriers. Iyer and Sant (1966) in a general survey carried out in India also reported that Phage Group III is the most common. Considering the above facts, a further investigation in another maternity hospital would help us to determine whether we were dealing with an outbreak of staphylococcal infection.

The skin lesions alone may not be a real measure of the problem. To obtain a true picture it is necessary to determine the extent of colonization of the infant population with staphylococci. Hence it was found that 62% of infants were colonized at approximately 72 hours. Plueckhahn (1961) in his investigation showed that 34.8% were colonized at 24 hours and the incidence of lesions was 50.5% during the first ten days of life. Simon, Allwood-Parades, and Trejos (1965) report 95% colonization in 24 hours and 100% after 48 hours in a hospital in El Salvador. Edmunds, Elias-Jones, Forfar and Balf (1915) by a comparison of findings in many hospitals found that the rate of infection with clinical manifestations and the rate of carriage do not always run parallel to each other.

It is seen that staphylococci were widely disseminated in most sections of the maternity unit. Mothers as a source of infection of the babies could be excluded as it was shown that the maternal staphylococci had phage pattern and antibiotic sensitivity pattern significantly different from the other staphylococci isolated in the unit. Therefore the source of infection of neonates has to be found within the hospital environment.

The possible routes of spread of staphylococcal infections could be illustrated as in Fig. 2 (Gluck and Wood, 1961). There is an interaction between the so called biological environment and the physical environment. The biological environment consists of the nursing attendants and the infant population. It is seen from this figure that the pathways of infection could be many as well as devious. Certain outbreaks are reported in which the attendant carriers have been the reservoirs of virulent strains of staphylococci and they by contact pass on the infection to the babies, (Allison and Hobbs, 1947). Outbreaks are also reported in which the environment and the babies play a major role where heavily infected babies pass on the infection to the environment and *vice versa*, (Rountree & Barbour, 1950).

Let us consider the probable method of infection in this unit. Only a small proportion of the nurses and midwives were carriers of staphylococci and no organisms were isolated from their hands. It is not possible to exclude nurses and attendants as a source of infection of the babies, but the available evidence shows that the environment is of greater importance. There was generalised contamination of the environment in most sections of the unit, but it was most widespread in the post natal section where almost 50% of beds, cots and lockers were positive. Furthermore this is the section which has the greatest overcrowding and the most rapid turnover of mothers and infants. Therefore it is more likely that the persistently high environmental contamination was infecting the neonates who in turn replenished the environmental reservoir. The common table on which all the babies are placed for napkin changing and umbilical toilet every morning would appear to be the most important point where infection is spread by indirect contact from baby to baby. Hurst (1960 a) showed that when babies were transferred from an old nursery to a new one, there was very rapid and sudden contamination of the environment due to extensive colonization of the bodies of infants. It is not possible for adults to contaminate the environment to such an extent as in normal breathing only a small number of organisms are liberated into the air.

The nose of the neonate and other skin sites including the umbilicus are very susceptible to colonization with staphylococci. With sampling of two sites the carriage rate is 62% in 72 hours. If more sites on the infant skin are sampled the number of positives is likely to be even more. It has been shown that different body sites of an individual infant become colonised with different strains of staphylococci (Hurst, 1960b) and therefore the true carriage rate can be assessed only by culturing several body sites. Of course the sites of preference are the umbilicus, the nose, perineum, groins and axilla. In our series the colonization at both sites was almost the same up to 48 hours, but thereafter the nose was colonized more frequently. Many authors have found that umbilical cord or cutaneous colonization precedes nasal colonization (Simon, Yaffe and Gluck, 1961, Hurst 1960 b). But perhaps it is possible that the nose may be colonized rapidly if there is heavy aerial contamination.

We have seen that the staphylococci isolated in the hospital environment had a higher antibiotic resistance than those from mothers who come from the community. The elimination of the antibiotic resistant staphylococci from the hospital environment is almost impossible, because of its devious pathways of infection and its powers of survival. What can possibly be done is to reduce the load of infection to a level that symptoms do not appear. (Plueckhahn and Banks, 1963).

Gillespie, Simpson and Tozer (1958) evaluated several methods of reducing staphylococcal cross infections in nurseries of the Bristol Maternity Hospital. They found that the most striking reduction was achieved when colonization of the umbilicus and skin was prevented by means of a dusting powder containing hexachlorophane. Corner, Crowther and Eades (1960) also tried several measures like reviewing sterilization methods and aseptic techniques and use of chlorhexidine hand cream by nurses, but the incidence remained high till the introduction of hexachlorophane. Simon *et al.* (1965) used hexachlorophane detergent 3%. After delivery, the skin and umbilical cord were washed thoroughly with "phisohex" applied manually and thereafter every morning during cord dressing. They compared the rate of colonization in a group of treated and untreated babies and found that 3.4% of the treated group and 64.8% in the control group were positive. They showed that a few treatment applications in the first one or two days exerted a definite deterrent effect on colonization and a decreased incidence which extended for a period of 3 months.

Therefore in most maternity units, as the main source of infection are the babies themselves, the easiest method of control is the prevention of the colonization of the skin and umbilicus of infants by the use of hexachlorophane. In the present investigation hexachlorophane was used for this purpose.

SUMMARY

Bacteriological and epidemiological investigations were carried out in the maternity unit of Ratnapura Hospital to determine the extent of staphylococcal cross infection among newborn babies. 62% of infants appeared to be colonized in 72 hours of birth. The staphylococci isolated from the babies, the ward environment and the staff were different from those isolated from the mothers, in respect of antibiotic sensitivity and phage group. The ward environment was highly contaminated and it is suggested that the babies are infected from the environment. Application of hexachlorophane detergent to the skin of babies reduced the incidence of skin infection.

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