

# Neonatal Infection

*With Particular Reference to Infection with Penicillin Resistant Staphylococci*

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INFECTION among the new born babies of a maternity hospital nursery always gives rise to anxiety and engenders a feeling that all is not well with the nursery technique, although this may be quite unjustifiable. However, the problem is one which interests the medical and nursing staff and involves the bacteriologist in extensive investigations if any attempt is to be made to trace the infection to its source. It has been shown that infection during this period of the life of the infant is largely due to invasion by a pathogenic staphylococcus and usually manifests itself as conjunctivitis or infection of the skin. The skin lesion consists of pustules which have been referred to as contagious subepithelial dermatitis and rarely proceeds to pemphigus neonatorum.

In the Royal Maternity Hospital, Belfast, cases of skin infection of infants in the neonatal period, while not frequent, are persistent and continue despite a rigid aseptic technique. As these infections are considered to be due largely to hospital cross infection, the incidence, source and method of spread require to be carefully investigated before control can be effectively employed.

## METHOD.

In the investigation of the carrier state, swabs for culture were collected from the hands, the throat and the anterior nares. Before specimens were collected from the hands and nares the swabs were first moistened in sterile 'Lemco' broth.

Swabs from all lesions and from carriers were planted on horse blood agar plates with a 'Lemco' broth base. The penicillin sensitivity was tested by the disc paper technique, using a five millimetre diameter filter paper disc and 0.02 ml. of penicillin solution containing 10 units/ml. After 18 hours culture at 37° C. the plates were examined for staphylococci. Coagulase production was determined by the slide test of Cadnes-Graves, Williams, Harper and Miles (1943) and the penicillin sensitivity of all coagulase positive staphylococci noted.

## INCIDENCE OF NEONATAL INFECTION.

The incidence of neonatal infection over a six month period in 1950, in one unit of the maternity hospitals where the infants were nursed in the same general ward as the mothers was determined and it was found that neonatal infection occurred in 9.7 per cent. of the total number of live births recorded during the period of observation. Of eighty-four instances of neonatal infection 56 per cent were infections of the skin, 34 per cent were infections of the conjunctivæ and

the remainder was a variety of miscellaneous infections. Thus it can be seen that the majority of the infections noted in neonates involved the skin and conjunctival sac, with infections of the skin predominating. The criteria used for the diagnosis of infection of the skin were stringent so that even the smallest pustule was so classified, yet the overall incidence during the period investigated was only of the order of 10 per cent. Corner (1950) reported a neonatal infection rate in Bristol of 20-30 per cent, Barber, Hayhoe and Whitehead (1949) reported from London a rate of 14 per cent, and Roscoe (1949) recorded a 10 per cent incidence in Cambridge. A neonatal infection rate of 9.7 per cent therefore compares most favourably with that found in other centres where the same criteria of classification were employed.

In an attempt to discover whether localisation of infection was determined by sweating, with infection occurring mainly in the warmer parts of the body or by air and dust contamination of exposed parts, the site of the main lesions was noted. It was found that the body folds were mainly involved in six instances, the limbs in ten, the trunk in thirteen and the face and neck in twenty-seven. As is to be expected these results are equivocal because the air and dust contamination of the exposed parts of the body would also contaminate the bedclothes of the infant and hence the body. However, the absence of any preponderance of lesions in the body folds tends, in itself, to exclude excessive sweating as a major predisposing factor to infection and suggests a more general environmental contamination

Representative swabs taken from the lesions were examined bacteriologically (Table I). It was found that in 88 per cent the causal organism was a coagulase positive *Staphylococcus pyogenes*, but the most disturbing feature was that of the strains of *Staph. pyogenes* isolated from lesions in infants 67 per cent were penicillin resistant.

TABLE I.  
BACTERIOLOGY OF NEONATAL INFECTIONS.

	Total	Coag. +ve Staphylococci	Penicillin Resistant
Eye - - - - -	31	29	22
Skin - - - - -	48	47	31
Miscellaneous - - -	5	0	0
	84	76	53

These results again emphasise the well established fact that the *Staph. pyogenes* is the most important pathogenic organism in infection acquired during the neonatal period.

Treatment of the skin lesions and of the conjunctivitis consisted at first of the application of penicillin ointment to the cutaneous lesions or the installation of penicillin drops into the eyes, but the response to this therapy was disappointing because the majority of the strains of *Staph. pyogenes* isolated from these lesions

were resistant to penicillin when tested in vitro. The routine use of penicillin was then discontinued and the antibiotic or sulpha drug used was selected on the basis of the in vitro sensitivity of the casual organism to a range of therapeutic agents.

#### PILOT SURVEY.

In April, 1950, a pilot survey was carried out in the Royal Maternity Hospital in one ward where the infants were nursed together with the mothers in the same general ward to determine the staphylococcal carrier state among the nurses, attendants and patients. In an attempt to try and trace the source of infection the kind assistance of Dr. R. E. O. Williams of the Staphylococcal Reference Laboratory, Colindale, London, was obtained and he undertook to phage type all the strains isolated.

This survey showed that about 50 per cent of the nurses and mothers were carriers of potentially pathogenic staphylococci and of the 38 strains isolated 24 (or 63 per cent) were resistant to penicillin. All the strains of staphylococci isolated were subjected to phage typing and although many of the strains were untypeable, two traceable types were found and were distributed as shown in Table II.

TABLE II.  
DISTRIBUTION OF PHAGE TYPED STRAINS OF STAPHYLOCOCCI.

	Cases	Carriers		
		Nurses	Mothers	
52/52 A - - - - -	6	9	3	
47/54 - - - - -	3	4	1	
Miscellaneous or				
Untypeable - - -	11	25	14	
	—	—	—	
	20	38	18	

Using the indicator strains it was obvious that the infection was not derived from one single chronic carrier among the staff or patients. On the contrary, there appeared to be a high carrier rate among all the ward inmates of many strains of staphylococci of differing phage type. This was associated with a heavy environmental contamination which was shown when dust was collected and swabs were taken from ward table tops, linen bins, wash-hand basins and various other sites in the ward. Air contamination was investigated by exposing 'settling plates' of blood agar in the ward at various times. Of some fifty specimens examined from the ward environment twenty showed the presence of coagulase positive staphylococci.

#### THE STAPHYLOCOCCAL CARRIER.

It has been recognised for some considerable time that potentially pathogenic staphylococci are frequently found in the anterior nares of otherwise normal healthy adults and some workers state that this carrier rate is of the order of

50 per cent (Hallman 1937; McFarlan 1938; Gillespie, Devenish and Cowan 1939). However, in any hospital community the carrier rate among the permanent staff or long stay patient is much higher than among the population at large and this is particularly true of the nursing staff (Miles, Williams and Clayton-Cooper 1944; Allison and Hobbs 1947).

To confirm these observations and to obtain information regarding the carrier state of *Staph. pyogenes* in this area among the general population and hospital inmates, a survey was made of a number of out-patients, taken as a rough sample of the local population, and of in-patients and staff of both the Royal Maternity Hospital and the Royal Victoria Hospital, Belfast.

TABLE III.

TOTAL STAPHYLOCOCCAL CARRIER RATE.

	Royal Victoria Hospital			Royal Maternity Hospital		
	Out-Patients	In-Patients	Nurses	Adult In-Patients	Babies	Nurses
Total	100	100	100	230	150	52
Carriers	31	47	62	98	92	30
Percentage	31	47	62	43	61	58

The results of the investigation into the carrier state are recorded in Table III from which it can be seen that the staphylococcal carrier rate is greater among hospital in-patients than among out-patients. The difference in incidence between these two groups is not large but is probably more significant than it appears when it is considered that the in-patient group is mixed and consists of many short stay patients or patients investigated shortly after hospitalisation, before they had time to acquire the ward flora.

The high carrier rate among the nursing staff of 58-62 per cent is the most significant finding and corroborates, if such were needed, the work of many others in this field. From this constant hospital source very heavy environmental contamination with *Staph. pyogenes* results so that there is a greatly increased risk of acquiring a staphylococcal infection in hospital. This risk is of course greater for patients with lowered resistance and constant exposure than it is for the hospital staff, and in hospital it is a very grave risk for infants with poorly developed powers of resistance to infection. As it will be shown that a high percentage of the strains of *Staph. pyogenes* isolated in hospitals are resistant to penicillin, any neonatal infection acquired in hospital will most likely prove not to be amenable to penicillin therapy.

Swabs were taken from the nose, throat and skin of the hands, of a group of patients and nursing staff of both the general and the maternity hospital. The results of the isolation of *Staph. pyogenes* from these sites is shown on Table IV which shows that the staphylococcal carrier is predominantly a nasal carrier and this fact is of considerable biological significance because a nasal carrier can so easily contaminate the environment.

TABLE IV.  
DISTRIBUTION OF THE STAPHYLOCOCCUS AMONG CARRIERS.

	Total Examined	Nose	Throat	Hands	Total Carrier State	Percentage Nasal Carriers
<b>MATERNITY HOSPITAL</b>						
Nursery Staff	30	26	12	13	27	96
Ward Nurses	52	26	6	7	30	87
Mothers	58	28	4	7	33	85
<b>GENERAL HOSPITAL</b>						
Out-Patients	100	22	1	13	31	71
In-Patients	100	43	12	28	47	91
Nurses	82	47	13	14	49	96
	—	—	—	—	—	—
	422	192	48	82	217	
	—	—	—	—	—	—
<b>AVERAGE PERCENTAGE</b>		46.1	11.6	19.8	52.4	88

**THE STAPHYLOCOCCAL CARRIER STATE IN THE NEONATAL PERIOD.**

During the course of this investigation swabs were collected from the anterior nares and skin of 150 newborn infants. Staph. pyogenes was isolated from 92 infants (61 per cent) and the majority (88 per cent) of these strains were isolated from the nose. Thus, it is seen that the carrier state in infants approximates to that found among the nursing staff and suggests that the infants are infected from the environment and are not directly infected from their mothers. This is in conformity with the views expressed by Allison and Hobbs (1947).

Concurrently with this investigation into the carrier state of staphylococci by infants, an attempt was made to determine the rapidity with which the infants in a maternity hospital acquired the flora of their environment by colonisation of the anterior nares. To this end swabs were taken at three day intervals from the noses of all infants born in this hospital and the isolation of Staph. pyogenes is recorded on Table V.

TABLE V.  
NASAL CARRIER RATE OF STAPHYLOCOCCUS PYOGENES IN NEONATES.

Age in days	0-	3-	6-	9-
Total	17	26	42	21
Staphylococcus pyogenes in nasal swabs	3	13	31	17
Percentage carriers	18	50	81	81

It can be readily seen that the newborn child, in hospital, rapidly acquires the staphylococcus from its heavily contaminated environment and that this risk

increases with the length of hospital stay, so that after one week some 80 per cent of infants have become carriers of a potentially pathogenic organism. In this connection the child is being used as a biological index of environmental contamination and it is probably true to say that if colonisation occurs in the nares at this alarming rate the skin and conjunctivæ are equally exposed to similar heavy contamination by a pathogenic organism which can readily invade the tissues of the infant if the normal biological bacterial barriers are temporarily lowered.

These facts require careful consideration by all ardent protagonists of institutional midwifery. The bacteriological data here presented would suggest that the shorter the post-partum period of hospitalisation the better from the point of view of the newborn infant—a practice which might do much to help the bed state in maternity hospitals.

#### PENICILLIN RESISTANT STAPHYLOCOCCI.

In chemotherapy one of the most important problems is therapeutic failure due to the appearance of drug resistant micro-organisms. When penicillin was introduced it was considered that resistance to the drug would not prove a major problem in therapy. This hope has not been realized. Prior to the extensive use of penicillin only 12 per cent of the strains of staphylococci isolated were found to be naturally resistant to penicillin, Spink, Ferris and Vivino (1944), Bondi and Dietz (1945). The appearance of an increasing number of penicillin resistant strains was noted in hospital practice to which the use of the drug was, at first, confined. North and Christie (1945) recorded the incidence of penicillin resistant strains isolated in the same ward before and after the introduction of penicillin and showed a marked increase in resistant strains. Thus, of 128 strains of staphylococci isolated before the introduction of penicillin therapy in the ward, no strains were found to be resistant to this drug. Of the first 31 strains isolated after the drug had been used in the ward 17 strains were penicillin resistant.

It is the hospital population which is most likely to be exposed to penicillin therapy and has always shown the highest incidence of strains resistant to the drug. Many workers including Forbes (1949), Barber and Whitehead (1949), have shown that strains of staphylococci isolated from lesions contracted outside hospitals are much more likely to be penicillin sensitive than are strains isolated from similar lesions acquired in hospital. However, the more widespread use of the drug in general practice is likely to be associated with the appearance of more resistant micro-organisms among the population at large. This has indeed proved to be the case and reports from all parts of the world, where penicillin has been in general use, indicate that this increase in resistant strains is general in its geographical distribution. It is also quite independent of age, for resistant staphylococci were found in the nasopharynx of 55 per cent of newborn babies by Martyn (1949), in 30 per cent of healthy children by Beigelman and Rantz (1950), and in a varying percentage of healthy adults. This increase is not a static state

but is actually rising and Barber has reported in a number of papers a marked increase in penicillin resistant strains of staphylococci.

1946	.....	14 per cent
1947	.....	38 per cent
1948	.....	59 per cent

During the course of this investigation the penicillin sensitivity of the majority of the strains isolated was determined and the results are recorded in Table VI. From these results it can be seen that the incidence of penicillin resistant staphylococci among the general population (out-patients) was 11 per cent, while the hospital population showed a very much higher proportion of carriers of penicillin resistant strains (39-94 per cent). The higher incidence of penicillin resistant strains isolated from carriers among the in-patients and nurses of the general hospital than from patients and nurses of the maternity hospital is not easily explained. In both hospitals, however, more penicillin resistant strains were isolated from nurses than from adult in-patients in the same hospital.

TABLE VI.

PENICILLIN RESISTANCE OF STAPHYLOCOCCUS PYOGENES ISOLATED FROM CARRIERS.

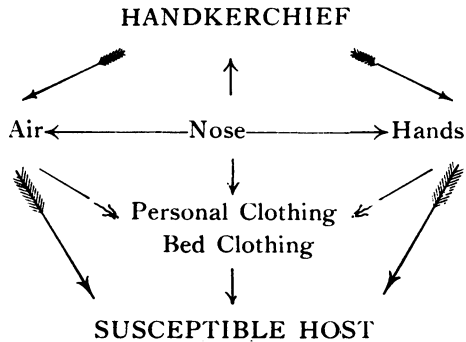
	Royal Victoria Hospital.				Royal Maternity Hospital			
	Out- Patients	In- Patients	Nurses	...	Babies	Adult In- Patients	Nurses	...
Total strains	36	83	55	...	47	38	...	42
Number resistant to penicillin	4	68	52	...	37	15	...	28
Percentage resistant	11	82	94	...	79	39	...	67

The high carrier rate of penicillin resistant staphylococci by the nursing staff is of considerable significance in the spread of penicillin resistant staphylococcal infections in hospitals and this must be regarded as the main source of hospital infection with these resistant organisms.

To explain the development of penicillin resistant forms of micro-organisms various theories have been propounded but the one most widely accepted is based on genetic principles. This theory postulates that in any large population of any penicillin sensitive strain of micro-organism there are a few, naturally occurring and relatively resistant variants. When such a population mixture is exposed to penicillin, the sensitive organisms are destroyed but the resistant forms not only survive but multiply. Among the progeny new variants appear which are resistant to higher concentrations of penicillin. This resistance is permanent but is not associated with any loss of invasiveness on the part of the micro-organism. We are therefore faced with a biological phenomenon of great importance to the host and one which poses a problem for penicillin therapy in the future. Fortunately aureomycin has so far proved to be a most effective antibiotic for penicillin-resistant staphylococci. It is left to the chemist to continue to produce antibiotics of wide range and greater effectiveness to circumvent this natural selection of resistant variants.

### METHOD OF SPREAD.

The main reservoir of pathogenic staphylococci is the anterior nares as has been shown by previous workers, Gillespie, Devenish and Cowan (1939); Miles, Williams and Clayton-Cooper (1944) and Williams (1946) and again demonstrated in this investigation where 88 per cent of carriers had *Staph. pyogenes* in their nasal swabs. From this source the method of spread has been shown by Hare and Mackenzie (1946) and others, to be largely indirect.



The nasal carrier is particularly likely to contaminate the environment, for Hamburger and Green (1946) have shown that the nasal carrier expels a hundred times as many pathogenic organisms into the air as a throat carrier who has negative nasal cultures. Millions of organisms are expelled by blowing the nose and the act of blowing the nose contaminates the handkerchief, the hands and the air. Once the hands are contaminated they infect everything they touch. Thus the great secondary "reservoir of infection" is created in the personal clothing and bedclothes of the patient which are readily contaminated by the hands or from the air. It is the major 'source' of air borne infection (Brown and Allison 1937).

The presence of *Staph. pyogenes* in the air and dust of the wards of the maternity hospital was amply demonstrated during this investigation by the presence of these organisms on 'settling plates' of blood agar exposed in the wards, in swabs collected from various sites and in various samples of dust.

### PREVENTION OF NEONATAL INFECTION.

The control of the spread of infection in a nursery can conveniently be discussed under three headings viz., the source of infection, the method of spread, and the susceptible host. As the majority of infections is caused by the *Staph. pyogenes* the control will be largely orientated towards methods designed against the spread of this particular organism.

(1) *The Source*.—This is recognised to be a contaminated person, either a mother, a nurse, or other attendant, who infects the air or dust of the ward. This indirect type of infection is thought to be much more important than any direct transfer of organisms to the susceptible infant. As nurses have a very



high carrier rate of penicillin resistant *Staph. pyogenes* they must always regard themselves as a potential source of danger and must at all times take such steps as to minimise environmental contamination. This is of course inherent in their training but must be rigidly carried out in practice. Particular attention should be paid to the face mask which must be of approved design, and worn in the appropriate way. Slipshod methods in using a face mask are to be deplored, as they give a false sense of security. The other great personal sources of environmental contamination are the handkerchief and the hands. The staphylococcus is carried predominantly in the anterior nares where it can readily be dispensed into the atmosphere and particularly into the handkerchief which is always the most heavily contaminated article of personal apparel. From the handkerchief or the pocket the hands can be secondarily contaminated and thence organisms are conveyed to everything which is touched. Therefore attendants should at all times be most careful about hand hygiene, especially after use of a handkerchief.

However, these measures are purely negative and do not take into account the obvious source of possible infection from nasal carriers among the mothers in the ward. A positive step to eradicate all carriers in a ward unit would involve treatment designed to remove or greatly reduce the carrier rate among all the ward inmates including the nursing mothers. This presents many difficulties. It requires the topical application to the anterior nares of a cream containing an antibiotic. This antibiotic must be one to which the organism is sensitive and to which the organism does not rapidly develop resistance. The method requires conscientious treatment but despite rigid application the objective may be vitiated by changes in personnel necessitated by off-duty and emergencies. A preliminary trial of the value of the local daily application of cream containing aureomycin to the anterior nares was made on persistent nasal carriers of *Staph. pyogenes* among the laboratory staff with completely satisfactory results. The method was then given an extensive trial on one ward unit in the Royal Maternity Hospital where the infants were nursed in the general ward, for an eight week period using either 5 mgm. of aureomycin or 5 mgm. of chloromycetin in a base containing 5 per cent Promulsin wax and 10 per cent ground nut oil made into an emulsion with water. The interest of the nursing staff was first aroused and the co-operation of all the staff was excellent. The cream was applied night and morning to the anterior nares of all the nurses in the ward and to all the mothers. The infants were left untreated and used as a biological index of environmental contamination. The results were most discouraging although it was noted that *permanent* nursing staff who had been persistent nasal carriers showed negative swabs throughout the period of the trial.

The average figures of the ward carrier rate before and during the trial are shown (Table VII) together with the nasal carrier rate of *Staph. pyogenes* in a control untreated ward unit where the infants were nursed in a separate nursery. Therefore, for the untreated ward figures for the neonatal carrier rate cannot be included.

TABLE VII.  
THERAPEUTIC TRIAL OF ANTIBIOTIC CREAM APPLIED TO THE NARES OF  
MOTHERS AND NURSES.

		Percentage Staphylococcal Carrier Rate	
		Ward not Treated	Ward Treated
Adults:	Control period	59	64
	Test period	35	40
Infants:	Control period	—	72
	Test period	—	65

It will be seen that there is a fall in the ward carrier rate but this occurred also concomitantly in the untreated ward and cannot therefore be regarded as due to the method of control under trial but due to general factors operative over the period surveyed. The carrier rate among the infants did not fall significantly, so that the environmental contamination appeared to be uncontrolled, probably because the method used did not reduce the general carrier rate in the ward below a critical level. These results were very disappointing and reflect the difficulties of the practical application on a wider scale of a successful but more easily controlled experiment on a few patients. It is interesting to note that no aureomycin or chloromycetin resistant strains of *Staph. pyogenes* were detected during the period of observation.

(2) *Method of Spread.*—Measures directed against the methods of spread of neonatal infection consist largely of control of the contaminated air and dust in the ward—i.e.

(a) *Dust Hygiene*

Wet sweeping or vacuum cleaning

Oiling of floors

Oiling of blankets

(b) *Air Hygiene*

Good cross ventilation

Germicidal aerosols

Ultra-violet light

Methods for dust suppression are already in use in the hospital concerned and include both wet sweeping and oiling of floors but the blankets are not treated. Ventilation is natural and no methods of air hygiene by the use of germicidal vapours or ultra-violet light are employed in the general wards.

The most popular germicidal aerosol at present in use is triethylene glycol vapour which has been extensively tried. However, Krugman and Ward (1951) reported after a prolonged trial of air sterilisation in an infant's ward by this method that although cross infections were statistically reduced the bacterial content of the air still remained high. This was probably due to the fact that the bactericidal properties of the aerosol are impeded by dust or dried dust-borne bacteria. These authors reported that the most significant reduction of

the bacterial content of the air was achieved by a combination of dust suppressive measures and the use of germicidal aerosols. Because of the disparity between the cross infection rate and bacterial content of the air, these authors were led to believe that air borne infection did not play the major role in cross infection in hospital—a view which is not widely held.

It has been known for some seventy-five years that ultra-violet rays will kill bacteria and more recent researches have established the effective wave length for bactericidal action to lie within the range 2,600-2,500 A.U. of the ultra-violet spectrum. Suitable lamps with a high emission around the effective range have been produced and extensively tried by various methods of which indirect or upper air irradiation has been the most popular. The results of this method of air sterilisation in hospital wards in America have been encouraging although conflicting reports have appeared. It is known that the germicidal action of ultra-violet light has its greatest effect in atmospheres free from dust and with low humidity and these environmental factors may affect the results obtained.

A trial of this method of air sterilisation was made. Settling plates were exposed in two wards of the nursery in four different sites and at four periods of one hour each, two during maximum and two during minimum periods of activity in the wards. From these a base line of general ward contamination was obtained. One ward was then fitted with ultra-violet lamps sited to irradiate the upper air and one ward was kept as a control. After a suitable working period the settling plates were again exposed in the same sites and for the same periods on two occasions and the results assessed. The results have shown a marked diminution of aerial contamination.

(3). *The Susceptible Host.*—It can be seen that the newborn infant nursed in the same general ward as the mother is exposed to the hazards of an environment heavily contaminated with pathogenic staphylococci. The nursing technique employed reduces the possibility of contact and droplet infection by ward attendants to a minimum and measures designed to prevent the contaminated air and dust of the ward from penetrating the delicate skin of the newborn baby are already in use. These largely consist of the application of a rigidly aseptic and non-traumatising technique. This has been reinforced in some centres by the application to the skin of the infant of an antiseptic lotion or barrier cream but this method has not achieved any popularity.

In actual practice, as Allison and Hobbs (1947) have shown, it is not easy to eradicate neonatal infection even by the application of the strictest aseptic precautions. This suggests, as the technical difficulties of adequate preventative measures in nurseries are so great, that it might be better to nurse mother and infant together in a small ward or cubicle. Whether this would completely solve the problem is doubtful, for Loosli, Smith, Cline and Nelson (1950) reported widespread dissemination of streptococci throughout the cubicalised wards of the Harriett Lane Home of the Johns Hopkins Hospital. The source of infection was a case of eczema infected with *Streptococcus pyogenes* and the spread occurred through contaminated air and dust despite the fact that air sterilisation procedures

using triethylene glycol were in use at the time. These authors were able to show that the efficient treatment of the focus of infection reduced the environmental contamination and the number of secondarily infected cases.

The statement of Coburn that the spread of infection among infants is uncontrollable in spite of strict aseptic precautions is most discouraging but emphasises the necessity for attacking the problem on a broad front with particular reference to control of air and dust contamination of the ward. It is also evident that the increasing numbers of penicillin resistant strains of the common infecting organism have not made the problem any easier.

#### SUMMARY.

In one unit of a maternity hospital neonatal infection was of the order of 10 per cent of all live births and this infection consisted largely of lesions of the skin and conjunctivæ.

The causative organism responsible for the majority of neonatal infections was the coagulase positive *Staph. pyogenes* which was isolated from 88 per cent of the lesions and of these strains 67 per cent were resistant to penicillin.

A high staphylococcal carrier rate was found among the maternity hospital nursing staff (58 per cent) and this carrier state was persistent. A survey of the carrier state of nurses in the nearby general hospital showed that the carrier state was of the same order (62 per cent).

The staphylococcal carrier state of adult in-patients was 43 per cent in the maternity hospital and 45 per cent in the general hospital. The incidence was lower among adult out-patients, 31 per cent.

As has been previously demonstrated, the staphylococcal carrier is most often a nasal carrier and in this series 88 per cent of carriers showed the presence of *Staphylococcus pyogenes* in the anterior nares.

The main reservoir of infection is from staphylococci in the anterior nares of such a high proportion of the nursing staff and to a lesser extent the in-patients of the ward. This is responsible for a heavy environmental contamination of the hospital ward, so that all newborn infants rapidly become carriers of the prevalent organism and could thus be used as an indirect index of environmental contamination. Direct evidence of general ward contamination is afforded by the isolation of coagulase positive staphylococci from various sites in the ward.

Prevention is discussed from the points of view of control of the source, the method of spread and the susceptible host.

My thanks are due to the medical and nursing staffs of both the Royal Maternity and Royal Victoria Hospitals, Belfast, for their very willing co-operation and to my clinical pathologists and technicians for much assistance during this investigation.

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## REVIEW

THE QUIET ART. Compiled by Dr. Robert Coope. (Pp. 280. 12s. 6d.).  
Edinburgh: E. & S. Livingstone, 1951.

MANY readers of this Journal are familiar with Doctor Coope's valuable work on Diseases of the Lungs, but here is another aspect of his scholarship. In the foreword Sir Russell Brain reminds us that an anthology is a collection of flowers, and one cannot recall a more varied and beautiful bouquet than is here presented. The sources are indeed so numerous that one wonders at the collector's range of travel and catholicity of taste; and every bloom is worthy of inclusion. There are quotations from Saint Theresa and George Bernard Shaw, from Byron and Bachya Ibn Pakudah, from Rabelais and John Lyle . . . and when you read the book we believe that you will never say "Now, why on earth did he put that in?" Each quotation seems to be worthy of a place in the book which will live as long as mankind has any need for doctors or doctors any love for their patients.

R. M.