for all local business, not different bodies for different parts of it. . . . The local, like the national, Parliament has for its proper business to consider the interest of the locality as a whole." Except for later ideas involving two-tier government, as in county council areas, he is probably right.

[*The second lecture, together with a list of references, will appear in our next issue.*]

STAPHYLOCOCCAL INFECTION OF THE NEWBORN*

BY

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During the neonatal period minor staphylococcal infection is a frequent occurrence. The recorded incidence of such infection depends so much on the criteria adopted and on the care with which minor septic lesions are looked for that a close comparison of published figures is of limited value. The wide variation in recorded neonatal skin and conjunctival sepsis rates in various maternity units in this country is shown in Table I. These figures do not refer to staphylococcal infection alone, but this is responsible for most of the skin and conjunctival sepsis in the neonatal period. Henderson (1948), for instance, has shown that the incidence of staphylococcal infection in neonatal conjunctivitis is approximately 80%. We have found, from 100 consecutive swabs from septic lesions of the skin and conjunctiva, that where an organism was isolated the incidence of staphylococcal infection was 91%. No growth was obtained from 18 swabs.

TABLE I.—*Reported Neonatal Skin and Conjunctival Sepsis Rates in Maternity Units*

Author	Period	Skin Sepsis	Conjunctivitis
Henderson (1943)	1940–1	6·8%	15·9%
Corner (1946)	1944–5	6·58%	13·49%
(2 maternity units)		10·0%	17·6%
Frazer (1948)	1946–7	1·58%	0·61%
Roscoe (1949)	1947–8	2·06%	4·32%
(2 maternity units)		5·4%	1·62%
Gaisford *et al.* (1951)	1949	4·7%	5·9%
Barber *et al.* (1949)	1949	3·6%	9·2%
Present series:			
Western General Hospital, 1951	1951	2·3%	4·1%
Eastern General Hospital, 1951	1951	2·3%	4·2%

In the two main maternity units in our group of hospitals births numbered 1,093 and 1,296 respectively during 1951 and the sepsis rates given are derived from the routine records on the baby charts. An attempt is made to record all septic lesions, no matter how small.

*Based on a paper delivered to the Scottish Paediatric Society on June 13, 1952, by Dr. Forfar.

No deaths from staphylococcal sepsis occurred during the lying-in period, but one baby (Case 3) was readmitted to hospital and died from staphylococcal infection, almost certainly acquired during his stay in one of the maternity units.

Most neonatal staphylococcal infections are trivial and short-lived, but they are potentially dangerous. A few years ago penicillin provided a weapon with which the severer types could be successfully treated, and its use soon spread to the treatment of minor lesions and even to prophylaxis (Wallace, 1947; Muhl, 1949). In recent years the emergence of resistant strains has rendered penicillin ineffective in the treatment of many staphylococcal lesions. There is a rising incidence of such strains (Barber, 1947; Barber and Rozwadowska-Dowzenko, 1948), particularly in hospitals (Forbes, 1949; Rountree and Thomson, 1949; Barber *et al.*, 1949). The newer antibiotics aureomycin and chloramphenicol have so far provided effective therapy in most resistant infections (Banks, 1952; *Lancet*, 1952).

It is the purpose of this paper to report several cases of serious staphylococcal infection in the newborn in which resistance to antibiotic drugs played an important part, to record a few observations on the background of staphylococcal carriage and infection in one of the maternity units from which some of the cases arose, and to draw attention to some of the problems of diagnosis, of management, and of treatment which such staphylococcal infections raise.

Case 1

A baby girl, born in a nursing-home, birth weight 5 lb. 10 oz. (2.55 kg.), was admitted from her own home to hospital at the age of 4½ weeks with a swelling of the left upper arm of three days' duration. This had been accompanied by pyrexia, and on the day before admission she had been given 200,000 units of penicillin.

On admission a purulent discharge from the left eye was noted. No growth was obtained from an eye swab. No other septic lesions were found. The white-cell count was 6,000 per c.mm. Radiological examination of the affected humerus showed osteomyelitis with patchy destruction of the lower end. Intramuscular penicillin, 100,000 units three-hourly, was given.

On the following day an abscess had formed and was incised, a large amount of pus escaping. On culture a profuse growth of *Staphylococcus aureus* sensitive to penicillin, streptomycin, aureomycin, and chloramphenicol was obtained. Despite the continued administration of penicillin the pyrexia persisted and the child's condition deteriorated. On the third day after admission she developed a cough, rapid shallow respirations, moist sounds at both bases, and a slight haemoptysis. An *x*-ray film of the chest showed consolidation at both bases. The white-cell count was 19,200 per c.mm. Aureomycin, 250 mg., and chloramphenicol, 125 mg., six-hourly, were begun.

Two days later pus from the wound in the left arm grew on culture a coagulase-positive *Staph. aureus* resistant to penicillin but sensitive to streptomycin, aureomycin, and chloramphenicol. At this time an abscess developed in the left parieto-occipital region. This required incision after 48 hours, and appeared to have arisen from infection of the underlying bone. A coagulase-positive *Staph. aureus* highly sensitive to streptomycin and chloramphenicol, moderately sensitive to aureomycin, and resistant to penicillin, was grown.

Penicillin was given for 17 days after admission. Treatment with aureomycin and chloramphenicol was continued for almost a month on account of several relapses of respiratory infection. After a period of two months the child had

improved considerably and was discharged home. Radiologically, several post-pneumonic pneumatoceles still existed. The humerus had almost completely re-formed.

Comment.—Conjunctival sepsis may have been the original focus of infection in this case, which illustrates the widespread metastatic dissemination which staphylococcal infection in the newborn may undergo. The staphylococcus isolated from pus drained from the original abscess of the left arm was penicillin-sensitive. Four days later pus from the same source revealed a penicillin-resistant organism. Presumably two strains of staphylococci, a penicillin-sensitive and a penicillin-resistant, were present initially, as resistance could hardly have developed within four days. Growth on culture of the sensitive organism only, created a false sense of security, and although penicillin rapidly removed this strain it produced no clinical improvement. The response of the original osteomyelitis to chloramphenicol and aureomycin was satisfactory, although these drugs did not prevent further progress of the infection to the scalp. They produced no dramatic improvement in the chest infection, but it seems doubtful whether the child would have survived without them.

Case 2

Birth weight 8 lb. 9 oz. (3.98 kg.). Condition satisfactory at birth. Discharged home after ten days. Two weeks later paronychia was noted on several fingers of each hand and local treatment with gentian violet was given. Three weeks later a septic spot on the right arm developed into a subcutaneous abscess. Three days thereafter her breathing became distressed.

Now 6 weeks old, she was admitted to the children's unit acutely ill with severe dyspnoea, high fever, clinical evidence of pneumonia, and a pleural effusion. Diagnostic aspiration showed thin yellow pus. The white-cell count was 21,000 per c.mm. Penicillin was given, but next day the temperature rose higher and the effusion had increased. Penicillin, 50,000 units, was injected into the pleural cavity. Culture of the pleural fluid showed the presence of *Staph. aureus* resistant to penicillin and streptomycin but sensitive to aureomycin and chloramphenicol. She was then given aureomycin, 500 mg. daily. This produced constitutional improvement, but further chest aspirations and finally open drainage were required.

Thereafter gradual re-expansion of the lungs occurred, and was complete three months after the illness started. At that time the baby's health was excellent.

Comment.—On admission to the children's medical ward the diagnosis of empyema was made, but it was not appreciated that the infection could be traced back to staphylococcal skin sepsis immediately after discharge from a maternity unit. Consequently, valuable time was lost before effective antibiotic therapy was instituted. The final result was satisfactory, yet it seems likely that immediate treatment with aureomycin or chloramphenicol might have resulted in a much less serious and prolonged illness.

Case 3

A baby boy, birth weight 6 lb. 1 oz. (2.75 kg.), was discharged home on the ninth day, gaining weight. On the twelfth day slight conjunctival injection was noted in the right eye. The next day the eye was swollen and a purulent discharge appeared at the right nostril. The family practitioner began injections of procaine penicillin, 300,000 units daily. These were continued for five days without improvement. At the end of this time the left arm was thought to be paralysed. No signs of toxaemia were noted.

Now 18 days old, he was readmitted to hospital. The right eye and cheek were swollen and dusky with abundant purulent discharge from the left nostril. Over the inner aspect of the right ankle there was a fluctuant swelling. The left upper arm was swollen. Deep subperiosteal oedema could be detected with some difficulty. No radiological evidence of bone destruction was found. Pus obtained from the nose and ankle grew *Staph. aureus* sensitive to streptomycin, chloramphenicol, and aureomycin and slightly sensitive to penicillin. Chloramphenicol was given before this result was available, and as the immediate clinical response was excellent it was continued. Three days after admission a subperiosteal abscess over the left humerus required incision. Antibiotic therapy was stopped on the eleventh day. Within 24 hours an acute relapse set in, involving all the previously affected areas. An *x*-ray film now showed gross destruction of the left humerus and some destruction of the right maxilla. Chloramphenicol again effected rapid improvement. Further sensitivity tests confirmed the original findings.

Progress, though slow, was satisfactory for four weeks. A persistent slight nasal discharge, however, suggested that the maxillary infection had not been entirely overcome, and after 28 days' continuous treatment with chloramphenicol an acute re-exacerbation occurred. A nasal swab grew *Staph. aureus* which was still reported sensitive to chloramphenicol. Aureomycin (125 mg. every six hours) was substituted for chloramphenicol, and improvement occurred within 24 hours. This treatment was continued for three weeks until repeated nasal swabs showed no evidence of staphylococcal infection. A solid involucrum formed over the left humerus and the patient was discharged home gaining weight and with full movement of the left arm. Routine surveillance over the next eight weeks showed satisfactory progress. At the end of this time he was readmitted to the ward with a reactivation of his humeral infection. The sensitivity of the *Staph. aureus* cultured remained as before and there was a rapid response to aureomycin.

Comment.—With an effective antibiotic it is unlikely that the initial infection would have undergone such widespread dissemination or that local bone destruction would have been so extensive. The rapidity of the relapse when chloramphenicol was stopped after 11 days suggests that large numbers of viable staphylococci were still present despite the absence of clinical evidence of activity for seven days, and is a warning against too early cessation of therapy with a drug which is bacteriostatic. The second relapse after 28 days' continued treatment emphasizes that even a sensitive organism may persist unhindered in abscess cavities.

Case 4

A baby boy, birth weight 7 lb. 10 oz. (3.4 kg.). On the third day, on account of suspected early respiratory infection, he was given chloramphenicol, 350 mg. daily, and this was continued until his discharge on the fourteenth day, when he appeared well. The cord had not completely separated.

Three days later he was readmitted on account of sudden anorexia and apathy. He was pale and listless. No cry could be elicited. No enlargement of liver or spleen was noted. The umbilicus was encrusted with a recent blood-stained discharge, but there was no exudate. The white-cell count was 4,800 per c.mm.

Chloramphenicol was started immediately—350 mg. daily, divided into four doses. During the next day he seemed somewhat improved, but the rectal temperature, which was 99° F. (37.2° C.) on admission, rose to 102° F. (38.9° C.). Two days after admission the respirations became a little distressed. The liver now appeared slightly enlarged. During the night the baby was found dead.

Post-mortem Examination.—Phlebitis of the umbilical vein was present with multiple abscesses throughout the liver. There were septic infarcts in the lungs, kidney, and heart; the latter involving a large coronary artery and resulting in severe muscle necrosis. Culture of various abscesses produced *Staph. aureus* resistant to penicillin, slightly sensitive to aureomycin, but markedly sensitive to chloramphenicol and streptomycin.

Comment.—The pathological findings suggest that infection originated from the umbilicus and spread via the umbilical vein. This spread must have developed during the time chloramphenicol was being given. In the presence of a

sensitive organism chloramphenicol was administered for 14 of the 19 days which this infant lived, and it must be concluded either that a dosage of 50 mg. per lb. (110 mg. per kg.) daily was incapable of maintaining adequate tissue levels or that on this occasion there was present a degree of *in vivo* resistance which the *in vitro* test did not reveal. That gross visceral infection may develop in the newborn without distinctive clinical signs and without leucocytosis was well illustrated.

Case 5

Birth weight 8 lb. 13 oz. (4 kg.). On the sixth day a purulent conjunctival discharge was noted, and culture produced *Staph. aureus* resistant to chloramphenicol and penicillin, but sensitive to aureomycin. Treatment was started with aureomycin, 500 mg. daily.

On the twelfth day, aureomycin therapy continuing, an abscess had developed in the left breast which on incision was found to originate from infection of the underlying rib. Culture produced a *Staph. aureus* sensitive to both chloramphenicol and aureomycin. The continued use of aureomycin was attended by prompt recovery.

Comment.—It is likely that two separate strains of staphylococci were involved in the initial infection, since it is unlikely on present evidence that a resistant organism could lose resistance to chloramphenicol within six days. The presence of two separate foci of infection strongly suggests blood spread, which, despite *in vitro* sensitivity to aureomycin, progressed while this drug was being given.

Case 6

Born by caesarean section at full term; birth weight 5 lb. 1 oz. (2.3 kg.). Some slight discharge from the eye was noted after twenty-four hours.

On the eighth day a few small pustules in both axillae and over the shoulders and a deep firm mass on the left side of the neck appeared. Chloramphenicol was started, 350 mg. daily. Despite treatment the mass increased in size and became fluctuant. Aspiration produced thick pus from which *Staph. aureus* resistant to chloramphenicol and penicillin but moderately sensitive to aureomycin and streptomycin was cultured. Aureomycin was given in a dose of 250 mg. daily, and with occasional further aspiration the abscess healed.

Comment.—Clinical chloramphenicol resistance was confirmed bacteriologically.

Bacteriological Studies

During the period when the majority of the clinical infections reported here occurred a limited number of tests were performed to identify the frequency and distribution of various types of staphylococci. In one of the maternity units concerned routine umbilical swabs were taken from the cord stump as soon as this separated, nasal swabs were taken from all the medical and nursing staff, and cultures were obtained from all cases with clinical infections, however benign, and sensitivity tests made. These results are presented in Tables II, III, IV, and V. The sensitivity tests were carried out with the impregnated disk technique described by Gould and Bowie (1952) modified in respect of the concentrations of antibiotics. The concentrations used were as follows: aureomycin 25 μg. per disk; penicillin, 1 unit per disk; streptomycin, 10 μg. per disk; chloramphenicol, 10 μg. per disk.

TABLE II.—*Clinical Infections, 1951: Analysis of Antibiotic Sensitivity of Staphylococci Isolated from 56 Separate Infections*

	Penicillin				Streptomycin				Chloramphenicol				Aureomycin			
Degree of sensitivity ..	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
No. ..	43	5	3	5	7	7	3	39	8	4	6	28	2	0	2	41
Total examined ..	56				56				46				45			
% resistant..	76·6				12·5				17·4				4·5			

0=No inhibition. 1=Slight inhibition. 2=Moderate inhibition. 3=Inhibition equivalent to standard sensitive strain.

TABLE III.—*Nasal Swabs (Hospital Staff) (51 Cases: Coagulase-positive, 26; Coagulase-negative, 22; no Staphylococci, 3) Antibiotic Sensitivity of Staphylococci (Coagulase-positive)*

	Penicillin				Streptomycin				Chloramphenicol				Aureomycin			
Sensitivity ..	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
No. ..	8	12	4	2	0	1	1	24	0	0	2	24	0	0	0	25
% resistant..	30·7				0·0				0·0				0·0			

Carriage rate for coagulase-positive staphylococci=53%.
Carriage rate for coagulase-positive penicillin resistant staphylococci=16·3%.

TABLE IV.—*Routine Culture of Umbilical Swabs*

Total Examined	Staphylococci Coagulase-positive	Staphylococci Coagulase-negative	No Staphylococci Isolated
121	73	20	28

Carriage rate:

Coagulase-positive staphylococci	=60%
Penicillin-resistant coagulase-positive staphylococci	=38·9%
Streptomycin-resistant ,, ,,	= 7·8%
Chloramphenicol-resistant ,, ,,	=18·1%
Aureomycin-resistant ,, ,,	= 3·3%

*Antibiotic Sensitivity of Coagulase-positive Staphylococci (73 Cases)**

	Penicillin				Streptomycin				Chloramphenicol				Aureomycin			
Sensitivity ..	0	1	2	3	0	1	2	3	0	1	2	3	0	1	2	3
No ..	47	13	1	12	9	8	9	44	21	4	2	43	4	2	1	65
% resistant..	64·4				12·9				30·0				5·5			

* Streptomycin and chloramphenicol sensitivity tests were not carried out on three cases and the aureomycin-sensitivity test was not carried out on one case.

TABLE V.—*Comparison of Antibiotic Resistance of Staphylococci (Coagulase-positive) Isolated from Patients with Clinical Infections and Adults and Infant Carriers*

Source	Penicillin	Streptomycin	Chloramphenicol	Aureomycin
Nasal swabs (staff)	30·7%	0·0%	0·0%	0·0%
Umbilical swabs (infants) ..	64·4%	12·9%	30·0%	5·5%
Clinical infection (infants) ..	76·6%	12·5%	17·4%	4·5%

Results are expressed 0, 1, 2, or 3, corresponding with the diameter of the zone of inhibition: 0 represents resistance to the antibiotics in the concentrations noted above; 3 represents a high degree of sensitivity. The correlation between reported degrees of sensitivity, the size of the zone of inhibition, the coefficient of resistance of the tested organism, and the minimum inhibitory concentration of antibiotic is shown in Table VI.

During the period under review the staff nasal carriage rate for coagulase-positive staphylococci was 53%. Similar figures have been published for other units: 53% by Rountree and Thomson (1949), 50% by Felsen *et al.* (1951), and 56–68% by Barber *et al.* (1949). The percentage of nasal carriers of penicillin-resistant coagulase-positive staphylococci among the staff (16.3) compares with other figures of 32% (Rountree and Thomson, 1949) and 40–54% (Barber *et al.*, 1949). Our figures for resistance refer only to organisms wholly resistant by the standard tests.

Our umbilical staphylococcal carriage rate of 60% for coagulase-positive organisms compares with neonatal carriage rates of 62% in the nasopharynx (Martyn, 1949) and 54% in the conjunctiva (Barber *et al.*, 1949), while the percentage of penicillin-resistant umbilical carriers (38.9%) compares

TABLE VI.—*Approximate Relationship Between Conventions Used in the Text and (1) Coefficient of Resistance (Sensitivity of N.C.T.C. 6571 Staphylococcus/sensitivity of Tested Organism). (2) Minimum Inhibitory Concentration (μg./ml.)*

Antibiotic	Degree of Sensitivity	Zone Diameter (mm.)	Coef. Resist.	Min. Inhib. Concn. (μg./ml.)
Aureomycin disk ≡ 25 μg.	3	>20	<4	<1
	2	12–20	4–40	1–10
	1	6–12	>40	>10
	0	No inhibition	—	—
Chloramphenicol disk ≡ 10 μg.	3	>18	<1·6	<2
	2	13–18	1·6–7	2–10
	1	6–13	7–20	10–30
	0	No inhibition	>20	>30
Penicillin disk ≡ 1 unit (1 unit=0·6 μg.)	3	>20	<5	<0·15*
	2	12–20	5–20	0·15–0·6*
	1	6–12	20–50	0·6–1·5*
	0	No inhibition	>50	>1·5*
Streptomycin disk ≡ 10 μg.	3	>19	<3	<1·5
	2	12–19	3–10	1·5–5
	1	6–12	10–20	5–10
	0	No inhibition	>20	>10

* Penicillin minimum inhibitory concentration expressed in units per ml.
Conventions used: 3, highly sensitive; 2, moderately sensitive; 1, slightly sensitive; 0, resistant.
In the case of aureomycin and chloramphenicol the term "slightly sensitive" can be seen from the table to be equivalent to a minimum inhibitory concentration of over 10 μg. per ml. As serum levels greater than this are not normally attainable, these antibiotics are unlikely to be effective, when used systemically, against an organism reported as "slightly sensitive." With penicillin and streptomycin, however, the fact that an organism is reported as only "slightly sensitive" does not necessarily exclude the possibility of effective systemic treatment.

with a nasopharyngeal rate of 34% (Martyn, 1949) and a conjunctival rate of 43% (Barber *et al.*, 1949) for such organisms.

Of the staphylococci isolated from clinical infections 76.6% were penicillin-resistant. This compares with the reported figures of 53% (Rountree and Thomson, 1949), 53.4% (Rountree *et al.*, 1951), and 50% (Summers, 1952), for hospital staphylococcal infection in general.

A comparison of the antibiotic resistance of organisms isolated from adult staff, from routine umbilical swabs, and from clinical infections reveals a close correspondence between the latter two groups (Table V). This would suggest that in the production of septic lesions cross-infection within the nurseries is more important than infection from the staff.

Penicillin resistance is well recognized. Chloramphenicol and aureomycin resistance are so far much less common. The percentage of aureomycin-resistant organisms here agrees with the previous reports of Long *et al.* (1950) and of Fairbrother *et al.* (1951). Aureomycin has not been used nearly so extensively in this unit as chloramphenicol. Lowbury *et al.* (1952) have shown that the administration of aureomycin in a burns unit produced in a period of six months a rising incidence of aureomycin-resistant organisms and an increase in the degree of resistance of these organisms. They also showed that the routine oral administration of aureomycin did not reduce the nasal carriage rate of staphylococci, and that the percentage of aureomycin-resistant organisms among these staphylococci increased.

Only 12.5% of clinical infections were resistant to streptomycin. This drug thus retains its value where a bactericidal effect is required. On account of the speed with which resistance may be acquired we have used it rarely, and only in the presence of serious sepsis.

Dosage Employed

Throughout the period under review the dosage of antibiotics used has been standardized. Penicillin has been given by intramuscular injections of 50,000 or 100,000 units at intervals of four or six hours, according to the clinical indications. Depot penicillin has not been used.

We have given streptomycin (0.5 g. daily) by intramuscular injections at intervals of six or twelve hours.

Chloramphenicol and aureomycin have both been given by mouth as powder freshly removed from the capsule in a dosage of 50 mg. per lb. (110 mg. per kg.) daily. Adequate serum levels have been found previously with a dosage of 11 mg. per kg. daily of aureomycin and 44 mg. per kg. daily of chloramphenicol (Hunt *et al.*, 1950). These and other studies (Ross *et al.*, 1952) confirm that in young children such dosage can be expected to produce serum levels of 10 μg. per ml. even during severe infections. We lack knowledge of tissue levels in babies treated with the newer antibiotics. It would be of the greatest value in the proper assessment of therapeutic failure if these levels could be measured. We had supposed that free diffusion would occur to infected areas in bone, kidney, lung, and liver. Our present experience suggests that this is not necessarily so with the dosage used (Cases 3 and 4).

Discussion

The cases reported illustrate the dangers which may attend minor staphylococcal infection in the newborn. While the recognition of minor infection of the conjunctiva, the skin, and the umbilicus presents little difficulty, it may be difficult to determine when an infection has ceased to be local and external and has spread, as in Case 4, to involve deeper or more distant structures. In such cases the systemic response is often of value in differentiating a trivial infection from a more serious one. Inactivity, failure to feed, diminished crying, the onset of pallor, vomiting, and pyrexia, occurring in a baby who has suffered from minor staphylococcal infections are warning signs which should not be ignored. Where there is the possibility that the initial local infection has been overlooked or where an infant born in hospital has developed serious infection after returning home the awareness of the high incidence of minor staphylococcal infection in infants born in hospital and the knowledge that the majority of the staphylococci are penicillin-resistant should, in differential diagnosis, give serious staphylococcal infection its due place and should remind those responsible for treatment of the limitations of penicillin therapy.

In the control of antibiotic therapy the laboratory plays an important part, particularly in suggesting suitable treatment in individual infections both with regard to clinical result and to the avoidance of expensive drugs which may be ineffective. Broadly speaking, we have found that the *in vitro* assessment of antibiotic sensitivity has been paralleled by the clinical response to treatment with an antibiotic which was assessed as appropriate, but there have been individual variations to this, as in Cases 1 and 3. It is as well, therefore, to bear in mind the limitations of *in vitro* sensitivity tests and to be prepared to change the treatment on clinical grounds alone. It is often necessary, too, with an infection of the neonate to begin treatment before the bacteriological report and the result of sensitivity tests are available. Under such circumstances failure to respond to treatment is a much more significant clinical guide to the organism's sensitivity than rapid response, because of the frequency with which spontaneous improvement may occur.

On the basis of laboratory tests it is clear that resistance to antibiotics is an increasing problem, particularly in hospitals. There the high carriage rate of coagulase-positive staphylococci and the high incidence of drug resistance constitute a special danger to the peculiarly susceptible newborn baby.

From the point of view of therapy the frequent difficulty of judging the severity of clinical infection, the natural tendency of so many lesions to heal without treatment, the occasional lack of correspondence between *in vitro* sensitivity tests and *in vivo* response, the time lag before the result of the bacteriological examination becomes available, the occurrence of drug resistance, and the danger of ultimately inducing this make a logical approach difficult.

The prophylactic use of penicillin in hospitals had its advocates before the extent of resistance to it became so widely recognized. More recently it has been suggested that

aureomycin should be used in this way (Felsen *et al.*, 1951). In the knowledge of the dangers of drug resistance this practice can scarcely be justified.

The majority of minor staphylococcal infections heal without treatment. Records of such infections, and in particular accurate bacteriological data, may assume great significance in the light of any subsequent illness which the child may develop during the following weeks. For mild skin lesions antibiotic therapy is probably not indicated, local treatment with an antiseptic such as gentian violet usually being sufficient. With purulent conjunctivitis the position is rather different. The amount of infected pus to which such a lesion gives rise must be responsible for the heavy contamination of clothes, floors, dust, air, and personnel. There is thus a case for controlling such lesions as early as possible. We have found local therapy with sulphacetamide, chloramphenicol, or aureomycin eyedrops, instilled at minute intervals for 30 minutes and thereafter every half-hour for 36 hours, effective in the majority of cases. Most infections clear within a few hours, but stubborn infections may require more than four days' systemic therapy.

The development of more serious sepsis often occurs after the child has returned home, and confronts the general practitioner in the first place. When diagnosis is difficult the fact that a baby has recently been discharged from a hospital maternity unit should bring the possibility of staphylococcal infection to mind, and such infection becomes increasingly likely if he is known to have suffered previously from a minor staphylococcal lesion. When the diagnosis is not in doubt the difficulty may be in determining the severity of the infection.

In view of its widespread use penicillin will doubtless tend to be given early. Because of the synergism which exists between the two drugs there is a case for giving streptomycin in addition (Alexander *et al.*, 1950). These drugs produce a combined bactericidal effect, and if no improvement is manifest within 24 hours the baby should probably be admitted to hospital or treated with another antibiotic, such as chloramphenicol or aureomycin.

The ultimate disposal of such cases depends very much upon the hospital facilities available in the area. Where adequate facilities exist serious staphylococcal infection merits hospital admission without the delay incurred by a therapeutic test.

In hospital practice we now find that penicillin is only of very limited value in the treatment of neonatal staphylococcal infection, whereas chloramphenicol and aureomycin give satisfactory results. The fact that aureomycin and chloramphenicol are bacteriostatic drugs, however, is probably responsible for the relapses which may follow early cessation of treatment, as in Case 3, and which make it very difficult to decide on the length of time that treatment should be continued. Apparent cessation of activity as judged clinically is not necessarily an indication for stopping therapy, particularly in deep-seated infections such as osteomyelitis. Nor do the newer antibiotics abolish the necessity for surgical intervention in certain cases : this is still often necessary to eradicate foci of infection to which, on account of the poor blood supply, systemically administered drugs have little access.

There is evidence that the staphylococcus is beginning to acquire resistance to the newer antibiotics as it has done to penicillin. At present, however, the use of combinations of antibiotics and the introduction of new antibiotics are keeping pace with the development of drug resistance.

Summary

The incidence of skin sepsis in two maternity units was 2.3% in each case and of conjunctival sepsis 4.1% and 4.2%. Most of these infections were due to the staphylococcus.

Cases are described illustrative of the serious lesions which staphylococcal infection may produce in the neonatal period, and comments are made on these cases, with particular reference to drug-resistant organisms, to bacteriological control of therapy, and to the difficulties of diagnosis and management.

An analysis has been made of the antibiotic sensitivity of organisms isolated from 56 separate staphylococcal infections occurring in a maternity unit during the year 1951 : 76.6% of these were resistant to penicillin, 12.5% to streptomycin, 17.4% to chloramphenicol, and 4.5% to aureomycin.

Nasal swabbing of the staff in this maternity unit showed that the carriage rate for coagulase-positive staphylococci was 53.0%, and out of these 30.7% were penicillin-resistant. None was resistant to chloramphenicol or aureomycin.

Routine swabs from the umbilicus just after the cord had separated showed that the infant carriage rate for coagulase-positive staphylococci was 60.0%, and that of these 64.4% were penicillin-resistant, 12.9% streptomycin-resistant, 30.0% chloramphenicol resistant, and 5.5% aureomycin resistant.

On the basis of relative drug resistance it is suggested that cross-infection may be more important in the production of neonatal staphylococcal lesions than infection from the attendant nursing staff.

Staphylococcal infections are discussed as they occur when the newborn infant is in hospital and when he has returned home. Particular reference is made to the significance of minor staphylococcal infection, to the importance of bacteriological investigation, to the type and dosage of antibiotic to be employed, and to the regimes of treatment which may be adopted under different circumstances.

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A roll of health visitor tutors is to be set up shortly by the Royal College of Nursing, at the request of the Standing Conference of Representatives of Health Visitor Training Centres. The roll is for the guidance of local authorities and others responsible for appointing tutors in health visitor training centres.