BACTERIOLOGICAL STUDIES IN OTITIS

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In the choice of a suitable antibiotic we are guided by various considerations such as the antibacterial range of an antibiotic, the sensitivity of the causative organism to the antibiotics available, the toxic effects of the antibiotics and their effect on the normal bacterial flora with the possible activation of certain moulds. The cost and available supplies of an antibiotic should also be taken into account. To treat every case with the newest antibiotic may be an impressive but unjustifiably costly practice (*Lancet*, 1951).

The identification of the causative or predominant organism and the determination of its sensitivity to the antibiotic chosen may, therefore, serve as useful guides in planning the treatment of a patient.

Moreover, the bacteriology of various diseases such as pneumonia (Scadding, 1951), otitis and others may from time to time present important variations. Such changes can only be fairly assessed in the course of a systematic bacteriological study.

In this part of a long-term study of various bacteriological aspects of otitis our aim was :

1. To collect data on the rate of incidence in otitis of penicillin- and streptomycin-resistant strains of *Staphylococcus aureus* in 1950 and on the possible role of cross-infection in spreading these organisms.

2. To study the competence of the older and newer antibiotics in otitis on the basis of the *in vitro* sensitivity of the isolated organisms.

The Incidence of Penicillin-Resistant *Staphylococcus aureus* in Otitis

The term *Staphylococcus aureus* has been reserved for the coagulase-positive pathogenic staphylococci regardless of the colour of the colony or the hæmolytic activity on blood agar (Miles *et al.*, 1944 ; R. E. O. Williams *et al.*, 1945). The coagulase test is recognized as a reliable criterion of the potential pathogenicity of staphylococci (Cruickshank, 1937 ; Collins and Hughes, 1944). Many papers on the bacteriology of otitis make no reference to this important distinction.

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METHODS

In order to obtain the highest rate of incidence of the staphylococci both discharging and non-discharging ears were examined. Aural and nasal swabs were grown on blood agar plates and in meat broth. The coagulase test was determined by the tube-method (Fisk). The sensitivity tests were carried out on double ditch plates (penicillin 10 units per c.c., streptomycin, aerosporin, chloromycetin and aureomycin 100 μg/c.c.).

TABLE I.

Clinical Diagnosis	No. of Cases	*Staph. aureus*	Per cent.	Penicillin Resistant	Per cent.*	Penicillin Sensitive	Per cent.*
Acute Otitis Media	664	300	46·3	99	14·9 (33)	201	31·4 (66)
Myringotomies ..	93	22	22·5	2	2 (10)	20	21·5 (90)
Mastoiditis ..	183	69	37·7	44	24·0 (64)	25	13·7 (36)
Chronic Otitis Media	318	104	32·7	43	13·8 (41)	61	18·4 (59)
External Otitis ..	211	93	44	32	15·1 (35)	61	28·9 (65)

* In brackets percentage of penicillin-resistant and sensitive staphylococci as referred to the number of strains of *Staphylococcus aureus*.

Table I shows that the overall incidence of pathogenic staphylococci was highest (46 per cent.) in acute otitis media. Young and Simson Hall (1948) in a study of 115 cases of acute otitis media briefly mention that " streptococci and staphylococci—none penicillin-resistant—were present in almost equal proportion ". But other workers seem to have failed to grow or to record the presence of *Staphylococcus aureus* in such proportion (Vaheri, 1938).

Whatever may be the ætiological significance of the presence of *Staphylococcus aureus* in 300 out of 664 cases of acute otitis media, its clinical and epidemiological significance should not be underestimated.

The incidence of penicillin-resistant *Staphylococcus aureus* in our cases of otitis, excluding mastoiditis, in 1950, was 14-15 per cent. However, most pathogenic staphylococci grown in acute otitis media were as sensitive to penicillin as the control Oxford *Staphylococcus aureus*.

So were all beta-hæmolytic streptococci (19·2 per cent.) and pneumococci (3 per cent.). Many cases, too, though infected with an *in vitro* penicillin-resistant strain of *Staphylococcus aureus* have clinically responded to treatment with penicillin. It is, therefore, fair to say that penicillin remains the antibiotic of choice for the treatment of acute otitis media.

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Bacteriological Studies in Otitis

Cross Infection in Otitis

Our clinical material consisted mainly of hospitalized cases. Different workers have reported on the high and increasing rate of incidence of penicillin-resistant staphylococci in hospital cases (Barber, 1947a, 1947b; Barber and Rozwadowska-Dowzenko, 1948; Forbes, 1949; Rountree, P., Thomson, E. F., 1949), 40-60 per cent. of staphylococci from hospital cases were found to be resistant to 1 or more units of penicillin (*Lancet*, 1949). Our figures were somewhat lower except in chronic otitis media and in the group of *infected mastoids*. The overall incidence of penicillin-resistant staphylococci in the latter group was 24 per cent.; and 64 per cent. of all the staphylococci grown from infected mastoids showed resistance to 10 units of penicillin. Compared with the figures in acute otitis media, this represents a statistically significant difference: $\chi^2=22\cdot4$ (Dr. Taylor).

The figures do not necessarily indicate that a primary infection due to penicillin-resistant staphylococci is more likely to give rise to mastoiditis. These cases usually spend longer periods in hospital and cross-infection may play an important role (Cairns and Summers, 1950).

The source of the cross-infection is most likely to be found among the hospital staff. A random swabbing of the staff showed these figures (Table II). Collins and Hughes (1944) have also drawn attention to the importance of the external route of infection in chronic infections of the ear and have emphasized the danger of re-infection in such cases.

TABLE II.

NASAL CARRIERS AMONG THE NURSING STAFF.

No. of persons examined	*Staph. aureus* in Nose	Penicillin-Resistant
67	24 (35·8%)	10 (6·7%)

Over a third of the staphylococci grown from nasal carriers (35·8 per cent.) among the hospital staff showed resistance to 10 units of penicillin.

Barber and Whitehead (1949) Rountree and Thomson (1949) and others have, by means of the phage-typing method found that most penicillin-resistant hospital strains belonged to a few types, while the sensitive staphylococci were distributed among many different types—a finding which substantiates the view that staphylococcal infections in hospitals are mostly cross-infections with the prevalent types.

Our figures fit well into the general epidemiological phage-pattern as most of our penicillin-resistant strains belonged to the predominant group 6/7/47 (Table III).

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TABLE III.

(Figures of Barber *et al.*, in brackets.)

6/7/47	68	(85)
52A	2	(21)
42/47/62	2	(3)
3	1	(1)
Non-typable	76	(29)
29/31/52	1	(1)
Total	149	(140)

Cross infection may thus to some extent explain the higher rate of incidence of penicillin-resistant *Staphylococcus aureus* in particular in the " mastoid " cases which during their longer stay in hospital are more likely to be exposed to the danger of cross-infection.

In acute conditions self-infection from the nose or nasopharynx may play a role though cross infection cannot be entirely excluded. Pathogenic staphylococci and also penicillin-resistant strains were frequently present in the nose of patients suffering from acute otitis media (Table IV).

TABLE IV.

NASAL CARRIER-RATE AMONG CHILDREN.

(Acute Otitis Media)

No. of Cases	*Staph. aureus*	Per cent.	Penicillin-Resistant	Per cent.
61	46	75	19	31 (41)

Sensitivity of *Staphylococcus aureus* to Streptomycin, Aureomycin and Chloramphenicol

Out of 366 strains of penicillin-resistant *Staphylococcus aureus* only 6 were found to be resistant to streptomycin (100 μg/c.c.). However, Rountree *et al.* (1951) noticed a definite increase of streptomycin-resistant *Staphylococcus aureus* in the material of a hospital in Sydney.

TABLE V.

THE INCIDENCE OF GRAM-NEGATIVE COLIFORM BACILLI IN OTITIS.

1950	Cases	*Coli-aerogenes*	Proteus	*Ps. aeruginosa*	Total	Per cent.
Acute Otitis Media ..	664	29	16	24	69	10·3
Chronic Otitis Media	318	34	87	51	172	54
Mastoid	183	16	25	13	54	29·5
External Otitis ..	211	24	33	32	89	42

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At least 65 of their doubly resistant strains belonged to phage-group 6/7/47.

All our penicillin-resistant strains were sensitive to Aureomycin (100 μg/c.c.) and Chloramphenicol (100 μg/c.c.).

The incidence of Gram-negative bacilli was highest in chronic otitis media and in external otitis, a fact which has been well recognized by many authors (Collins and Hughes, 1944). However, we have also grown a variety of Gram-negative coliform bacilli in a considerable number of cases of acute otitis media.

TABLE VI.

THE ANTIBIOTIC PATTERN OF *B. Coli*, *A. aerogenes*, *B. proteus*, *Ps. aeruginosa*.

Organism	No. of Strains	Sensitivity to			
		Streptomycin	Chloromycetin	Aerosporin	Aureomycin
Coli-aerogenes	60	58	48	44	47
B. proteus ..	86	83	42	11	26
Ps. aeruginosa	57	41	8	51	22

The antibiotic pattern of individual Gram-negative bacilli may vary considerably. The analysis of 203 strains showed that the coli-aerogenes group was usually sensitive to streptomycin, chloromycetin, aureomycin and aerosporin. *B. proteus* showed preference to streptomycin with chloromycetin a good second. Only about 20 per cent. were sensitive to aureomycin. That, however, does not exclude the possibility of an individual strain to be sensitive to aureomycin only. *Ps. aeruginosa* (*pyocyanea*) responded best to aerosporin although we have seen a small number of strains showing resistance to aerosporin on the ditchplate.

The majority of Gram-negative bacilli was sensitive to streptomycin *in vitro*. Sensitization of the skin and drug-fastness developing with rapidity have forced many clinicians to abandon its use, although in my opinion it can be frequently used to good advantage in infections due to *B. proteus* and *Ps. pyocyanea* (0·5 g. b.d.s. for 5-7 days).

Summary

1. Figures of the incidence of penicillin-resistant *Staphylococcus aureus* in otitis in the material of the Royal National Throat, Nose and Ear Hospital in 1950 were given.
2. In acute otitis media it reached the figure 14·9 per cent., but it was considered that penicillin remained the antibiotic of choice in the treatment of acute otitis media.

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3. The role of cross infection in hospitalized cases was considered.

   Phage typing of 149 penicillin-resistant strains of *Staphylococcus aureus* showed the predominance of the group 6/7/47, the prevalent epidemiological group in many hospitals in the London area.

4. The incidence in otitis of some Gram-negative bacilli and their antibiotic pattern were also discussed.

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