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### BACTERIAL SENSITIVITY TO ANTIBIOTICS

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The purpose of this paper is twofold. Firstly, it is to indicate the common pathogenic microorganisms (other than *M. tuberculosis*) which were isolated in this laboratory from 1955 to May, 1958. The source of these microorganisms is also given. Secondly, it is to demonstrate their sensitivity to the available antibiotics.

The pathogenic organisms most commonly isolated, in order of frequency, were: *Staphylococcus aureus*, *Escherichia coli* and the *proteus* group. They were tested against the following antibiotics: Penicillin, aureomycin, terramycin, chloromycetin, erythromycin, novobiocin and streptomycin. The total number of organisms tested was 1607.

#### METHOD

For all these tests the dried filter-paper disc was the method employed. The discs were prepared in the laboratory and used in the following concentrations: Aureomycin, terramycin, chloromycetin and streptomycin 5 and 25  $\mu\text{g}$ . per disc, novobiocin 5 and 30  $\mu\text{g}$ . per disc., erythromycin 2 and 10  $\mu\text{g}$ . per disc. and penicillin 10 units per disc.

Blood agar plates were inoculated with the organism to be tested and when these were dry the discs were applied. Results were read after 15-18 hours' incubation at 37°C.

The disc method does not allow exact quantitative readings to be made, but it does indicate sensitivity or resistance by the presence or absence of inhibition zones. In some cases resistant colony variants have been observed within the clear zones. There has been some controversy regarding the reliability of these *in vitro* tests in selecting the best antibiotic for clinical use. Nevertheless, the majority of cases show good correspondence.

#### *Staphylococcus Aureus*

Altogether 838 tests were carried out. The organism was isolated from the following sources: Abscesses, wounds, septic skin lesions 612, urinary infections 47, sputum 36, vaginal swabs 33, throat and nose 29, eye swabs 27, blood cultures 9 and elsewhere 46. Table I shows the results of the sensitivity tests.

It will be seen that novobiocin is the one to which there is the greatest sensitivity, while penicillin is the one which is least effective. Aureomycin, terramycin, chloromycetin

and erythromycin are intermediate in their effect. Hence these observations show that novobiocin is the most generally

TABLE I. SENSITIVITY % OF STAPH. AUREUS TO ANTIBIOTICS

Year	Total No.	Penicillin	Aureomycin	Terramycin	Chloromycetin	Erythromycin	Novobiocin
1955	296	34	64	63	97	97	
1956	182	34	64	64	95	95	100
1957	230	15	59	51	92	87	99
1958	130	31	52	54	86	87	96
1955-58	838	29	59	58	92	92	98

suitable antibiotic for staphylococcal infections. The high degree of resistance to penicillin is already well known. It is the newer antibiotics (erythromycin and novobiocin) that are the most effective, and strains which were only sensitive to these two antibiotics, or novobiocin alone, have been encountered. In *S. aureus* infections, sensitivity tests would appear to be the quickest guide to the practitioner in selecting the appropriate antibiotic.

#### *Escherichia coli*

Altogether, during this period, 415 cultures of *E. coli* were isolated from the following sources: Urinary infections 293, vaginal swabs 45 and wounds, abscesses, ulcers 77. The results of the sensitivity tests are set out in Table II.

From these figures chloromycetin appears to be the most generally effective antibiotic against *E. coli*, while

TABLE II. SENSITIVITY % OF E. COLI TO ANTIBIOTICS

Year	Total No.	Aureomycin	Chloromycetin	Terramycin	Streptomycin
1955	148	78	93	86	73
1956	58	72	74	70	64
1957	140	51	82	64	66
1958	69	52	84	60	66
1955-58	415	63	83	70	67

aureomycin is the least effective. Within the last 2 years the sensitivity to aureomycin has decreased considerably, while the figures for terramycin and streptomycin also show a decrease. It is moreover demonstrated that the tetracyclines show partial drug resistance.

#### *Proteus Group*

Altogether 354 cultures of this group were isolated during this period. The sources of these were as follows: Urinary

infections 159, wounds, abscesses, ulcers 102, faeces 41, vaginal swabs 27, ear infections 19 and sputum 6. Table III shows the results of the sensitivity tests against these cultures.

It will be seen that the members of the proteus group are highly resistant to aureomycin and terramycin and somewhat

TABLE III. SENSITIVITY % OF PROTEUS TO ANTIBIOTICS

Year	Total No.	Aureo-mycin	Terra-mycin	Chloro-mycetin	Strepto-mycin	Novo-biocin
1955	107	6	18	55	54	
1956	62	8	8	68	61	
1957	106	8	10	58	68	86
1958	79	8	11	63	78	77
1955-58	354	8	12	61	65	81

more sensitive to chloromycetin and streptomycin. Novobiocin sensitivity tests were introduced in 1957 and, although the number tested to date is not very high, the results indicate that it is a useful antibiotic in combating proteus infections.

Experience in this laboratory therefore shows that the 3 commonest pathogenic organisms, exclusive of *M. tuberculosis*, are staphylococci, *E. coli* and proteus, and that the 3 antibiotics with the widest effectiveness are novobiocin, erythromycin and chloromycetin. This does not mean that on occasion chloromycetin, for example, is not effective, and perhaps even more effective than novobiocin, against staphylococci, or that novobiocin is not effective against proteus. But when therapy is instituted without the guidance of sensitivity tests, or while awaiting the results of such tests, there can be no doubt that the drugs of choice for the treatment of staphylococci and *E. coli* are novobiocin and chloromycetin respectively.

#### DISCUSSION

The performance of sensitivity tests of the commoner bacterial pathogens to the various antibiotics, as they became available for therapeutic use, has become part of the routine work in the medical laboratory. The importance of laboratory control of such therapy has therefore been recognized. Most, if not all, bacterial infections can now be controlled and cured by the correct use of a suitable antibacterial agent. It is essential, then, to know which is the effective antibiotic as soon as possible, since the range of the various preparations varies considerably and, also, different strains of many bacterial species do not react consistently towards the antibiotics. It is therefore not possible in every case to predict clinically the sensitivity of any particular organism. In such cases laboratory tests have proved their value. Bacteriological tests are necessary in the first instance to identify the causal organism, on which antibiotic sensitivity tests can then be

carried out. These *in vitro* tests indicate, within limitations, to which antibiotics the organism is sensitive or resistant, and provide the most convenient guide for therapy.

The picture of antibiotic sensitivity is ever-changing, due partly to the development of resistant strains and to the discovery of newer antibiotics. Giles and Shuttleworth<sup>1</sup> have analysed the figures for sensitivity tests carried out in a large hospital laboratory in England. Comparison of the figures quoted with those in this paper shows the general picture of sensitivity and resistance of the organisms to be similar. However, the percentage sensitive, especially with regard to *E. coli*, is appreciably lower in the present series under examination, although there has been no significant rise in resistance to the antibiotics over the past few years, except possibly to aureomycin. It has been stated by Giles and Shuttleworth<sup>1</sup> that most American writers also record a significantly higher resistance rate.

The resistance of proteus strains has remained at a consistent high level. The isolation of these organisms from a wide variety of lesions, where they are probably secondary invaders, is becoming more and more frequent. As has been stated before in the literature, this may be due to the large-scale use of the tetracyclines and penicillin, which effectively remove the susceptible organisms, but favour the survival of resistant strains.

At present the sensitivity of *E. coli* and proteus organisms is being tested against nitrofurantoin. Although the number of tests is not yet high enough to warrant any justifiable conclusions, it would appear that the sensitivity to nitrofurantoin closely follows that of chloromycetin and streptomycin. A few strains sensitive to this agent only, and resistant to antibiotics, have been isolated.

#### SUMMARY

The sensitivity to antibiotics of the commoner pathogenic bacteria is surveyed. *S. aureus* is the most frequent pathogen isolated in the laboratory. The highest resistance of this organism is to penicillin, while erythromycin and novobiocin are the most effective.

The sensitivity of *E. coli*, during the last 3 years, has remained fairly constant, except to aureomycin; here it shows an appreciable decrease. Chloromycetin appears to be the antibiotic of choice.

The proteus strains show a higher degree of sensitivity to chloromycetin and streptomycin than to aureomycin and terramycin. Novobiocin is also effective.

#### REFERENCE

1. Giles, C. and Shuttleworth, E. M. (1958): *J. Clin. Path.*, **2**, 185.