should never be used wet, except when enough solution is available to allow of a first wash.

6. The Folin copper solution has a tendency to deposit cuprous oxide. This can be seen on the bottom of the bottle when present, and is orange-red in colour. The solution is kept in a dark bottle to prevent this; but if it occurs the solution must be decanted and the bottle washed and dried before the solution is returned.

7. Cleaning.—A good wash under running cold water, and draining, is all the cleaning necessary. Wash tube A before it has time to dry.

8. Ordinary tap-water is perfectly safe to use in making the estimations.

In evolving this method I am greatly indebted to Dr. R. D. Lawrence for his invaluable criticism and suggestions and for his kind permission to carry out the work in the diabetic clinic at King's College Hospital. I owe thanks to the whole staff of the clinic for their encouragement.

THE SEROLOGICAL GROUPS AND TYPES OF STREPTOCOCCI ISOLATED FROM EXCISED TONSILS

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A survey of the serological types of haemolytic streptococci in Australia has been proceeding at these laboratories for the past year. The progress findings in respect of the streptococci isolated from scarlet fever patients in Melbourne and Adelaide, from puerperal and surgical infections, and from normal throats in Melbourne have already been reported (Keogh and Kelsey, 1939; Keogh, Macdonald, Battle, and Puckey, 1939). The strains found in scarlet fever patients were rarely isolated from normal throats or from patients with puerperal or surgical infections. This present study was undertaken primarily to discover whether the predominant serological types of streptococci encountered in the tonsils would be those commonly associated with scarlet fever or those commonly found in surgical infections and in the throats of healthy adults and children. The results, however, will be discussed not so much from that particular viewpoint as from their bearing on the much-debated question of the indications for tonsillectomy.

There have been numerous previous investigations of the bacterial flora of tonsils, most of them, however, undertaken before the introduction by Lancefield of the precipitin methods, which enable a distinction to be made between probable pathogens (Group A) and probable non-pathogens (not Group A) among strains of haemolytic streptococci. So far as we are aware, no study of the tonsillar flora using the finer analysis of identification of the type of strains by the slide agglutination method of Griffith has been carried out, though a similar line of inquiry is being pursued in Sydney at the present time.

Methods

The tonsils examined were removed at routine operations at the Children's Hospital, Melbourne, during last summer and autumn (November, 1938, to March, 1939). Immediately after excision they were put in sterile containers and placed in a refrigerator until the following morning. Both tonsils of each patient were minced up in a single tube of sterile broth, a drop of which was plated on neo-peptone blood agar. Subcultures into tryptic digest broth were made from the various colonial types of beta-haemolytic streptococci present on the plates. The broth tubes were incubated overnight at 30° C. and the deposit used for typing by Griffith's technique. Strains which failed to show specific agglutination with the type sera at our disposal were then allotted to their respective Lancefield groups, using the formamide method of Fuller (1938) for extraction of the group polysaccharide. Any strains which agglutinated with our Type 4 or Type 28 sera were also checked as to group, since we find that these sera may give apparently specific agglutination with strains belonging to Group B, C, or G. The sera used had already been employed in the classification of large numbers of strains, and included samples of the following Australian types not appearing in the Griffith series, provisionally named "Wade," "Stewart," "Hale," "Woodbury," "John," and "Alli," which had been isolated from surgical and puerperal infections.

Results

Haemolytic streptococci were isolated from 259 of 378 pairs of tonsils (68.5 per cent.). Sawers and Barrett (1933) found haemolytic streptococci in the crypts of 61 per cent. of tonsils examined by them in Sydney. The strains which we isolated belonged to the following groups (Lancefield): Group A, 189 (50 per cent.); Group B, 21 (5.5 per cent.); Group C, 33 (8.7 per cent.); Group G, 28 (7.4 per cent.). It will be noted that 271 strains were isolated from 259 tonsils; in twelve cases two different strains were present. In eleven instances one strain belonged to Group A, the other to either Group B, C, or G; in the remaining case two different serological types of Group A streptococci were isolated (Types 12 and "Alli"). This incidence of Group A strains in the tonsils is ten times higher than in the throats of healthy children and adults. The details are set out in Table I.

TABLE I

Source of Strains	Percentage from which Haemolytic Streptococci were Isolated	
	Group A	Groups B, C, G
378 tonsils removed at operation	50.0	21.7
466 throats of healthy adults and children	4.5	13.1

This comparative incidence of Group A and non-Group A strains in the throats of healthy subjects agrees with the findings of workers in other countries. Hare (1935) estimated that in England about 7 per cent. of the general population carry Group A streptococci and 13 per cent. other groups. Davis and Guzdar (1936) found a carrier rate of 3 per cent. of Group A streptococci and 6.4 per cent. of non-Group A streptococci in healthy Chinese. Our figures in the healthy group for Groups B, C, G (13.1 per cent.) may be high, owing to the inclusion of a number of children from an institution many of whom were carriers of a Group C strain. The objection may be raised that this very high incidence of the potentially pathogenic

Group A strains is due to a greater *a priori* probability of isolating haemolytic streptococci from the excised tonsil than from a throat swab. But since there is no statistically significant difference in the percentages of non-Group A strains recovered from both sources, this factor cannot entirely account for the discrepancy. Further evidence against this assumption is provided by the fact that if haemolytic streptococci were present in the tonsils they were usually the predominant organism and were frequently obtained in practically pure culture. The data are shown in Table II.

TABLE II.—Percentage of Haemolytic Streptococci in Bacterial Flora of Excised Tonsils (excluding 12 Tonsils which contained Two Strains each)

Percentage of Colonies of Haemolytic Streptococci to Total Colonies per Plate	Group A Strains	Non-A Strains	Total
Less than 10.	30 (17.1%)	14 (19.7%)	44 (17.8%)
10 to 50	37 (21.0%)	10 (14.1%)	47 (19.0%)
50 to 90	50 (18.4%)	18 (25.4%)	68 (27.5%)
90 to 100	59 (33.5%)	39 (40.8%)	88 (35.6%)

It will be seen that colonies of haemolytic streptococci predominated in the plates from 63 per cent. of these infected tonsils, and were practically the only colonies present in 36 per cent. of them. It is improbable that throat swabs taken by an experienced paediatrician or otorhinologist, as were all in our "normal" series, would have failed to disclose the presence of streptococci in tonsils harbouring them in such numbers. Tonsils from which either the predominant scarlatinal strains (2, 17, "Wade") or non-scarlatinal strains (6, 27, "Stewart") were isolated showed no significant differences in the intensity of infection when these two groups were compared with each other or with the group of tonsils infected by other types. Taken at their face value the results reveal that, as a group, children coming up for tonsillectomy at the Children's Hospital, Melbourne, show a significant and large increase in the incidence of pathogenic streptococci in their tonsils, but no significant increase in the incidence of the doubtfully pathogenic non-Group A strains.

Of the 189 Group A strains isolated from the tonsils, 143 (75.6 per cent.) were identifiable by the type sera at our disposal. The distribution of types was as follows:

Type	No.	Type	No.
6 "Stewart"	38	"Coleman"	4
27	23	22	4
2	16	"Wade"	3
4	11	"Hale"	3
"Alli"	10	"Murphy"	2
11	10	9	1
17	6	"John"	1
12	6	Untyped	46
	5		

Of these, Types 6, "Stewart," and 27 account for 40.7 per cent. of the total. They are the types encountered most often in surgical streptococcal infections and in the throats of healthy subjects. Strains of the types (2, 17, and "Wade") which were together responsible for 90.5 per cent. of cases of scarlet fever in Melbourne during the same period are only rarely found in the tonsils, being 10.6 per cent. of the total. The data are given in Table III.

The close correlation between the distribution of types in the tonsils removed at operation and in surgical infections is apparent. We have not yet investigated the streptococci associated with acute follicular tonsillitis, but sixteen strains

TABLE III

Source of Strains	No. of Strains	Type 2, 17, or "Wade"	Type 6, 27, or "Stewart"
Scarlet fever	198	90.5%	1.5%
Surgical infections	31	6.5%	58.1%
Tonsils (removed at operation)	271	10.6%	40.7%

labelled "tonsillitis" which we have received during the past year from various sources in Melbourne were equally distributed between "scarlatinal" and "non-scarlatinal" types: seven being either Type 2, 17, or "Wade," seven being either Type 6, 27, or "Stewart," and two belonging to other types. Also, of five strains isolated from cases of bronchopneumonia, three of which were complicated by empyemata, two belonged to Type 17, two to Type "Stewart," and one to Type "Wade." These findings, although limited in number, suggest that there may be no great difference in pathogenicity between these "scarlatinal" and "non-scarlatinal" strains, although infection with the "scarlatinal" types is much more likely to be associated with the appearance of a rash.

In a small group of the children there is conclusive evidence that the streptococci isolated from the removed tonsils had been present in the throat months previously and were responsible originally for acute or mild symptoms. Of eleven children from whose excised tonsils Type 2 strains were isolated the histories of ten could be traced. Of these ten, two had had scarlet fever due to Type 2, and six had been direct contacts of scarlet fever patients (Type 2). One had a history of severe septic sore throat (diagnosed in the acute stage at the Children's Hospital, Melbourne) but no history of direct contact with scarlet fever. The remaining child had not, so far as could be ascertained, been in contact with scarlet fever, nor had he any very acute symptoms. In respect of the two children who had had scarlet fever, and of one contact, we know the original date of isolation of the Type 2 strain, and can state definitely, therefore, that in these children the same strain of streptococcus had been present in the tonsils for four, five, and five months, respectively. As yet no such evidence is available for those types not associated with a rash, since the onset of the original infection is not so easily determined. We hope, however, in the next year, to follow the state of tonsils in children bacteriologically examined during an attack of follicular tonsillitis.

Discussion

The findings presented in this paper leave little room for doubt that the tonsils removed at the Children's Hospital, Melbourne, contain haemolytic streptococci in a proportion greatly in excess of normal—a difference due almost entirely to a preponderance of pathogenic strains (Group A), with no corresponding increase in the number of doubtfully pathogenic strains of other groups. The clinical indications for tonsillectomy, therefore, seem to be supported by the bacterial findings in about 33 to 50 per cent. of the cases. It seemed not unlikely that more rigorous indications for the operation might be required in a teaching hospital than in general practice. We therefore examined all tonsils (twenty) removed during a three-week period at a large private hospital. We were unaware of the names of the surgeons, who were ignorant of the purpose of the inquiry. The bacteriological findings in this group coincided so precisely with those of the hospital group that we did not pursue this line of investigation.

It can be argued that, given enough time, the natural resistance of the children would have succeeded in eliminating the streptococci from the infected tonsils, and that, even if the infection persisted indefinitely, there is no direct evidence that a tonsillar carrier of pathogenic streptococci suffers any disturbance in health. In the three instances in which there is certain evidence of the date of the original infection it could be shown that this had persisted for from four to five months and that the cocci were still present in large numbers at operation. We have no definite information as to the duration of infection with types other than Type 2. But since from four to eight weeks usually elapsed between the recommendation for operation and its actual performance, and in most cases symptoms had been present for weeks or months before operation was advised, the presumption is that if these symptoms were due to streptococcal infection of the tonsils spontaneous cure had not occurred.

Chronic tonsillar carriers of diphtheria bacilli do not suffer any apparent ill effects from continued absorption of toxin if it occurs. Such evidence is also lacking in regard to chronic streptococcal infections of the tonsils, apart from their debatable relation to rheumatic conditions. Group A streptococci produce erythrogenic toxin *in vitro*, whether they are commonly associated with scarlet fever or not, though there is a certain amount of direct and indirect evidence that strains of types commonly causing scarlet fever are more powerful toxin producers (Allison, 1932). The chronic nasal diphtheria carrier often has a persistent sanguineous nasal discharge, usually without any noticeable constitutional upset. Perhaps the child with chronic streptococcal tonsillitis suffers a roughly comparable inconvenience. Were the chronic diphtheritic rhinitis curable by as simple an operation as tonsillectomy the indication for such treatment would be strong, from the point of view of both benefit to the child and elimination of a carrier. Chronic streptococcal carriers must menace the health of other children, and we know of instances where they have been the origin of cases of scarlet fever. It would be premature to recommend tonsillectomy on these grounds alone, except in special circumstances.

The preceding remarks refer only to the children—from a half to a third of the total—from whose tonsils streptococci were isolated. It has been urged by various writers that not only are a number of tonsillectomies carried out when the symptoms are in reality due to sinusitis, but, further, that the chronic infection of the tonsils is caused by reinfection from the sinus secretions. We wish only to discuss whether such a process could account for the high proportion of streptococcal tonsillar infections in this series. Simultaneously with this investigation of the tonsils, McInnes, at these laboratories, has been studying the bacterial flora of acute and chronic infections of the maxillary antrum. Out of 100 consecutive cases haemolytic streptococci were isolated on only five occasions, and only two of the five strains belonged to Group A. It is unlikely, therefore, that the tonsillar infection with streptococci is secondary to streptococcal antral infection.

The above should not be construed as a panegyric on routine tonsillectomy. In Melbourne about 17 per cent. of children of school age have lost their tonsils, as compared with 50 per cent. in the English "public" schools, and of these 17 per cent. probably not more than a third could ever have been classed as streptococcal carriers. The deductions from the data form a working hypothesis for further investigations on these lines, in which we shall attempt to correlate the clinical, bacteriological, and histopathological findings.

Summary

Group A haemolytic streptococci were isolated from 50 per cent. of a group of tonsils removed at operation in Melbourne, but from only 4.5 per cent. of throat swabs from healthy children and adults.

Haemolytic streptococci of others groups (B, C, G), which are rarely the cause of serious human infections, were recovered from 22 per cent. of the tonsils and from 13 per cent. of the throat swabs of the healthy group.

The significance of these findings is discussed in relation to the indications for tonsillectomy.

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RETROPULSION OF THE NUCLEUS PULPOSUS

A CRITICAL REVIEW

BY

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There should be a close season for the writing of articles. This would provide a breathing space in which the new ideas could be digested and the new operative procedures considered thoroughly from their theoretical aspects before embarking on the practice of them. Orthopaedic surgery is in great need of this close season. With the change from the use of hands and simple apparatus to the use of pneumatic hammers and mechanical marvels of rare alloys—a change, as it were, from the white coat to the boiler suit—there has resulted a flux of articles, mostly advocating some bolder, and therefore better, operative procedure. I, fortunately, have had enough leisure to examine in some detail the claims of a new procedure.

Before operating I decided to solve certain questions. These were: Can retropulsion of the nucleus pulposus cause symptoms? If it can, is laminectomy the only treatment? Are the results of laminectomy such as to justify operation? A study of the main articles on the subject revealed certain surprising facts which are the subject of this essay. The articles under review are:

- I. Mixer and Barr (1934). *New Eng. J. Med.*, **211**, 210.
- II. Mixer and Ayer (1935). *Ibid.*, **213**, 385.
- III. Barr (1937). *J. Bone Jt. Surg.*, **19**, 323.
- IV. Barr, Hampton, and Mixer (1937). *J. Amer. med. Ass.*, **109**, 1265.
- V. Mixer (1937). *Ann. Surg.*, **106**, 777.
- VI. Barr (1938). *British Medical Journal*, **2**, 1247.
- VII. Live and Camp (1937). *J. Bone Jt. Surg.*, **19**, 776.

The first six articles deal with a gradually increasing number of cases under the care of the same group of Boston authors, each article including the previously recorded cases in the series. I propose to refer to statements in these articles, and I shall then give the number of the article, the page, and the column for easy verification.

Can the Retropulsion cause Symptoms?

That retropulsion of the nucleus pulposus does occur is quite true. Andrae, working with Schmorl, found it in 15.2 per cent. of all spines. It must therefore be shown