A STUDY OF RHEUMATIC FEVER AND STREPTOCOCCAL INFECTION IN DIFFERENT SOCIAL GROUPS IN MELBOURNE

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INTRODUCTION

The widely accepted opinion that rheumatic fever is a disease associated with poor living conditions has received support in recent years from surveys such as those of Daniel (1942) in England and Quinn & Quinn (1951) in America, which have shown that the incidence of rheumatic fever is related to both income group and overcrowding in the home. In England the geographical distribution of rheumatic heart disease has been related to the social conditions in different areas (Morris & Titmuss, 1942; Knowelden, 1949).

During recent years clinical and laboratory evidence has been collected to show the close association between rheumatic fever and streptococcal disease. Numerous studies have shown that sera of patients suffering from rheumatic fever usually have an antibody titre (e.g. antistreptolysin O) which is indistinguishable from that of patients convalescent from streptococcal tonsillitis or scarlet fever, thus confirming the early clinical observation that the onset of rheumatic fever is commonly preceded by an attack of tonsillitis.

Epidemics of rheumatic fever have been reported following outbreaks of streptococcal infection in schools, and in the Armed Forces (e.g. Bradley, 1932; Thompson & Glazebrook, 1941; Coburn, 1945).

Trials of sulphonamide prophylaxis have shown that a reduction in the streptococcal infection rate is associated with a reduction in the incidence of recurrences in rheumatic patients (e.g. Rubbo, Holmes & Stokes, 1949). The experience of the American Navy and Air Force with sulphadiazine prophylaxis showed that when the scarlet fever and tonsillitis morbidity rates were controlled there was a corresponding fall in the number of cases of rheumatic disease (Coburn & Young, 1949).

Despite this evidence that rheumatic fever is closely associated with streptoccocal infection, little attention has been paid to the possibility that the social class distribution of rheumatic fever might be due to a similar distribution of streptococcal infection within the community.

The distribution of haemolytic streptococci in the various social groups of urban communities has not been widely studied. Several surveys of antistreptolysin O levels have been reported in recent years, but the value of these from the point of view of social distribution is somewhat limited; some of the reports have been based on small numbers of children at various ages, on children from single schools, or on those in institutions. Within these limits antistreptolysin O titres have usually

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been found to be higher in children from large than from small families and in those from poorer than in those from well-to-do areas (Mote & Jones, 1941; Hammon, Sather & Hollinger, 1950; Melnick & Ledinko, 1951; Quinn, Liao & Quinn, 1951).

This paper reports an investigation of the distribution of cases of childhood rheumatic fever in the different social classes in Melbourne, and an attempt to relate this to the incidence of streptococcal infection.

SOURCES OF INFORMATION

The period included in the survey of rheumatic fever incidence was from July 1938 to June 1948.

Case finding

Rheumatic fever was not a notifiable disease in Victoria during the period studied, so that the only sources of information readily available to us were hospital histories. While this method of case-finding presents obvious limitations, which will be mentioned later, it had the advantage of enabling us to check the accuracy of diagnosis by reference to the history of each patient in collaboration with Dr H. L. Stokes, Honorary Physician-in-Charge of the Rheumatic Fever Clinic of the Children's Hospital.

Records were obtained of all children up to the age of 14 years who were treated for rheumatic fever (including chorea) at the Rheumatic Fever Clinic of the Children's Hospital, all the Public Hospitals and the larger Private Hospitals in Melbourne and at the Royal Hobart Hospital and the Launceston General Hospital in Tasmania. In Melbourne, 1469 cases were discovered for the 10-year period 1938–48.

Population

The two censuses carried out in Australia in 1933 and 1947 showed that the population of Melbourne increased considerably during this period, but the expansion in each of the three rental areas under study was about the same. The population figures from both the 1933 and the 1947 censuses were used to calculate incidence of rheumatic fever in the population aged from 5 to 14 years inclusive.

Social classification

The local government districts of Melbourne were classified as high, medium and low rental areas. This broad subdivision was chosen, since Prest (1945) had shown a close approximation to a linear relationship between income and rent in the metropolitan area of Melbourne.

Slum areas are few in this city, and those that do exist are found almost exclusively in the low rental areas. The distinction between medium and high rental districts is not marked, each enjoying an adequate standard of living and an absence of concentrated industrial development.

The only data available on crowding were the numbers of persons per acre or per dwelling, neither of which was a satisfactory index, since the former made no

allowance for space occupied by factories or other areas not used for housing, and the latter did not take into consideration the size of the home. Statistics on the number of persons per room were not available.

METHODS

The risk of exposure to haemolytic streptococci and the incidence of streptococcal disease apart from rheumatic fever were measured in three different ways.

Since the maximum age incidence of rheumatic fever was from 6 to 10 years it appeared that the school environment provided the most important source of recurrent streptococcal infection. Accordingly, our first approach was to survey the carrier rate for streptococci using 530 school children, aged 7–11 years, from six schools in the low, medium and high rental areas. The number of children in the three schools in the low rental area was 285, in the single school in the medium rental area 87, and in the two high rental area schools 158 (see Table 3). The survey was repeated three times, in the autumn of 1947 and the summers of 1947 and 1948. The method of collecting and examining throat swabs has been described in an earlier paper (Rubbo *et al.* 1949).

The second technique involved the measurement of the Dick reactor rate as an indicator of previous streptococcal infection. To this end all children who were swabbed during the final bacteriological survey were tested, together with additional children from the low rental area schools. The Dick tests were done in the usual manner using a control of heated toxin, and the reactions were read after 22–26 hr.

In the third method scarlet-fever notifications were tabulated according to social and seasonal distribution. Unfortunately, these records were not classified by age, but, since most cases occur in children, it was thought justifiable to assign all cases to the age-group 5–14 years for the purpose of estimating the juvenile attack rates in the different social levels.

RESULTS

A close study of 386 case histories of rheumatic fever patients admitted to the Children's Hospital showed that the clinical features of the disease in Melbourne did not differ from those reported elsewhere.

The age distribution conformed to the usual pattern, with a maximum incidence between the ages of 6 and 10 years. The mean age at first attack for children aged up to 14 years was 7·9 years for rheumatic fever and 8·9 years for chorea.

In regard to the seasonal distribution, there was no significant difference between the number of primary attacks of rheumatic fever (in 494 children) which occurred in spring (23 %), summer (26 %), autumn (25 %) or winter (26 %), or in the distribution of recurrences (154 children) or attacks of chorea (129 children). In short, no seasonal pattern was discernible in Melbourne.

Prevalence of rheumatic fever

During the study period, the hospitals treated 1469 Melbourne children with rheumatic fever or chorea. The annual attack rate, calculated on the assumption that the population increased logarithmically between the 1933 and 1947 censuses,

is shown in Table 1. The average incidence was 11·8 cases of rheumatic fever per 10,000 children per year.

Table 1. *Estimated annual attack rate of rheumatic fever in children, aged 5–14 years, living in Melbourne*

Year of onset	No. of cases treated at Children's Hospital	Attack rate per 10,000 children
1938	56 (July–Dec.)	13·8
1939	122	14·4
1940	119	13·5
1941	118	12·9
1942	79	8·3
1943	137	13·3
1944	187	18·2
1945	135	12·9
1946	86	7·7
1947	93	8·0
1948	38 (Jan.–June)	6·3
Mean attack rate		11·8

It has been assumed that the child population aged between 5 and 14 years increased logarithmically between the two censuses taken in 1933 (83,942) and 1947 (145,726) and that the proportion of the total cases (80 %) treated anually at the Children's Hospital, remained constant.

The incidence in Tasmania was similar to that in Melbourne, being 10·4 per 10,000 per annum in Hobart and 7·2 per 10,000 per annum in Launceston (1947 census).

Social incidence of rheumatic fever

There were marked differences in the incidence of rheumatic fever in the three social classes (Table 2). Using the 1947 census the attack rates were 4·7, 7·5 and 15·0 per 10,000 per year in the high, medium and low rental districts respectively and on the 1933 census the same proportional differences were observed.

Table 2. *The social incidence of rheumatic fever in children*

Rental areas	Total no. of cases detected 1938–48	Total population aged 5–14 years (1947 census)	No. of cases per year (1947 census) per 10,000 children	No. of cases per year (1933 census per) 10,000 children
High	202	42,656	4·7	8·9
Medium	325	40,309	7·5	14·6
Low	942	62,761	15·0	24·2
Total	1,469	145,726	10·1	17·5

The child population figures for the different rental areas were not available for Hobart and Launceston but it was quite clear that most cases lived in poor areas.

Throat carrier rates for Streptococcus pyogenes

The carrier rate for *Str. pyogenes* (Lancefield Group A) in the schoolchildren living in the high rental areas (12·5 %) was only half that for those in the low rental area (25·3 %), and the rate for the medium rental area (18·0 %) was intermediate (Table 3).

Although the actual carrier rates varied from one swabbing to another, the correspondence of their relative sizes with social class did not change.

Table 3. *Throat carrier rates of* Streptococcus pyogenes *in schools in high, medium and low rental areas*

School	Rental area	No. of children		Total no. of swabs		Percentage carrier rates of *Str. pyogenes* 1st swabbing	2nd swabbing	3rd swabbing	Combined	
1	High	58	158	152	406	6·9	9·4	17·1	10·5	**12·5**
2	High	100		254		5·0	19·2	21·1	14·2	
3	Medium		87		209	12·7	16·7	30·0		**18·6**
4	Low	89	285	217	660	20·2	20·2	26·6	22·2	**25·3**
5	Low	113		260		19·5	24·2	41·7	25·4	
6	Low	83		183		28·9	14·3	48·6	27·8	

Comparing the combined carrier rates in the three rental districts $\chi^2 = 22{\cdot}89$. $P < 0{\cdot}001$.

Dick reactor rate

Dick testing of those children who were included in the throat-swabbing experiments showed that those in the high rental areas had a 26 % Dick-negative reactor rate compared with 68 % and 56 % for those in the low and medium rental areas respectively.

Table 4. *Dick reactor rate in schools in high, medium and low rental areas of Melbourne (children then aged* 8–12 *years)*

School	Rental area	No. of tests		Negative reaction per cent	
1	High	36	107	22·2	**26·2**
2	High	71		31·0	
3	Medium	43			**55·7**
4	Low	38	108	57·8	**67·5**
5	Low	44		75·0	
6	Low	26		69·2	

Twenty-nine children who had had clinical scarlet fever were excluded from this table.

On testing a large number (254) of children in the three low rental schools it was found that the incidence of previous streptococcal infection increased with age and school experience. In this particular social group approximately 50 % showed evidence of infection (Dick-negative) at the age of 6 and almost 100 % at the age of 12. These findings, which are illustrated below, are striking when compared with those for children attending schools in the high rental areas shown in Table 4:

Age (years)	6	7	8	9	10	11	12
No. tested	29	32	44	50	45	32	22
% Dick-negative	55	56	64	70	72	72	95

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Prevalence and social incidence of scarlet fever

Analysis of scarlet-fever notifications from 1938 to 1948, 25,861 in all, showed a fairly even social and seasonal distribution in the metropolitan area of Melbourne. The attack rates, based on these notifications and the 1947 census, were 18·4, 16·4 and 18·2 per 1000 children per annum in the high, medium and low rental areas respectively.

Tonsillectomy rates

Irrespective of age, the proportion of children in the high rental district schools who had had their tonsils removed (60 %) was greater than in the low rental district schools (35 %). Furthermore, the children whose tonsils had been removed had a much lower streptococcal carrier rate (9 %) than the children with tonsils present (29 %), irrespective of their social grading (Table 5).

Table 5. *Influence of tonsillectomy on the throat carrier rate of* Streptococcus pyogenes

School	Rental area	No. of swabs		Tonsillectomy rate per cent.		Percentage carrier rate: Tonsils present			Percentage carrier rate: Tonsils removed		
1	High	152	406	56·4	59·5	18·2	21·0	28·7	4·7	7·4	9·4
2	High	254		61·5		22·9			9·0		
3	Medium	209		43·8		28·0			6·5		
4	Low	217	660	25·8	34·9	25·0	31·7		14·3	12·6	
5	Low	260		42·0		38·4			7·3		
6	Low	183		35·8		32·2			20·0		

In 250 of the 386 histories of rheumatic fever the tonsillar status of the patient was recorded. Of these patients, 66 (26 %) had had their tonsils removed, whereas the tonsillectomy rate for non-rheumatic children in the poorest districts, i.e. those districts from which the majority of rheumatic patients came, was 35 % (Table 5).

DISCUSSION

A study which attempts to estimate the incidence of a non-notifiable disease which may be treated in the home, misdiagnosed, or may run a subacute course not requiring medical advice cannot be accurate. Rheumatic fever in Melbourne is a case in point. It seems, however, improbable that the three-fold greater incidence in the poor areas, when compared with the better-class districts (Table 2), could be due solely to these factors, and, indeed, it is likely that undiagnosed cases might occur more frequently in the poorer social group.

The throat-swabbing results (Table 3) suggested, and the Dick tests confirmed (Table 4), that *Str. pyogenes* has a higher incidence among the children in the poorer districts. The notifications of scarlet fever, on the other hand, did not differ between the social classes, but the higher proportion of Dick-negative children in the poorer districts suggested that natural immunization to the erythrogenic toxin could account for the relatively low incidence of scarlet fever among them. It is of interest to point out here the difference between attack rates of rheumatic fever

and of scarlet fever in the districts studied. For example, in the poor districts, for every case of rheumatic fever detected approximately twelve cases of scarlet fever were notified, whereas in the high rental areas the proportion was 1 to 40; which seems to indicate that rheumatic fever follows repeated streptococcal infections, some of which result in immunization against scarlet fever.

These findings support the view that the social distribution of rheumatic fever is closely related to the social distribution of streptococcal infection. It follows, therefore, that factors which modify the distribution of streptococcal infection within the community are of basic importance.

The striking association we found between the presence or absence of tonsils and the presence or absence of throat carriage of *Str. pyogenes* (Table 5) has been noted before (MacDonald, Simmons & Keogh, 1940; Public Health Dep., London County Council, 1947). Furthermore, the observation that the incidence of tonsillectomy has a marked social distribution in Melbourne is consistent with the pattern observed in England by Glover (1948). A possible interpretation of the present findings and those of others is that a substantial part of the difference in carrier rate, in infection rate and in prevalence of rheumatic fever in the various social classes could be due to the difference in incidence of tonsillectomy. When the tonsillectomy rate was high the 'infection pressure' was low. This view is further supported by noting that the incidence of tonsillectomy in patients with rheumatic fever was below the expected average for the poor rental districts (see p. 455).

It is clearly necessary, however, to distinguish between factors which actually modify susceptibility to infection and those which merely modify the outcome of infection once it is established, by prolonging the carrier state for example. Further investigations will be necessary to determine at which of these stages tonsillectomy exerts its effect.

SUMMARY

1. Hospital records of 1469 cases of rheumatic fever (including chorea) up to the age of 14 years were used to study the social distribution of the disease in Melbourne. On this evidence the incidence of rheumatic fever was three times greater in low than in high rental districts.

2. The results of throat-swab surveys and Dick tests on schoolchildren living in different districts showed that children in the poor districts contracted streptococcal infections more frequently than those in well-to-do districts.

3. One factor associated with the carrier rate of *Streptococcus pyogenes* in the various social groups was the incidence of tonsillectomy. In the better class districts where the tonsillectomy rate was high (60 %) the *Str. pyogenes* carrier rate was 12·5 %, whereas the rates in poor areas were 35 and 25·3 % respectively.

4. Differences in social incidence of rheumatic fever might therefore be explained by differences in social incidence of streptococcal infection, which, in turn, might be influenced by the incidence of tonsillectomy.

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