

EPIDEMIOLOGY OF HAEMOLYTIC STREPTOCOCCAL INFECTION IN RELATION TO ACUTE RHEUMATISM

III. COMPARATIVE INCIDENCE OF VARIOUS INFECTIONS AND ACUTE RHEUMATISM IN CERTAIN TRAINING CENTRES

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(With 9 Figures in the Text)

INTRODUCTION

Longstaff (1904) drew attention to the fact that waves of streptococcal diseases, such as erysipelas, scarlatina and puerperal fever synchronized with rheumatic fever. Atwater (1927) came to the same conclusion, and, in addition, he noted the correlation between the mortality rates of the same conditions.

Reviewing the position of acute rheumatism in the Forces, Glover (1930) observed that the incidence varied as the pressure on sleeping accommodation. He drew an analogy between acute rheumatism and cerebro-spinal meningitis on the grounds that waves of acute tonsillitis preceded the appearance of cases of both diseases. Thus, in 1928, a tonsillitis epidemic involving 175 per 1000 of the personnel of 3530, was followed by forty-one cases of rheumatic fever of whom seventeen had carditis. Dudley (1926) also noted the effect of overcrowding, but considered that damp and chill were also factors in determining the appearance of rheumatism. This conclusion was based on the fourfold drop in the incidence at a training centre after an improvement in hygiene administration which was especially directed to prevent damp and chill. Other factors demonstrated by Dudley to be of prime importance in influencing the incidence of infectious disease, including rheumatism, were the rate of change of population in training centres occasioned by the system of recruiting and discharging, and the herd immunity of the community. In Dudley's report, Vickery was quoted as observing that the incidence of disease fell more heavily on the newly joined boys. Thus, in 1912, there were 2949 entries on the sick list of one training centre of which 60% were boys in their first 3 months, 24% in the second and 16% in the last 3 months of their training. Similar findings have been detailed by Green (1942*a, b*) in regard to haemolytic streptococcal epidemics and acute rheumatism, and attention has been drawn to the longer exposure required before the maximum incidence of the latter disease was obtained.

The subject is now considered on a wider basis by examining the incidences of rheumatism and other diseases in several training centres which showed marked variation in morbidity rates.

EPIDEMIOLOGICAL OBSERVATIONS

The weekly records of sickness in various training establishments are graphically presented. The figures for tonsillitis, sore throat, pharyngitis and scarlatina have been combined to give a total figure because one or other of these terms had been used to describe the same condition in different centres.

Training centre Hd.

The period represented in Fig. 1 includes 1937, 1938 and 1939. Recruits were entered at the commencement of terms and were aged 14–16 years. The complement remained fairly steady until May and September of 1939 when two large increases were made.

Acute rheumatism was entirely absent, but various epidemics of other diseases were experienced as follows:

Mumps:	Spring and summer, 1939	Common cold:	Spring, 1938
Rubella:	Spring, 1938		Spring, 1939
	Summer, 1939	Tonsillitis:	Spring, 1938
Measles:	Summer, 1938		Spring, 1939
Chickenpox:	Spring, 1939		

As the combined total of throat infections shows, there was little to note apart from the two seasonal epidemics. Dick immunization was practised and accounted in part for the absence of scarlatina in a susceptible age group.

Training centre Dc.

The period represented in Fig. 2 was the first 10 months of the existence of the unit. Recruits were added at short intervals in varying numbers so that the complement was raised from 500 to 3000 during the year. The recruits were of an older age group than in the centre previously described, the majority being 20–24 years.

Apart from the epidemic of common cold at the start of the graph, the health of this centre was excellent and the incidence of rheumatism negligible, despite the heavy recruiting of the year.

Training centre Eg.

The period represented in Fig. 3 covers the autumn term of 1939, when the establishment was opened, and the whole of 1940. The recruits were aged 15–17 years, and the addition of new entries at short intervals raised the complement from an initial 1400 to approximately 2750 in 1940. In the last term the complement dropped rapidly to 1750.

Throat infections were moderately frequent during the observation period, the greatest number accompanying the epidemic of common cold in the spring of 1940. The estimated incidence of combined throat infections in 1940 was 140 per 1000, and of acute rheumatism 8 per 1000.

Training centre Tv.

The period represented in Fig. 4 includes the autumn term of 1938 together with the spring and summer terms of 1939. Recruits were entered at short intervals in small groups. The complement was approximately 750 but gradually fell as a slightly larger number of trained personnel were discharged at the time of admission of new recruits.

Acute rheumatism had been prevalent in this centre for several years, and during the year of observation an estimated incidence of 34 per 1000 was noted. Epidemics were experienced as follows:

Rubella:	Summer, 1939
Common cold:	Spring and summer, 1939
Tonsillitis:	Summer, 1939

While no exact parallelism between the incidence of any two diseases can be distinguished, it may be noted that in the summer term of 1939 seven cases of acute rheu-

Hd.

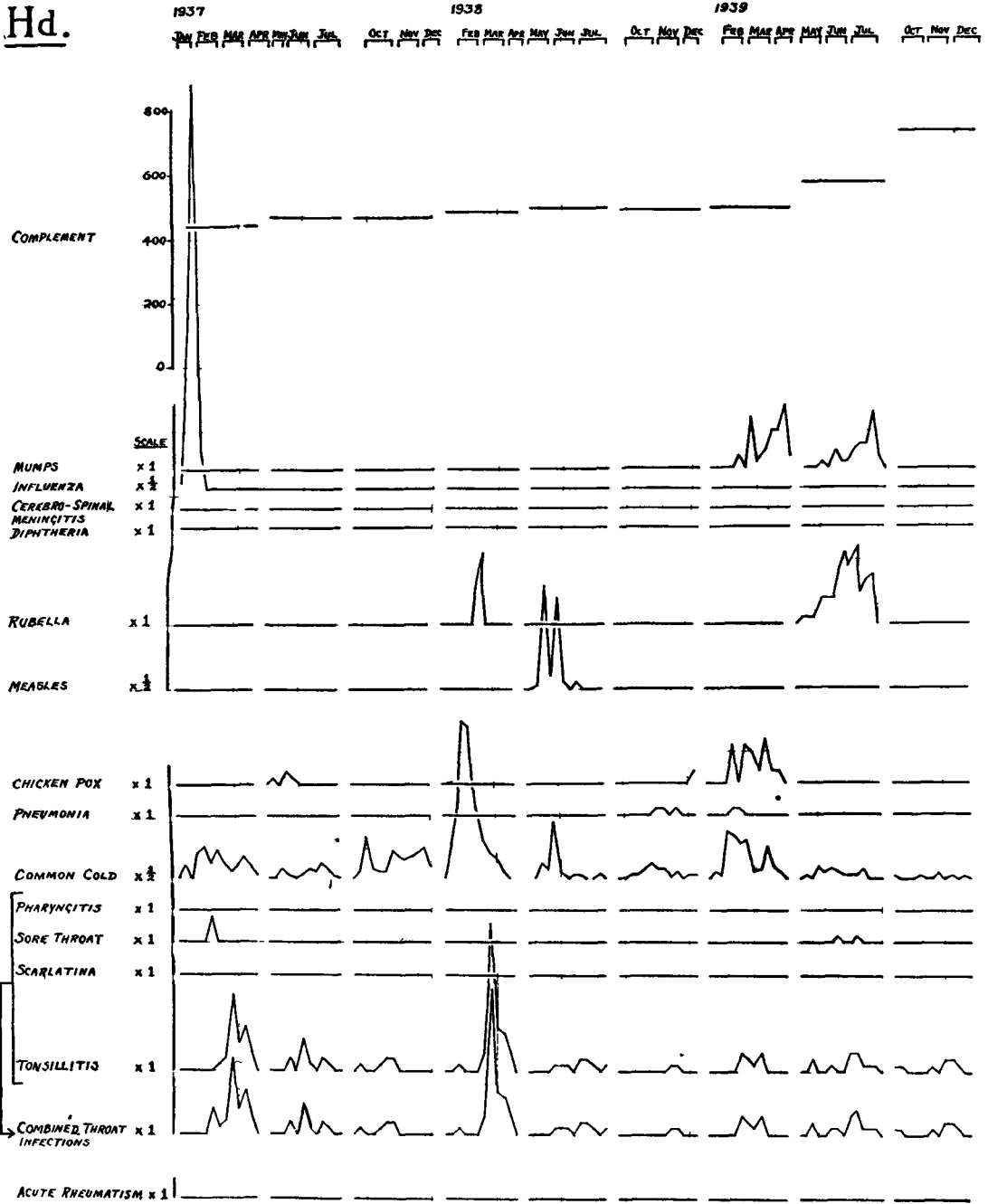


Fig. 1. Showing the incidence of various infections and of acute rheumatism in training centre Hd.

Dc.

1940

MAR APR May JUN JUL AUG SEP OCT NOV DEC

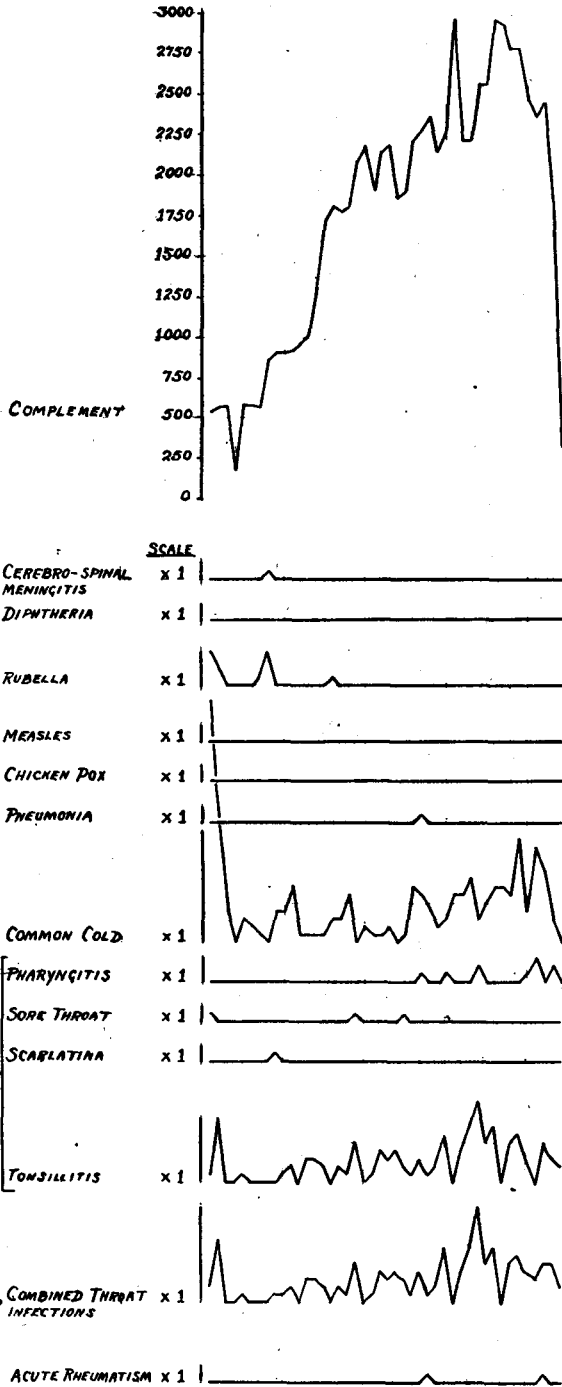


FIG. 2. Showing the incidence of various infections and of acute rheumatism in training centre Dc.

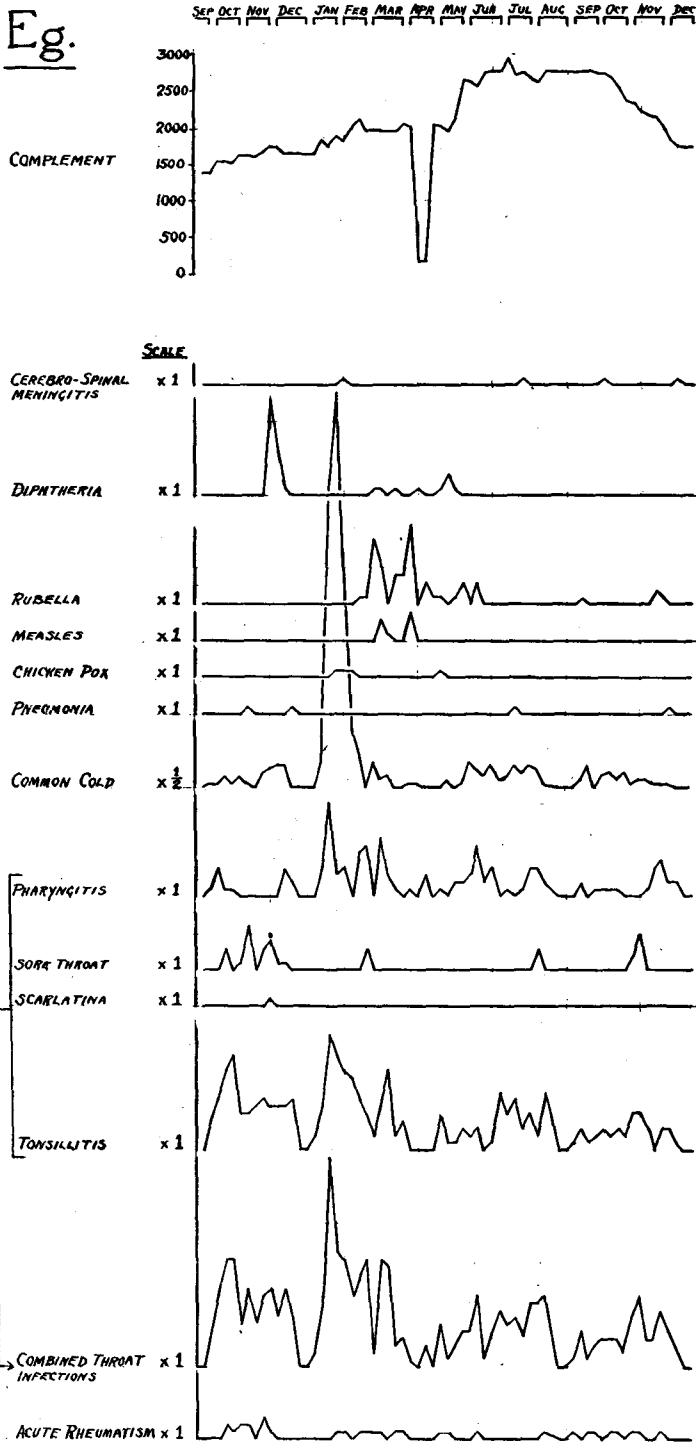


Fig. 3. Showing the incidence of various infections and of acute rheumatism in training centre Eg.

matism were notified in the 2 weeks of the first wave of a minor epidemic of tonsillitis which unexpectedly developed. In this summer term, ten cases of acute rheumatism occurred as compared with three cases in the preceding autumn term, and eleven cases in the intervening spring term.

Training centre Sg.

The period represented in Fig. 5 covers the years 1938, 1939 and 1940. Recruits were aged 15–17 years, and, with slight variations, the complement approximated to 2100 until the spring term of 1940. The personnel was not fixed, but entries and discharges were made at short intervals as in the last establishment. In the spring term of 1940, new entries were stopped, but discharging continued so that the complement dropped. The personnel were finally transferred elsewhere in May 1940.

In the past, acute rheumatism has been common in this centre. In the three terms of 1939, forty-six cases were notified, giving an estimated incidence for the year of 22 per 1000.

Epidemics were experienced as follows:

Diphtheria: Autumn, 1938	Sore throat: Spring, 1939
Rubella: Autumn, 1938	Spring, 1940
Spring, 1940	Scarlatina: Autumn, 1938
	Autumn, 1940

The prevalence of haemolytic streptococcal infection was demonstrated by the occurrence of cases of scarlatina over the entire period in addition to the two epidemics. Acute rheumatism was similarly distributed over every term, and although there was no exact parallelism, there was a closer similarity between the curves for acute rheumatism and combined throat infections than for any other two conditions. Thus the lowest figures for acute rheumatism were recorded in the autumn and summer terms of 1939 when throat infections were less frequent.

In Fig. 6 the term totals for rheumatism, scarlatina and combined throat infections are contrasted. It will be seen that in the first three terms, throat infections diminished to a slight extent, whereas scarlatina showed a marked reduction which probably indicated the increase in herd immunity against the toxic manifestations of haemolytic streptococcal infection. Acute rheumatism presented an equally steep fall during these three terms. In the last term the combined infection figures almost trebled those of the previous term and scarlatina increased sevenfold. Reference to Fig. 5 will show that the maximum complement for trainees aged 15–17 years was reached in this term after the admission of large numbers of recruits. Hence the sudden reappearance of multiple cases of scarlatina. There was a significant increase in rheumatism during this term though not to an extent comparable with that of scarlatina.

Effect of change in personnel. Trainees were readmitted to this centre in June 1940, but they were of an older age group, being 21 years or more. The complement varied greatly during the remainder of the year, but the mean population was approximately equal to that of the previous 2 years when the trainees were aged 15–17 years.

Fig. 5 shows the significant and immediate reduction in the incidence of all respiratory diseases which accompanied the change-over in personnel. Only two cases of acute rheumatism were notified in the following 7 months as against twenty-two and thirty-seven in the same months in 1939 and 1938 respectively. The point is further illustrated by Fig. 7

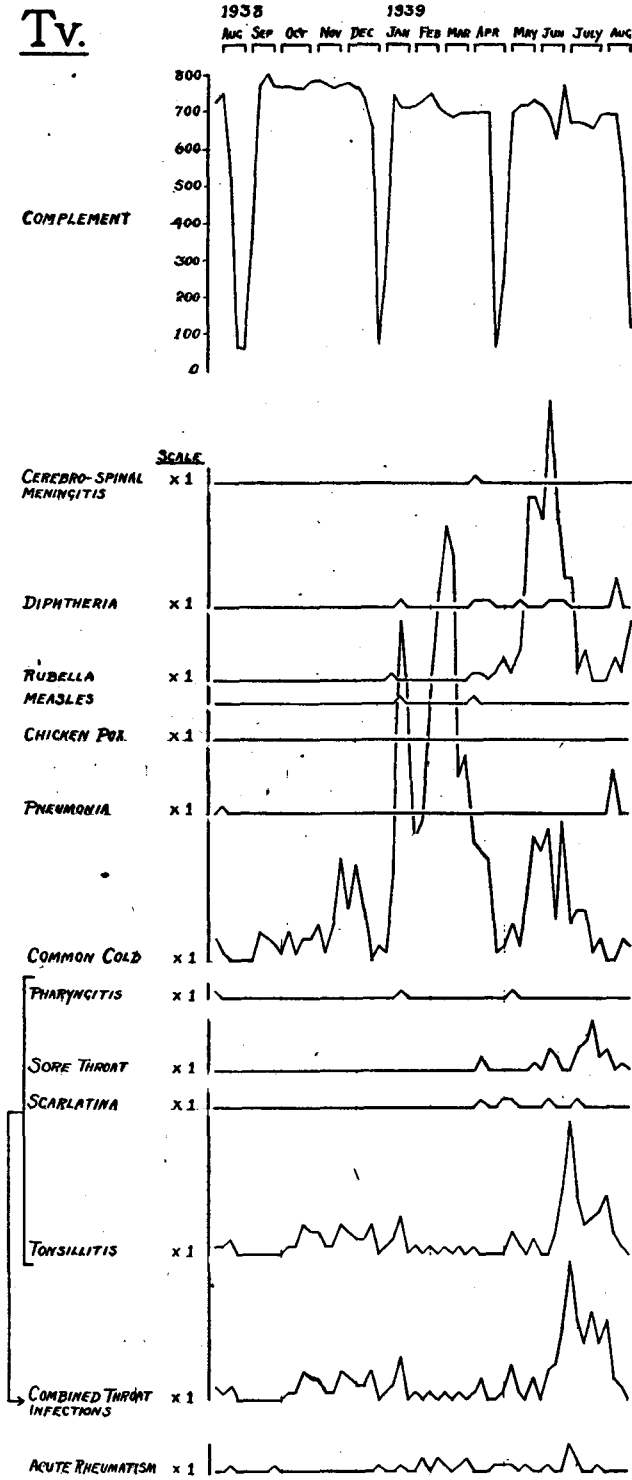


Fig. 4. Showing the incidence of various infections and of acute rheumatism in training centre Tv.

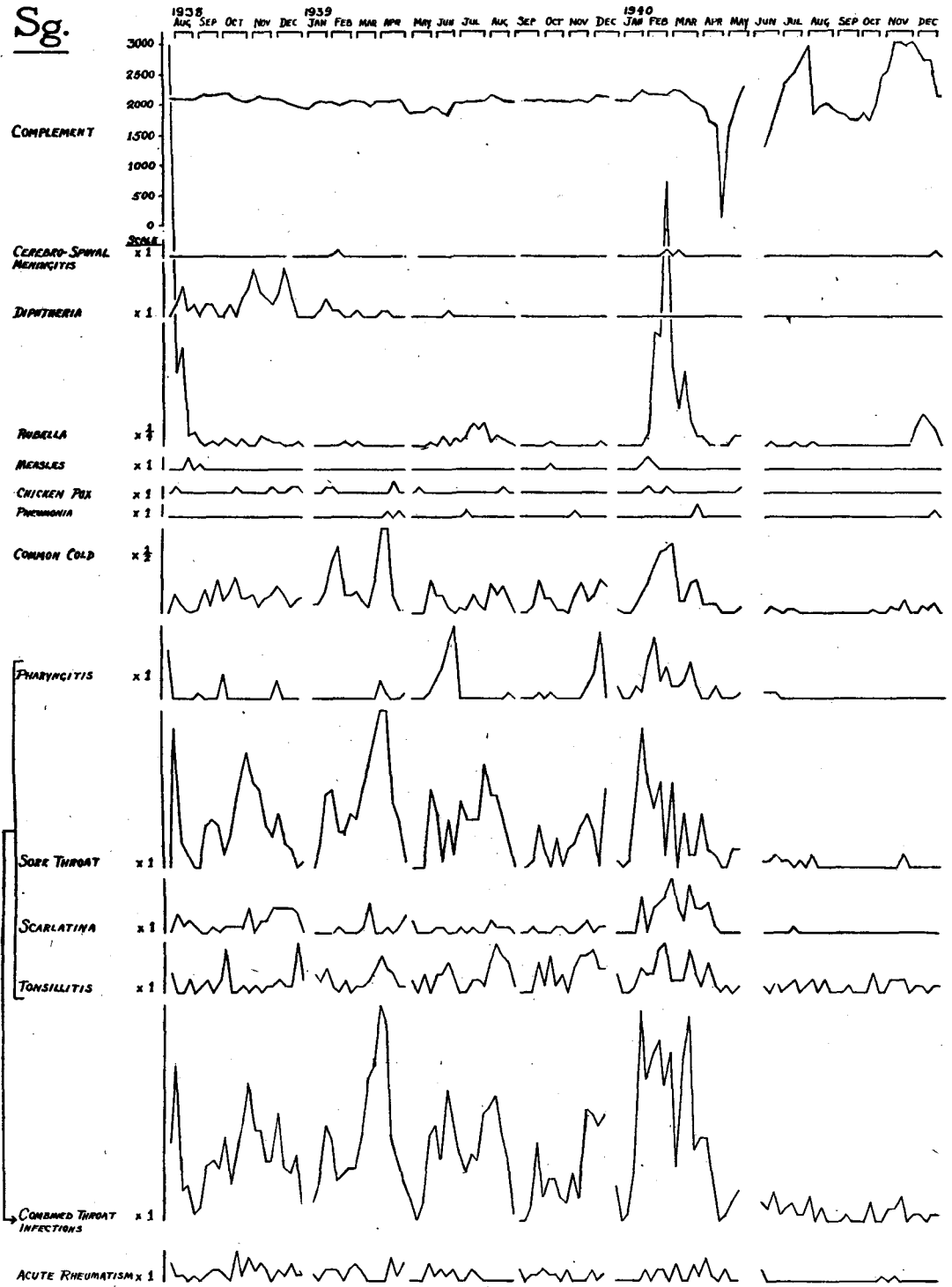


Fig. 5. Showing the incidence of various infections and of acute rheumatism in training centre Sg.

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which contrasts the total number of cases of rheumatism, scarlatina and combined throat infections over similar periods in 1938, 1939 and 1940. The high rheumatism rate in 1938 and 1939 had been maintained for several years, and there was no reason to suppose that the dramatic reduction in 1940 would have been witnessed had the younger age group continued in residence. This group was actually sent as part of the complement in the centre Eg., which had an estimated incidence of 8 per 1000 for acute rheumatism in 1940, but the rate in Sg. youths only was not ascertained. Conditions in the training centre were

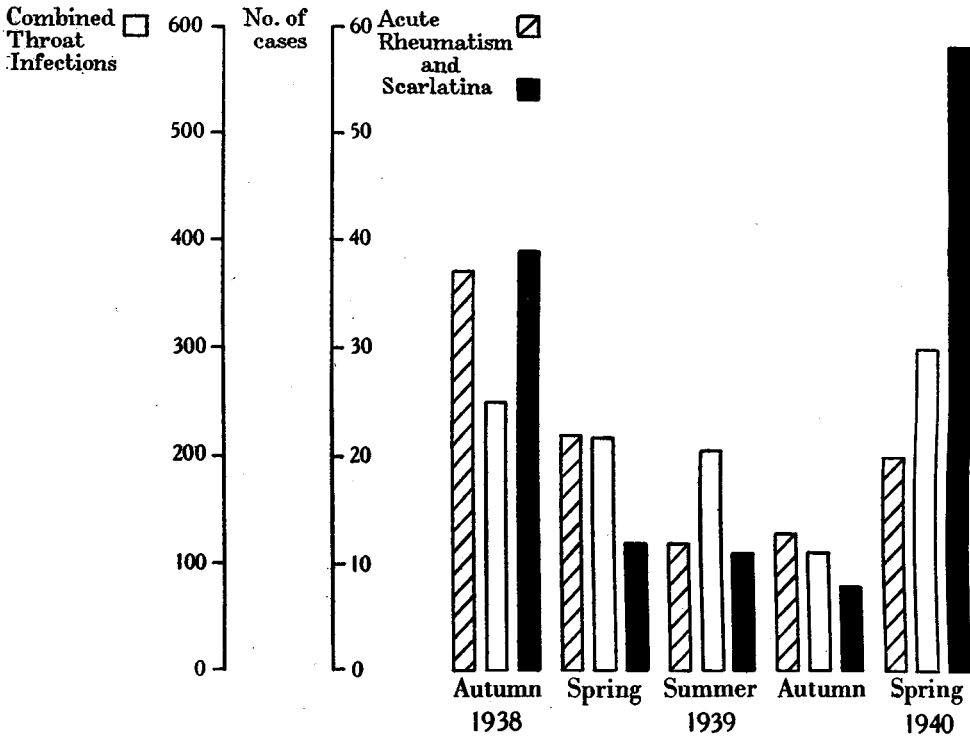


Fig. 6. Contrasting the term incidence of combined throat infections, scarlatina and acute rheumatism in training centre Sg.

the same for both age groups, and the observed difference in the incidence of rheumatism was certainly significant.

Training centre Ew.

The period represented in Fig. 8 covers the autumn term of 1938, 1939 and the spring term of 1940. The complement averaged 550, except in the last two terms. The recruits were aged 15–17 years, and joined in small groups at short intervals.

Epidemics were experienced as follows:

Rubella: Summer, 1939
 Common cold: Spring, 1939

In the past, acute rheumatism has been prevalent at this centre, and in 1939 twenty cases were notified, giving an incidence for the year of 36 per 1000.

Tonsillitis was common in every term, and the estimated incidence of combined throat infections in 1939 was 450 per 1000. Despite the prevalence of throat infections, only nine cases of scarlatina were notified in 1939, giving an estimated incidence per 1000 of 16.4. Cases of rheumatism occurred throughout the whole period.

DISCUSSION

The investigation has indicated the complete absence of any relationship between acute rheumatism and epidemics of rubella, measles, chickenpox, common cold and diphtheria. On the other hand, the distribution of rheumatism was similar to that of tonsillitis or haemolytic streptococcal infection. Thus centres such as Hd. or De., in which rheumatism

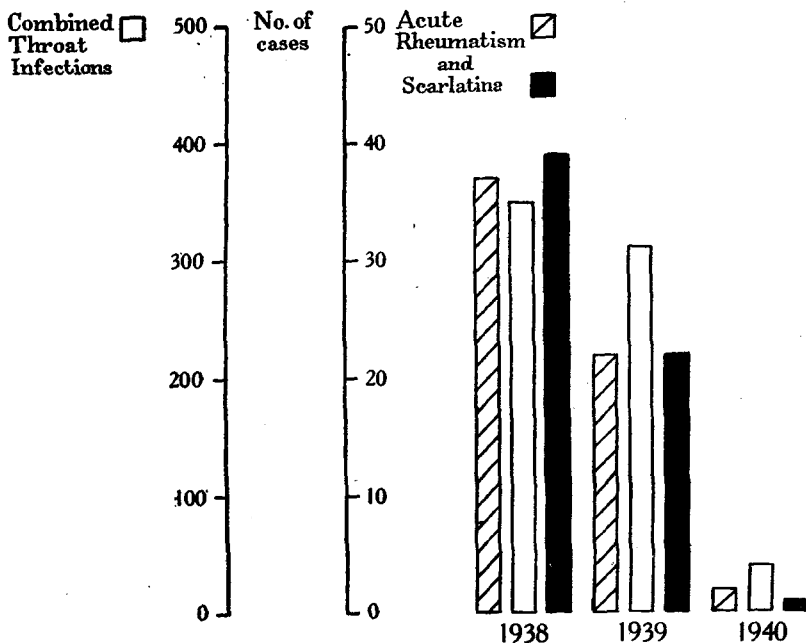


Fig. 7. Contrasting the total number of cases of combined throat infections, scarlatina and acute rheumatism in training centre Sg. over similar periods in 1938, 1939 and 1940.

was infrequent, produced a correspondingly low incidence of throat infections, and such epidemics as did occur were mild and seasonal. When infection was rife, as in centre Sg., the figures for rheumatism were also high. This does not mean that scarlatina, tonsillitis and acute rheumatism could be exactly correlated, and the difficulties in attempting this are illustrated in Fig. 9. The chart was constructed with data, referring to the same period of time, from four of the centres described in the text, together with the figures from another institution which have been previously reported (Green, 1942*b*). It will be seen that two of the centres, Sg. and Ew., had the same rheumatism rate of 22 per 1000, but the throat infection rates per 1000 differed markedly, being 148 and 778 respectively. The incidence of scarlatina, however, was slightly higher in centre Sg. As the exposed populations were of the same age group, the different rates for combined infections and for scarlatina probably indicated that streptococcal infection in Ew., though more wide-

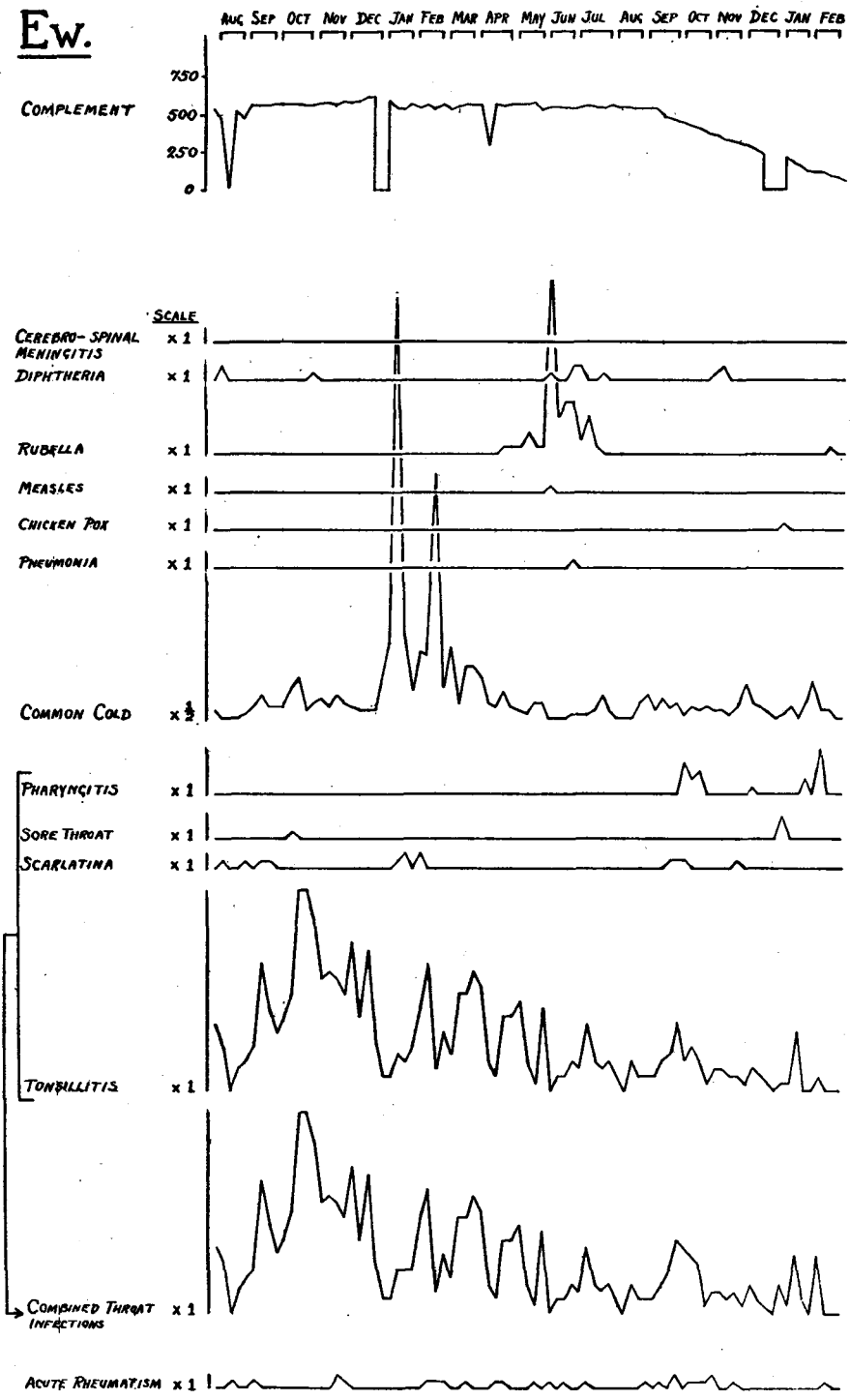


Fig. 8. Showing the incidence of various infections and of acute rheumatism in training centre Ew.

spread, was milder in type. As another example of difficulty in correlation, it may be seen that the rheumatism rate in Ac. was thrice that of Ew., whereas the throat infection rate was less than half, though scarlatina was much more frequent.

The effect of age on the incidence of rheumatism in training centres was well demonstrated in the training centre Sg., the experimental conditions being ideal except for the fact that the two groups were, of necessity, in occupation at different times. The climatic conditions, however, were similar in each year and could not be used to explain the difference in the incidence of rheumatism. The evidence indicated that the more frequent occurrence of acute rheumatism during the winter months was due to the simultaneous increase in respiratory infections and not to any influence of climate per se. If the usual

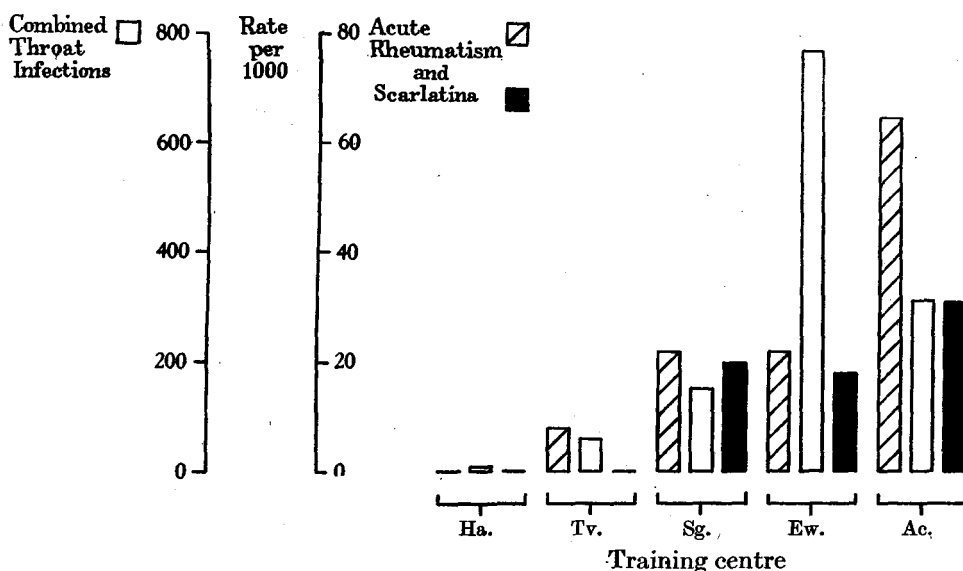


Fig. 9. Comparing the incidence of combined throat infections, scarlatina and acute rheumatism in five training centres during the same period of time.

conditions are reversed and infection becomes more common in the summer, then rheumatism is also more in evidence. This has been demonstrated in a semi-closed community during a widespread streptococcal outbreak of tonsillitis and scarlatina during the summer term of 1938 when rheumatism reached epidemic proportions (Green, 1942*b*). The importance of age was also demonstrated in the comparative absence of rheumatism in the centre Dc. despite a sixfold increase in the personnel during the first year of its existence. Provided the individual resistance to streptococcal infection is high, resulting in the absence of epidemics, as in the centre referred to, then multiple cases of acute rheumatism are rarely seen.

SUMMARY

The distribution of various infectious diseases in certain training centres is discussed in relation to the streptococcal aetiology of acute rheumatism, and the relative importance of age and environment are noted.

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REFERENCES

- ATWATER, R. M. (1927). *Amer. J. Hyg.* **7**, 343.
DUDLEY, S. F. (1926). *Spec. Rep. Ser. Med. Res. Coun., Lond.*, no. 3.
GLOVER, J. A. (1930). *Lancet*, **1**, 499.
GREEN, C. A. (1942a). *J. Hyg., Camb.*, **42**, 365.
GREEN, C. A. (1942b). *J. Hyg., Camb.*, **42**, 371.
LONGSTAFF, G. B. (1904). *Trans. Epidem. Soc., Lond.*, **24**, 33.

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