

## SCHICK AND DICK REACTIONS IN DIFFERENT CLASSES OF THE COMMUNITY

BY SCOTT THOMSON, M.B., CH.B., D.P.H., A. J. GLAZEBROOK, L.R.C.P., M.R.C.S., AND C. A. GREEN, M.B., CH.B., D.P.H.

*From the Department of Bacteriology, University of Edinburgh, and the Royal Naval Hospital, Port Edgar*

### INTRODUCTION

THE Schick and Dick reactions are of value not only in determining susceptibility or immunity in the individual to diphtheria and scarlet fever respectively, but also in ascertaining the level of immunity to these diseases in different races and in different sections of a community, a matter of interest in the study of the factors influencing immunity to these diseases.

It is agreed that immunity to diphtheria and scarlet fever depends upon specific antitoxins in the blood, and it is established that the number of susceptibles (Schick & Dick positive) decreases with age until at age 20 some 10–15% of people in Europe and America react to these toxins. There is not, however, complete agreement as to the mechanism which stimulates the production of antitoxins and consequently brings about this increased immunity, but the problem of the source of “natural” antibodies is more easily investigated in diphtheria and scarlet fever than in many other diseases, because of the existence of these skin tests. Two views have been advanced to explain the rising “herd” immunity. One view is that the immunity is due to some physiological maturation process and develops in the absence of any specific contact with the diphtheria bacillus or haemolytic streptococcus. The other view is that the rising immunity is due to specific contact with the infecting agents with resulting subclinical or latent infections. The evidence on the subject is confusing.

A correlation between blood groups, which are inherited according to Mendelian law, and Schick reactions in young children has been described by Hirszfeld, Hirszfeld & Brokman (1924) and the correlation is advanced as evidence to support the view that the reaction to the Schick test is determined by a normal physiological process. This view has been challenged by Rosling (1928).

Much of the evidence in favour of the view that immune persons (Schick-negative and Dick-negative reactors) acquire this state in the absence of specific contact has been obtained by investigating the reactions in races in whom diphtheria and streptococcal infections are rare. Thus, Schick tests have been carried out amongst the Eskimos by Heinbecker & Irvine-Jones (1928)

and Asbelew & Margo (1932); in East Africa by Kleine & Kroo (1930); in Southern Africa by Grasset (1933) and Grasset & Perret-Gentil (1933); in Annam by Soucharde & Tournier (1937); in Katanga by Serra (1936); in Indo-China by Vaucel, Joyeux & Hoang-tich-Try (1936) and in Nigeria by Cauchi & Smith (1934). All of these workers consider that the Schick negative state develops with age in persons of these races though diphtheria is rare or even unknown at approximately the same rate as it does amongst Europeans. Asbelew & Margo (1932), in addition to determining the Schick reaction, took throat swabs from 200 Eskimos, but failed to isolate the *C. diphtheriae*. They claimed, therefore, that not only was diphtheria unknown in the community, but that the diphtheria bacillus was absent. For the latter conclusion, however, their survey was rather small.

The same type of investigation has been made with the Dick test but the conclusions drawn are complicated by the fact that haemolytic streptococci are responsible for many clinical syndromes besides scarlet fever. Bormann (1936) determined the reaction to Dick toxin in a small group of natives of German West Africa, and found that the number of reactors decreased with age, though scarlet fever is almost unknown there. Van Slype (1935) stated that in the Belgian Congo not only is scarlet fever almost unknown but other streptococcal diseases are also very rare. He found that children became Dick negative before reaching 5 years of age. He obtained only 10% of reactors in all of his tests. Davis, Guzdar & Fernando (1935) state that in Hong-Kong scarlet fever is very rare, but the number of reactors falls with age as in Europe. Amongst children of 1 and 4 years 70% gave a positive reaction, while amongst persons about 40 years of age only 6% gave a positive reaction. They found, however, a haemolytic streptococcal carrier rate of 6.6%. The incidence of scarlet fever appears to differ in various parts of China. Gear (1937) states that it has a wide distribution throughout China and is endemic in Shanghai.

The results of Schick and Dick tests in countries where there is more than one race are of special interest. In Formosa, Sugie, Honda & Kawai (1937) performed over 30,000 Schick tests in children up to 15 years of age and found 85% of positive reactors in Japanese children and 44% positive in the Chinese children. They found also, however, that the Schick-positive rate in Japanese children born in Formosa was lower than that found in children born in Japan.

In New Zealand, Turbott (1931) found 80% of white children Schick-positive as against 10% of pure Maori children. In children who were half-breeds he found 23% positive. This work was done in a somewhat isolated district where diphtheria is very rare amongst the Maoris.

Work of a very similar nature has been done in Manchuria by Ando, Nishimura & Ozaki (1929) with the Dick tests. The incidence of Dick positives amongst the Japanese was twice that found amongst the Chinese.

On the other hand, there is no doubt that latent infections can play a very definite part in immunizing against diphtheria and scarlet fever. Dudley

(1923) found that the number of reactors to the Schick test in a semi-closed community decreased considerably following an outbreak of diphtheria. Dungal (1932) in Iceland, where diphtheria is rare, recorded the effects on the Schick test of an epidemic of diphtheria which had occurred eleven years previously. He found a very slow rise in the percentage of non-reactors between the ages of 5 and 12 years. In children aged 12, however, there was a sharp increase in the number of non-reactors, presumably because they were just old enough to have experienced the epidemic eleven years previously. Three years later, Dungal & Sigurjonsson (1935) did not find this sharp rise in incidence of non-reactors in that age group.

Of interest too, are the marked differences in results obtained by testing different social classes of the same race. Zingher (1923) determined the Schick reactions of school children and found many more reactors amongst the more fortunate classes than amongst the less fortunate. The same type of result was found to hold true for the Dick test by Dyer, Caton & Sockrider (1926).

Pulley & Fleisher (1938) found that 40% of students in St Louis University were still Schick-positive and that there was some correlation between the reactions and the size of town in which the student had lived.

In this paper we describe the results of Schick and Dick tests in different classes of the community, but these tests were done on adults.

### RESULTS

The tests were made on medical students aged 20–22 years, in their third year of University life; on militia men, aged 20, about three weeks after their period of training had begun and on youths (including recruits) in a naval training establishment.

The medical students in their third year had started ward work only a few months before these tests were made. The militia men had gone into barracks only three weeks before the tests were made and we regarded them as representative of the population at that age. The recruits in the naval training establishment were aged 15–18, and were tested within a week of their arrival at the institution. The other youths of the establishment had been in the institution for varying periods up to a year.

There was no selection of cases except amongst the militia men. All the medical students were tested in their class rooms. In the naval training establishment the whole of one term's recruits were tested. The forty-six youths who had been in the training establishment for some time were tested in the sick quarters. They were youths who had minor surgical ailments and no one suffering from tonsillitis at the time was tested.

The militia men were tested by calling for volunteers and more than half offered themselves.

#### *Schick tests*

In Table I are given the results of tests on those who gave no history of diphtheria and no history of immunization.

Table I

Class	Total	Schick +	Schick -	Percentage positive
Students	243	171	72	70
Militia men	103	37	66	36

The difference greatly exceeds three times the standard error.

We suggest that the high incidence of reactions among the students as compared with that amongst the militia men can be interpreted in terms of living conditions, for the students on the whole were drawn from more privileged social classes and had not been as exposed to infections as had been the average member of the community.

The incidence of 36% amongst the militia men was higher than we had expected from previous experience of the test in the general population, but it must be noted that Edinburgh is a residential city and has a higher proportion of more fortunate social classes than would be found in other cities, and the militia men had been drawn from Edinburgh and district.

The same type of result was obtained with the Dick test, but a more extensive investigation was possible. The results in the medical students were compared with the results obtained amongst the youths in a naval training centre. During the year preceding these investigations there had been an epidemic of streptococcal tonsillitis in the institution. The total complement of the institution is 1300, but during the course of the preceding year 1820 youths had had experience of this epidemic because recruits join and trained youths leave at frequent intervals. There were recorded 1550 cases of "tonsillitis", "pharyngitis", etc., and this epidemic was undoubtedly caused by haemolytic streptococci. There were 112 cases of scarlet fever.

Several visits were made to the institution during the epidemic year for the purposes of taking throat swabs, and of 126 swabs 112 yielded a rich culture of haemolytic streptococci. Of forty-six youths who were Dick tested and who had experienced at least part of this epidemic, twenty-eight gave a history of acute tonsillitis since entering the institution.

Dick tests were made also on a large number of recruits from the North Midlands of England and Scotland within a few days of joining the establishment.

Table II. *Dick tests*

Group	Total	Dick +	Dick -	Percentage positive
Students (age 19-20)	165	92	73	56
Recruits to the establishment (age 14-16)	238	64	174	27
Youths in the establishment (age 15-19)	46	5	41	11

The number of youths in the last class in Table II is very small, but there seems to be a significant difference between the number of reactors found amongst them and amongst the recruits to the establishment who were of the

same social class. The result shows how effective an epidemic of tonsillitis can be in immunizing against scarlet fever. There were many more reactors among the medical students than among the recruits and it is only reasonable to apply the same argument to explain this difference. In these groups, however, the process of immunization was not highly active over a short period owing to an epidemic, but, presumably, quietly active over the whole of these youths' lives, for in the course of their upbringing the recruits to the establishment had been probably more subjected to streptococcal infections than had the medical students.

Of three comparisons possible from the results shown in Table II, in two the difference obtained greatly exceeded three times the standard error of the difference. On the remaining one, namely that of the recruits to the establishment to the youths in the establishment, the difference was 2.3 times the standard error.

#### DISCUSSION

Immunity to diphtheria and scarlet fever can be correlated directly with the presence of antitoxins in the blood. Even in the absence of clinically recognizable attacks of diphtheria and scarlet fever the majority of people are, before reaching adult life, immune to both diseases. One view put in explanation of this fact is that the immunity develops as a normal physiological property of growth, the other is that the immunity, which increases with age, is due to contact with the respective infecting agents. The evidence quoted appears to show that specific contact undoubtedly plays some part. Whether or not it plays the whole part is still undecided.

The observations recorded in this paper are of particular value because the tests were made on young adults at an age when the majority of people do not react to these toxins. If antitoxins can be produced by physiological processes they should be present in the great majority of persons who have reached the age of 20. Moreover, although the physiological production of antitoxins might conceivably differ in various races, there ought not to be marked differences between different classes of the same race. On the other hand, if it is admitted that specific contact with the infecting agent can produce a rise in immunity among people who are more than usually exposed, we should expect to find fewer reactors. If the physiological explanation is correct, the students represent a population of normal resistance with some slight addition from specific contact, and the militia men a similar population with a larger addition. The fact that 70 % of the students were Schick-positive suggests that physiological processes played no part in determining the immune state.

If specific contact alone determines the grade of immunity, then the militia men seem to represent an average population and the medical students a group less exposed to infections in their upbringing than the average individuals of their age.

Our results with the Dick test seem to show the marked effect of a few months of life in an institution where streptococcal infections are common.

There was a rapid immunization, and accordingly a marked difference in the number of reactors among the recruits and the youths who had been in the establishment for some months. On the other hand, the students showed a very high number of reactors as compared with the recruits probably for reasons similar to those which produced the difference between the two groups in the naval establishment. It is to be noted that for the purpose of these arguments the students (age 20) and the youths (age 15-18) in the naval establishment have been accepted as comparable groups. If the recruits to the naval establishment had reached the age of 20 the difference would presumably have been even greater, as there should have been fewer reactors.

It is difficult to find an explanation for the results obtained in coloured races. There must be some interplay by factors not yet fully investigated, but, until the possibility of active immunization has been entirely excluded, it does not seem justifiable to assume that their immunity is due to normal physiological processes.

#### SUMMARY

1. Great differences in the number of young adult reactors to the Schick and Dick toxins were found in different social classes.

2. In white races the immunity in young adults, in the absence of previous clinical disease, to diphtheria and scarlet fever, as evidenced by negative reactions to Schick and Dick tests, seems to be caused wholly by contact with the infective agents.

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