with moderate frequency, the fact would be almost conclusive evidence against the essential unity of chorea and rheumatism. In the present series only one of the current attacks could be brought into relation with immediately precedent scarlet fever. But there were five others, recurrent attacks, with regard to which it was convincingly stated that the first or (in one case) second bouts of chorea had followed close in the wake of scarlet fever. Fourteen of the 75 children had suffered from scarlet fever, and of them no less than 6 had developed chorea shortly after their return from the fever hospital. The discrepancy between these figures and those of the fever hospitals is explained by a consideration of the history of the only attack in the series which was closely associated with scarlet fever. The child returned from the fever hospital and was kept at home for three weeks, during which she exhibited no movements. She was then sent back to school, and the very next day was observed to be jerking herself about. It seems clear that the ordered placidity of a fever hospital exercised in her case, and presumably in the others, a sedative influence upon a nervous system already in a state of potential chorea, and that the withdrawal of this steadying influence combined with exposure to the chances of everyday life admitted the determining factor, emotional stress, which in the case of the child under discussion was provided by her first visit to school since her illness. There is no other assumption than this which will account for the otherwise singular fact that chorea should be actually rarer in a fever hospital than among the common run of hospital patients; but the fact chimes well with the conception of chorea given above.

Fourthly. It is quite certain that amputation of the tonsils is ineffectual for any other purpose than the removal of a physical obstruction in the airway. The tonsillar remains or tonsillar lymphatic glands were still enlarged in all but 3 of the 16 children previously operated upon, and of those 3, 1 had been treated by enucleation.

CONCLUSIONS.

1. That Sydenham's chorea and rheumatic fever are due to one and the same infecting agent.
2. That the action of the rheumatic poison upon a specifically predisposed central nervous system produces a characteristic nervous instability which may precede the appearance of choreic movements by some weeks, and may in other cases itself constitute the sole evidence of the choreic tendency, the phase of movements never becoming developed at all.
3. That the emergence of choreic movements is determined by emotional stimuli acting upon a central nervous system thus previously disequibrated.
4. That the commonest avenue of rheumatic infection is the tonsil, and next to it the nose.
5. That the first essential of rational treatment of rheumatic infection is restoration of the upper air passages to a healthy condition.
6. That irrigation and thorough cleansing of the nasal passages, combined with antiseptic treatment of the nose and pharynx, should be a routine item of antirheumatic treatment; and that the operation of enucleation should be performed without delay upon all rheumatic children who exhibit chronic enlargement of the tonsils or of the tonsillar lymphatic glands.
7. That chorea is a common sequel of scarlet fever, but that the appearance of movements is usually postponed until the patient has left the fever hospital.

STATISTICAL TABLE.

Total number of cases	...	...	...	75
Proportion of girls to boys	...	...	...	5.25 to 1
Average age	...	...	...	10 years
Family history of rheumatic fever or chorea (67 cases)—				
Father and mother	...	...	...	6
Father, not mother	...	...	...	9
Mother, not father	...	...	...	8
Total parental	...	...	...	23 (34.3%)
Brother, sister, uncle or aunt	...	...	...	15
Total with positive family history	...	...	...	38 (56.7%)
Colour of hair (59 cases)—				
Red or rufous	...	...	...	15
Not red or rufous	...	...	...	27
Total fair	...	...	...	42
Brown	...	...	...	8
Dark	...	...	...	9

Immediately precedent shock (51 cases)—			
Plausible history present in	...	...	41 %
Condition of heart (75 cases)—			
Normal in	...	...	30 (40%)
Organic disease in	...	...	25 (33.3%)
Doubtful murmurs in	...	...	20 (26.6%)

Relation to scarlet fever (67 cases)—			
No previous scarlet fever	...	...	53
Previous scarlet fever	...	...	14
No chorea or rheumatism as direct sequel			
Chorea as direct sequel	...	...	6
Rheumatism as direct sequel	...	...	2

Enlarged movable lymphatic glands along lower border of mandible, unexplained by condition of teeth or gums, in			
...	...	...	4

Present condition with regard to tonsils and tonsillar glands of 15 cases previously operated upon by amputation—			
Tonsillar glands enlarged	...	...	13
Remnants of tonsil enlarged	...	...	7
Tonsillar region healthy	...	...	2

Table showing Age at Onset of First Attack of Chorea (70 Cases).

First attack occurred at—			
4 years of age in	2 cases.	11 years of age in	6 cases.
5 "	" 4 "	12 "	" 6 "
6 "	" 9 "	13 "	" 3 "
7 "	" 12 "	14 "	" 2 "
8 "	" 9 "	15 "	" 1 case
9 "	" 9 "	16 "	" 1 "
10 "	" 6 "		

Table of Recurrences (73 Cases).

The current attack was the first in	...	...	33 cases.
" " second in	...	...	21 "
" " third in	...	...	11 "
" " fourth in	...	...	3 "
" " fifth in	...	...	5 "

Percentage of recurrences = 54.7.

REFERENCES.

- 1 Elmslie: L.C.C. Med. Off. Rep., 1909, p. 86.
- 2 Branson: *Ibid.*, 1910.
- 3 Branson: BRITISH MEDICAL JOURNAL, 1905, p. 72.
- 4 Poynton: Osler and McCrae's *System*, 1907, ii, p. 712.
- 5 Senator: *Deut. med. Woch.*, 1912, No. 9, p. 414.
- 6 Menier: *Zeit. f. Laryng.*, Würzburg, 1908, i, 335.
- 7 de Ponthière: Translation by Yearsley, *Journ. of Laryng.*, vol. xxv, p. 461.
- 8 Turner and Stewart: *Textbook of Nervous Diseases*, 1910.
- 9 Fletcher, H. Morley: *St. Bartholomew's Hosp.*, vol. xxxii, p. 397. Miller: *Medical Diseases of Children*, 1911.
- 10 Fletcher, H. Morley: *Loc. cit.*, p. 392. Mackenzie, S.: *Rep. of Coll. Investigation*, BRITISH MEDICAL JOURNAL, 1887, p. 425.
- 11 Miller: *Loc. cit.*
- 12 Langmead, *Lancet*, October 31st, 1911, p. 1134.
- 13 Yearsley, Macleod: *Brit. Journ. of Children's Diseases*, 1910, vii, 61, 97.
- 14 Stratton: BRITISH MEDICAL JOURNAL, 1885, vol. ii, p. 437.
- 15 Caiger: *Allbutt's System of Medicine*, 1906, vol. ii, part I, art. Scarlet Fever.
- 16 Priestley: BRITISH MEDICAL JOURNAL, 1897, vol. ii, p. 805.
- 17 Osler: *On Choreia*, 1894.

A POSSIBLE TEST IN THE DIFFERENTIATION BETWEEN HUMAN AND BOVINE TYPES OF THE TUBERCLE BACILLUS.

BY

JOHN FRASER, M.D., CH.M., F.R.C.S.E.,

ASSISTANT SURGEON, ROYAL HOSPITAL FOR SICK CHILDREN, EDINBURGH.

(From the Royal College of Physicians' Laboratory, Edinburgh.)

THE most reliable test which we possess in the process of differentiation between human and bovine tubercle bacilli is the inoculation of certain animals (most commonly the rabbit or the calf) with a small known quantity* of the organism under investigation. If the infection results in a rapid dissemination of the disease and the speedy death of the animal, it may be affirmed that the bovine bacillus in the organism present.

* The exact amount varies in the case of the rabbit; 0.01 mg. of the dried bacilli is the most suitable quantity (Royal Commission Reports).

If, on the other hand, the resulting lesions are few and tending to be retrogressive, and death ensues after a very considerable interval of time, or from some intercurrent disease, the infection may be classified as human.

The inoculation is made intravenously, and the dissemination of the disease is a general one. When the inoculation is made locally, there results a localized development of tubercle, and the degree of local reaction varies according to whether the human or the bovine bacillus has been the causative factor.

A distinction can be drawn between human and bovine bacilli by the local reaction, as well as by the general reaction produced in these animals.

The difficulty lies in appreciating the degree of local reaction. In subcutaneous or intramuscular injection finer distinctions are impossible. It is necessary to make use of some structure in which the changes are distinct and definite. I have found that the ideal situation in which to demonstrate such is the synovial membrane, and more especially the synovial membrane of the knee-joint of the rabbit.

By the degree of reaction, clinical and pathological, consequent upon inoculation of the joint with a small quantity of bacillary emulsion one can differentiate between the human and the bovine types of tubercle bacilli.

Technique.

Rabbits were employed in the various experiments. The test is best demonstrated when an emulsion of the bacilli is injected into the part, but it may be carried out with pus or other pathogenic fluid; it is essential, however, that no mixed infection be present.

I have chosen the knee-joint as being the most convenient and accessible. Admission to the interior of the joint is gained by strongly flexing the joint and inserting the needle by the side of the ligamentum patellae.

It is not necessary to weigh out any exact amount. I make up a thin emulsion, and inject 1 c.cm. It is difficult to define the standard of the emulsion, but it is usually of such a density that one can read through it the leader type of a newspaper.

The sequelae are distinct. If the human bacillus is introduced, there are few resulting changes; the synovial membrane becomes slightly thickened, and there is some excess of fluid in the joint—there is no degree of stiffness and no joint pain; the animal continues to put on weight or remains constant.

If the joint is examined three or four months later, there is found to be a chronic synovial tubercle. It is rare to find any degree of disease in the bones or articular cartilages or throughout the body.

When, on the other hand, the bovine bacillus is injected, the changes are rapid and acute. About ten days after inoculation the animal becomes cripple, the joint becomes swollen and painful, the limb takes up a permanently flexed position; there is a progressive and continuous loss of weight. Examination of the joint three to four weeks after inoculation shows the presence of acute synovial tubercle; the interior of the joint is full of caseous debris; the articular cartilages are eroded; there are foci in the neighbouring bones and throughout the body; the lungs, spleen, and kidneys are diseased. Nothing could be more striking than the distinction clinically and pathologically.

In the following table the results of fifteen applications of the test will be found. In twelve of these, strains of bacilli isolated from bone and joint tuberculosis were employed. These strains had been fully investigated by me, and the details will be found in a paper published in the current volume of the *Journal of Experimental Medicine*. In the remaining three cases pus from clinically tuberculous lesions was employed.

Summary of Experiments.

No.	Animal.	Date of Inoculation.	Date of Examination.	Clinical Condition.	Post-mortem Examination.	Result.	Control Experiment.
1	Rabbit; weight 2,100 grams	February 10th	May 15th; 3 months later	Some thickening of joints; no limping or pain	Chronic synovial tubercle	Human	Human.
2	Rabbit; weight 1,890 grams	February 10th	May 20th; 3 months later	Thickening of joint; no pain	Chronic synovial tubercle	Human	Human.
3	Rabbit; weight 2,000 grams	February 10th	June 10th; 4 months later	Slight hydrops of infected joint	Chronic synovial tubercle	Human	Human.
4	Rabbit; weight 1,980 grams	February 14th	March 11th; 1 month later	Joint swollen, painful; animal cripple	Acute tubercle: joint full of caseous debris	Bovine	Bovine.
5	Rabbit; weight 1,750 grams	February 15th	February 25th; 10 days later	Joint distended with fluid; animal cripple	Acute synovial tubercle; joint full of caseous debris; general tuberculosis	Bovine	Bovine.
6	Rabbit; weight 1,800 grams	February 15th	March 8th; 21 days later	Joint distended; knee flexed and painful; losing weight	Acute synovial tubercle; caseous material in joint; general tuberculosis	Bovine	Bovine.
7	Rabbit; weight 2,100 grams	February 18th	March 10th; 20 days later	Acute change in joint; losing weight	Acute synovial tubercle; tubercle in lung and spleen	Bovine	Bovine.
8	Rabbit; weight 1,900 grams	March 8th	August 8th; 5 months later	No change beyond slight synovial thickening	Chronic synovial tubercle; no general tuberculosis	Human	Human.
9	Rabbit; weight 2,200 grams	March 8th	July; 4 months later	No change beyond synovial thickening	Chronic synovial tubercle; no general tuberculosis	Human	Human.
10	Rabbit; weight 1,980 grams	April 8th	April 20th; 12 days later	Evidence of acute arthritis; joint flexed	Acute synovial tubercle	Bovine	Bovine.
11	Rabbit; weight 2,100 grams	April 9th	April 19th; 10 days later	Evidence of acute arthritis; animal cripple; losing weight	Acute synovial tubercle	Bovine	Bovine.
12	Rabbit; weight 2,000 grams	May 3rd	May 26th; 23 days later	Evidence of acute arthritis; animal cripple and losing weight	Acute synovial tubercle; joint full of caseous debris; losing weight	Bovine	Bovine.
13	Rabbit; weight 2,100 grams	May 3rd	May 26th; 23 days later	Evidence of acute arthritis; cripple and losing weight	Acute synovial tubercle; caseous debris in joint; losing weight	Bovine	Bovine.
14	Rabbit; weight 2,000 grams	May 3rd		Thickening of joint; no evidence of acute change; weight constant		Human	Human.
15	Rabbit; weight 1,970 grams	April 9th	May 9th; 1 month later	Evidence of acute arthritis; losing weight	Acute synovial tubercle; general tuberculosis	Bovine	Bovine.

The control experiment quoted above was the intravenous inoculation of the rabbit with 0.01 mg. of the culture.

Advantages of the Test.

1. It may be applied equally readily with bacillary emulsion, with pus or other pathogenic fluid.*
2. The distinctions in the degrees of reaction produced in the joint are absolute.
3. The result of the test is apparent in a comparatively short time; if no acute signs are present three weeks after inoculation the test may be taken as indicating a human infection, and vice versa.
4. The test is specially recommended by its simplicity.

Conclusions.

(a) Just as the general reaction of the rabbit to infection by the human or bovine bacillus varies greatly in degree, so does the local reaction.

(b) The best situation in which to demonstrate such a local reaction is the synovial membrane of the knee-joint.

(c) Infection of the knee-joint of the rabbit with a bovine bacillus produces an intense reaction with acute synovial tuberculosis; infection with the human bacillus results in a chronic synovial thickening.

(d) The test is of value as quickly distinguishing between the human and bovine types of the tubercle bacillus.

I have to acknowledge my indebtedness to Dr. James Ritchie, Director of the College of Physicians' Laboratory, Edinburgh, for his guidance and advice; also to the trustees of the McCunn Research Trust and the Carnegie Trust for defraying the expenses of the research.

THE SOIL AND THE SEED IN TUBERCULOSIS.

BY

HALLIDAY SUTHERLAND, M.D.,

MEDICAL OFFICER, ST. MARILEBONE TUBERCULOSIS DISPENSARY.

THE battle of the soil and the seed—*hérédité du terrain ou hérédité du grain*—has been waged for a century around tuberculosis. If one accepts congenital tuberculosis as a possible but infrequent occurrence, the issue is then centred upon the existence or non-existence of a direct transmitted predisposition to the disease. Those physical signs regarded as evidence of a tuberculous diathesis in childhood are too well known to require recollection, and have generally been ascribed to a transmitted weakness of tissue as the result of tuberculosis in the parents. To D. J. Hamilton² the physical signs of this predisposition were so well marked that he held it to be a true inherited strain of a variation which took place far back in the history of the race. Others have suggested that these physical signs, so far from connoting an inherited predisposition, are the expression of the actual infection of the child after birth. Some years ago, believing in an inherited predisposition, I attempted to controvert this suggestion by a collation of all the myths that had haloed round that blessed word "diathesis."¹

The practice of a tuberculosis dispensary demonstrated to me that which was first proved by R. W. Philip—that childhood is the age at which tuberculous infection is most frequent. If we admit the frequency of tuberculous infection in childhood, it is certain that the actual presence of so profound a neuro-muscular toxin as the tuberculous toxin will exercise a more powerful influence on the metabolism of the child than the influence of a far-off inherited strain. It is not from that standpoint that the question is approached in this paper, but from a consideration of the amount of tuberculous infection among a "contact" population in relation to the absence or presence of the tubercle bacillus in the expectoration of the original patients.

A diagnosis of early pulmonary tuberculosis is made when the following signs are present: Philip's small glands above the clavicle, diminished tidal expansion on the affected side, rapid tailing off of the resonant area above the clavicle, relative dullness, alteration—usually a weakening—of the inspiratory murmur on the affected side, *plus* the presence of a positive tuberculin reaction.

From the dispensary during the year ending December, 31st, 1911, the "contacts" (persons living in the same household) of 204 cases of pulmonary tuberculosis were

The fluid is centrifuged and an emulsion of the deposit injected.

examined. A total of 723 contacts were examined, of whom 420 were found to be healthy, 290 infected with tuberculosis of the lung, and 13 with other forms of the disease. In all 41.9 per cent. of contacts were infected. Of the original patients, some were infectious, having tubercle bacilli in the sputum, while others were non-infectious at the time, since no tubercle bacilli were found. The amount of infection in the contacts showed a marked relationship to exposure to infection. In the families of those in an infectious stage of the disease, the majority (60 per cent.) were infected with tuberculosis. In the families of non-infectious patients, the majority (75.5 per cent.) were healthy. The actual figures are given in the accompanying tables (p. 1435), the original cases being divided into four groups—non-infectious males, non-infectious females, infectious males, and infectious females.

The results are shown graphically in the following diagram:

If we combine certain of these age groups, the amount of infection at different periods of life in relation to exposure or non-exposure to immediate human infection appears as follows:

In Children under the Age of 15 Years.

211 were in relation to non-infectious patients, and 92, or 43.6 per cent., were infected.

161 were in relation to infectious patients, and 120, or 74.5 per cent., were infected.

In Adults between the Ages of 15 and 25 Years.

41 were in relation to non-infectious patients, and 5, or 12.1 per cent., were infected.

63 were in relation to infectious patients, and 42, or 66.6 per cent., were infected.