In commencing a study of rheumatic fever, it is necessary in the first place to come to some decision as to what is to be included in the term. Speaking generally, it may be said that, clinically, rheumatic fever is a disease of indefinite duration characterized by fever, sweating, transient non-suppurating inflammation of joints, and by the very frequent occurrence of cardiac lesions. It is well-known, however, that all or most of this group of symptoms may be produced by gout, may occur as complications of gonorrhoea, or as part of a pneumococcal, staphylococcal, streptococcal or other septicæmia, or again as the result of serum disease. Cases of this kind are frequently reported in medical journals and there are probably few practitioners who have not come across them. As examples the series of five cases of pneumococcic septicæmia recorded by MacCordick¹ might be mentioned. In all of these there was non-suppurative arthritis, resembling that of rheumatic fever; endocarditis or pericarditis occurred in some of them; four of the patients had a previous history of "rheumatic fever" and one had had chorea. I have also reported a case of this kind,²

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the causal organism being apparently a *Staphylococcus aureus*. In many instances the presence of special features sooner or later gives a clue to the nature of such cases; if the inflammation fixes itself in a joint, produces permanent damage of joints, or goes on to suppuration, most observers would remove the case from the classification of acute rheumatism. Though even in these circumstances there is not absolute unanimity; Poynton¹ asserts that suppuration may occur in rheumatic fever, and that the transient character of the arthritis may be missing, so that we may even get osteo-arthritis as a part of acute rheumatism. Gonorrhoeal arthritis has for its special characters the tendency to involve peri-articular tissues and tendon sheaths, and to become localized in one or two joints after a preliminary skirmish round the body; but quite a number of undoubted cases of gonorrhoeal arthritis behave in every particular like rheumatic fever. Similarly it is by no means the rule for arthritis occurring in the course of one of the septicemias to go on to suppuration. Where blood and joint cultures are undertaken the true nature of many of these cases, which would otherwise be classed as rheumatic fever, is disclosed; but there still remains a residuum in which neither clinical symptoms nor pathological findings provide a certain guide, and which one must, until the advent of further knowledge, class as rheumatic fever.

Those who believe that salicylates have a specific effect on rheumatic fever would take the action of these drugs as the final touchstone in cases of doubt; how then are cases which do not respond in the slightest to the drug to be classified? During the past three years we have had a number of cases at Millbank which presented the classical symptoms, fever, sweating, pain and swelling of large joints flitting about from one articulation to another, cardiac lesions being present in some of them, and yet large doses of salicylates had not the slightest effect on them; they usually ran a course of one to three weeks and then recovered spontaneously. Side by side with such cases were others with precisely similar symptoms which improved immediately with the same doses of salicylates. It is necessary to believe either that salicylates act erratically in acute rheumatism, or else that there is one disease called acute rheumatism in which they act, and another set of diseases bearing the same name in which they do not act. The distinction is sharp, for as a rule the drug either produces marked and definite relief in a short time, or it does no good at all. The position seems to be

¹ *Quart. Journ. of Med.*, 1909, vol. iii, No. 9, p. 15.
much the same as that of dysentery before it was recognized that there is one dysentery due to amœbiasis and others which are bacillary in origin. Those who chiefly came across amœbic dysentery had great faith in the value of ipecacuanha; a faith which, as events proved, turned out to be well grounded; whilst those whose practice brought them in contact chiefly with the bacillary dysenteries found that ipecacuanha was useless. Some observers consider that salicylates act only as analgesics and antipyretics; but these drugs do more than that—they interfere definitely, in those cases where they act, with the recurring attacks of arthritis; if they acted only as analgesics and antipyretics they should give relief in gonorrhœal arthritis, or in the arthritis of Malta fever, in which they are notoriously useless.

It seems highly probable then that there is one disease called rheumatic fever which is influenced by salicylates, which causes the greater number of cases of cardiac lesions in the young, and to which very likely the cardiac lesions described by Aschoff and Tawara, Carey Coombs, and others, are peculiar; alongside of this disease there are others indistinguishable from it clinically, except for the fact that they are not influenced by salicylates, but which have another causation. If this conception be a true one it is not difficult to understand how it is that the results of investigation as to causation have varied in different hands, and how one’s mental picture of acute rheumatism must vary according to the nature of one’s practice; in civil hospitals and especially in children’s one is more likely to come across the more severe and prolonged cases, and possibly a higher proportion of those cases which are amenable to the action of salicylates, whilst doctors in general practice come across all varieties, from the most severe and persistent forms to those presenting the mildest transient arthritis.

The bearing of these remarks will become apparent when we come to consider the various bacteriological findings in the disease, and they are important to keep in mind in view of the fact that in papers by Poynton and Paine much importance is given to the fact that many of their cases were selected by clinicians of the highest eminence, and therefore, according to these authors, were undoubted cases of rheumatic fever. It would serve very little purpose to enter with great detail into the various speculations

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which have been held as to the causation of rheumatic fever; one can only mention the lactic acid theory, the nervous hypothesis, and the neuro-toxic hypothesis, all of which depend but little on experimental or epidemiological data, and fail in many points to explain the lesions found, especially in the heart. MacLagan's comparisons between malaria and rheumatic fever are chiefly of interest nowadays because of the way in which he draws attention to the action of salicylates in rheumatic fever. It is indeed a remarkable circumstance that if rheumatic fever is a bacterial disease it stands alone among bacterial diseases in the fact that it is influenced by a drug. On the other hand, there are many examples of drugs having a curative action on protozoal diseases; one need only instance malaria, syphilis and amoebic dysentery. Sahli, in 1892, isolated a staphylococcus from the synovial membrane of a case of "rheumatic fever" fourteen hours after death; he expressed the opinion that acute rheumatism is an attenuated pyrexia caused by streptococci or staphylococci of slight virulence. This view, however, cannot be upheld in view of the fact that the cardiac lesions of streptococcic and staphylococcic pyrexia are, as pointed out by Carey Coombs, essentially supplicative in nature, and differ entirely from the submiliary nodules with multinucleated cells which were described by Aschoff and Tawara, and by Carey Coombs, as occurring in the heart walls of cases of rheumatic pericarditis, and which are peculiar to that form of carditis. Carey Coombs himself failed to find organisms in the nodules, but he suggests that possibly this may have been due to the fact that he did not examine the material sufficiently soon after death. The distribution of the cardiac lesions in nodules and their localization chiefly along the cardiac vessels lends considerable support to the idea that they are more likely to be due to a particulate virus than to a soluble toxin, which might be expected to be more diffuse in its effects.

In 1891 Achalme described a large sporing anaerobic bacillus which he found in the blood of rheumatic fever patients both before and after death. Several other observers found this same

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1 "Twentieth Century Practice of Medicine."
2 Correspondenzbl. für Schweiz. Ärzte, 1892, vol. xxii.
3 Lancet, June 8, 1912, p. 1529.
4 Loc. cit.
5 Loc. cit.
organism, though the majority failed to recover it from their cases. Thiroloix\(^1\) by injecting a culture of this germ into rabbits produced symptoms resembling those of rheumatic fever, and some at any rate of the rabbits showed cardiac lesions; it has, however, been pointed out by Foulerton that it is by no means unusual to find valvular lesions in apparently normal rabbits, and Hewlett\(^2\) identified Achalme's bacillus with *Bacillus enteritidis sporogenes* (Klein). Several observers have recovered streptococci or staphylococci from patients suffering from rheumatic fever, but they do not appear to have succeeded in reproducing arthritis with their cultures. Westphal, Wassermann and Malkoff\(^3\), however, recovered a streptococcus from the blood, heart valves and brain of a girl dead of endocarditis and nephritis associated with chorea; cultures of this organism injected into rabbits produced multiple arthritis after an incubation period of nine to ten days. The coccus grew in chains on culture and required a highly alkaline medium for its growth. In 1900 Poynton and Paine\(^4\) reported the finding in eight successive cases of rheumatic fever of diplococci in the blood during life, and post mortem in the cardiac valves, pericardial exudate and in a nodule. They also isolated streptococci from the throat of a patient suffering from rheumatic fever and from the urine of two cases of pericarditis. Inoculation of large doses of some of the strains produced multiple arthritis in rabbits, the affected animals showing clear to opaque fluid in the joints involved and diplococci or diplostreptococci were again isolated from the joints of the experimental animals. These authors have published from time to time records of further work in the same direction and in 1910\(^5\) reported that altogether they had recovered streptococci from forty cases, and had succeeded in producing in rabbits not only multiple arthritis but all forms of carditis of the same order as is found in rheumatic fever, viz., scattered foci with degeneration of muscle around. They do not, however, give any description of the myocardial lesions present in their experimental animals, so that it is uncertain whether they showed the same structure as the submiliary nodules described by Aschoff and Tawara, or whether they were more of a simple inflammatory

\(^1\) *La Semaine Médicale*, 1896, pp. 376, 420.  
\(^2\) *Trans. Path. Soc. Lond.*, 1900.  
\(^3\) *Berl. klin. Woch.*, 1899, p. 688.  
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care. Carey Coombs (Brit. Med. Journ., 1912, vol. ii, p. 933) has recently made a preliminary announcement that he has succeeded in finding cardiac lesions essentially similar to those which are characteristic of rheumatic fever in rabbits inoculated with five different strains of streptococci isolated from cases of rheumatic fever. On the other hand, Leila Jackson (Journ. of Infect. Dis., vol. ii, No. 2, p. 243), describing the heart lesions resulting from the intravenous inoculation of Streptococcus viridans, reports the finding in one rabbit (which had received four doses during two months) of nodules composed mainly of mononuclear elements, but including a number of large multinucleated cells. The streptococci which Poynton and Paine found appeared to grow best on acid media and preferred especially a medium containing broth and milk with a little lactic acid; beyond this and the fact that intravenous inoculations of their germs produced arthritis in rabbits, these authors give no details which would serve to distinguish the streptococci which they found from many others of the same group. Shaw1 described the cultural characters of Wassermann's coccus; he found that it grew in chains of 8 to 10 elements, produced no general turbidity of broth, turned the haemoglobin of blood agar to a brown or greenish-brown, and grew best on alkaline media; as a result of comparisons with Poynton and Paine's coccus he concluded that the latter was identical with Wassermann's strain, notwithstanding the fact that the one grew best on a highly alkaline medium and the other appeared to prefer acid media. Beattie2 in 1904 gave a more detailed description of Poynton and Paine's coccus; he found that it grew in pairs or short chains, that it was smaller than most streptococci and the elements were often oval, broth was turned acid, and there was a slight turbidity which, however, soon cleared, leaving a flocculent deposit. On blood agar it produced the colour changes described by Shaw, and on this medium proved to be very long lived, up to eight and a half months; milk was acidulated in twenty-four hours and clotted after seventy-two hours. Beattie considered that the length of time it lived on suitable media and the marked acidity which it produced in broth served to distinguish it absolutely from other streptococci. In 1907 Beattie3 reported further results of his examination of

1 Journ. of Path. and Bact., vol. ix, p. 158.
cocci recovered from cases of rheumatic fever, the main results of which will be found in the table (Table I) appended; he again pointed out the great vitality of the germ, and gave as the only definite and very distinctive reaction the precipitation of bile salt in bile salt lactose broth, a reaction given by none of the other streptococci tested. Rabbits inoculated with streptococci from other sources gave doubtful agglutinins for the \textit{S. rheumaticus}, whilst animals inoculated with the latter gave definite agglutinins for it as well as for streptococci isolated from a case of cellulitis. Beattie himself recovered the streptococcus in three cases from the synovial membrane, but not from the blood; in one case he isolated it from the synovial membrane, but not from the joint exudate. In 1911 this same author along with Yates\textsuperscript{1} gave still further results of their studies of the \textit{S. rheumaticus}; the cultural results are given in the appended table, and with regard to these they found that the reactions were fairly constant, the only variations from the streptococcus of rheumatic fever cases occurring with inulin. They succeeded in giving non-suppurative arthritis to rabbits by inoculation of cultures of streptococci from rheumatic throats and a similar result was obtained in one case by inoculation of a streptococcus from a case of peritonitis complicated by septicæmia. They state that "even with the organisms isolated from cases of rheumatism the inoculation results, though extremely interesting and suggestive, are not definite enough to justify any conclusions as to specificity." Buchanan\textsuperscript{2} reported good results from the inoculation of a vaccine prepared from a streptococcus isolated from a case of endocarditis; the fermentation reactions of the organism which he describes are given in the appended Table I. He found in addition that the streptococcus gave acid in bile salt lactose broth with precipitate, formed formic acid in broth and gave positive results (arthritis) on inoculation into rabbits. With regard to the reactions shown in the table it will be noted that they vary considerably with strains of streptococci isolated from cases of rheumatic fever, even in the same worker's hands, and that streptococci from sources which are frankly not rheumatic fever may give the same reactions as those from cases diagnosed rheumatic fever. Two alternative explanations suggest themselves, either that more than one streptococcus may be concerned in the production of symptoms labelled rheumatic fever, or that the cultural characters

\begin{thebibliography}{9}
\bibitem{1} \textit{Journ. of and Path. Bact.}, 1911, vol. xvi, p. 247.
\bibitem{2} \textit{Journ. of Vaccine Therapy.}, vol. i, No. 1, p. 1.
\end{thebibliography}
which are given in the table are not sufficiently stable or sufficiently distinctive to enable one to separate sharply those streptococci which have been isolated from cases of acute rheumatism from those isolated from other sources.

With a view to settling in my own mind the relation of the so-called *S. rheumaticus* to acute rheumatism, I obtained from Dr. Beattie a culture of the germ which he had recently isolated from a joint of a fatal case of rheumatic fever. I also obtained another strain from a different source; the history of the latter I do not know, but it seemed to be identical, so far as I could judge from cultural reactions and animal experiments, with the strain obtained from Dr. Beattie. The experiments which are given below were made chiefly with Dr. Beattie’s culture. The organism was a small Gram-staining streptococcus, growing in short chains; its Gram-staining properties were distinct, though when recovered later on from joint effusion it showed a tendency to decolorize; this, however, is a usual finding with Gram-staining bacteria in tissues and exudates. The organism grew without difficulty on ordinary media, producing a very thin transparent growth on ordinary agar, which it seemed to prefer to blood agar; it did, however, grow on the latter to some extent and there was quite definite haemolysis along the streak; there was diffuse growth in broth with no tendency to granulation of the growth or to deposit, milk and milk broth were clotted within twenty-four hours, and in media containing litmus the reagent was bleached in all but the upper inch or so of the tube. The remainder of the fermentation reactions are given in the table, from which it will be seen that the results differ from those given by Beattie; these, however, may be due to differences in the media used. One very remarkable feature of the culture was its extraordinary vitality, a point to which Beattie has drawn attention; in my hands it lived for over nine months in milk broth without subculture; I found, also, that it would live in ⅓ per cent. carbolic acid for more than two weeks and that it was not killed by heating to 60° C. for half an hour. This character of resistance seems to separate the organism sharply from most other streptococci and is obviously one to take advantage of in further searches for the germ. As regards its pathogenic effects on rabbits it is necessary to give a very big dose (six agar slopes of a twenty-four hour agar culture as a rule) if a certain result is to be obtained, though I have produced lameness with a dose of three agar slopes. When given in these doses, and intravenously, it produces lameness in from one to five days;
the lameness varies from day to day, sometimes the animal appears to recover completely for a while and then it breaks down again, practically always in the same limb, though now and again in the earlier stages of the illness lameness in another limb may be added. I have never observed the tendency for the lesions to flit about from joint to joint, which is so characteristic of acute rheumatism in man, nor have I been able to satisfy myself that chill was a factor in the causation of relapses. It is true that at times a rabbit is found more lame after a cold night, but equally often this happens when there has been no particular lowering of the temperature. The disease lasts a variable time; a rabbit may have a transient attack of lameness and recover completely in a few days, or it may go on for two months, relapsing and recovering. I have not kept them longer than this. The rabbits do not seem to suffer in their general health, they keep fat and their coats remain in good condition. Post mortem, alterations are found in one or more joints of the affected limb: sometimes in joints which have caused no symptoms for as long as ten days. There is a thick glairy fluid which may be transparent or markedly opalescent; at the early stages of the disease the fluid contains considerable numbers of endothelial cells and polymorphonuclear leucocytes, later on the latter are scanty and masses of coarse eosinophile granules, as well as fragments of chromatin, are found in the cytoplasm of the desquamated endothelial cells. The synovial membrane is swollen and jelly-like, and now and again patches of congestion, as described by Beattie, are seen on it. In one case, where the animal had been lame for eight weeks, there was thickening of the humerus and some erosion of the cartilage, a condition somewhat resembling that found in osteo-arthritis. Culture of the joint fluids and of the synovial membrane usually gave negative results in my hands unless the animal was killed and the cultures made within the first seven to ten days of the illness. I have not succeeded in recovering streptococci from patches of synovial membrane in cases where I failed to find them in the joint fluid. On three occasions I have seen definite vegetations on the heart valves, once on the tricuspid and twice on the mitral, but I have been unable to get any growth from any of these specimens; whilst sections of the heart muscle in the same cases showed no definite lesions. The serum of infected animals was found to contain thermostable opsonins for the streptococcus with which they were inoculated, but not for other streptococci. I showed
Some time ago\(^1\) that the thermostable opsonins which result from the injection of rabbits with streptococci are remarkably specific. The serum of infected rabbits also showed the presence of agglutinins when tested by growing the streptococcus in a broth containing 1:10 or 1:20 dilution of the serum; in this medium the organism, which ordinarily grows diffusely, grew as clumps at the bottom of the tube and the supernatant fluid was left almost clear.

In order to test the effect of giving salicylates to affected rabbits, four rabbits were each given a dose of five agar slopes of the streptococcus intravenously, lameness appeared as usual in all of them within the first week, and on the twelfth day after inoculation their condition was as follows:—

No. 1 was lame in both front legs. No. 2 was lame in both front legs. No. 3 was lame in the right hind leg. No. 4 was lame in the left front leg. From this date Nos. 1 and 2 were given daily doses of 3 gr. of sodium salicylate, subsequently increased to 5 gr., while Nos. 3 and 4 remained as controls; the subsequent progress of the animals is given in Table II. It will be seen from this that the salicylate had no effect on the symptoms, and as a matter of fact the animal which showed most symptoms throughout was one of those which was receiving salicylates; this animal recovered spontaneously a month later. With regard to these experiments on rabbits it will be noted that the dose of the germ required is very large and that it is not till we, as it were, flood the animal with streptococci that we produce joint lesions resembling those of rheumatic fever. It is, moreover, possible to produce arthritis in rabbits by germs from other sources than rheumatic fever, and the type of the arthritis depends greatly on the virulence of the germ. For example, four rabbits were inoculated intravenously with streptococci coming, in three cases, from erysipelas patients and in the fourth from a case of empyema. All four animals developed lameness in one or two limbs; in the case of those which had received the erysipelas cultures the arthritis was non-suppurative in character, while the rabbit which received the empyema streptococcus showed definite suppuration in both knees, the joints being found post-mortem to be filled with cheesy pus.

To pass on to rheumatic fever in man, if the causal organism is one which can be cultivated, as the \(S.\) \(rheumaticus\) can be, it would be expected that once in a way at any rate the streptococcus

would be found in the blood-stream, since the lesions flit about from joint to joint, and it would seem likely that the germ, if there be one, would be carried by the blood-stream; moreover, in many cases of rheumatic fever there is affected tissue in the form of the heart valves actually lying in the blood-stream itself. I have made blood cultures in twenty-six cases of acute rheumatism, taking 5 c.c. of blood from a vein and inoculating it into milk broth, peptone broth, ascitic fluid and other media; the cultures were incubated at 37° C. at first aerobically, and later anaerobically; in every case I failed to get a growth of *S. rheumaticus* or any other germ; this result agrees with those obtained by McCrae,\(^1\) Phillip,\(^2\) and many others. I did, however, on one occasion recover a streptococcus from a case which was diagnosed clinically as malignant endocarditis. The patient had had an attack of tonsillitis eight days previously and returned to hospital suffering from gastric symptoms; two days later he had a rigor and from that time on for a month had high fever, urticarial rashes and severe pain over the pectorium and just above the middle of the clavicle there was also a double aortic murmur. A culture made with 5 c.c. of blood from a vein showed a growth of a short streptococcus resembling in many respects that of Beattie. As will be seen on reference to Table I, it showed much the same vitality, resisting heat to 60° C. for half an hour, but it only survived in \(\frac{1}{4}\) per cent carbolic acid for seven days and died out in a milk culture within a fortnight. I failed to produce joint lesions in rabbits with this germ and a rabbit whose serum showed thermostable opsonins for Beattie's streptococcus had none for the streptococcus of the endocarditis case. The patient recovered very rapidly and completely after the administration of four doses of an autogenous vaccine. In view of this it was thought desirable to try the effect of a vaccine of *S. rheumaticus* on rheumatic fever; six cases in all were treated in this way and none of them benefited in the least. This result contrasts with that of Buchanan\(^3\) who reported good results in a number of cases of rheumatic fever and of chorea; the organism which he used seems to have resembled that of Beattie in many respects, but it did not clot milk, and there is no record as to whether it showed the curious capacity for surviving outside the human body which is so marked a feature of Beattie's strains. Microscopical examinations and

\(^3\) Loc. cit.
cultures of joint fluids from twenty-eight cases have been made; the fluid was removed as soon as possible, a portion of it was centrifuged for microscopic examination, and the remainder inoculated in various media; blood agar, blood broth, serum agar, milk broth, hydrocele water, glucose peptone and other media were tried, especially efforts being made to get a growth on the milk broth medium recommended by Poynton and Paine. In one case a smear of the centrifuged deposit showed two short chains of Gram-staining streptococci, but culture in this case gave no growth; in another case the patient had been in hospital for a few days suffering from "influenza" when he developed arthritis in one knee; an anaerobic culture in hydrocele water, peptone, dextrose, glycerine (3 per cent) resulted in a growth of a Gram-staining streptococcus; this proved to be a facultative anaerobe which gave a diffuse growth in broth, grew in a characteristic streptococcus fashion on agar and on Loeffler's serum, which it preferred; it produced acid in milk, but no clot. On my media it fermented glucose, saccharose, maltose, raffinose, salicin and inulin after forty-eight hours, but did not ferment lactose, thus contrasting with the reactions obtained on the same media with Beattie's coccus. It died out in milk within fourteen days and I lost the opportunity of trying the effect of heat and carbolic acid on it. Two rabbits were given intravenous doses of the germ, one receiving the growth on a Loeffler slope and the other that on five agar slopes; neither of the rabbits showed any symptoms as a result. The search for streptococci in the remaining twenty-four joint fluids was unsuccessful. The frequent association of sore throat with acute rheumatism naturally suggests that one might search in the pharynx and tonsils for the germ, and Poynton and Paine have reported the recovery in some cases of streptococci from the throats of rheumatic patients which caused arthritis when injected into animals. As, however, they did not attempt to differentiate the streptococci in any other way than by their effect on animals it is doubtful whether the germs which they recovered were the same as the ones which they obtained from joints, heart lesions, &c. The variety of streptococci found in throats, and especially in sore throats, is so great that the task would be endless if one tested every culture, so I adopted the plan of growing them in milk broth and only testing those which lived in this medium for four or five days. I found now and again a short streptococcus which clotted milk within twenty-four hours with bleaching of the litmus and which, on my media, fermented glucose only within the first twenty-four
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hours, but none of them showed the same vitality as the *S. rheumaticus*; they all died out in milk broth within fourteen days, nor did I succeed in producing lameness in rabbits with any of them, except in the case of one culture. This was obtained from a man who had had several attacks of pain and swelling in his shoulders, elbows and wrists; he stated that each attack had been preceded by sore throat. A culture taken from the throat resulted in the isolation of a streptococcus which clotted milk within forty-eight hours, gave a diffuse growth in broth and an almost invisible growth on agar; it acidulated glucose peptone within twenty-four hours and after three days produced acid in lactose, sucrose, maltose and mannite; inulin, salicin and raffinose were unfortunately not tried. The culture in milk broth was found to be dead after fourteen days. A half-grown rabbit was given eleven agar slopes of this germ and five days later it developed lameness in its left hind leg, the lameness was not severe and the animal recovered completely in four weeks. The germ found in this case would seem to differ from the *S. rheumaticus* in the fact that it did not survive in milk broth and on my media it was much more active as a fermenter; it differed also in the appearance of the growth on agar, which was so scanty that at first sight there appeared to be no growth at all.

Examination of the opsonic index to *S. rheumaticus* of patients suffering from acute rheumatism regularly failed to reveal any alteration from the normal. As an example I might quote the following experiment in which the sera were taken and numbered by an independent observer. The opsonic index of the sera to *S. rheumaticus* was then taken, the control being the pooled sera of three normal persons; the results were as follows:

<table>
<thead>
<tr>
<th>Serum Description</th>
<th>Opsonic Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pleural effusion (tubercular)</td>
<td>1.16</td>
</tr>
<tr>
<td>Pleural effusion (cause?)</td>
<td>1.13</td>
</tr>
<tr>
<td>Case of chorea with mitral disease</td>
<td>0.77</td>
</tr>
<tr>
<td>Healthy man</td>
<td>0.96</td>
</tr>
<tr>
<td>Case with four relapses of acute rheumatism in four</td>
<td>0.88</td>
</tr>
<tr>
<td>months (mitral disease)</td>
<td></td>
</tr>
<tr>
<td>Healthy man</td>
<td>1.08</td>
</tr>
<tr>
<td>Recent rheumatism (mitral disease)</td>
<td>0.91</td>
</tr>
<tr>
<td>Healthy man</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Lastly, an attempt was made to find out whether the sera of rheumatic fever patients contain thermostable opsonins or agglutinins for the *S. rheumaticus*. For this purpose the sera of men who had suffered from frequent attacks, or who had been ill for some time with the disease, were taken. The experiments showed that there were no thermostable opsonins or agglutinins for the *S. rheumaticus* in the sera of such cases, contrasting with the
### TABLE I.

<table>
<thead>
<tr>
<th>Observer</th>
<th>Origin of culture</th>
<th>Broth</th>
<th>Blood agar</th>
<th>Milk</th>
<th>Glucose</th>
<th>Lactose</th>
<th>Saccharose</th>
<th>Maltose</th>
<th>Mannite</th>
<th>Salicin</th>
<th>Inulin</th>
<th>Raaffose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beattie (Journ. Exper. Med., 1907, p. 186)</td>
<td>Case of rheumatic fever. Joint (?)</td>
<td>Slight turbidity, soon clears and culture deposits, marked acid formation</td>
<td>White colonies Hb becomes chocolate-coloured</td>
<td>Acid, 24 hours; clot, 48 hours</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Beattie and Yates (Journ Path. and Bact., 1911-12, vol. xvi, p. 247)</td>
<td>(p) Acute rheumatism (pi. m.)</td>
<td>Do.</td>
<td>Do.</td>
<td>Acid, clot</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(o) Acute miliary tuberculosis</td>
<td>Do.</td>
<td>Do.</td>
<td></td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>(l) Ruptured aneurism</td>
<td>?</td>
<td>?</td>
<td></td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>?</td>
<td></td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Case of acute miliary tuberculosis</td>
<td>?</td>
<td>?</td>
<td></td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>?</td>
<td></td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Case of broncho-pneumonia</td>
<td>?</td>
<td>?</td>
<td></td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>?</td>
<td></td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Case of septicemia</td>
<td>?</td>
<td>?</td>
<td></td>
<td>+</td>
<td>+</td>
<td>?</td>
<td>?</td>
<td></td>
<td>+</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Harrison</td>
<td>Strain supplied by Prof. Beattie</td>
<td>Diffuse growth</td>
<td>White colonies, Haemolysis</td>
<td>Acid and clot, 24 hours</td>
<td>+</td>
<td>-</td>
<td>+ after 10 days</td>
<td>+ after 10 days</td>
<td>± after 10 days</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Buchanan</td>
<td>Case of acute rheumatism, with endocarditis</td>
<td>Forms acid</td>
<td>?</td>
<td>Acid, no clot</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td></td>
<td>?</td>
</tr>
</tbody>
</table>

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**Note:** The table continues with more entries, but has been truncated for the sake of clarity.
condition of rabbits infected with *S. rheumaticus* where these substances are present.

**TABLE II.—ACTION OF SALICYLATES ON RABBITS INOCULATED WITH Streptococcus rheumaticus.**

<table>
<thead>
<tr>
<th>Rabbit No.</th>
<th>Treatment</th>
<th>Condition on 12th day</th>
<th>Condition on 19th day</th>
<th>Condition on 21st day</th>
<th>Condition on 28th day</th>
<th>Condition on 37th day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sod. sal. 3 gr. daily 12th to 19th day; 5 gr. daily 19th to 28th day</td>
<td>Lame both front legs</td>
<td>Better, but still lame front legs</td>
<td>Much worse both front legs</td>
<td>No change</td>
<td>Lame</td>
</tr>
<tr>
<td>2</td>
<td>Ditto</td>
<td>Lame both front legs</td>
<td>No lameness</td>
<td>No lameness</td>
<td>No lameness</td>
<td>No lameness</td>
</tr>
<tr>
<td>3</td>
<td>Control</td>
<td>Lame right hind leg</td>
<td>Very lame right hind leg</td>
<td>Still lame right hind leg</td>
<td>Rather better but still lame</td>
<td>Recovered</td>
</tr>
<tr>
<td>4</td>
<td>Control</td>
<td>Lame left front leg</td>
<td>Slightly lame left front leg</td>
<td>No lameness</td>
<td>No lameness</td>
<td>No lameness</td>
</tr>
</tbody>
</table>

**SUMMARY.**

(1) The *S. rheumaticus* has a special vitality outside the human body which serves to distinguish it from other streptococci.

(2) Inoculation of this streptococcus into rabbits in sufficiently large doses will produce arthritis and at times endocarditis.

(3) Inoculation of other streptococci will also produce arthritis at times, indistinguishable in character from that produced by the *S. rheumaticus*.

(4) Attempts to isolate the streptococcus from the blood failed in twenty-six cases.

(5) Streptococci were found in two joint fluids out of twenty-seven, but there was no evidence that they were identical with the *S. rheumaticus*.

(6) Attempts to isolate the *S. rheumaticus* from the throats of rheumatic fever patients failed.

(7) Treatment of six patients with a *S. rheumaticus* vaccine produced no results.

(8) Examination of the blood of rheumatic fever patients for antibodies to the *S. rheumaticus* produced negative results.

(9) Rabbits infected with *S. rheumaticus* are not benefited by the administration of sodium salicylate.

**CONCLUSIONS.**

There is no evidence that the *S. rheumaticus* is the cause of the usual kinds of rheumatic fever.