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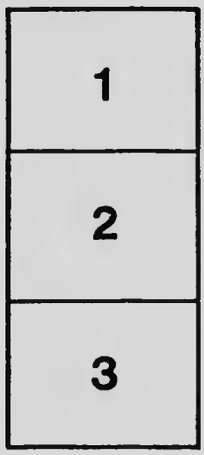

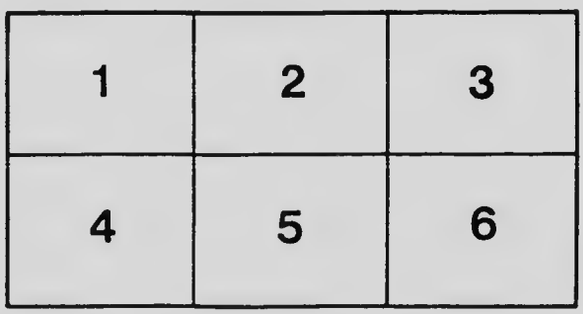

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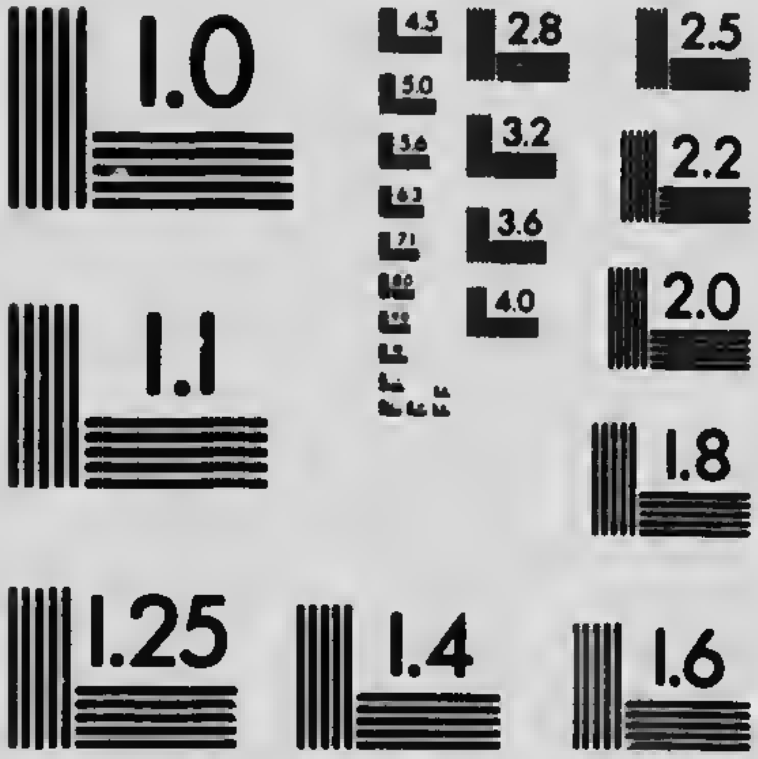

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SECOND REPORT

ON THE

INVESTIGATION

INTO

JOINT-ILL IN FOALS

EXISTING IN THE

PROVINCE OF ONTARIO

BY

F. W. SCHOFIELD, D.V.Sc.

Department of Bacteriology, Ontario Veterinary College, Toronto

(PRINTED BY AUTHORITY OF THE MINISTER OF AGRICULTURE)

ONTARIO

TORONTO:
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1916

Laboratories, No. 5 Queen's Park,

Toronto, April 3rd, 1916.

SIR.—I have the honour to submit a further report on the disease Joint-Ill.

Extensive experiments were carried on during the summer of 1915, in connection with this disease. The report contains a full account of these experiments and the results obtained.

Although these experiments have not been uniformly successful, I am confident that the methods advocated in this and other reports, will, if properly employed, greatly reduce the mortality of the disease.

One of the most interesting facts brought to light by this investigation is the presence of similar organisms in the milk of the dam as are found in the diseased joints of the foal. The exact significance of this cannot be stated at present.

All of which is respectfully submitted.

FRANK W. SCHOFIELD.

The HON. JAS. S. DUFF,

Minister of Agriculture,

Parliament Buildings, Toronto.

A FURTHER REPORT
ON
JOINT-ILL IN FOALS

PART I.

INTRODUCTION.

A previous investigation having brought to light certain facts that seemed to be of importance in connection with this disease, it was considered advisable to immediately test the value of this information by practical application. This report contains the results of tests made during the spring and summer months of the year 1915, along with much bacteriological data collected from individual cases of the disease which were investigated.

It may be advisable to briefly mention some of the important facts which were the outcome of the previous investigation.

(*a*) That no organism was found to be constantly present in this disease. In other words, no specific organism was isolated.

(*b*) That apparently several organisms may be responsible for the infection.

(*c*) That the cause of the disease can be transmitted to the foal before birth, or placental transmission.

(*d*) That streptococci were the organisms most frequently isolated from the lesions, except in districts where contagious equine abortion was prevalent. In the latter case the Bacillus Abortivus Equinus may frequently be isolated.

(*e*) That a vaccine (bacterin) prepared from the organism commonly associated with the disease gave very promising results in treatment.

It was the last fact which led to the major part of the experimental work here recorded. In a preliminary experiment, the use of a vaccine in the treatment of this disease had reduced the mortality from about 66 per cent. to 25 per cent. The question then arose, if such good results can be obtained when using the vaccine [illegible] could not equally good results be secured in preventing the disease by [illegible] vaccine as a prophylactic? Or, in other words, might not the disease [illegible] by administering a suitable dose of the vaccine to the foal as soon after [illegible] possible? It is well known that satisfactory immunity can be developed both in animals and man against certain diseases by suitable methods of inoculation. No better example could be given than the use of blackleg vaccine as a prophylactic against symptomatic anthrax in cattle. Although my expectations ran high as to the possible results from using a preventive vaccine against the disease, the fact that the immunity had to be against a streptococcal infection lessened the possibility of anything really phenomenal. It has been the experience of many investigators, that antibodies to streptococci are both difficult to produce or demonstrate.

The large group of bacteria known as the streptococci are still a puzzle to the bacteriologist. At the present, there is no satisfactory classification of these organisms, so that from many standpoints one is working entirely in the dark.

The protection of rabbits against streptococcal arthritis was attempted by J. J. Moore, but with unfavourable results. His conclusions were, that prophylactic inoculations in the rabbit, against a disease almost identical with septic arthritis in the foal, were an absolute failure.

These peculiar difficulties must be remembered when passing judgment on the results obtained.

Nature of the Preventive Experiments.

As previously indicated the object of the major experiments was to determine the value of a vaccine in preventing the disease Joint-Ill.

Method of Carrying Out Experiment.—The following method was adopted in order to secure sufficient material, so that the results, when obtained, might be conclusive.

Arrangements were made whereby five veterinary surgeons, in a similar number of districts, were to inoculate, as far as possible, all the foals dropped in their respective territories. The veterinary surgeon was remunerated for this work at the rate of one dollar per head. The farmer received the treatment absolutely free. The treatment had to be administered to the foal within twenty-four hours after birth. The latter demand was made because infection may so easily be implanted during the first few days of life. In almost all cases these conditions were consistently carried out.

The experimental districts had for many years suffered considerably from the ravages of Joint-Ill. They were, therefore, very suitable for the carrying out of such an experiment. Through the energies of the veterinary surgeons this scheme was made widely known to the farmers. Some of those who had suffered no loss from this disease were loath to have their animals "experimented with." However, little difficulty was experienced in convincing the majority of the stock men that the material used was not only harmless but definitely beneficial. A record of all inoculations was kept by the veterinary surgeon and forwarded to me at regular intervals. A copy of the record sheet will be found in the appendix.

Instructions were given to the veterinarians to inoculate only those foals that were apparently in normal health. The temperature was a useful guide in determining the condition of the animal. When either subnormal or above normal the vaccine was withheld. These clinical observations saved the reputation of the vaccine on several occasions. Had they been more carefully followed the few disasters which did occur might have been avoided. At the time of inoculation a few general instructions as to the care of the foal were given to the owner.

Nature of Vaccine Employed.—The vaccine used would be designated technically as, a polyvalent mixed infection vaccine (bacterin). Two kinds of vaccine were employed, the one containing Streptococci, Staphylococcus Aureus, and B.Coli, the other containing in addition the Bacillus of Equine Abortion. This latter was used exclusively in territories infected with abortion.

Six strains of streptococci were used, all having been isolated from diseased joints, where in most cases they had been present in pure culture. Due to artificial cultivation these strains had lost some of their virulence. This was shown by their reduced pathogenicity for rabbits. When isolated an intraperitoneal injection of about one-eighth of a blood agar slant will kill a full-grown rabbit in about twenty-six hours. It is generally considered that in immunizing, better results are obtained by the use of virulent in preference to avirulent strains of streptococci. As the method employed in raising the virulence and growing the vaccine was original in a few details, I will record it briefly.

From the stock cultures blood streaked agar slants were made, and incubated for about twenty-four hours. The growth was then washed off in 4c.c. of saline, one-half this quantity was injected into the peritoneal cavity of a rabbit. The first animals injected with the different strains frequently survived the infection for three or four days, and at post-mortem did not show the characteristic changes

produced by the more virulent streptococci. As soon as a rabbit had died, cultures were made either from the peritoneal exudate or heart's blood on plain agar slants. After an incubation of twenty-four hours at 37 degrees C. part of the culture was injected into rabbits as previously described. After a few passages the virulence of the strain is very pronounced, and death ensues in about eighteen to twenty-four hours after inoculation.

A very characteristic condition is found in the chest, the pleura is acutely inflamed and the pleural cavity contains from .5 to 10cc. of clear red fluid. In some cases the fluid may be almost black in color, but quite clear. This fluid is teeming with streptococci, usually in small chains or pairs. This pleural exudate is utilized in making all the streptococcus cultures for the vaccine in the following manner. One or two cubic centimeters of the fluid are carefully removed from the chest with a pipette and the fluid discharged over the agar surface of a Blake bottle. After two days incubation a splendid growth is obtained. Occasionally a colony or two of colon will develop on the surface of the agar, but this is of little significance as long as the agar surface is not flooded with water of condensation. The growth is then washed off, heated at 60 degrees C. for one hour, tested for purity and preserved with .25 per cent. tricresol.

Numerical standardization of the streptococcus was not attempted. Instead various quantities from the large stock supply were injected subcutaneously into young guinea pigs. The quantity necessary to produce a slight local reaction was used as the initial dose in the vaccine. The strains of staphylococcus aureus had been isolated from various suppurative conditions, but the colon bacilli were strains isolated from cases of Joint-Ill. These organisms were either grown on agar slopes in bottles, or test tubes, then killed and standardized by the Wright blood method. The vaccine was put up in 25c.c. bottles with rubber caps. Each cubic centimeter contained, beside the dose of streptococci, colon bacilli 100 million, staphylococcus au.. 200 million.

Dosage of Vaccine.—The same supply of vaccine had to be used for both prophylactic and curative purposes. As a preventive 1.0c.c. was given, generally but a few hours after birth. No untoward results were noticed from the injection, occasionally a slight depression would follow.

Although the whole experiment was on the one dose basis I advised veterinarians in other districts to repeat the injection in about ten days giving 2.0c.c. Naturally the latter method should produce more favourable results. One may ask, why then was one injection only employed in this experiment? The answer is, the experiment had to be entirely practical, so that if successful the method could be immediately adopted. I feel that in the majority of cases two injections would be impracticable when the farmer had to pay the expenses. Many farmers would be willing to pay from one to two dollars per head, but if the price of protecting a foal against a disease which it may never have, exceeds this figure, the protection will never be attempted.

Results of Experiments in District No. 1.

The district can roughly be considered as the country surrounding the town of Exeter (Huron) for a radius of about six miles.

The work was performed by Doctors Sweet and Reed. The following figures present the results of our work in this locality:

General Data.		*Special Data.*	
Approximate number of foals born 1915	250	Number of foals inoculated	90
Average annual number of Joint-Ill cases	25	Total number of cases	14
Maximum number of cases	40	Number among inoculated	7
Minimum number of cases	20	Number among uninoculated	7
Average mortality	66⅔	Mortality	48⅔
Or 20 deaths per year.		Or 6 deaths.	

It would appear that in this district the preventive vaccine was entirely unsuccessful. However, it must be noticed that the total number of cases for the year are far below even the minimum for previous years. As a result the number of deaths, six, is the lowest on record for any year. The low death rate had a beneficial effect upon the farmers, as it was apparently due to the use of the preventive vaccine. Whether this deduction was correct or not will be discussed later.

Three of the seven which are recorded as having contracted the disease subsequent to inoculation deserve special mention.

Case A, (No. 17). This foal should never have been inoculated as a subnormal temperature was recorded a few hours after birth when treatment was given. Both hock joints became acutely inflamed and swollen within a day or two, later the pleura and peritoneum became inflamed and from all these regions as well as from the blood a streptococcus was isolated. The animal died after suffering for three weeks.

Case B, (No. 5). This foal was apparently perfectly well until the tenth day after birth, when both fore legs became stiff, about two weeks later signs of peritonitis were evident. The foal died twenty-one days after the initial symptoms. The peritoneal cavity contained several pints of pus from which a pure culture of a hæmolytic streptococcus was isolated.

This could not really be called a case of Joint-Ill, but the infection was streptococcal, against which the foal had been protected.

Case C. This animal was foaled on the same premises as Case A. The foal was very dull at time of inoculation, having no desire to get up and nurse. Two days after the inoculation, the foal showed the symptoms of an acute infection, followed by general stiffness the next day. The animal died within twenty-four hours, showing no local lesions. This infection was very acute in type and could not be considered as true Joint-Ill. As all diseases of this kind are classified as such by the veterinarians and farmers, and also as the infection usually due to streptococci, the case has been included.

In cases A and C the vaccine did not get a chance, the onset of the disease being too rapid, and the infection being, most likely, intrauterine.

An interesting point in connection with the other four cases occurring among the protected foals is the average length of time, twenty-two days, between inoculation and disease. There is a possibility that a second inoculation, ten days later than the first might have prevented infection.

Report of the Experiment in District No. 2.

The headquarters of this district was Crediton and the work was undertaken by Dr. Eckert. The territory covered was the greater part of Stephen Township in Huron County.

General Data.

Approximate number of foals born 1915	190
Approximate number of Joint-Ill cases (1914)	30

(No figures could be obtained for previous years.)

Special Data.

Number of foals inoculated	110
Total number of cases	13
Total number inoculated	0
Total number among uninoculated	13

In this territory the result of the inoculation was highly satisfactory and was much appreciated by the farmers. Inoculation was unavoidably delayed until the foaling season was in full swing, and already eight or nine cases of Joint-Ill had occurred. It is interesting to note that but a few cases developed after systematic inoculation was employed, and of these none among the inoculated.

The reputation earned by the vaccine in the following cases, was I hope well merited:

Case I. Brood mare, property of Mr. R—, had lost three foals with Joint-Ill in succession, this year's foal was inoculated when born and has remained perfectly healthy.

Case II. Mare belonging to Mr. W—, this year's inoculated foal is the first to be raised out of four, all others suffering from Joint-Ill.

Case III. Two mares on this farm had lost their foals due to Joint-Ill in 1914, this year all foals were injected with no cases following.

In several other cases foals were raised on premises which had been notoriously infected.

Results in District No. 3.

This is the Kirkton district, and probably the most extensive one worked in. The territory extends southwards to within a few miles of St. Mary's, eastward towards Mitchell, on the west of Exeter, the north of Staffa. The veterinarians operating in this district were Doctors Jose and Jose.

The district has for many years been badly infected with Joint-Ill.

General Data.

Approximate number of foals born 1915	250
Average annual number of Joint-Ill cases	30
Maximum number of cases	45
Minimum number of cases	20
Average mortality	66%

Or 20 deaths per year.

Special Data.

Number of foals inoculated	140
Total number of cases	19
Number of cases among inoculated	6
Number of cases among uninoculated	4
Mortality	50%

Or 5 deaths.

In this district the value of prophylactic inoculation is very doubtful. However, there is a very evident decrease in the total number of cases. Never in the history of the district have fewer cases been mentioned.

The fact, previously recorded, that injected foals were exposed to infection to a greater extent than the non-injected must be especially remembered in considering this district. A great many injections were made on farms having bad records of Joint-Ill. Three of the six cases occurring in inoculated foals were of a most severe type and were rapidly fatal. In these cases the hæmolytic streptococcus type II was isolated.

Results of Experiment in District 4.

The centre of this territory is the town of Mitchell (Perth County). The district covered is that lying within a radius of about six miles from the town. Dr. Schillinglaw was in charge of the work.

General Data.

Approximate number of foals born 1915	150
Average annual number of Joint-Ill cases	10
Average annual mortality	75%
Or 6.6 deaths.	

Special Data.

Number of foals inoculated	63
Total number of cases	4
Number amongst inoculated	1
Number amongst uninoculated	3
Mortality	50%
Or 2 deaths.	

Locally, the vaccine has been considered a great success, as in the other districts, the total number of cases for the season is far below the average. Many foals were successfully protected on premises where the disease had been rife for many years. It is interesting to note that in the single cases where inoculation was followed by Joint-Ill, a hæmolytic streptococcus type II was isolated from the milk of the dam.

Results of Experiments in District No. 5.

This is the district surrounding the town of Ailsa Craig (Middlesex County). Dr. Archibald Stewart and his assistant Mr. Spurr were in charge of the work. The territory covered in this practice is a large one, and one in which the disease is very common.

General Data.

Approximate number of foals born 1915	275
Average yearly number of cases	25
Maximum number of cases	60
Mortality about	75%
Or 18.6 deaths.	

Special Data.

Number of foals inoculated	53
Number of cases among inoculated	0
Number of cases among uninoculated	13
Mortality not known.	

Unfortunately, the foals injected represent but a small number of the foals born.

From the above data it can be readily calculated that the number of cases among the injected should have been at least two, according to the case rate amongst the uninoculated. There is, therefore, evidence of protection following the inoculation.

It is gratifying to know that the horse breeders are satisfied with the results obtained. As usual the vaccine was used largely on infected farms.

A strange coincidence occurred on one farm; four out of five foals were given the protective vaccine, the one not receiving the treatment was the only one to develop the disease. On this farm two or three cases had developed annually.

Discussion of Results.

First.—It is quite evident that the vaccine as prepared and administered in these experiments did not generally confer very satisfactory immunity.

Second.—That there was greater evidence of protection following inoculation in some territories than in others. This I think is chiefly due to the difference in the virulence of the infecting organism.

Third.—That the case rate in all districts was greatly reduced. Thus the average number of cases for the five districts totals annually 110 cases, against 53 cases for the present year. Even the minimum number of cases in these districts totals between 65 and 70 cases per annum.

This general reduction in the case rate was interpreted locally by both veterinarians, laity and myself, to be entirely due to the use of the preventive vaccine. In order to satisfy myself in this connection, circular letters were sent to veterinary surgeons in surrounding districts, asking for information as to the number of cases of Joint-Ill occurring during the season (1915), as compared with previous years.

The figures given below are compiled from the reports received and are also compared with the reports from the experimental districts.

Number of cases occurring in adjacent territory, 1914	72
" " " experimental territory, 1914	170
" " " adjacent territory, 1915	30
" " " experimental territory, 1915	53
Percentage reduction in adjacent territory, 1915	58.3
" " experimental territory, 1915	68.8

Thus it will be seen that, for some unknown reason, the case rate amongst the unprotected foals of the adjacent territory showed a decrease almost equal to that occurring in the experimental districts.

Such a phenomenal manoeuvre on the part of the disease makes a correct interpretation of results most difficult. However, as shown later the results are definitely favourable to preventive inoculation.

Fourth. In passing judgment on the results one important fact must be kept in mind; that the inoculated foals were as a group more susceptible to infection than the non-inoculated. This, because the inoculated were generally foals born on farms where the disease has occurred either regularly or irregularly for many years. In many instances the foals were offspring of dams which had given birth to as many as two or three diseased foals during previous years.

Brief Summary of Experimental Data.

The following are a few statistics covering the whole experimental area:

Total number of foals inoculated in experimental area	458
Approximate number of foals not inoculated in experimental area	642
Total number of foals born in experimental area	1,100
Total number of cases of Joint-Ill among inoculated foals	14 or 3.0%
Total number of cases of Joint-Ill among uninoculated foals	40 or 6.2%

After carefully studying the individual statistics and the above summary I think that the most severe critic would admit that the vaccine is of prophylactic value. The fact must be recognized that the case rate among the unprotected was twice as high as among the protected, yet as has been pointed out, the latter were the most susceptible to infection. In addition to the cases here reported the vaccine was used elsewhere on about one hundred and fifty foals with very good results.

Conclusion.

I. That the disease Joint-Ill can be prevented in many cases by the use of a suitable prophylactic vaccine.

II. That the vaccine used in this experiment while producing results that are far from ideal, was of definite prophylactic value.

III. That the treatment has no untoward effect upon the foal either immediate or delayed.

IV. That the vaccine should be used in conjunction with the other prophylactic measures in combating this disease.

PART II.

Bacterial Vaccines (Bacterins)

Introduction.

Many years may elapse before an absolutely satisfactory preventive treatment for the disease is discovered, therefore, it is necessary that investigations should be carried on to determine the most satisfactory method of treating the disease when developed. In a previous report made by the writer,[2] the promising results obtained by the use of a bacterial vaccine were recorded. During the present year (1915), a similar vaccine has been tried out on a scale large enough to warrant the formation of definite conclusions as to its value. The following figures speak for themselves.

Results of Vaccine Treatment.

Total number of cases treated	670
" " deaths	173
Mortality	25.8%

When it is remembered that the usual mortality in this disease is from 50 per cent. to 90 per cent. the results are very satisfactory. It is interesting to note that the mortality in the 170 cases treated during the previous year (1914), was 25.5 per cent.

All manner of cases are represented in the above figures, mild single arthritis, and many cases of the acute septic type, where the vaccine is of little value.

The vaccine could not be expected to produce equally good results in all cases, due to differences in individual resistance and response to injection, also there is undoubtedly a great difference in the virulence of the infecting organism. In some localities the infection seems to be unusually virulent. Another important factor and yet one often overlooked, is the beneficial influence of careful nursing.

Quantity of Vaccine Prepared and Distributed.

It was very encouraging to find so many veterinarians eager to co-operate in this work by trying the vaccine out in their practice. A number of them had proven the value of the treatment during the two preceding seasons and were anxious to be again supplied.

Requests for the vaccine came from all parts of Canada and the United States. The total number of doses distributed was five thousand seven hundred (5,700). The bulk of this was used in the Province of Ontario. About one thousand doses were shipped to the other Provinces and eight hundred to the United States.

The Vaccine (Bacterin).

The same vaccine was employed for both curative and prophylactic purposes (see page 6). I do not consider this an ideal method, but working conditions made impossible any elaborate modification.

A more suitable vaccine would be one in which the dosage of streptococci could be increased without simultaneously increasing the number of S. Aureus and B.Coli. In this case the vaccine would have to be contained in individual ampoules and not in the Wright bottles as used in this experiment. In preparing the vaccine I think it is of importance that only those strains of streptococci which have been isolated from typical cases should be incorporated. Such strains should also be virulent.

Even though future work further corroborates my findings that a streptococcus is the organism of supreme importance in producing this disease, I think it would be unwise to leave out of the vaccine the staphylococcus aureus and colon bacilli, because of their value in preventing and curing a frequent concomitant of Joint-Ill—suppurating navel. Unfortunately, the latter condition is frequently confused with septic arthritis, because the term Navel-Ill is used as a synonym for Joint-Ill. Omphalitis (inflammation of the navel) without any articular inflammation is quite common, the latter frequently exists apart from any navel infection. Many reports coming from veterinarians had to be discarded due to confusion between these two conditions.

Dosage and Method of Administering the Vaccine.

As previously stated foals can be inoculated with comparatively large doses of vaccine without producing severe reactions either local or general.

One-half the prophylactic dose was usually given for the first curative dose. The injections were given at five day intervals, using increasing quantities of the vaccine. The dosage recommended was .5cc., 1.0cc., 2.0cc., 3.0cc. and 4.0cc. to be given subcutaneously at intervals of five or six days. But great care must be exercised in this matter, and no hard and fast rules can be laid down or followed. It is usually quite safe to increase the dose if the foal is holding its own or progressing, providing the reaction to the previous injection was satisfactory.

In regard to reaction, a satisfactory local reaction consists of slight swelling over an area as large as one-half the size of the palm of the hand. The hair generally stands out somewhat over the reactionary area. This local swelling should all pass away in a day or two. I think that a general reaction such as depression and elevation of temperature is inadvisable in any case.

From previous experiences I would outline the following as a satisfactory dosage system.

First Inoculation.

Staphylococcus Aureus	100 million.
B. Coli	50 "
Streptococci	(According to animal titration half the quantity which produced slight local reaction.)

SECOND INOCULATION.

Staphylococcus Aureus .....100 million.
B. Coli ..... 75 "
Streptococci .....Double the initial dose.

THIRD INOCULATION.

Staphylococcus Aureus .....200 million.
B. Coli ..... 75 "
Streptococci .....Treble the initial dose.

FOURTH INOCULATION.

Staphylococcus Aureus .....200 million.
B. Coli .....100 "
Streptococci .....Four times the initial dose.

These inoculations should be made at five or six days intervals. The age, size, and conditions of the foal must always be considered, and subsequent doses regulated by the local reaction and progress of the case.

I would like to emphasize one point of great importance. Do not neglect symptomatic treatment, either surgical or medicinal. Stimulants and laxatives are frequently indicated and should be administered with just the same care as if the vaccine were being withheld. Also, when suppuration occurs either in the joint or muscle, the pus should be evacuated and the joint be treated as an infected wound. The vaccine should not be employed in moribund cases.

ADMINISTRATION.

Injections should be made subcutaneously after cleansing the skin with some antiseptic. The bottle must always be well shaken before the dose is withdrawn.

CONCLUSIONS.

1. That better results are obtained from the use of vaccines in the treatment of Joint-Ill than from any other method of treatment.

2. That there is much room for improvement as the average mortality is still far in excess of what it should be.

NOTE.—Anti-streptococcus serum made against the special strains isolated, when used in large doses, might have a beneficial effect in treatment. I think that an endeavour should be made to produce such a serum of high potency and that experiments as to its value would be well worth while.

PART III.

The Bacteriology of Joint-Ill

In earlier investigations the importance of this phase of the subject had not been overlooked, but due to unavoidable difficulties, a careful study of the disease from this standpoint had been impossible. During the last summer a number of cases were seen and much material obtained for bacteriological examination.

After a careful examination of the diseased animal, cultures were generally made from the blood and joint fluid. As much as possible of the latter was removed from the joint, as the organisms when present are rarely plentiful. On arriving at the laboratory some of the synovia was injected into either the rabbit or guinea pig.

For making cultures in the field, Wright vaccine bottles and caps were used with excellent success, contamination will rarely occur if proper precautions are taken.

No 1. A typical case of Joint-Ill. Notice the swollen hock joint.

The etiological relationship of certain organisms to this disease has been discussed in earlier reports.[3] The ability of the B.Abortivus Equinus to excite septic arthritis was dealt with at that time. Streptococci have frequently been found in the diseased joints either alone or associated with other bacteria.

Some of the previous work had unfortunately to be undertaken with samples of synovia, which had been collected and forwarded to the laboratory by persons not familiar with bacteriological technique. Therefore, the value of the bacteriological findings must be considered as doubtful.

In purulent cases slight extraneous contamination would have no effect, but where the initial infection was slight or absent such a mishap might be disastrous. Since taking the samples in person, I have absolutely failed to find certain organisms that were frequently present in mailed specimens. The value of correct knowledge in regard to the cause of a disease in very apparent if treatment along biological lines is anticipated. Therefore, as many samples as possible were taken during the season and a careful record of each case kept.

The following table contains most of the information in a condensed form.

BACTERIOLOGICAL FINDINGS IN

Case No.	Brief History.	Origin and Nature of Material.	Microscopical Examination.
1	Suddenly taken ill, with swelling at stifle, and all symptoms of an acute infection. Pus at navel. Died four days after first symptoms.	A. Fluid from stifle joint. Thin, purulent and blood-stained. Did not clot. B. Pus from umbilicus.	A. Showed pus cells, debris, and teeming with Gram positive cocci in pairs and small chains. B. Numerous Gram positive streptococci.
2	Foal dead when seen. Had been inoculated twenty-eight days previously. Ill for one week. Extensive swelling from hip to stifle.	A. Thin, purulent fluid from swelling over the thigh. Orange color. Did not clot. B. Clear serous fluid from tissues. Did clot.	A. Numerous pus cells. Teeming with Gram positive streptococci, in small chains. B. Contained numerous chains of streptococci.
3	Foal severely swollen between hip and stifle. Died in about two weeks after first symptoms.	Thin pinkish pus from swelling. Clotted shortly after removal.	Many pus cells and Gram positive cocci in pairs and small chains.
4	A. Foal about ten days old. Swelling in stifle. B. Stifle again aspirated five days later. C. Stifle again aspirated five days later. D. Foal died about two days after last aspiration.	A. Yellowish serous fluid, which clotted. B. More purulent in character. C. No apparent change. D. Little change; more pink in color.	A. Pus cells and chains of cocci. B. Marked increase in the cocci. C. No apparent change. D. Far more streptococci than when first examined.
5	Became ill nineteen days after prophylactic inoculation. Died three weeks after first symptoms. General stiffness, no joints swollen. See remarks.	Pus from peritoneal cavity.	Pus cells and small chains of Gram positive streptococci.
6	Diffuse swelling from stifle to foot. Abscess on inside of thigh which was aspirated. Foal had been ill about five days. Died about one week later.	Pus from swelling at inside of thigh. Brownish in color. Did not clot.	Numerous cells and debris. Very many Gram positive streptococci.
7	Hock and fetlock swollen and superficial slough.	Swabs taken from both lesions.	Numerous chains of Gram. positive streptococci.
8	Foal had just died when seen. Subcutaneous swelling around hocks, and in various places on the body. Foal had always been a weakling. See remarks.	A. Serous fluid from swollen subcutaneous tissues Clotted. B. Fluid from chest.	A. Few chains of streptococci and pus cells. B. Gram positive diplococci.
9	Not a severe case, of ten days' duration. Swelling in hip which was aspirated.	Thin chocolate colored pus Did not clot.	Gram positive streptococci in long chains.

TWENTY-THREE CASES OF JOINT-ILL.

Organisms Isolated.	Blood Culture.	Animals Inoculated.	Remarks.
A. Almost pure culture of a hæmolytic streptococcus. Type II. B. Almost pure culture of streptococcus. Type II.	Not made.	None.	Foal had been inoculated at birth. Eighteen days old when died. A very acute case.
A. Almost pure culture of a hæmolytic streptococcus. Type II. B. Pure culture of hæmolytic streptococcus. Type II.	Positive streptococcus. Type A.	Rabbit inoculated with pus died in about twenty-four hours, showing typical lesions.	Case did not seem serious at first; foal suddenly became much worse and died.
Pure culture of hæmolytic streptococcus. Type II.	Negative.	Rabbit inoculated with culture died rapidly, showing typical lesions.	
A. Pure culture of hæmolytic streptococci. Type II. B. Pure culture of streptococci. Type II. C. Pure culture of streptococci. Type II. D. No cultures made.	Not made. Negative. Not made. Not made.	None. Rabbit, intra peritoneal, died with typical lesions. None. None.	In this case elbow became involved as well as stifle. P.M. showed abscess in peritoneal cavity near umbilicus. Liver contained numerous abscesses.
Pure culture of hæmolytic streptococcus. Type II.	Negative. Taken at beginning of illness.)	None.	At P.M. about two gallons of fluid, yellow pus, was found in the peritoneum.
Pure culture of hæmolytic streptococci. Type II.	Negative.	Rabbit inoculated with pus, intra peritoneal, died with typical lesions in eighteen hours.	
Almost pure culture of hæmolytic streptococcus. Type III.	Not made.	None.	Foal recovered.
A. Pure culture of Type II. B. Mixed culture, but hæmolytic streptococcus Type II. predominated.	Not made.	None.	P.M. Peritoneal cavity contained much fluid Pericardial sac full of fluid. Chest contained much fluid also. Milk of dam contained Type II.
Pure culture of hæmolytic streptococcus. Type "C."	Not made.	None.	Recovered.

BACTERIOLOGICAL FINDINGS IN TWENTY

Case No.	Brief History.	Origin and Nature of Material.	Microscopical Examination.
10	A most severe case. Rt. elbow and rt. hock swollen. Subcutaneous swellings on various parts of body.	A. Turbid, yellowish fluid, which clotted. B. Thick, cheesy pus from around the right hock. C. Fluid from chest.	A. Many cells, but no bacteria. B. Numerous Gram positive streptococci. Short chains. C. Some cells. No bacteria.
11	A severe case. Aged seven days when first symptoms were shown. Lived for five days; right hip and right stifle involved.	Yellowish fluid pus. Slight clotting.	Numerous Gram positive streptococci.
12	No history.	Fluid pus.	Numerous gram positive streptococci.
13	Foal had been ill for two weeks. Very weak. Right stifle very much enlarged.	Turbid, yellow fluid, which clotted.	Numerous pus cells, but no bacteria could be seen.
14		Aspirated from an abscess. Fairly thick yellow pus.	Numerous pus cells and long chains of Gram positive streptococci
15		Grayish white fluid pus aspirated from abscess.	Many pus cells and numerous chains of Gram positive streptococcus.
16		Aspirated from a joint. Rusty yellow thick pus.	Pus cells and chains of Gram positive streptococci.
17	A severe case. Foal became ill on May 20th. 1st. A. Aspiration right hock joint, May 31st. 2nd. B. Aspiration right hock joint, June 5th. 3rd. D. Aspiration right hock joint, June 10th. Foal died on June 10th.	A. Turbid yellow fluid from right hock joint, May 31st. B. Turbid yellow fluid, which clotted, from same joint,, June 5th. C. Turbid yellow fluid, which clotted, from left hock joint, June 5th. D. Pinkish fluid pus, did not clot, from right hock, June 10th.	A. Pus cells but no organisms. B. Lots of pus cells and Gram positive streptococci. C. Same as "B." D. Same as "B."
18		Swab of pus from hock joint, which had been opened.	Mixture of Gram negative and positive bacilli and cocci.
19	Foal had been ill for about ten days. Very emaciated and weak. Left hock very swollen.	Fluid aspirated from the diseased joint. Turbid yellow fluid, which clotted.	Numerous cells but no bacteria.

THREE CASES OF JOINT-ILL—Continued.

Organisms Isolated.	Blood Culture.	Animals Inoculated.	Remarks.
A. Hæmolytic streptococcus Type II and a non-hæmolytic streptococcus. B. Pure culture of a hæmolytic streptococcus. Type II. C. Pure culture of hæmolytic streptococcus. Type II.	Not made.	None.	Foal died.
Almost pure culture of hæmolytic streptococci. Type II.	Not made.	None.	Foal died.
Pure culture of hæmolytic streptococcus. Type II.	Not made.	None.	
Pure culture of Gram positive hæmolytic streptococci. Type II. Six colonies only.	Negative.	Rabbit injected with several c.c. of fluid but remained well	Foal died.
Pure culture of hæmolytic streptococcus. Type C.		Rabbit with ½ c.c. of the pus remained well.	Strain died out.
Pure culture of hæmolytic streptococcus. Type III?			
Blood agarplate showed equal numbers of a hæmolytic Type II and non-hæmolytic streptococcus.			
A. No organisms were isolated; plates remained sterile. B. Pure culture of a non-hæmolytic streptococcus. C. Pure culture or organism similar to "B." D. Same as "B."	June 5th; positive, a non-hæmolytic streptococcus. June 10th; positive, pure culture of hæmolytic streptococcus. Type II.		A hæmolytic streptococcus, Type II was isolated from the peritoneum and urachas on post mortem.
Chiefly colon, but some hæmolytic colonies of streptococci. Type "C."			
Five c.c. of the fluid was plated, but no growth was obtained from any of the cultures.	Negative.	Rabbit was inoculated intravenously with about 5 c.c. but remained healthy.	Hæmolytic streptococci isolated from milk of the dam.

BACTERIOLOGICAL FINDINGS IN TWENTY

Case No.	Brief History.	Origin and Nature of Material.	Microscopic Examination.
20	Foal recovering from a fairly severe attack.	Fluid from the hock joint. The fluid looked like normal synovia, was sticky, but clotted.	Numerous cells but no organisms.
21	Foal recovering from Joint-Ill.	Fluid from the stifle joint. Turbid yellowish fluid, which clotted.	Numerous cells.
22	Foal recovering from Joint-Ill.	Fluid from hock joint. Sticky brown fluid, which did not clot.	Numerous cells.
23	Foal recovering from Joint-Ill.	Clear sticky fluid from knee joint.	

24-34. All of these were samples of synovia received by mail. No reliance can be pla streptococci, in some cases, spore-formers, and the pyogenic cocci. Four contained was fairly clear and not purulent. Extraneous contamination of such samples would

No. 2. The result of Joint-Ill. A yearling with anchylosed joints.

THREE CASES OF JOINT-ILL—Continued.

Organisms Isolated.	Blood Culture.	Animals Inoculated.	Remarks.
One or two colonies, which were contamination.	Negative.	Rabbit inoculated with 2.5 c.c. intravenously remained healthy.	About 10 oz. were taken from the joint.
No growth on any cultures.		Rabbit with about 3.0 c.c. intravenous remained healthy.	About 8 oz. were taken from the joint.
Four colonies of S. aureus.			
No growth on any cultures.			

ced in the bacteriological findings. Five of the eleven gave colon or colonoid mixed with non-hæmolytic streptococci mixed with other bacterial species. In all cases the synovia naturally be far more serious than in the case of purulent specimens.

No. 3. Same as number two.

No. 4. Both hock joints are involved in this case.

Discussion on Table.

I. The most striking point in the table is the constant presence of streptococci in the diseased joints. Moreover, there is a predominating type, a hæmolytic streptococcus, or one having the power to destroy red blood cells. This organism was found in pure culture in 15 out of the 18 cases in which growth was obtained. It will be noticed also, that in 11 out of the 15 cases the hæmolytic streptococcus is of type "II." The difference between types II, III and C is fully discussed later.

II. Another interesting point is, that every case from which type "II" was isolated proved fatal.

III. Cases 13 and 19 are interesting, in that both were practically moribund when seen, yet blood cultures were negative and in the latter case no bacteria could be isolated from the joint, although same was badly swollen. In case No. 13 only a few colonies were obtained. Such cases seem to die from exhaustion, the result of prolonged pain and inability to nurse rather than from toxæmia.

IV. Cases Nos. 20-23 inclusive, are interesting. The foals were recovering, which fact was evidenced by the change in the consistency of the synovia. Also, there was freedom from infection. With convalescence the synovia becomes darker in colour, more tenacious, and does not tend to coagulate, in other words becomes normal.

V. Number 17 is an unusual case, the foal being infected with both hæmolytic and non-hæmolytic streptococci. These organisms have retained their original characteristics so far. This was undoubtedly a mixed infection with two different types of streptococci.

Characteristics of the Streptococci Isolated.

Morphology.—There was generally marked uniformity in the size of the organisms. The arrangement was frequently in pairs except when grown in broth.

Stains.—The organism stains well with all aniline stains and is Gram positive. However, occasionally there was irregularity in reaction to the latter strain.

Culture Characteristics.—It will have been noticed that the streptococci have been tentatively grouped in types II, III and C, the cultural characteristics mentioned are common to all unless stated otherwise.

Nutrient Agar (+8 to Ph.). Growth generally good, not heavy and frequently consisting of a mass of confluent colonies, rather than a uniform surface growth.

Nutrient Broth (+8 to Ph.). Growth slight and almost always attached to the side of the test tube.

Hæmolytic Power.—In order to compare the hæmolytic power of different strains, the following method of preparing blood agar was employed.

To every 10c.c. of Nutrient Agar 1.0c.c. of defibrinated blood was added. This was well mixed and then poured into petri dishes of similar capacity. The organism to be tested was streaked across the plate and incubated for a definite period of time.

Organisms of type "II" cause very pronounced hæmolysis, there being a clear space of five or six m.m. between the border of the growth and that of the hæmolytic zone. Another interesting point is that there is never any "staining" of the agar underneath the growth, which commonly occurs in the organisms of

type "III." Moreover, organisms of the latter type are not such powerful hæmolysers, but as mentioned later, grow more profusely. Even the most powerful hæmolytic streptococci fail to hæmolyse the blood cells of different animal species equally. Thus, the blood cells of the rabbit seem to be most readily attacked, next come the blood cells of the horse, and human being, and lastly those of the guinea-pig. Some strains showing marked hæmolytic power for horse cells, almost fail to attack guinea-pig cells. This is not due to any inhibiting effect on the part of the guinea-pig's blood serum, as washed cells are quite as resistant as those suspended in the blood serum.

Reactions in Carbohydrate Media.—All of the hæmolytic strains fermented the following, glucose, lactose, saccharose and salicin, but failed to ferment inulin, dulcite, raffinose and mannite. The quantity of acid produced varied with the same strains under different conditions, and with similar strains under the same conditions. It is important, however, to note that no strains have changed in reaction since isolation, that is none have either lost or acquired fermentative power. Some strains have now been under observation for quite two years.

From the above mentioned characteristics one would be inclined to say: "Well, this is surely the well-known Streptococcus Pyogenes."

I have come to the conclusion that there is no definite type that can be considered as streptococcus pyogenes. Which of the types under discussion should be called S. pyogenes? Both have pyogenic power, but I am convinced that they are different. Infecting the lower animals we have at least three types of hæmolytic streptococci. The characteristics common to all are pus formation, Gram positive staining, fermentation of glucose, lactose, saccharose, salicin.

Type I.—Is represented by the streptococci of Schutz.

Type II.—The one most commonly associated with cases of Joint-Ill.

Type III.—Pathogenicity for rabbit low, growth always more dense than, and hæmolysis less than the previous types.

Pathogenicity or Disease Producing Power of this Type.

The most constant and differentiating feature of type "II" is its pathogenicity for the rabbit. This power is retained by the organism for long periods, even when grown artificially. For instance, organisms which had been subcultured on agar slants for one year are still markedly pathogenic. When small quantities of pus from a type II infection are injected intraperitoneally into a rabbit, the latter succumbs to a septicæmia, and usually well within forty-eight hours. Similar results follow the injection of cultures. The post-mortem appearance is very typical. Peritoneum may show but slight signs of inflammation, with little exudate. The chest contains from one or two to fifteen (15) c.c. of a clear blood stained fluid. A similar fluid generally fills the pericardial sac. The lungs may be congested, but are frequently normal to the naked eye. The blood and fluid contain the organism in large numbers. The superficial pectoral muscles are very dark in color. The urine may also be blood stained.

Another very important point is the lower pathogenicity of this organism for the guinea-pig. Frequently when an equal dose is injected into both rabbit and guinea-pig, the former will rapidly succumb while the latter evidences but little reaction.

Type III only occurs twice in the table, but is frequently associated with such conditions as fistula, poll evil, and suppurating wounds.

The most important point of difference between this and the type previously described is its low pathogenic power for both rabbits and guinea-pigs. Both

animals can stand large injections of the living organism either subcutaneously or intraperitoneally with little inconvenience. The dense growth on plain or blood agar with the staining beneath the growth on the latter make distinction between these types relatively easy.

Organisms designated type "C," will have been noticed in the table. These are most likely varieties of type II, but differing from that type in their irregular pathogenicity and lack of vitality on culture media.

Experimental Infection.

Unfortunately, up to the present it has been impossible to secure foals for the purpose of experimental infection. Therefore, circumstantial evidence alone incriminates the streptococci as being responsible for this disease. When the horse is inoculated subcutaneously with type "II," a pronounced local inflammatory reaction results, which gradually subsides.

In the rabbit a similar injection usually results in a fatal septicæmia. However, there is always a very marked local reaction as in the horse. When the animal lives for a few days after the injection rapid emaciation occurs.

Many inoculations have been made into rabbits with the object of producing an experimental arthritis, but so far with no success. When a small dose of organisms was used nothing happened, and with larger quantities acute septicæmia followed. Inoculation with large doses of dead organisms also failed to produce satisfactory agglutinins.

Natural Infection.

I do not intend to deal with this subject in detail, but merely to record some findings that I believe will throw more light on the question of "How does infection occur?" The unhealed navel has long been recognized as an important portal of entry. Intrauterine infection has also been demonstrated and recorded in previous reports. Ingestion infection, that is the cause of the disease entering the animal body by way of the intestinal tract has been hinted at and considered likely, but no evidence has been offered to support this view.

The following facts lend much support to infection by this method.

Hæmolytic streptococci identical with type "II" were isolated from the milk of three out of four mares whose foals had died of Joint-Ill.

The streptococcus was not found in the milk of seven mares whose foals were healthy.

The data is limited but very suggestive. Unfortunately, the idea to examine the milk for the presence of the streptococcus was not thought of until rather too late in the season to secure many specimens.

Further investigation along this line may be productive of very interesting results. In no case was there any apparent diseased condition of the udder.

Should these preliminary findings prove to be generally correct, the vexed question of how the infection is maintained from year to year will be partially answered. The fact that very frequently the same mare will give birth to several infected foals year after year strongly suggests that the dam may be the carrier of the infection, which is later transferred to the foal.

It is very difficult to understand how the infection is carried over from season to season, unless it is in some such manner. The difficulty is increased if streptococci are considered as the infecting organisms, because the latter are not spore forming.

Fæcal examinations for similar streptococci have proved negative. However, hæmolytic streptococci very similar to type "II" have been isolated from the nostrils.

No. 5. The knee to the left is diseased.
This foal made a good recovery.

Conclusions.

I. That a hæmolytic streptococcus is apparently very closely related to the disease Joint-Ill.

II. That marked pathogenicity for the rabbit is characteristic of the hæmolytic streptococcus of Joint-Ill.

III. In some of the most severe cases, no organisms could be isolated from the joint fluid or blood.

IV. That ingestion infection is quite probable since the presence of streptococci have been found in the milk of the dam identical with those recovered from the diseased joints of foals.

In closing, I desire to express my hearty thanks to the many veterinarians who so readily co-operated with me in this work. I am especially grateful to those who were in charge of the experimental districts for the generous way in which they sacrificed their time for the sake of the work.

References.

No. 1. Journal of Infectious Diseases, Vol. 15, p. 251.
No. 2. Report on Joint Ill, F. W. Schofield, 1915.
No. 3. The Etiology of Pyemic Arthritis. Jr. of Infectious Diseases, Vol. 15, Sept., 1914.

APPENDIX.

The following data sheets are self-explanatory.
Sheet A was used for recording "Prophylactic Inoculation."

RECORD OF PROPHYLACTIC INOCULATION.

Case No. ..... Date .....
Name of Veterinarian .....Name of Farmer .....
Age when injected? .....
Apparent health .....
Temperature..... °F.
Had the navel received proper antiseptic treatment? .....
What .....
Mare ever give birth to Joint-Ill foal before? .....
Any abortion on farm? .....
Reaction .....
Remarks .....
Result .....
.....

Sheet B was for keeping record of cases treated.

DATA SHEET—SEPTIC ARTHRITIS.

Date.....
Case No. .....Name of Owner .....Name of Doctor .....
Information regarding mare.
Any history of abortion on premises? .....When.....
Has she ever given birth to a diseased foal before? .....
Information regarding foal.

Had the foal received prophylactic inoculation? .....
How many days after the inoculation did symptoms develop? .....
How long sick before treatment began? .....
What joints involved? .....
Was there any evidence of navel infection? .....
Temperature at outset..... °F.
Joints aspirated .....
How did the case terminate? .....
.....
Remarks .....
.....
.....

Sheet C was for use when complete records had not been made.

DATA SHEET.

How many cases of Joint-Ill have you treated with the vaccine? .....
How many cases recovered? .....
How many cases died? .....
Were any of the cases too far advanced to be helped when first seen? .....
.....
Do you consider the vaccine was beneficial? .....
.....
About what is your mortality in this disease with usual treatment? .....
.....
About how many cases of Joint-Ill occur during the season in your territory? .....
About how many foals are born each year in your territory? .....
Remarks .....
.....
.....

Kindly fill in the above space and return to me as soon as convenient.