THE RELATION TO THE BLOOD OF THE VIRUS OF EPIDEMIC POLIOMYELITIS.*

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Early in the history of experimental poliomyelitis Flexner and Lewis[1] succeeded in one instance in producing infection in a Macacus monkey through the intravenous injection of twenty-five cubic centimeters of the defibrinated blood obtained from a recently paralyzed monkey. When a smaller quantity (ten cubic centimeters) of the blood was injected into the circulation, or still smaller quantities were introduced intracerebrally, paralysis did not follow. Leiner and von Wiesner[2] at first reported only negative results from the injection of blood from both human and experimental cases of poliomyelitis; but later[3] they observed in one instance paralysis following the injection, partly intracerebral and partly intravenous, of defibrinated blood taken from a monkey on the third day of paralysis. Römer[4] and Landsteiner and Levaditi[5] also record only failure both with the blood of human and of experimental cases of the disease.

The subject of the relation to the blood of the virus of poliomyelitis is of more than theoretical interest, as it may have a bearing on the manner of transmission of the disease. On that account we have carried out a larger series of experiments in order to determine, as far as possible with the methods at present available, what this relation is.

The first series of inoculations was performed with blood taken

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[1] Flexner, S., and Lewis, P. A., *Jour. Exper. Med.*, 1910, xii, 227.

[2] Leiner, K., and von Wiesner, R., *Wien. klin. Wchnschr.*, 1909, xxii, 1698.

[3] Zappert, J., von Wiesner, R., and Leiner, K., Studien über die Heine-Medinsche Krankheit, Leipzig and Vienna, 1911, 171.

[4] Römer, P. H., *München. med. Wchnschr.*, 1910, lvii, 229.

[5] Landsteiner, K., and Levaditi, C., *Ann. de l'Inst. Pasteur*, 1910, xxiv, 833.

from human cases admitted to the Hospital of The Rockefeller Institute.

SURVIVING HUMAN CASES.

Case 1.—N. B. Age, 21 years. Onset Oct. 1, 1910. Condition: weakness and atrophy of muscles of right shoulder girdle and arm, atrophy of muscles of right thigh. Blood and spinal fluid normal. Blood collected 24/24.[6]

Oct. 25. 2 c.c. of defibrinated blood injected intracerebrally and 6 c.c. intraperitoneally into a *Macacus rhesus*. No symptoms of poliomyelitis developed.

Case 2.—J. H. Age, 12½ years. Onset Oct. 16, 1910. Condition: partial paralysis of legs; temperature 101.6° F. Oct. 27. Increased globulin in spinal fluid. Blood collected 13/9.

Oct. 27. Immediately after collection 3 c.c. of the whole blood were injected intracerebrally and 6 c.c. intraperitoneally into a *Macacus rhesus*. No effects followed.

Case 3.—J. A. Age, 20 years. Onset July 14, 1911. Condition: complete paralysis of right and partial paralysis of left leg. Increased cells and globulin in spinal fluid. July 22. Blood collected and defibrinated 9/7.

July 22. 4 c.c. of the blood were injected intracerebrally and 10 c.c. intraperitoneally into a *Macacus rhesus*. Monkey remained well.

Case 4.—M. B. Age, 5 years. Onset Oct. 3, 1912. Condition: temperature 104.8° F.; right leg paralyzed; left leg weak; neck and back stiff; facial muscles on left side weak. Increased cells in spinal fluid. Oct. 8. Right arm paralyzed. Blood collected 6/3.

Oct. 8. The whole blood was immediately injected as follows: 2 c.c. intracerebrally, and 30 c.c. intraperitoneally into a *Macacus rhesus*. No ill effects followed.

Case 5.—A. J. Age, 10 years. Onset Oct. 13, 1912. Condition: tenderness in limbs and back; left arm weak; right shoulder and extensors of right arm paralyzed; intercostal muscles on both sides paralyzed. Oct. 23. Blood collected 11/7.

Oct. 23. Injected 30 c.c. of whole blood into the femoral vein of a *Macacus rhesus*. Monkey remained well.

Case 6.—H. O'C. Age, 3 years. Onset Nov. 1, 1912. Condition: temperature 101.8° F.; right leg paralyzed; intercostal muscles on left side weak; muscles of anterior abdominal wall and anal sphincters weak. Increased cells in spinal fluid. Nov. 5. Blood collected 5/4.

Nov. 5. 2 c.c. of whole blood were injected into the left sciatic nerve of a *Macacus rhesus*. No symptoms of poliomyelitis developed.

FATAL HUMAN CASES.

Case 7.—G. G. Age, 9½ years. Onset Aug. 23, 1911. Aug. 30. Condition: temperature 102.2° F.; legs completely, arms partially paralyzed; intercostal muscles completely, diaphragm partially paralyzed. Sept. 1. Death. Blood collected aseptically from the heart post mortem.

[6] In each case the numerator of the fraction denotes the day of the disease and the denominator the day of the paralysis on which the blood was collected from the arm vein for injection.

Sept. 2. Injected 3 c.c. of the defibrinated blood intracerebrally and 12 c.c. intraperitoneally. Monkey remained well.

Case 8.—J. L. Age, 5½ years. Onset July 12, 1912. July 20. Condition: temperature 105° F.; legs and muscles of shoulders paralyzed; facial muscles of right side weak; intercostal muscles paralyzed. Death same day. Blood collected aseptically from heart post mortem.

July 21. 30 c.c. of citrated blood were injected intraperitoneally into a *Macacus rhesus* monkey, and 0.75 c.c. intracerebrally and 30 c.c. intraperitoneally into another *Macacus rhesus*. Neither monkey developed symptoms of poliomyelitis.

Case 9.—S. N. Age, 6 years. Onset Sept. 28, 1912. Sept. 30. Condition: patient cyanotic and gasping for breath; intercostal muscles paralyzed and diaphragm weak. Increased globulin and cells in spinal fluid. Died same day. Blood collected aseptically from heart post mortem.

Case 10.—G. G. Age, 20 months. Onset gradual and indefinite. Sept. 30, 1912. Intercostals paralyzed; shoulder muscles and facial muscles on right side weak. Oct. 2. Death. Blood collected from heart post mortem.

Case 11.—M. K. Age, 2 years. Onset Sept. 28, 1912. Oct. 1. Temperature 102.4° F.; legs completely paralyzed; intercostals weak; pulse weak and irregular. Increased cells and globulin in spinal fluid. Oct. 4. Consolidation of both lungs. Temperature 104.5° F. Death on same day. Blood collected from heart post mortem.

Oct. 11. Injected 2.5 c.c. of the mixed defibrinated blood of these three fatal cases intracerebrally, and 7 c.c. intraperitoneally into a *Macacus rhesus* which showed excitability on Oct. 15. No paralysis occurred; and later a test inoculation with M A virus caused typical paralysis. Hence it was concluded that this monkey had not developed an abortive attack of experimental poliomyelitis from the injection of the blood.

Case 12.—J. C. Age, 9 years. Onset Oct. 5, 1912. Oct. 8. Condition: temperature 102.6° F.; muscles of right leg and both shoulder girdles paralyzed; intercostal muscles weak. Increased cells and globulin in spinal fluid. Oct. 9. Death. Blood collected from heart post mortem.

Oct. 9. 2 c.c. of the whole blood injected intracerebrally and 35 c.c. intraperitoneally into a *Macacus rhesus*. No effects followed.

These tests confirm those previously made by others with the blood from human cases of poliomyelitis. They do not, however, suffice to exclude altogether the possibility of the virus being present in the blood, since it is known that the original human strains are not as infectious for monkeys as the adapted strains. Another complicating factor may sometimes play a part in preventing infection from the blood. After the first week of acute illness immune bodies which have a neutralizing effect on the virus appear in the blood, and it is not improbable that by acting on the virus, originally of low infective power for monkeys, they may further diminish the chances of producing paralysis. In view of these considerations

we have turned to the experimental cases of poliomyelitis in order to find a solution of the question.

EXPERIMENTAL.

In several instances in the course of our experimental study of poliomyelitis we have made inoculations of the blood of monkeys in the acute stage of paralysis into the brain or peritoneum of normal monkeys in order to ascertain whether the virus is thus demonstrable in the circulating blood. They all resulted negatively.

The experiments were now modified as follows: heavy emulsions of the spinal cord taken from a recently paralyzed animal were injected (a) intracerebrally and (b) both intracerebrally and intraspinously into monkeys from which blood was taken at intervals for inoculation intracerebrally into other monkeys. It was reasoned that the virus would be carried from the subarachnoid spaces into the veins of the membranes of the spinal cord and thence into the general blood. The protocols follow.

Experiment A.—Mar. 24, 1913. 3 c.c. of a suspension of glycerinated M A spinal cord were injected intracerebrally into a *Macacus rhesus.* Blood was taken one, six, twenty-four, and forty-eight hours after inoculation. Mar. 31. Paralysis of arms and back. Apr. 2. Etherized. With the blood taken at the intervals given other monkeys received intracerebral injections of 1 c.c. each. None developed symptoms of poliomyelitis.

Experiment B.—May 16, 1913. A *Macacus rhesus* was injected intracerebrally with 2 c.c., and intraspinally with 5 c.c. of emulsion of the spinal cord (M A) taken from a paralyzed monkey. Blood was taken one, six, and twenty-four hours after inoculation for reinoculation into other monkeys. May 24. Paralysis and prostration; etherized. With the blood withdrawn at intervals, from 2 to 3 c.c. were injected intracerebrally into *Macacus rhesus* monkeys, none of which showed symptoms of poliomyelitis.

Hence under conditions favorable for the passage of the virus into the blood none could be detected by the experiments performed. However, as will appear later, the negative results obtained might have been due in part to the relatively weak virulence of the strain of virus employed since the M A virus had at this period lost a large part of its activity.[7] When a highly active virus is employed for intracerebral inoculation it has happened exceptionally that the

[7] Flexner, S., Clark, P. F., and Amoss, H. L., *Jour. Exper. Med.*, 1914, xix, 195.

blood is infective when taken early in the paralysis or at the onset of symptoms,[8] as is shown in the following protocol.

Experiment C.—A *Macacus rhesus* had been inoculated intracerebrally with K virus on Nov. 17, 1913, and on Nov. 24 had begun to show definite early symptoms of infection. Blood was immediately withdrawn and defibrinated, and 4 c.c. were injected intracerebrally into another rhesus monkey which on Nov. 29 was somewhat excitable. On Nov. 30 the latter showed paralysis of the left leg. On Dec. 1 the arms and back were weak. On Dec. 2 animal died. Typical lesions of poliomyelitis were present.

We next resorted to the active K virus for the double inoculation.

Experiment D.—Jan. 5, 1914. A needle was introduced into the lumbar cistern of the spinal cord of a *Macacus rhesus,* and a few drops of clear cerebrospinal fluid were permitted to escape. While in position 2 c.c. of an emulsion of K virus were injected intracerebrally. The injection was followed at first by the escape of clear fluid, and in two and a half minutes turbid blood-tinted fluid escaped from the lumbar puncture needle. On completion of the intracerebral inoculation 2 c.c. of the emulsion were injected intraspinously. Five hours and seventy-two hours later blood was taken from the median basilic vein and defibrinated for intracerebral inoculation. Jan. 8. Excitable; left arm and back weak; nystagmus. Jan. 10. Paralysis of arms. Jan. 12. Death. Lesions of poliomyelitis present.

Two Macacus monkeys were injected intracerebrally, one with the defibrinated blood taken five hours, and the other three days (at onset of paralysis) after the double inoculation. Both remained well.

This experiment indicates that the detection by inoculation of even a highly pathogenic virus in the blood following combined intracerebral and intraspinous injection is difficult and uncertain. That the virus may sometimes appear in the blood after intraspinous inoculation is shown by the detection of the globoid microörganisms in the film preparations in one such instance.[9]

The problem was now approached from another side. The virus was injected into the veins and the blood tested subsequently in order to ascertain whether it remains and multiplies there or is filtered out and removed. While doubt may exist as to whether the virus enters the blood in quantity and remains there in the case of intracerebral inoculation there can be no doubt of the entrance by the intravenous mode of inoculation, in which the quantity introduced may also be varied at will. Hence a series of experiments

[8] Zappert, J., Leiner, K., and von Wiesner, R., *loc. cit.*

[9] Amoss, H. L., *Jour. Exper. Med.,* 1914, xix, 212.

was made by injecting the virus intravenously and withdrawing blood at intervals from a distant vein and injecting it intracerebrally into normal animals.

Experiment E. Macacus rhesus 1.—Oct. 30, 1913, 3 P. M. 180 c.c. of a filtrate of K virus were injected into the right external saphenous vein. 4 P. M. Sufficient blood was withdrawn from the left external saphenous vein to yield 4 c.c. after defibrination. Oct. 31, 3 P. M. The same quantity was withdrawn from the left leg, and the defibrinated blood specimens were inoculated into two *Macacus rhesus* monkeys, 2 and 3. Nov. 9. Very weak; excitable. Died during night. Lesions of poliomyelitis present in spinal cord. Control died in six days. Typical lesions.

Monkey 2.—Oct. 30. One hour blood specimen inoculated intracerebrally. Nov. 9. Excitable and weak. Nov. 10. Left facial paralysis; ataxic. Nov. 12. Prostrate. Etherized. Lesions of poliomyelitis were present.

Monkey 3.—Oct. 31. 24 hour specimen inoculated intracerebrally. Nov. 10. Excitable; back and arms paralyzed. Nov. 11. Prostrate. Etherized. Lesions of poliomyelitis were present.

Experiment F. Macacus rhesus 1.—Nov. 14, 1913, 10.50 A. M. 100 c.c. of a filtrate of K virus were injected into a vein of the right leg. 12 M. Sufficient blood was withdrawn from a vein in the left leg to yield 4 c.c. after defibrination. Nov. 15, 11 A. M. Same quantity of blood withdrawn. Nov. 16, 11 A. M. Same quantity withdrawn. Nov. 17, 11 A. M. Same quantity withdrawn. Nov. 24. Excitable; left leg paralyzed; left facial paralysis. Sufficient blood withdrawn to yield 4 c.c. when defibrinated. Nov. 25. Legs, arms, and back weak or paralyzed. Dec. 1. Died. Lesions of poliomyelitis were present.

Monkey 2.—Nov. 14. One hour blood specimen was injected intracerebrally into a *Macacus rhesus*. Nov. 18. Excitable; left facial paralysis. Nov. 19. Extremities paralyzed. Nov. 20. Prostrate. Etherized. Lesions of poliomyelitis.

Monkey 3.—Nov. 15. 24 hour specimen inoculated intracerebrally. No symptoms developed.

Monkey 4.—Nov. 16. 48 hour specimen inoculated intracerebrally. Nov. 22. Excitable. Arms paralyzed. Nov. 24. Prostrate. Died. Lesions of poliomyelitis.

Monkey 5.—Nov. 17. 72 hour specimen inoculated intracerebrally. Nov. 24. Excitable. Arms and legs paralyzed. Blood was withdrawn for reinoculation, and employed in experiment C (page 227). Etherized. Lesions of poliomyelitis were present.

Monkey 6.—Nov. 24. 4 c.c. of defibrinated blood, taken 10 days after the intravenous injection of the filtrate when paralysis appeared, was inoculated intracerebrally into monkey 6. No symptoms appeared.

These experiments show clearly that when large and overwhelming quantities of an active filtrate are injected into the circulation the virus persists in the blood for seventy-two hours at least. Finally, it appears to be removed, as ten days after its injection, at the period of the onset of paralysis, it may not be detectable by

the inoculation test. The failure of the monkey inoculated with the twenty-four hour specimen in experiment F to respond may have been due to resistance in the animal rather than to absence of the virus; however, this animal when subsequently tested with an emulsion became typically paralyzed. That the ten day specimen of blood was no longer infectious is not remarkable in view of the many negative results from inoculations of blood at the beginning of the paralysis; but the successful result (experiment C, page 227) in which the blood was infectious at the onset of the paralysis seven days after an intracerebral injection shows that the active virus may pass into the blood from the nervous tissues in which it has multiplied and may survive there for a time.

The infectivity of the blood is affected by the amount of virus injected. Experiments were made also with intravenous injections of ten cubic centimeters of filtrate.

Experiment G.—Dec. 15, 1913. 10 c.c. of filtrate of active K virus were injected into the right external saphenous vein of a *Macacus rhesus.* Dec. 16 (24 hours later) and Dec. 17 (48 hours later) 5 c.c. of blood withdrawn from the left external saphenous vein were defibrinated and each lot was injected intracerebrally into a *Macacus rhesus.* None of the three monkeys of this series developed symptoms.

Experiment H. Macacus rhesus 1.—Jan. 5, 1914. 10 c.c. of filtrate of active K virus were injected intravenously. Six and twenty-four hours later 5 c.c. of blood were withdrawn, defibrinated, and injected separately into *Macacus rhesus* monkeys 2 and 3. The animal receiving the intravenous injection showed indefinite symptoms of excitability but developed no paralysis; it gradually became thinner and weaker and died on the twenty-first day after the injection. No apparent cause of death was found in the viscera. No lesions of poliomyelitis existed.

Monkey 2.—Jan 5. Received the 5 hour specimen of blood intracerebrally. Jan. 14. Excitable; arms paralyzed. Jan. 15. Legs paralyzed; prostrate. Jan. 17. Dead. Lesions of poliomyelitis present.

Monkey 3.—Jan. 6. Received the 24 hour specimen of blood intracerebrally. Jan. 14. Excitable; left arm weak. Jan. 15. Arms, legs, and back weak or paralyzed. Jan. 18. Prostrate. Jan. 24. Prostrate, moribund. Death hastened by ether. Lesions of poliomyelitis were present.

Experiments G and H bring out clearly the uncertainty of the intravenous mode of inoculation first in causing paralysis and second in maintaining the infectivity of the blood. It would appear that only when the blood is overwhelmed by the virus is it certainly infectious over a period of three days or less. Moreover, the failure

of an intravenous dose of ten cubic centimeters of filtrate of K virus to cause paralysis when 0.2 of a cubic centimeter or less is a certainly effective dose by intracerebral injection, not only emphasizes the relative susceptibilities of monkeys to the two modes of inoculation but indicates also the possession of mechanisms by the body capable of excluding the virus within the blood from the nervous tissues. Whether it is the choroid plexus that is responsible or some other structure can only be surmised. It is conceivable that access of the virus to the central nervous system is secured only by way of the cerebrospinal fluid, in which case the virus within the blood must first penetrate the barrier of the choroid plexus which possibly takes place only when overwhelming doses are injected intravenously. When the virus is successfully inoculated subcutaneously or intraperitoneally it is always possible that the penetration to the central nervous organs is by way of the nerves. Hence the results may bear on the mode of infection of poliomyelitis in man.[10] In this connection it may be stated that the incubation period of the disease is longer with intravenous than with intracerebral inoculation. With the latter the average in a series of ten animals was 6.6 days and with the former in a series of six animals it was 10 days.

That the degree of virulence of the strain has a share in the effects is clearly illustrated by an experiment carried out with M A virus at a time when its infectious power had diminished.

Experiment I.—Oct. 3, 1913. 100 c.c. of filtrate of M A virus were infused into the leg vein of a *Macacus rhesus*. One hour and twenty-four hours later blood was withdrawn from the opposite leg and defibrinated. 3 c.c. were inoculated intracerebrally into each of two *Macacus rhesus* monkeys. None of the monkeys inoculated showed symptoms.

This experiment may have a bearing upon the unsuccessful inoculations with blood from human cases. There is little doubt of the presence of the virus in the one hour and the twenty-four hour samples of blood; and yet the quality of the virus was such that it failed to cause infection even when employed for intracerebral inoculation.

[10] Flexner, S., *Jour. Am. Med. Assn.*, 1910, lv, 1105.

EXPERIMENTS WITH STOMOXYS CALCITRANS.

To the data on the infectivity of the blood given in the preceding pages there may be added briefly the results of a few experiments carried out with *Stomoxys calcitrans*. Rosenau and Brues[11] reported several instances of successful transmission of experimental poliomyelitis by means of the biting stable fly, a fact that was at first quickly confirmed by Anderson and Frost.[12] Through the courtesy of Dr. Rosenau one of us (Clark) was enabled to study his method of experimentation so that in the tests made by us Rosenau's method could be followed. Highly active M A virus was used in the experiments.

Experiment 1.—Oct. 1, 1912. 2 c.c. of a suspension of the spinal cord were inoculated intracerebrally into a *Macacus rhesus*. Oct. 4. Excitable. Oct. 6. Partial paralysis. Oct. 7. Prostrate. Oct. 9. Death.

On Oct. 4 and each day thereafter until Oct. 9 about 200 *Stomoxys calcitrans* were permitted to feed on the inoculated monkeys for two or three hours daily. The stable flies were caught in stables in New York City, and the losses from death were made up by adding fresh flies from time to time. The total number of flies employed in the experiment was about 400.

Oct. 7. A *Macacus rhesus* was inoculated intracerebrally with M A virus. Paralysis occurred on Oct. 16, prostration on the 17th, and death on the 18th. The same flies that fed on the preceding monkey were allowed to feed on this animal on Oct. 12 and again on Oct. 14, 15, 16, and 17. These flies were, therefore, permitted to feed ten times upon infected monkeys within fourteen days, five of the feedings taking place before, and five after the onset of paralysis.

From Oct. 6 to 18, except on three days, the 12th, 15th, and 16th, when fresh flies were introduced into the cage and fed first on infected animals, all these flies were given access, for two to three hours at a time, to four healthy monkeys (two *Macacus rhesus* and two *Macacus cynomolgus*). The healthy monkeys were therefore exposed to the flies ten times, covering a period of thirteen days. None of the monkeys developed symptoms of poliomyelitis.

At the conclusion of the feedings the dead flies were collected, ground up, and converted into a Berkefeld filtrate which was inoculated intracerebrally into a *Macacus rhesus* with negative result.

Experiment 2.—Six *Macacus rhesus* monkeys were inoculated intracerebrally between Oct. 18 and Nov. 9, 1912, with M A virus, and a *Macacus cynomolgus* with tonsils from a fatal human case of poliomyelitis. The rhesus monkeys became paralyzed and succumbed; the cynomolgus developed a partial paralysis and was etherized.

Stomoxys were allowed to feed on at least one of the monkeys of this series twenty-one times between Oct. 22 to Nov. 17, or a period of twenty-seven days.

[11] Rosenau, M. J., and Brues, C. T., Fifteenth International Congress of Hygiene and Demography, Washington, 1912.

[12] Anderson, J. F., and Frost, W. H., *Public Health Reports*, 1912, xxvii, 1733.

Monkeys in the preparalytic and paralytic stages were exposed to the flies. Since the death losses were large, about 1,400 flies in all were used in the experiment.

Beginning on Oct. 25 two healthy animals, one *Macacus rhesus* and one *Macacus cynomolgus*, were exposed to the bites of this lot of flies, for two to three hours at each exposure, on twenty-one days. The rhesus monkey appeared somewhat excitable on Nov. 4, and the excitability persisted until Nov. 11, when an examination of the cerebrospinal fluid showed it to be normal. No paralysis developed. The cynomolgus became somewhat excitable and developed weakness of one arm on Nov. 1. The condition did not progress, and on Nov. 4 the animal was etherized. Reinoculation of the spinal cord gave a negative result, and microscopical examination of the spinal cord and intervertebral ganglia showed them to be normal. Possibly the arm may have been hurt by the handling of the animal. This cynomolgus was replaced by another which was exposed to the flies from Nov. 4 to 17. It remained well.

At the conclusion of the experiment a filtrate was prepared from the dead flies, which was without effect when inoculated intracerebrally into a *Macacus rhesus*.

Experiment 3.—About 100 Stomoxys were allowed to feed on a *Macacus rhesus* during the two days following injection of a suspension of M A virus (spinal cord), and 150 Stomoxys were permitted to feed on a paralyzed and moribund monkey. The two lots were ground together and the filtrate from this emulsion was inoculated intracerebrally and intraperitoneally into a *Macacus rhesus*. The animal remained well.

The experiments conducted with Stomoxys gave negative results. In view of the tests on the infectivity of the blood given in the first part of this paper they are quite comprehensible, since it is only under exceptional circumstances that in intracerebrally inoculated monkeys the virus can be demonstrated in the blood by inoculation tests. The negative character of the tests with Berkefeld filtrates prepared from the bodies of the dead flies derives some significance from the single and exceptional successful inoculation with a similar filtrate prepared from *Cimex lectularius* (the bedbug), as reported by Howard and Clark.[13] Finally, it should be stated that a second series of experiments with the stable fly conducted by Anderson and Frost[14] was wholly negative, as were the comprehensive and critical experiments carried out by Sawyer and Herms.[15]

[13] Howard, C. W., and Clark, P. F., *Jour. Exper. Med.*, 1912, xvi, 850.

[14] Anderson, J. F., and Frost, W. H., *Public Health Reports*, 1913, xxviii, 833.

[15] Sawyer, W. A., and Herms, W. B., *Jour. Am. Med. Assn.*, 1913, lxi, 461.

SUMMARY.

Specimens of human blood taken during the paralytic stage of poliomyelitis and post mortem have proved not to be capable of infecting Macacus monkeys.

Specimens of monkey blood taken at various stages of experimental poliomyelitis have not proved as a rule to be capable of infecting monkeys. In a single instance, among ten tests, infection was secured with a specimen of blood removed at the beginning of the paralysis on the seventh day following an intracerebral inoculation.

When suspensions of the spinal cord from a paralyzed monkey have been injected into the brain or simultaneously into the brain and spinal canal, the blood removed from one to forty-eight hours later failed to cause paralysis after intracerebral injection.

When large volumes of active filtrate are injected into the circulation the blood remains infective for seventy-two hours at least, but may be no longer infective after ten days when the paralytic symptoms first appear. When, however, the filtrate is injected in smaller amount or when a filtrate of a less active virus is employed in large quantity, the blood either fails to convey infection or conveys it irregularly.

It is only when overwhelming quantities of an active virus are injected into the blood that paralysis results. The injection of moderate doses is not followed by paralysis, although the virus may still be detected in a blood sample twenty-four hours after the injection. The existence of a mechanism capable of excluding the virus within the blood from the central nervous organs is therefore inferred.

Infection is accomplished far less readily through the circulation than by means of the more direct lymphatic and nervous channels of communication with the central nervous system.

Several series of feeding experiments conducted with the biting stable fly (*Stomoxys calcitrans*) resulted negatively.