SUMMER DIARRHEA IN INFANTS.*

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IN the spring of 1904, acting upon the suggestion of Dr. Bathena Coone, the management of the Chicago Daily News Sanitarium for sick babies requested the prosecution of some work directed toward the solution of some of the problems connected with the intestinal diseases in children. Funds for the purpose were furnished by the Sanitarium, while the Memorial Institute for Infectious Diseases and the Bacteriological Laboratory of the University of Chicago furnished the laboratory facilities.

It was believed that it would be especially valuable at this time to extend the work done last year under the direction of Dr. Flexner, with the object of learning whether the conditions in Chicago were identical with those in the eastern American cities. This seemed practically important, as physicians were being asked to try antidysenteric serum in the treatment of summer diarrhea.

In order to accomplish as much as possible in the short time during which summer diarrhea is prevalent, and in order to do it in the most satisfactory manner, various phases of the work were assigned to different persons. The clinical part of the study was left in the hands of Dr. Coone and Dr. Michael who were in attendance at the Sanitarium. Dr. Weaver and Dr. Tunnicliff undertook the bacterial examination of the stools, and the isolation and study of all bacilli which seemed to fall within the dysentery group. All cultures which corresponded culturally to the dysentery group of bacilli were sent to Mr. Heinemann, who undertook to test them as to their agglutinability with immune sera. The cultures were sent upon slants of agar, marked with numbers, but without intimation as to their cultural characters. Several known dysentery cultures were given him among the rest, marked also with simple numbers. It was hoped in this way to eliminate the personal factor as largely as possible.

The report of the work is here presented in three parts:

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I.

THE DYSENTERY BACILLUS GROUP IN DIARRHEAL DISEASES OF CHILDREN.

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INTRODUCTION.

WHEN Shiga announced the discovery of the dysentery bacillus as the specific cause of epidemic dysentery in Japan, and Flexner in Manila, Kruse in Germany, Vedder and Duval in America, and other observers in various parts of the world found identical bacilli in cases of dysentery, the hope arose that the much-studied problem of the etiology of non-amebic dysentery had been solved. However, further study by improved methods of the bacilli isolated by these different workers has shown that bacilli which were said to be identical with the bacillus of Shiga were not always so in several physiological properties at least.

Flexner's bacillus, isolated in the Philippines, differs from the Shiga bacillus in its ability to break up carbohydrates and to produce indol. Jürgens in Europe has found bacilli in an epidemic of dysentery which correspond to the "Flexner-Harris" organism. In various epidemics of dysentery in this country Park and others have found bacilli corresponding to the true Shiga bacillus, and also the forms which differ from it in their effects upon carbohydrates.

Both Flexner and Park now recognize, not a single bacillus, but a group of bacilli, as causes of dysentery, and each has formulated a classification based upon the effects which the bacilli exert upon certain carbohydrates.* The bacilli included within these groups possess certain properties in common; i. e., inability to ferment glucose with liberation of gas, absence of motility, production of transient and faint acidity in litmus milk with subsequent return to an alkaline reaction. They are divided into two main groups

*Types of dysentery bacilli according to Park: (1) Shiga type. Do not ferment mannite, maltose, or saccharose; (2) Ferment mannite. Do not ferment maltose or saccharose. Produce indol; (3) Ferment mannite actively, also maltose (energetically), and saccharose (feebly). Produce indol.

Types of dysentery bacilli according to Flexner: (1) Shiga type: attacks glucose only; (2) Flexner-Harris type: attacks glucose, mannite, and dextrin, not lactose; (3) Bacillus "Y" type: attacks glucose and mannite, not dextrin and lactose.

by their ability or inability to break up *mannite* with formation of acid, and the former group is subdivided according to the action exhibited by the individuals upon maltose, saccharose, and dextrin.

Deycke[1] has described a bacillus, occurring in cases of severe dysentery in Constantinople, which differs again from any of these, in that it causes gaseous fermentation of glucose and acidifies milk even to a degree provoking coagulation. By feeding his cultures to cats he produced the anatomical lesions of dysentery. The experimental production of dysentery lesions in animals has also been reported as following the feeding and injection of other forms of dysentery bacilli.

The present tendency seems to be to enlarge the group of dysentery bacilli so as to make it include forms which differ quite widely from Shiga's bacillus as originally described. Our conception of dysentery at the present time is that of a clinical picture associated with considerable variation in the anatomical conditions, and due to any one of a group of bacilli which differ considerably among themselves. Our present position is much the same as before Shiga's discovery in that we must look upon dysentery as due to several different causes, although we know much more about a certain group of bacilli which probably bear an etiological relation to certain epidemics, and perhaps to sporadic cases. Before Shiga's time several investigators had apparently shown some relationship between certain organisms belonging in the group of colon bacilli and dysentery. The studies of Celli and Fiocca were especially valuable. They described Bacterium coli dysenteriæ as the essential cause of dysentery and they produced the disease in cats. This organism appears to be the same as that recently described by Deycke. Escherich, as early as 1886, in his pioneer work on intestinal bacteria in children, showed that colon bacilli and also B. lactis aerogenes produced hyperemia, swelling, and hemorrhage in the mucous membrane of the intestine in various animals when introduced subcutaneously or intravenously.

It seems that the poisonous products of many organisms, belonging to the colon and closely related groups of bacteria, are

[1] *Für die Türkei*, 1904, 2, p. 181.

able to give rise to marked disturbances in the intestinal mucosa in animals, corresponding more or less closely to the lesions found in human dysentery. In view of the fact that various forms of bacteria are associated with dysentery at different times, it seems not unreasonable to believe that each may cause the disease. Libman[1] stated this when he said: "One cannot help thinking it would be better to believe that dysentery may be due to a variety of organisms, although the disease is probably, in a great number of cases, in certain epidemics, due to one particular organism."

Since Shiga's publication, in which he laid stress upon the agglutinating power of the dysenteric patient's blood upon the specific organism, subsequent investigators have placed much reliance upon this phenomenon as an aid in the identification of dysentery bacilli. That too much dependence must not be attached to the agglutination reaction as a means of diagnosis of a disease, or for the identification of the specific cause of a disease must be acknowledged. The agglutination reaction in typhoid fever has lost much of its specific interpretation as a result of more extensive and comprehensive investigation.

Durham[2] performed many tests to determine whether it was possible to differentiate various organisms of the colon-typhoid group by agglutinative serum reactions, and concluded that "it is clear that the clumping reaction is of little value for differentiating and classifying these bacilli in a satisfactory manner." Stober,[3] working upon the agglutination of typhoid and paratyphoid bacilli by various immune sera, found that in certain agglutinations it was necessary to remove the common agglutinins by saturation methods, before anything final could be arrived at concerning specific agglutinins for typhoid and paratyphoid bacilli. In a study of agglutination in the group of fluorescent bacteria, Lincoln[4] found no definite relation between the biological characteristics and the agglutinative reaction. Park and Collins[5] found it necessary to remove the "normal agglutinins" or "common agglutinins" from an immune serum

[1] *Jour. Amer. Med. Assn.*, 1904, 43, p. 383.
[2] *Jour. of Exper. Med.*, 1901, 5, p. 353.
[3] *Jour. of Infect. Dis.*, 1904, 1, p. 445.
[4] *Ibid.*, 1904, 1, p. 268.
[5] *Proc. N. Y. Path. Soc.*, 1904, 3, p. 213.

in order to obtain a specific agglutinating serum for the dysentery organism injected.

Stimulated by the successful results obtained through bacteriological studies of dysentery, Duval and Bassett[1] in the summer of 1902 undertook by the same methods a study of summer diarrhea in infants, availing themselves of the agglutinating power of the blood of the patients upon the bacteria isolated to determine the relationship between the bacteria and the disease. They studied 53 cases, and in the stools of 42 the bacillus of dysentery was found, 11 cases giving negative results. Agglutination reactions were obtained when the organisms were tested: (*a*) with the blood serum of the patients from whom they were secured; (*b*) with the serum of other infants suffering from summer diarrhea; (*c*) with the serum of adult patients with acute dysentery; (*d*) with anti-dysenteric, immune serum. The specific bacillus was not found in the stools of 25 healthy children, nor of those suffering from simple diarrhea, marasmus, and malnutrition; nor did the blood serum of these latter individuals agglutinate the dysentery bacillus. The cases from which the dysentery bacillus was isolated included examples of so-called dyspeptic diarrhea, of enterocolitis, and of malnutrition and marasmus with superimposed infection. They believed that their findings justified them in the conclusion that the summer diarrheas of children are caused by intestinal infection with Bacillus dysenteriæ Shiga, and therefore are etiologically identical with the acute bacillary dysentery of adults.

The following winter Wollstein[2] made a bacteriological study of 114 cases of diarrhea in infants and children occurring in New York city. The dysentery bacillus was found in 39. The agglutinating power of the patient's blood upon dysentery bacilli was tested, and a good reaction obtained in 21 cases. The important observation was made that the reaction was obtained in seven cases, only after injection of "Harris" serum.

During the summer of 1903 extensive bacteriological studies of the diarrheal diseases of children were undertaken by the

[1] *Amer. Med.*, Sept. 13, 1902, 4, p. 417.

[2] *Jour. of Med. Research*, 1903, 10, p. 11.

Rockefeller Institute for Medical Research[1] under the direction of Dr. Flexner. In this collective investigation 412 cases of diarrheal disease among children were studied with reference to the presence of the bacillus of dysentery. Positive results were obtained in 279, or 63.2 per cent. The cases were mostly unselected, and the examinations were carried out by nine different investigators or pairs of investigators in Boston, Baltimore, New York, and Philadelphia. The proportion of cases yielding dysentery bacilli varied much with different investigators, and was from 40 to 94 per cent. About one-third of the positive results were obtained in the examination of stools containing blood, and in all cases yielding positive results mucus was present in the stools, with the exception of three cases in which the stools were entirely fecal with no blood or mucus. In 23 cases the Shiga type of bacillus was alone cultivated, in six it was associated with the "Flexner-Harris" type, and in the others the "Flexner-Harris" type was found alone. All the *mannite* fermenters were classed as examples of the "Flexner-Harris" type. Duval and Shorer, however, found 12 examples of the Bacillus "Y" of Hiss and Russell among their "Flexner-Harris" cultures.

In the course of these investigations Duval[2] encountered a form of bacillus, which differs radically from the "Shiga" and "Flexner-Harris" types, and which he places in the group of dysentery bacilli. It produces a primary acidity in litmus milk, which is replaced by an alkaline reaction after 48 hours, and after a second period of five or six days a second acidity, exceeding the primary in intensity, makes its appearance and is permanent. Flexner classifies this new type as "Bacillus A" and "Bacillus B;" the former attacking glucose, *mannite* and lactose, but not dextrin; the latter attacking dextrin as well as the others. He, however, holds that this type demands additional study before admission to the group. It would appear to approach more nearly to the group of colon bacilli. In the course of these studies it was found that the blood of children suffering from diarrheal disease agglutinates at time the bacillus of dysentery in

[1] *Studies from the Rockefeller Institute for Medical Research*, 1904, 2, p. 7.

[2] *Ibid.*, p. 42, and *Jour. Amer. Med. Assn.*, 1904, 43, p. 381.

"high dilution" (1:20 to 1:1500), but that it could not be treated as an index of the presence of, or infection with Bacillus dysenteriæ. In the negative cases, i. e., those in which no dysentery bacilli were found, the agglutination reaction was often obtained by Bassett at the same dilutions. Search was made for the dysentery bacillus in the stools of healthy children by Wollstein and Duval, and the latter isolated a small number of dysentery bacilli from the stools of two healthy, milk-fed children. These bacilli gave all the reactions of the "Flexner-Harris" bacillus.

During the summer of 1903 Dunn[1] examined 61 cases of summer diarrhea, and found the dysentery bacillus in 10. Organisms were found in other cases, which corresponded culturally to dysentery bacilli, but they were excluded because agglutination reactions were unsatisfactory.

Park, Collins, and Goodwin[2] reported the examination of the stools from a large number of cases of summer diarrhea with excessive mucus, with or without blood. In a majority of the cases the *mannite* fermenting type of dysentery bacillus was found, although at times in small numbers. In none was the Shiga bacillus discovered. In cases of cholera infantum, no dysentery bacilli of either type were found. The blood from cases of cholera infantum and simple diarrhea did not agglutinate any of the dysentery bacilli in their collection higher than 1:10.

Schwartz[3] examined 30 cases of typical summer diarrhea with profuse watery stools and little or no mucus. He did not find dysentery bacilli in any. The blood of such cases did not agglutinate dysentery bacilli.

BACTERIAL EXAMINATION OF THE CONTENTS OF THE LOWER PART OF THE INTESTINE IN CASES OF SUMMER DIARRHEA.*

As there were no laboratory facilities at the Sanitarium, it was necessary to carry the material for cultures to the Laboratory of the Memorial Institute for Infectious Diseases. In order that the material might be collected and transported without danger

[1] *Amer. Med.*, 1904, 7, p. 737. [2] *Proc. N. Y. Path. Soc.*, 1903, 3, p. 148.

[3] *Proc. N. Y. Path. Soc.*, 1903, 3, p. 172.

*The authors desire to express their thanks to Dr. Alice Hamilton for help in working out some of the earlier cases.

of contamination, a simple piece of apparatus was devised. An eight-ounce, wide-mouthed bottle was supplied with a tight-fitting rubber stopper having two perforations. Through one perforation was passed a piece of glass tubing, reaching three centimeters above the stopper, and half-way to the bottom of the bottle. This was closed by a cotton plug at the outer end. A second glass tube was passed just through the stopper in the other perforation, and connected without to a piece of rubber tubing 50 cm. long. By means of a short piece of glass tubing, the distal end of this rubber tubing was connected with a No. 12 or 14 soft rubber catheter. The distal 25 cm. of the catheter was covered by a piece of soft rubber tubing, large enough to slide freely over the catheter, and closed at the ends with cotton. In the bottle was placed two to three ounces of 0.85% solution of sodium chloride. The entire apparatus was then sterilized in the autoclave, and before removal, the rubber stopper was forced tightly into the bottle. If any of the cotton plugs had become wet during the sterilization, they were carefully replaced by dry, sterile cotton.

A number of such sterile outfits were carried to the Sanitarium, and the material obtained as follows: The cotton plugging having been removed from the rubber shield covering the catheter, the free end of the catheter was pushed a little beyond the end of the shield, and some sterile vaseline rubbed over it with a sterile applicator. The bottle was then inverted and elevated by an assistant, care being taken that no fluid entered the air tube, and the salt solution allowed to fill the tube and catheter. The further flow being prevented by pinching the tube near the bottle, the catheter was carefully introduced into the rectum. The manipulations were all carried out by means of the shield, the hands never touching the part of the catheter which entered the rectum. When the catheter had been introduced from 10 to 12 cm., the salt solution was allowed to run out through the catheter, the flow being stopped by pressure upon the rubber tubing while the tube and catheter were still filled with the solution. The bottle was now turned upright and lowered to a position considerably below that of the child's body, and part or all of the salt solution

allowed to flow back into the bottle carrying with it some intestinal contents. When the stools contained mucus, some of it was readily obtained in this way, quite often large masses escaping into the bottle. After withdrawal of the catheter, the rubber stopper was at once replaced by one of sterile cotton. The bottles with the samples were then taken directly to the laboratory, the transportation requiring about one hour, and cultures were prepared at once.

This method of collecting the intestinal contents was devised to meet the demands of our peculiar position. It, however, possesses certain advantages over making cultures from diapers. The material is less apt to contain the organisms which multiply especially in the rectum (B. alcaligenes, B. pseudodysentericus Müller), and contamination from without is impossible.

In making the cultures the methods elaborated by Duval and Bassett were employed. When mucus was present in the salt solution, some was removed, washed in sterile broth once or twice, and then broken up in a tube of sterile broth, and plates prepared from it. Pieces of mucus with blood were chosen when present. In the specimens from which no mucus could be obtained, and in the ones with mucus after some of it had been removed, the fluid was thoroughly agitated, and after standing long enough for the coarse particles to settle, some of the upper turbid fluid was removed with sterile pipettes, and plate cultures prepared from it.* The plates were made from nutrient peptone-agar with a reaction of 1.5% acid to phenolphthalein. From 8 to 16 plate cultures were made from each specimen, and when mucus was obtained as many plate cultures were prepared from it also. The plates were placed in the incubator in an inverted position, and after 18 hours the colonies which had grown out in the suitable plates were marked by a circle with a wax pencil. The plates were then returned to the incubator, and allowed to remain 24 hours longer. From the colonies most resembling dysentery bacilli, stab inoculations were made into glucose-agar. The

*Sometimes the cultures prepared directly from particles of mucus yielded much more numerous bacilli resembling dysentery bacilli than did cultures from the salt solution. As often, however, the opposite was true, and there did not seem to be any particular advantage in making cultures from the washed mucus only.

colonies which grew out in the second 24 hours were selected by preference, but some of the more delicate ones among those growing out in 18 hours were also studied.

The cultures which did not form gas in glucose-agar after two days in the incubator were reserved for further study, the others being discarded. Litmus milk was inoculated from the non-gas-forming cultures. Those which did not produce a strong acidity in three days were studied fully as to their cultural properties, and effects upon carbohydrates. All the cultures which corresponded to the dysentery bacillus group were sent to Mr. Heinemann for agglutination tests.

Cultures were made and studied from 102 cases.* From 76 cases no bacilli corresponding to any of the types included in the dysentery bacillus group were found. From these cases a total of 2757 colonies were studied. From 26 cases (25.4 per cent.) bacilli were cultivated which possess the cultural properties shown by one or the other member of the dysentery bacillus group.

The appended tables show the cases from which cultures were prepared and the number of colonies studied from the plates in each case.

In Table I is given a list of the cases from which no bacilli resembling the dysentery bacillus group were obtained.

Table II shows the principal cultural and physiological properties of the cultures which corresponded to the dysentery group. It also gives the results of Mr. Heinemann's agglutination tests upon these cultures. A few known cultures are included for comparison.

All the cultures included in this table possessed the following common characteristics: Morphologically they were short rods, about as long as typhoid bacilli, but thicker and plumper with rounded ends. Threads of two to six members were occasionally observed. In the same culture, shorter individuals were sometimes seen among the longer ones. In glucose-agar involution forms were often present. No considerable difference could be observed among the various cultures. None of them stained by

* Ninety-eight of the cases were in the Daily News Sanitarium. Cases A, B, and C were in the Presbyterian and Cook County Hospital, and for the opportunity to study them we are under obligation to Dr. A. C. Cotton and Dr. Wm. J. Butler.

Gram's method. No efforts were made to stain flagella. In broth after 24 hours there was a dense cloudiness, some bacilli beginning to settle to the bottom. Later the precipitate was abundant, the upper fluid becoming clear. On the agar slant the growth was delicate, pearly, not elevated, spreading but little, with even or slightly irregular edges. There occurred a cloudiness in the water of condensation with rapid precipitation of the growth to the bottom. On the surface of the gelatin stab culture they spread out two to three millimeters as a semitransparent, typhoid-like growth. A continuous filament developed along the stab. There was no liquefaction. No gas was formed in glucose-agar. They rendered litmus milk slightly acid in 24 hours, and on the third day the original color was restored and was permanent for a month. They all grew as non-motile organisms in Hiss's semisolid medium.

It will be observed that no culture was obtained which corresponded to the true Shiga bacillus. Grouped according to the classification of Flexner, 15 cultures from 11 cases corresponded to the "Flexner-Harris" type, and 18 cultures from 17 cases to the "Bacillus Y" type. From two cases both these types were obtained.

When we attempt to group these cultures according to the classification of Park, there remains a group which is not provided for, which ferments saccharose and not maltose. The agglutination reactions do not bear any relationship to the cultural properties in many cases.

It is of interest to note a peculiar behavior exhibited by several cultures as regards their effects upon sugars. Some of the cultures immediately after isolation failed to ferment maltose or saccharose or dextrin, and after cultivation for several generations they were able to ferment one or more of the sugars which they were not able to attack at first. In a few instances the opposite was true, the ability to ferment one of these sugars being lost. The results given in the table were obtained with the cultures after they had been cultivated for several generations upon artificial media. Flexner has said that "the manner in which this group of organisms agrees and differs is of interest

and importance, and cannot fail to arouse the suspicion that their physiological properties are at present in a very unstable condition." It would appear from the observations here recorded, that the effects of these organisms upon maltose, saccharose and dextrin are not constant but may vary according to the conditions in which the organisms have been growing.

If we attempt to decide which of our cultures were true dysentery bacilli from the agglutinating effects of immune sera upon them, we shall be at a loss to know which should be included and which not. Because of the absence of agglutination, several of the cultures would be classed as Bacillus pseudodysentericus Müller. Ford[1] has found this organism in 10 out of 50 cases in which he studied the intestinal flora. He found it most often in the rectum. None of the cases from which he cultivated it were cases of dysentery. This bacillus possessed all the cultural and morphological features of B. dysenteriæ, and it was differentiated only by its failure to give characteristic serum reactions.

When we try to arrive at any conclusions regarding the relationship existing between the dysentery bacillus and cases of summer diarrhea in children, we were met by certain difficulties. In the first place, which of the bacteria cultivated from stools and corresponding more or less closely to the original cultures of dysentery bacilli, shall be called dysentery bacilli? Are we to depend upon the agglutination of the bacilli by immune serum as the final test, and if so are we to employ a serum in each case prepared with a culture similar to the one to be tested?

A second difficulty is dependent upon the fact that however many colonies are studied from the plates prepared from a case, the failure to find the bacilli sought does not exclude the possibility that they were present in such numbers as to have been missed, and that they might have been found if several hundred or more colonies had been studied.

However the case may be, in epidemic dysentery in children, it looks as if we should be obliged for the present to say that we are unacquainted with a specific cause for all cases of summer diarrhea in infants, but that it is likely that many cases are due

[1] *Studies from the Royal Victoria Hospital*, 1903, 1, No. 5.

to the single or combined action of various forms of bacteria. Booker[1] long ago pointed out the fact that in infants affected with summer diarrhea, the inconstant varieties of intestinal bacteria are much more prominent and frequently appear in immense numbers. Alterations in the chemical composition of the intestinal contents dependent upon disturbances in digestion from improper feeding, high temperature, etc., may furnish favorable conditions for the growth of various bacteria which are present in the intestine more or less constantly in small numbers, and on the other hand conditions which are inhibitory to the growth of the bacteria which are present in largest numbers in health. The presence of a certain bacterium in large numbers does not determine its etiological connection with the disease.

The degree of agglutinability is so variable in the case of certain well-known bacteria (as the typhoid bacillus), varying at different times even in the same culture, that it is unsafe to build too much upon such reactions in certain imperfectly studied cultures for purposes of diagnosis.

A limited number of tests were made by us to determine if possible the extent to which the agglutination of dysentery bacilli by the blood of children suffering from summer diarrhea could be considered specific. These tests were made by the microscopic method as the amount of blood serum obtained was small. The results are given in Table III, and they appear to show that agglutinins for the dysentery group of bacilli may be formed in the course of infectious diseases having no possible connection with dysenteric or diarrheal diseases.

In two of the cases of diarrhea from which we obtained blood for agglutination tests, a previous injection of antidysenteric serum had been administered. The serum from these cases agglutinated at higher dilution than in the others. Wollstein had previously noted that agglutinins appear in the blood after the injection of antidysenteric serum. When agglutination tests in summer diarrhea are reported, it is important to know whether antidysenteric serum has been given previously, as the degree of

[1] *Johns Hopkins Hosp. Rpts.*, 1897, 6, p. 251.

agglutination may probably be very much increased in this manner. In view of the presence of dysentery bacilli in normal milk stools, and their absence or presence in small numbers in the stools of a large proportion of children with summer diarrhea, it is not safe to assume that their presence is connected causally with the majority of cases of summer diarrhea.

TABLE I.

CASES FROM WHICH NO CULTURES RESEMBLING THE DYSENTERY BACILLUS GROUP WERE OBTAINED.

CASE	NO. OF COLONIES STUDIED FROM PLATES		CASE	NO. OF COLONIES STUDIED FROM PLATES	
	Forming Gas	Not Forming Gas		Forming Gas	Not Forming Gas
1	28	0	55	10	16
2	23	1	57	23	12
3	19	0	59	16	2
4	25	9	60	39	1
5	33	2	61	15	8
6	33	5	62	28	8
7	0	16	63	42	0
9	55	4	64	43	0
10	52	3	65	33	0
12	71	0	77	21	12
13	52	0	79	7	25
14	24	0	80	0	34
16	24	0	81	1	13
18	21	3	84	36	0
20	71	0	85	36	0
21	46	2	87	9	14
22	31	0	88	25	0
24	53	3	89	21	2
25	36	0	90	9	15
26	130	2	91	24	0
28	24	10	92	24	0
29	36	0	97	72	0
30	34	1	98	36	0
31	25	11	99	23	1
32	48	0	100	35	1
33	31	4	101	50	0
34	24	0	105	50	0
35	5	19	107	1	35
38	9	0	108	48	0
40	34	4	111	35	1
41	23	12	113	0	14
42	1	33	114	22	0
44	32	1	116	22	15
45	28	1	C	65	1
47	35	1	D	36	0
48	29	7			
49	36	0	Total	2368	389
50	36	0			2368
51	35	1			
52	37	1			
53	22	3	Grand total		2757

TABLE II.

CULTURES BELONGING IN THE DYSENTERY BACILLUS GROUP.

CASE	CULTURE	NO. OF COLONIES STUDIED FROM PLATES		INDOL		NUTROSE-LITMUS[1] SOLUTIONS +1% CARBOHYDRATES (Results after 14 Days)								AGGLUTINATION BY IMMUNE RABBIT'S SERUM (Numbers Represent Dilutions at Which Reaction Occurred)				TYPES (FLEXNER)	TYPES (PARK)
		No. Corresponding to Description	No. not Resembling Dysentery Bacillus Culturally	5 Days	9 Days	Mannit	Maltose	Saccharose	Dextrin	Lactose	Dextrose	Galactose	Levulose	Shiga	Kruse	Flexner	"Y" Hiss		
11	6	2	132	?	0	1	0	0	0	0	C	C	C	...	...	...	...	3	II
15	1	10	14	+	++	3	0	0	0	0	3	3	..	...	100	...	100	3	II
17	1	32	0	?	0	3	0	0	0	0	C	3	..	...	50	200	100	3	II
19	1	59	9	+	++	3	C	1	1	0	C	C	C	...	...	100	...	2	III
19	30	1	..	+	++	3	3	0	2	0	C	C	..	100	50	200	...	2	III
27	1	1	79	+	0	3	3	1	1	0	C	C	..	...	...	100	100	2	III
36	1	13	5	+	+	3	0	0	1	0	3	3	..	...	...	100	...	3	II
36 (2)	1	4	20	+	+	3	0	0	1	0	C	C	C	...	200	...	50	3	...
37	1	1	23	?	0	1	0	3	0	0	C	C	C	100	...	...	100	3	II
39	1	7	8	+	++	3	3	3	0	0	C	3	..	200	...	200	...	3	III
43	5	6	11	..	+	3	0	C	0	0	C	3	..	...	...	...	...	3	...
54	3	3	..	..	+	3	0	0	0	0	C	3	..	...	...	100	200	3	II
55	11	3	24	+	+	3	0	0	3	0	C	C	..	200	100	200	200	3	...
56	1	4	18	+	?	3	0	0	0	0	3	3	..	200	...	50	200	3	II
76	3	15	14	?	++	3	0	0	2	0	C	C	..	...	50	...	100	2	II
78	1	4	16	?	+	3	3	0	0	0	C	3	..	200	...	200	...	3	III
82	1	1	35	?	?	2	3	0	3	0	C	C	C	200	100	200	100	2	III
83	1	2	34	0	0	3	2	1	1	0	C	C	C	100	100	...	100	2	III
86	1	35	1	+	+	3	0	1	0	0	C	C	C	50	...	...	100	3	...
93	1	3	32	+	+	C	2	1	1	0	C	C	C	...	...	...	100	2	III
93	3	1	..	+	+	3	1	1	1	0	C	C	C	...	...	...	...	2	III
96	1	1	35	+	0	3	C	1	2	0	C	C	C	...	50	...	...	2	III
101	1	6	44	0	+	3	3	1	1	0	C	C	C	200	...	...	...	2	III
101	5	1	..	0	0	3	0	2	0	0	C	C	C	200	...	...	...	3	...
102	1	4	50	?	?	1	0	3	3	0	C	C	C	50	200	50	50	2	III
102	2	..	50	++	++	1	C	0	1	0	C	C	C	...	...	200	...	2	III
102	6	..	50	++	++	1	C	0	3	0	C	C	C	100	...	200	...	2	III

TABLE II—*Continued.*

Case	Culture	No. of Colonies Studied from Plates: No. Corresponding to Description	No. of Colonies Studied from Plates: No. not Resembling Dysentery Bacillus Culturally	Indol: 5 Days	Indol: 9 Days	Nutrose-Litmus[1] Solutions + 1% Carbohydrates (Results after 14 Days): Mannit	Maltose	Saccharose	Dextrin	Lactose	Dextrose	Galactose	Levulose	Agglutination by Immune Rabbit's Serum (Numbers Represent Dilutions at Which Reaction Occurred): Shiga	Kruse	Flexner	"Y" Hiss	Types (Flexner)	Types (Park)
103	7	1	35	++	++	C	0	2	0	0	3	C	C	...	50	...	50	3	...
109	4	4	32	+	+	2	0	0	0	0	C	C	..	100	...	...	3	3	II
110	1	40	28	+	+	3	0	0	0	0	C	C	..	100	...	200	200	3	II
A	1	34	2	+	++	C	C	0	1	0	C	3	C	...	...	...	...	2	III
B	1	10	1	?	0	3	C	2	3	0	C	3	C	...	...	200	...	2	III
B	4	25	1	....	+	3	0	2	0	0	C	3	C	...	...	200	200	3	...
Known Cultures[2]—																			
B. Dys.—Shiga		..	...	0	?	0	0	0	0	0	C	C	C	100	200	...	...	1	I
B. Dys.—Kruse		..	...	?	0	0	0	0	0	0	C	C	C	100	200	...	...	1	I
B. Dys.—Flexner		..	...	+++	+++	3	C	1	3	0	C	C	C	...	...	200	200	2	III
B. Dys.—Mt. Vernon CC_2		..	...	....	...	2	0	0	0	0	C	C	C	...	...	100	200	3	II
B. Dys.—N. Y. city—Salant		..	...	+++	+++	2	2	1	0	0	3	C	C	...	...	...	...	3	III
B. Dys.—Coney Isl.—Etieme		..	...	+	+	1	3	2	0	0	3	1	..	...	...	...	...	3	III
B. Dys.—Mt. Desert—Park		..	...	+	+	2	0	0	0	0	3	C	..	200	...	...	...	3	II
B. Dys.—"Y" Hiss & Russell		..	...	+	+	2	0	0	0	0	C	C	..	200	100	...	200	3	II

[1] All the cultures in nutrose-litmus solutions were made at the same time, and from the same lot of medium. These same cultures in the same nutrose-litmus solution without the addition of any carbohydrate failed to bring about any alteration in color. The sugars added were Merck's chemically pure. "1," "2," and "3" indicate changes in the color of the litmus due to acid production; from the slightest perceptible reddening ("1") to a strong acid reaction ("3"). "C" signified a precipitation of the nutrose.

[2] For the first three and the last of these cultures, we are under obligation to Professor Jordan, of the University of Chicago; for the remainder to Dr. Collins in Dr. Park's laboratory in New York city.

TABLE III.

MICROSCOPIC AGGLUTINATION OF BACILLI OF THE DYSENTERY GROUP BY THE SERA OF CHILDREN.*

SOURCES OF SERA	CULTURES FIGURES REPRESENT DEGREES OF DILUTION							
	19 – 1	B. Dys. Mt. Desert Park	B. Dys. Shiga	B. Dys. Flexner	B. Dys. N. Y. City; Salant	B. Dys. "Y" Hiss and Russell	A – 1	B – 1
Case 19: Entero-colitis. Dys. bacilli cultivated. Had received antidysenteric serum.	1:800=+	1:50 =+	1:50 =0	1:100=+	.....	.....	.....	.....
Case A: Entero-colitis. Dys. bacilli cultivated. Had received antidysenteric serum.	1:20 =+	1:100=+	1:20 =+	1:100=+	1:400=+	1:100=+	1:400=+	.....
Case 71: Entero-colitis. No bacteriologic examination.	1:20 =0	1:20 =0	1:20 =+	1:20 =+	1:20 =+	1:20 =0	1:20 =+	.....
Case 74: Entero-colitis. No bacteriologic examination.	1:20 =+	1:20 =+	1:20 =+	1:20 =+	1:100=+	1:20 =+	1:100=+	.....
Case 113: Entero-colitis. No Dys. bacilli found in cultures.	1:100=+	1:50 =0	1:50 =0	1:50 =0	1:50 =0	1:50 =0	1:50 =0	.....
Case 116: Entero-colitis. No Dys. bacilli found in cultures.	1:20 =0	1:20 =0	1:20 =0	1:20 =0	1:20 =0	1:20 =0	1:20 =+	.....
Case B: Entero-colitis. Dys. bacilli cultivated.	1:50 =+	1:50 =+	1:20 =0	1:100=+	1:50 =+	1:50 =+	1:20 =+	1:200=+
Case C: Entero-colitis. No Dys. bacilli found in cultures.	1:20 =0	1:20 =0	1:20 =0	1:50 =+	1:50 =+	1:20 =+	1:20 =0	1:50 =+
Scarlet-fever—Case 378	1:20 =+	1:20 =0	1:20 =0	1:100=+	1:50 =+	1:20 =0	1:20 =+	1:200=+
Scarlet-fever—Case 379	1:100=+	1:100=+	1:20 =+	1:100=+	1:100=+	1:50 =+	1:50 =+	1:200=+
Scarlet-fever—Case 380	1:20 =0	1:20 =0	1:20 =0	1:20 =0	1:50 =0	1:20 =0	1:20 =0	1:20 =0
Typhoid-fever—convalescent—E. E.	1:50 =+	1:50 =0	1:50 =0	1:50 =+	1:50 =0	1:50 =0	1:50 =0	1:50 =0
Typhoid-fever—convalescent—P. E.	1:50 =+	1:100=+	1:50 =+	1:100=+	1:100=+	1:200=+	1:50 =0	1:200=+
Typhoid-fever—convalescent—R. H.	1:50 =+	1:50 =+	1:50 =0	1:100=+	1:50 =+	1:50 =+	1:50 =0	1:100=+
Measles—fifth day—P. J.	1:100=+	1:100=0	1:100=0	1:100=+	1:100=+	1:100=0	1:100=+	.....
Measles—fifth day—M. L.	1:100=+	1:100=0	1:100=0	1:100=+	1:100=+	1:100=0	1:100=0	.....

*The dilution at which a negative result is recorded was the lowest dilution tested; and, with a few exceptions, where positive results were recorded, it was determined that agglutination did not occur at a dilution twice as great.

The character of the cultures will be found in Table II.

II.

STUDY OF THE AGGLUTINATING POWER OF IMMUNE RABBIT SERA UPON 33 CULTURES OF THE DYSENTERY BACILLUS GROUP, ISOLATED FROM CASES OF SUMMER DIARRHEA.*

P. G. HEINEMANN.

THE methods employed in testing the agglutinative properties of organisms obtained from infantile diarrhea may be briefly summed up as follows:

Four different strains of dysentery bacilli were obtained from the laboratory collection known as:

1) Shiga type.[1]
2) Kruse type.[2]
3) Flexner ("Gray" Manila) type.[3]
4) The organism described by Hiss and Russell as type "Y."[4]

These four organisms were sent to the University of Chicago laboratory by Dr. P. H. Hiss of Columbia University, and were received on May 9, 1903. Subcultures had been made from the original cultures at regular intervals.

Eight healthy rabbits were selected and injected subcutaneously, two always with the same type. Only two survived longer than a few weeks, in consequence of which fact the agglutinating power of the serum never exceeded a dilution of 1:200. This, however, may not have been a serious disadvantage. Bergey[5] states, that a high immunization of an animal against a particular organism not only increases the agglutinin for that organism, but also induces an augmentation of the agglutinins of other organisms of closely allied species. This principle seems especially applicable to the different strains of dysentery organisms, as several authors have shown that sera of animals immunized with one strain will agglutinate others in fairly high dilutions. Jürgens[6]

*The work was done at the Bacteriological Laboratory at the University of Chicago under the direction of Professor E. O. Jordan, and I take this opportunity of acknowledging my indebtedness for his kind interest and advice.

[1] *Centralbl. f. Bakt.*, 1898, 23, p. 599.
[2] *Deutsche med. Wchnschr.*, 1900, 26, p. 637.
[3] *Johns Hopkins Hosp. Bull.*, 1900, 11, p. 23.
[4] *Med. News*, Feb. 14, 1903, 82, p. 82.
[5] *Jour. Med. Research*, 1903, 10, p. 21.
[6] *Ztschr. f. klin. Med.*, 1904, 51, p. 365.

has shown that the serum of a patient, which agglutinates the "Kruse" type, will also agglutinate the "Flexner" type and calls this phenomenon "Group agglutination."

In a recent paper[1] Dr. Park describes a number of experiments and states that specific agglutinins develop in the early period of treatment far in excess of group agglutinins. At later periods group agglutinins develop with greater rapidity than specific agglutinins, often constituting 50% of the total amount of agglutinins present. At still later periods of treatment specific agglutinins diminish with greater rapidity than group agglutinins.

Injections were given regularly twice a week, with a few exceptions, so as to enable the animals to fully recover from the effects. The initial amount injected was 0.5 c.c. of a 24-hour broth culture. The Shiga cultures seemed the most fatal of the four strains, the rabbits sometimes dying after two or three injections, ten rabbits having succumbed apparently directly from dysentery bacillus infection. Martini and Lentz[2] report a similar experience in regard to rabbits and guinea pigs. The other three strains were fatal to two rabbits each, two additional ones having died from different infections. There can be little doubt that the summer weather contributed toward the death of all these animals.

After such experiences, the new rabbits were treated with smaller doses, commencing with 0.25 c.c. of the 24-hour broth culture. Later, agar slant cultures were used exclusively. The growth was scraped off by means of a platinum loop, suspended in 4 c.c. 0.85% NaCl solution and this suspension exposed to a temperature of 65° C. for 30 minutes. This mode of procedure seemed more successful, proving to be less fatal to the animals as well as producing an agglutinating power of the blood serum in a shorter time. This method was continued to the end, with increasing doses as shown in Table IV.

The rabbits, immunized to the same strain, were bled alternately, unless the death of one of the pair made it necessary to use the same animal twice in succession. The blood obtained was

[1] *Jour. of Med. Research*, 1904, 12, p. 491.

[2] *Ztschr. f. Hyg. u. Infektionskr.*, 1902, 41, p. 540.

TABLE IV.

DATA RELATING TO INJECTION OF ANIMALS.

DATE	MATERIAL INJECTED	SHIGA-BACILLUS								KRUSE-BACILLUS						FLEXNER-BACILLUS				"Y"-BACILLUS			
		Amount Injected into Rabbit No.								Amount Injected into Rabbit No.						Amount Injected into Rabbit No.				Amount Injected into Rabbit No.			
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	Broth	c.c.	c.c.	c.c.	c.c.	c.c.		c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c.c.	c c.	c.c.
June 28..	Cultures	0.5	0.5							0.5	0.5					0.5	0.5			0.5	0.5		
July 1..	"	0.5	0.5							0.5	0.5					0.5	0.5			0.5	0.5		
July 6..	"	0.5	dead							0.5	0.5					0.5	0.5			0.5	0.5		
July 9..	"	0.5		0.5						dead	0.5					0.5	0.5			0.5	0.5		
July 12..	"	0.5		dead							0.5	0.5				0.5	dead			0.5	0.5		
July 15..	"				0.25						dead	0.5	0.25					0.25					
July 19..	"	0.5			dead	0.25						0.5	0.5			0.5		0.25		0.5	0.5		
July 22..	"	0.5				dead						0.5	0.5			0.5		0.25		0.5	0.5		
	Agar Cul's.																						
July 25..	killed at 65°	1.					0.5					1.	1.			1.		1.		1.	1.		
July 30..	"	1.					1.					1.	1			1.		1.		1.	dead		
Aug. 3..	"	1.5					1.5					1.5	dead	1.		1.5		1.5		1.5		1.	
Aug. 6..	"	1.5					1.5					1.5		1.		1.5		1.5		1.5		dead	0.5
Aug. 10..	"	1.5					1.5					1.5		1.5		1.5		1.5		1.5			1.
Aug. 19..	"	dead					1.5	1.				1.5		1.5		1.5		1.5		1.5			1.5
Aug. 24..	"						1.5	1.				1.5		1.5		1.5		1.5		2.			1.5
Aug. 29..	"						1.5	1.				1.5		1.5		1.5		dead	0.5	2.			1.5
Sept. 2..	"						1.5					1.5		1.5		1.5			0.5	2.			1.5
Sept. 14..	"						1.5	dead	0.5			dead		1.5	0.5	1.5			1.	2.			1.5
Sept. 17..	"						1.5		1.					1.5	1.	1.5			1.	2.			1.5
Sept. 21..	"						1.5		1.5					1.5	1.5	1.5			1.5	2.			1.5
Sept. 24..	"						1.5		1.5					1.5	1.5	1.5			1.5	2.			1.5
Total....	.....	10.0	1.0	0.5	0.25	0.25	18.0	3.0	4.5	1.5	2.5	14.5	3.25	15.5	4.5	22.0	2.0	10.25	6.0	25.5	4.5	1.0	13.5

left in the ice-chest over night, the serum collected the following morning, and if necessary filtered through sterile absorbent cotton and then mixed with a suspension of the different organisms under investigation.

These organisms were received at the laboratory cultivated on agar slants, the tubes being numbered, without any indication whatever as to their properties. Subcultures on agar slants were prepared and incubated at 37° C. for 24 hours.

The agglutination tests were made by the macroscopic method exclusively. The 24-hour-old agar growth was scraped off, shaken and diluted with a sufficient amount of 0.85 % NaCl solution to obtain a light and uniform degree of cloudiness. This suspension was then filtered through absorbent cotton, often repeatedly, until perfectly free from flakes and until the cloudiness was uniform.

The next step was to arrange five small tubes of uniform diameter, carefully cleaned, finally washed in distilled water and dried. Each one of the organisms, including a suspension prepared from the homologous organism, was tested in four steadily increasing dilutions. The amounts used and final dilutions reached are shown in Table V, No. 5 of the first column, representing a plain suspension in NaCl solution without serum, as a control:

TABLE V.

SERUM DILUTIONS.

Tube No.	Amount of Suspension	Serum (Undiluted)	Serum Diluted with 0.85% NaCl 1:10	Final Dilution
1.....	24 minims	1 minim	.....	1:25
2.....	16 "	.....	4 minims	1:50
3.....	18 "	.....	2 "	1:100
4.....	19 "	.....	1 "	1:200
5.....	25 "	.....	.....	.....

The tubes were placed in the incubator at 37° C. at 12 o'clock, and the first observations made at one o'clock. The second observations were made at two o'clock, the third at six and the final ones at eight o'clock the following morning, the tubes always being kept at 37° C. The testing of every set of organisms sent to the laboratory was accompanied by a control experiment with the homologous organism.

The results after 20 hours at 37° C. are given in Table VI. Agglutination usually began to appear in two hours. In six hours many of the reactions were complete, but especially in higher dilutions, reactions which were partial after six hours often became complete in twenty hours. The suspensions in NaCl solution never showed any agglutination.

TABLE VI.

AGGLUTINATION OF CULTURES BY IMMUNE RABBIT'S SERA.

CASE	CULTURE	IMMUNE RABBIT'S SERA											
		Shiga			Kruse			Flexner			"Y" of Hiss and Russell		
		+++	++	+	+++	++	+	+++	++	+	+++	++	+
11	6	...	...	...	...	...	...	...	...	...	...	...	...
15	1	...	...	...	50	...	100	...	...	...	25	50	100
17	1	...	...	...	...	25	50	100	200	...	25	50	100
19	1	...	...	...	...	...	...	25	50	100	...	...	...
19	30	50	...	100	...	25	50	25	50	200	...	...	...
27	1	...	...	...	No test			25	50	100	25	50	100
36	1	...	...	...	...	...	...	...	50	100	...	...	...
36 (2)	1	...	...	...	50	100	200	...	...	...	...	25	50
37	1	25	50	100	...	...	...	...	...	...	25	50	100
39	1	50	100	200	...	...	...	100	...	200	...	...	...
43	5	...	...	...	...	...	...	...	...	...	...	...	...
54	3	...	...	...	...	...	...	25	50	100	50	100	200
55	11	50	100	200	25	50	100	50	100	200	50	100	200
56	1	100	200	...	...	...	...	...	25	50	50	100	200
76	3	...	...	...	...	25	50	...	...	...	25	50	100
78	1	50	100	200	...	...	...	50	100	200	...	...	...
82	1	100	200	...	25	50	100	50	100	200	25	50	100
83	1	25	50	100	25	50	100	...	...	...	50	100	...
86	1	...	25	50	...	...	...	...	...	...	50	...	100
93	1	...	...	...	...	...	...	...	...	...	25	50	100
93	3	...	...	...	...	...	...	...	...	...	...	...	...
96	1	...	...	...	...	25	50	...	...	...	...	...	...
101	1	50	100	200	...	...	...	...	...	...	...	...	...
101	5	50	100	200	...	...	...	...	...	...	...	...	...
102	1	...	25	50	50	100	200	...	...	50	...	25	50
102	2	...	...	...	...	...	...	100	200	...	...	...	...
102	6	25	50	100	...	...	...	100	200	...	...	...	...
103	7	...	...	...	...	25	50	...	...	...	...	25	50
109	4	25	50	100	...	...	...	...	...	...	...	...	...
110	1	25	50	100	...	...	...	50	100	200	50	100	200
A	1	...	...	...	...	...	...	...	...	...	...	...	...
B	1	...	...	...	...	...	...	100	200	...	...	...	...
B	4	...	...	...	...	...	...	100	200	...	50	100	200
Homologous cul.		100	200	...	50	100	200	100	...	200	100	200	...

The figures represent the dilutions at which agglutination took place after 20 hours at 37° C.

+++ = perfect clearing of supernated fluid, with the clumps of agglutinated bacilli settled to the bottom.

++ = a fairly complete result.

+ = a distinct clumping with a small amount of turbidity of the supernatant fluid.

A summary of this work shows that 29 of the 33 organisms examined gave positive results with one or more of the sera. Of these 29, nine agglutinated with a single serum, as follows: three

with Shiga serum, one with Kruse serum, four with Flexner serum, and one with "Y" serum.

Twelve agglutinated with two kinds of sera, as follows: three with Shiga and Flexner sera, two with Shiga and "Y" sera, four with Kruse and "Y" sera, three with Flexner and "Y" sera.

Six agglutinated with three kinds of sera: two with Shiga, Kruse and Flexner sera, one with Shiga, Kruse and "Y" sera, two with Shiga, Flexner and "Y" sera, one with Kruse, Flexner and "Y" sera.

Two organisms agglutinated with the four different sera employed.

III.

CLINICAL STUDY OF 97 CASES OF SUMMER DIARRHEA IN WHICH THE INTESTINAL CONTENTS WERE EXAMINED FOR DYSENTERY BACILLI.

MAY MICHAEL.

THIS report contains a synopsis of the clinical features of the cases of summer diarrhea studied bacteriologically by Dr. Weaver and his associates. The records were made at the Daily News Sanitarium by Dr. Coone, Dr. Vail, and the author. The character of this sanitarium, which is more of a temporary refuge than a place for permanent treatment and care, explains the incompleteness of some of these observations.

SYNOPSIS OF THE 97 CASES STUDIED.

Age and sex.—Of the 97 cases of summer diarrhea examined for dysentery bacilli 60 were males and 37 females. Sixteen cases were less than six months of age and of these four were severe, six moderately severe, six mild. Of 36 cases between six months and one year 14 were severe, 11 moderately severe, 11 mild. Of 40 cases between one and two years six were severe, 18 moderately severe, 16 mild, and of four cases over two years one was moderately severe, three mild. Consequently the majority of the cases occurred between one and two years. It seemed that cases between six months and one year were most severe.

Method of feeding.—Only nine of the children were breast fed at the time of the attack; 16 others were partly breast-fed. Of these 16, two received, in addition to the breast, condensed milk, 12 mixed diet, one laboratory milk, one Mellin's food. Of the 66 artificially fed children 43 had

general diet, 10 milk or modified milk, eight condensed milk, two Eskay's food, one oatmeal gruel. Hence the largest number of cases occurred in artificially fed infants.

Predisposing causes.—In only 24 cases did the attack seem to depend upon special conditions: in three cases it followed weaning, in two change of diet, in 19 the feeding had been manifestly improper.

Principal symptoms.—In 45 cases the stools contained mucus and blood; in 28 only mucus; in 23 neither mucus nor blood; in one case there is no record.

The number of stools varied from 2 to thirty in 24 hours. In about half of the cases there were from two to ten stools in 24 hours.

Tenesmus occurred in 23, vomiting in 52, persistent vomiting in seven.

Complications.—Eczema in two, furunculosis in three, bronchitis in 16, pneumonia in two, stomatitis in seven, prolapse of rectum in five, convulsions in three. In 28 cases there was evidence of rickets; all except eight were or had been breast-fed; in 10 of these cases the attack was severe, in 12 moderately severe, in six mild.

Termination.—Three died, 54 improved, 11 remained stationary, and of 29 there was no final record left at the sanitarium.

These 97 cases may fairly well be divided into two groups: (1) Cases of gastro-intestinal catarrh, or fermental diarrhea, in which the toxic symptoms predominated; (2) Cases of follicular enteritis, ileocolitis or colitis, in which the inflammatory symptoms predominated.

Cases of the first group were characterized by sudden onset, loss of appetite, vomiting, and diarrhea. The fever ranged from 99° to 101° in mild cases, and rose to 104°–105° in the severe ones. The stools numbered from 6–10 a day, were yellow or green and slimy, thin and watery, or brown and offensive; they often contained undigested food and mucus. The child was restless, with dry mouth and coated tongue. Sometimes, if the toxemia was great, convulsions occurred at the onset and the disease ran a severe course with continued high fever and marked nervous symptoms.

Complications were not common, but at times eczema, furunculosis, stomatitis, whooping-cough, bronchitis, and pneumonia occurred. Recovery within five to six days was the general termination, although the disease occasionally became chronic and lasted for weeks.

In the second group the inflammatory symptoms were more marked. The onset was acute, the attacks being ushered in by diarrhea, often accompanied by vomiting; the stools, at first fecal,

soon consisted almost entirely of mucus or mucus and blood, this last element varying from a few flecks to a large amount. The temperature was, as a rule, but slightly elevated, 100–101°, although at times normal or subnormal, and sometimes at the beginning very high. Tenesmus was usually present and often associated with prolapse of the rectum. Abdominal pain was frequent and quite intense just before stool. These cases ran a variable course from one to six weeks, but recovery was the rule.

SYNOPSIS OF 24 CASES OF SUMMER DIARRHEA FROM THE STOOLS OF WHICH DYSENTERY BACILLI WERE ISOLATED.

Age.—Under six months, one; between six and twelve months, two; between one and two years, 15.

Method of Feeding.—Breast-fed, three; partly breast-fed, three; artificially fed, 12 (eight, general diet; two, cow's milk; two, condensed milk); no record, six.

Principal Symptoms.—In 22 cases the stools contained mucus and blood, in two only mucus. Tenesmus occurred in 11 cases and vomiting in 13; rectal prolapse in two; bronchitis in four.

Termination.—Recovered or improved, ten; unimproved, five; died, two; no final record, seven.

Hence cases associated with dysentery bacilli in the stools presented more the clinical picture of ileocolitis.

The question whether infection with B. dysenteriæ causes a clinical entity has been discussed by a number of writers. Dorothy Reed[1] has studied a series of cases in which B. dysenteriæ was isolated from the stools and has drawn the following conclusions: "blood and mucus or much mucus in the stools, where there is no occasion for such an appearance, as intussusception, extreme purgation, etc., indicates infection with the B. dysenteriæ; even a little mucus points to such an infection if such stools have existed for a long time. A certain number of cases of infantile diarrhea present a symptom complex comparable to adult dysentery and are caused by the B. dysenteriæ."

Knox[2] says that among children, diarrheas due to B. dysenteriæ cannot be differentiated from the ordinary summer diarrheas.

Hastings[3] has found the Shiga bacillus in cases diagnosed clinically as follows: ileocolitis (25), cholera infantum (one), ente-

[1] *Studies from Rockefeller Institute for Medical Research*, 1904, 2, p. 175.

[2] *Jour. Am. Med. Assn.*, 1903, 41, p. 173.

[3] *Ibid.*, 1904, 42, p. 1121.

rocolitis (two), fermental diarrhea (one), gastro-enteritis (two), enteritis (four).

La Fetra and Howland[1] believe that all types of diarrheal disease as characterized by their clinical symptoms are to be found among these cases (62 cases in which the Shiga bacillus was found); some of these were examples of severe and some of mild ileocolitis; others could be classed only as the mildest form of intestinal indigestion.

Holt[2] drawing his conclusion from all the cases studied by the Rockefeller Institute says: "Infection with the dysentery bacillus is associated with almost every sort of intestinal disturbance accompanied by diarrhea, except the severe acute intestinal intoxication, cholera infantum. The B. dysenteriæ is associated with inflammatory forms of diarrhea of all degrees of severity, mildest, most severe, acute, protracted, subacute; occurring both as a primary disease and a secondary disease, often occurring in institutions as a terminal infection in infants suffering from marasmus."

Rotch,[3] from the study of a series of cases, concludes: (1) That there are no specific symptoms besides the presence of B. dysenteriæ in the discharges to determine that B. dysenteriæ is the cause of an especial case of ileocolitis; (2) that B. dysenteriæ may cause the clinical type known as fermental diarrhea or as ileocolitis.

Koplik,[4] in discussing the question, says the bacilliary diarrheas occur for the most part in older children, although they may occur in very young children and have been found in institutions or in certain localities. They are a distinctly limited class of diarrheas and do not include all the forms which are gradually being controlled by modern methods of infant feeding.

Duval and Bassett[5] state that summer diarrheas are caused by intestinal infection with B. dysenteriæ Shiga, and are therefore etiologically identical with acute bacilliary dysentery of adults. These cases from which the dysentery bacillus was isolated include

[1] *Studies from Rockefeller Institute of Medical Research*, 1904, 11, p. 137.

[2] *Ibid.*, p. 185.

[3] *N. Y. State Jour. of Med.*, 1904, 4, p. 173.

[4] *Archives of Pediatrics*, 1903, 20, p. 808.

[5] *Studies from Rockefeller Institute for Medical Research*, 1904, 2, p. 7.

examples of so-called dyspeptic diarrhea, enterocolitis, malnutrition, and marasmus with superimposed infection.

Clinically the 24 of our 97 cases in which dysentery bacilli were found did not differ from the cases of ileocolitis in which the dysentery bacilli were not found.

The success which has been attained in Japan with the specific serum treatment of dysentery in adults encouraged its use in infantile dysentery. According to Shiga the mortality in adult dysentery by its use was reduced to one-third below that given by the symptomatic treatment. On the whole, however, the results in infantile dysentery are disappointing. Only 12 of the 87 cases reported by the Rockefeller Institute showed any improvement attributable to its use. Holt[1] says the conditions for success in the use of the serum are, first that it must be used early before serious lesions have developed, and second that it must be used in repeated doses (10 c.c. daily in moderate cases, repeated two or three times daily for several days, in severe ones). He believes that the promising cases are the sharp acute attacks with symptoms of severe infection, where the real problem is to combat the infection, not to maintain the nutrition; also that inasmuch as two days are required for bacteriological diagnosis, if used at all, the serum must be injected on a clinical diagnosis. The variety of serum usually used is that obtained by immunizing animals with both the "Harris-Flexner" and the "Shiga" types of bacilli. The serum was used in only two of our series of cases; neither showed marked improvement from its use. As Holt says, a more extended trial upon more carefully selected cases is necessary before definite statement can be made as to the value of antidysenteric serum.

CONCLUSIONS.

I. Dysentery bacilli were not found in all cases characterized by mucus and bloody stools.

II. The group of cases in which dysentery bacilli were isolated from the stools presented the clinical picture of ileocolitis.

III. Cases of ileocolitis in which dysentery bacilli were isolated from the stools did not differ clinically from cases of ileocolitis in which these bacilli were not found.

[1] *Loc. cit.*