EVIDENCE THAT SUMMER DIARRHEA IS AN INFECTIOUS ENTERITIS*

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In a previous paper¹ I discussed the various theories which have been proposed to explain the great prevalence of gastro-enteric diseases in infants during the summer. The general conclusion in that study was that the heat theory is inadequate to explain the occurrence of diarrhea during the hot weather, although it may act as a predisposing cause. Excessively hot weather also increases the mortality of infants suffering from digestive disorders.

Three years ago the study was taken up again. The cases were studied from the practitioner's standpoint. Each case was studied carefully in regard to its history and clinical characters. The question at issue was, what kind of cases make up the class which bring about the great mortality of the summer?

First, there is the infant who has been suffering for a long period from digestive disorders, has lingered at the threshold of death, and the sudden appearance of extremely hot weather has served as the last killing factor. The sharp peak in the mortality curve is made up of a large number of these cases.

The second group of cases is made up of young children who are given new articles of diet during the summer, such as cherries, apples, strawberries, plums, green vegetables, peaches, melons, etc. These cases are rarely serious and do not add to the mortality, but increase the number of clinical cases.

A third group embraces infants suffering from acute indigestion due to overfeeding on hot days. These patients have the well known symptoms of fermental diarrhea and rapidly recover under dietetic measures. It is questionable whether these cases are much more frequent in the summer than in the winter.

A fourth group of cases is undoubtedly due to spoilt milk. These occur on very hot days when even the refrigerators and ice boxes have a temperature of 60 F. or more, and all housewives report that their milk and cream are sour. Except in infants whose nutrition is already very low, these cases are rarely serious. Vomiting is the most pronounced symptom in these cases.

Fifth, there is the dysenteric group. The infant is acutely ill, and

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remains sick for one or more weeks. The disease is characterized by the passage of mucus, blood and macroscopic pus in the stool. This group is well recognized and need not be discussed at length.

Sixth, summer diarrhea.

For want of another term this name "summer diarrhea" is applied to the principal group of diarrheal diseases which occur during the summer. No doubt it is a composite group.

The characteristic symptoms of summer diarrhea are a sudden, acute onset, usually with fever and toxic symptoms, vomiting and diarrhea. The toxic symptoms, as a rule, disappear in from twenty-four to thirty-six hours (except in very young babies), the fever drops to normal, the infant feels better, but the diarrhea persists for several days; sometimes for several weeks. This persistency of the diarrhea distinguishes the disease from the ordinary fermental diarrhea from overfeeding.

The stools have only one common character, and that is they are thin and watery. The color is often green, but may be brown, yellow or gray. The watery character of the stool is easily recognized when it is freshly drawn from the rectum by a tube. After two or three days the stools become more mushy and on close inspection some mucus or mucopus will be noticed. Blood spots are occasionally observed. The acidity, as a rule, is not high except the first day of the disease, when the administration of milk has not been discontinued. I have never found the acidity in these cases as high as in ordinary fermental diarrhea (for example, after the administration of malt soup, Mellin's food, etc.).

Two years ago it occurred to me that if these cases were really infectious enteritis, some evidence of this infectious process ought to be found in the stools. From pathologic studies it is known that the principal lesions in fatal cases of summer diarrhea are swelling and ulceration of the solitary follicles. If one or more solitary follicles are infected (and it is reasonable to assume that any bacteria which enter the mucous membrane would be conveyed to the adjacent lymphoid mass), the pathologic process would be similar to that occurring in the tonsil. There would be hyperemia, swelling, and finally an extrusion of the offending micro-organisms into the intestine, accompanied by leukocytes and lymphoid cells. These leukocytes and lymphoid cells ought to be found in the stools.

I began the study of the stools two years ago, but in this report the cases are limited to those observed in private practice in St. Louis in the summer of 1917.

The technic used was as follows:

A large catheter was introduced into the rectum. In the early stage of most cases the stool readily flowed through the catheter into a

vessel. As mentioned, the stools have a variety of color, but the fluid character is marked. With a splinter of wood a small particle of this stool is mixed with 2 drops of water on a slide. It is examined under the microscope with low power.

In the vast majority of cases the field will show hundreds of leukocytes and round cells.

I have provisionally adopted the following rule in designating the amount of pus in the stool. If more than 100 cells are present, it is called pus index 100. If there is a less number of cells they are designated by approximately the number of cells counted in one field. Thus, if only 30 cells are seen, it is pus index 30. If less than 5 leukocytes are observed the pus index is zero and an inflammatory enteritis is not confirmed.

When the stools become thicker, a small mass of stool, or, if possible, a lump of mucus is mixed with the water on a slide and the cells are observed and counted as before.

Dr. J. L. Swarts, who is studying these cases with me, will report on the type of cells in a later paper.

Here I wish to emphasize that in all severe, toxic, or protracted cases of summer diarrhea in 1917, pus was demonstrable in the stools. The evidence so far goes to show that these cases are due to an infection of the solitary follicles in the upper part of the colon or the ileum. The conclusion is based on the clinical axiom that the presence of pus cells indicates an infectious process.

During the summer of 1917 we examined the stools of 85 infants suffering with diarrhea. Of these, only 12 showed macroscopic pus and blood, symptoms of dysentery. In 7 cases pus was detected only by the most careful inspection. In 53 cases pus could be found only with the microscope (See Table).

Six cases are herewith reported in detail.

CASE 1.—D. S., girl, aged 7 months. She was naturally fed for two months, when the mother's milk failed. Since then the infant has been fed on raw certified milk and thrived. At present (June 26, 1917) her food consists of 4 ounces of milk, 2 ounces of barley water, and 4 per cent. milk sugar added. She has had diarrhea for one week—eight to ten stools daily. The trouble was traced to some ice cream which had been given to the baby at a picnic. No fever has been noticed.

The baby is well nourished; skin feels dry; breathing normal; rectal temperature, 100.2 F. Physical examination otherwise negative. The stool, obtained with catheter, consists of limpid green water, the consistency of urine; acidity of this fluid, 50. Diluted with equal parts of water and a drop placed under the microscope, it shows a solid field of corpuscles. Pus index 100+.

Diagnosis, enteritis. Treatment, bismuth and rhubarb. Diet, barley water, followed after twenty-four hours by barley water and buttermilk (2 to 1).

June 29. Better; temperature 99.6 F.; stools four or five daily, thin dark, not so watery. Pus index 10. Diet, buttermilk and barley water (1 to 1) with 3 per cent. milk sugar.

SUMMARY OF CASES OBSERVED BY THE AUTHOR

No.	Age, Mos.	Sex	Date of Onset	Food	Symptoms of Onset	Fever	No. of Stools	Character of Stools	Pus Index	Febrile Period, Days	Length of Illness, Days*
1	7	♀	8/ 6	Raw milk	Vomited	103	15	Watery	100	5	16
2	11	♂	6/27	Boiled milk	Diarrhea	101	5	Watery	15	6	24
3	7	♂	10/ 5	Pasteur. milk	Diarrhea	None	7	Mucous	100	..	10
4	11	♂	10/ 4	Raw milk	Diarrhea	101	9	Watery	100	2	11
5	5	♀	8/ 6	Raw milk	Diarrhea	103	20	Mucous	100	10	35
6	7	♀	9/ 1	Cond. milk	Vomiting	101	5	Watery	100	2	21
7	12	♀	7/ 5	Raw milk	Diarrhea	104	6	Slimy	100	2	5
8	14	♀	6/26	Raw milk	Vomited	None	7	Mucous	50	1	12
9	13	♀	7/12	Mixed	Diarrhea	None	6	Watery	20	..	5
10	14	♂	8/20	Mixed	Diarrhea	None	6	Watery	100	..	6
11	12	♂	8/ 6	Mixed	Diarrhea	None	5	Green	100	..	14
12	9	♂	8/ 2	Cond. milk	Diarrhea	100	4	Mucous	10	..	20
13	16	♂	9/ 5	Mixed	Diarrhea	100	8	Mucous	100	2	10
14	6	♂	9/ 6	Raw milk	Diarrhea	102	7	Mucous	100	5	14
15	1	♂	8/25	Cond. milk	Diarrhea	None	5	Green	15	..	..
16	17	♂	9/ 1	Mixed	Diarrhea	None	7	Mucous	100	..	14
17	21	♀	8/ 1	Mixed	Diarrhea	101	10	Watery	50	7	26
18	8	♀	8/ 2	Human	Diarrhea	None	5	Green	20	..	7
19	6	♂	7/ 1	Boiled milk	Diarrhea	None	7	Watery	10	..	5
20	3	♂	8/16	Raw milk	Diarrhea	None	5	Watery	50	..	13
21	5	♂	9/ 7	Boiled milk	Diarrhea	103	8	Watery	20	2	13
22	8	♂	8/23		Diarrhea	None	..	Watery	30	..	20
23	7	♂	8/ 6	Human	Fever	...	..	Loose	20	6	..
24	1	♀	8/14	Mellin's	Diarrhea	...	7	Watery	5	..	21
25	2	♂	8/ 4	Mixed	Diarrhea	None	5	Thin	5	..	3
26	13	♀	8/ 3	Mixed	Fever	100	7		10	..	3
27	15	♂	8/10	Mixed	Fever	...	15	Pus, Mucous Watery	100	5	15
28	15	♀	8/17	Mixed	Vomiting	102	6	Watery	100	2	9
29	2	♂	9/15	Mellin's Raw milk	Diarrhea	None	6	Watery	100	..	10
30	10	♀	9/20	Raw milk	Fever	102	10	Bloody	100	7	13
31	7	♂	9/ 6	Raw milk	Diarrhea	None	6	Mucous	100	..	16
32	24	♂	9/ 6	Raw milk	Diarrhea	103	5	Blood, Mucous Watery	100	2	9
33	12	♀	8/ 5	Raw milk	Fever	101	10	Watery	100	2	9
34	24	♂	7/	Mixed	Slight fever	...	..	Blood, Mucous Mucous	100	1	7
35	25	♂	8/ 8	Mixed	Anemia	102	5	Mucous	20	10	..
36	2	♀	8/31	Boiled milk	Diarrhea	...	7	Watery	100	..	8
37	2	♀	9/ 7	Human	Colic	...	2	Mucous	5	..	..
38	2	♂	9/ 7	Raw milk	Colic	...	2	Green	5	..	..
39	3	♀	9/12	Malted milk	Diarrhea	None	..	Blood, Green Mucous	100	..	6
40	14	♀	7/24	Mixed	Vomiting and Diarrhea	100	8	Mucous	100	..	14
41	1	♀	6/15	Human	Diarrhea	100	17	Green	100	4	12
42	4	♂	8/	Raw milk	Diarrhea	101	5	Mucous	10	..	7
43	1	♀	8/12	Human	Diarrhea	...	5	Green watery	20	..	4

* All cases terminated in recovery except Cases 34 and 35, in which the patients died.

SUMMARY OF CASES OBSERVED BY THE AUTHOR—(Continued)

No.	Age, Mos.	Sex	Date of Onset	Food	Symptoms of Onset	Fever	Stools No. of	of Stools Character	Index Pus	Period, Febrile Days	Illness, Length Days*
44	5	♂	9/20	Raw milk	Diarrhea	...	6	Mucous	10	..	6
45	1	♀	8/23	Human	Diarrhea	...	7	Green	100	..	15
46	4	♂		Mixed	Diarrhea	None	5	Green	20	..	16
47	4	♂	10/ 3	Raw milk	Vomiting and Diarrhea	None	7	Watery	15	..	8
48	22	♂	8/22	Mixed	Diarrhea	103	12	Bloody, Mucous Yellow	100	2	17
49	10	♀	8/ 1	Mixed	Diarrhea	101	8	Yellow	25	2	..
50	12	♀	8/25	Mixed	Vomiting	100	20	Brown, Watery	100	1	..
51	9	♂	9/ 7	Raw milk	Diarrhea	None	10	Liquid, Green	100	..	8
52	11	♀	6/ 3	Raw milk	Diarrhea	None	8	Watery	20	..	10
53	11	♀	8/20	Mixed	Diarrhea	None	6	Mucous	100	..	5
54	12	♂	8/ 3	Mixed	Fever	100	8	Mucous	100	1	6
55	9	♂	7/10	Human	Fever	102	6	Green, Mucous	100	..	20
56	5	♀	6/ 7	Boiled milk	Diarrhea	None	5	Watery	10	..	3
57	7	♀	8/29	Raw milk	Diarrhea	101	5	Watery	50	2	7
58	7	♂	7/ 7	Raw milk	Vomiting and Fever	102	14	Mucous	50	10	12
59	3	♀	7/16	Boiled milk	Colic	None	6	Mucous	20	..	14
60	24	♂	10/ 2	Mixed	Diarrhea	None	12	Watery	100	..	30
61	14	♂	9/12	Buttermilk	Diarrhea	None	8	Watery	50	..	7
62	1	♂	10/	Human	Diarrhea	None	7	Green	100	..	7
63	15	♂	7/ 8	Raw milk	Diarrhea	99	6	Green	50	..	21
64	9	♀	8/10	Boiled milk	Diarrhea	None	8	Green	..	..	7
65	21	♂	6/16	Boiled milk	Diarrhea	None	4	Mucous	20	..	14
66	13	♀	8/25	Mixed	Diarrhea	None	3	Thin	20	..	7
67	23	♂	8/24	Mixed	Diarrhea	99	4	Thin	5	..	10
68	7	♀	6/25	Human	Diarrhea	101	8	Green	100	..	20
69	27	♀	8/ 1	Mixed	Fever	103	7	Mucous	100	..	9
70	4	♂	10/ 4	Raw milk	Diarrhea	None	5	Watery	10	..	8
71	3	♂	7/18	Boiled milk	Diarrhea	None	9	Watery	100	..	10
72	12	♀	8/23	Boiled milk	Vomiting	101	12	Watery	100	..	15
73	17	♀	7/25	Raw milk	Vomiting and Diarrhea	100	10	Watery	50	1	5
74	12	♀	7/10	Mixed	Diarrhea	None	10	Watery	100	..	7
75	7	♂	8/ 9	Cond. milk	Diarrhea	None	14	Watery	100	..	16
76	12	♀	8/25	Mixed	Diarrhea	None	11	Green, Mucous	100	..	11
77	17	♀	7/25	Mixed	Fever	None	12	Green, Blood	100	..	21
78	24	♀	8/13	Mixed	Fever	99	11	Mucous, Blood	100	..	7
79	24	♀	7/10	Mixed	Fever	104	15	Mucous	100	5	20
80	5	♂	7/16	Buttermilk	Fever	100	6	Yellow, Watery	50	1	25
81	26	♂	6/18	Mixed	Fever	101	10	Green	100	1	22
82	20	♂	8/16	Mixed	Diarrhea	None	8	Mucous	30	..	7
83	6	♂	8/10	Boiled milk	Diarrhea	102	7	Mucous	100	5	12
84	9	♀	6/10	Human	Fever	105	25	Blood, Mucous	100	3	3
85	17	♀	6/ 5	Mixed	Fever	103	20	Blood, Mucous	100	7	7

July 4. Two or three stools daily; restless; stools normal; seems hungry; weight 6,825 gm. Treatment, 6 drops paregoric twice a day. Diet, buttermilk and barley water (3 to 2), with milk sugar.

July 20. Very restless; spits up; had a chill today followed by high fever; Urine obtained in the evening full of pus corpuscles. Diagnosis, pyelitis. Temperature 105 F. Treatment, alkalies.

July 31. High, irregular fever (101 to 105 F.) for eleven days; urine almost solid with pus cells; bowels loose again. Has been on dextrinized cereal, sweet milk and cocoa during the last week. Treatment, alkalies; weight 6,356 gm.

August 4. Much better; no fever; looks very pale; weight 6,290 gm. Treatment, hexamethylenamin.

August 11. No fever for several days; urine still contains much pus; very constipated; weight 6,790 gm. Treatment, alkalies. Diet, milk and barley water sweetened with honey, bread and crackers.

September 13. Suffering with a cough and cold in the head; had high fever last night; diarrhea began again; stools watery. Pus index 100. Mucus in the stools; weight 7,230 gm. Treatment, camphor and rhubarb. Diet, barley water, to which milk should be slowly added.

September 20. Perfectly well.

CASE 2.—D. S., girl, aged 1 year; bottle fed since birth. During the previous two months she was fed on malted milk, supplemented with cereals and soup. She was put on boiled milk with flour water.

August 10. She did well for two weeks, when a diarrhea started. The father had given her ice cream. Stool thin and watery. Pus index 50. No fever. Treatment, rhubarb.

August 27. No change; nine stools in twenty-four hours; no fever; is taking one third milk and two thirds barley water; bismuth given.

August 29. Stools still very loose; brownish in color; vomited twice; slight fever during the night. Temperature 100 F. Pus index 100. Diet, barley water; bismuth; paregoric given. The baby did not return.

CASE 3.—T. H., girl, aged 2 months. The baby had been fed on raw milk, water and Mellin's food and lost in weight. When seen (August 30) had no fever; buttocks irritated; seemed hungry; no fever. Diet, baked flour and milk.

September 4. Stools twice a day; stools rather thin; gained 4 ounces; restless; same diet.

September 8. Liquid, frequent greenish stools; severe proctitis. Temperature 98.6 F.; buttocks scalded. Pus index 100 + +. Diet, casein-buttermilk.

September 10. Four stools daily; some mucus. Pus index 20. Stools mushy; no gain in weight. Add dextrimaltose.

September 15. Temperature 99.4 F. Stools yellow, mushy. Pus index 20. Weight 9 pounds 14 ounces.

September 17. Seems well; weight 9 pounds 14 ounces.

CASE 4.—R. A., girl, aged 7 months; seen first Aug. 8, 1916. The infant was naturally fed four weeks, then placed on dextrinized flour and cow's milk. She has had attacks of diarrhea all summer. Mother boils the milk when the bowels are loose and gives the milk raw when she becomes constipated. Certified milk is used. Diarrhea began again two days and fever one day before being seen.

Baby thin, but has good color; skin elastic; temperature 102.6 F.; respiration slightly hurried, not deep; stools thin, watery, no blood; microscopically full of pus. Pus index 100 +. Diagnosis, enterocolitis. Treatment, alkalies, magnesia, rhubarb. Diet, barley water for twelve hours, then buttermilk and barley water, equal parts.

August 9. Looks about the same. Temperature 101.4 F.; respiration normal; eyes bright. Tannin given. Diet, barley water and buttermilk.

August 11. Stools very loose, twelve to fifteen daily; high fever at night; temperature 102.5; weight 5,760 gm.; eyes not so bright; skin elastic. Rectal injections of buttermilk whey given twice a day. Diet, barley water mixed with dextrinized flour; two feedings of Mellin's food daily; stool still full of pus cells.

August 13. Very much better; temperature 99.1 F.; looks brighter; two stools today; vomited twice yesterday; weight 5,790 gm. Milk was tried but was vomited.

August 17. Looks well; constipated. Pus index 10. Weight 5,760 gm. Salicylic acid and rhubarb given; diet the same.

August 22. Weight 5,700 gm.; two stools daily; no pus in the stool. Diet, roasted flour, to which a little milk is to be added.

August 30. Seems well; weight 5,900 gm.; stools normal. Diet, roasted flour, milk and sugar; orange juice.

CASE 5.—V. B., girl, aged 14 months, was seen first Aug. 17, 1917. Was naturally fed a few weeks only, then given condensed milk and barley water. In October, 1916, she had an attack of diarrhea which continued more or less for three weeks. Recovered under the use of buttermilk and dextrinized flour. Had two attacks of acute respiratory infections last winter. She has been fed cereals and certified milk. Began to have frequent movements two weeks prior to being seen; was put on barley water; looseness of the bowels continued; stools green and watery. A few days later she developed cough and high fever. The temperature ranged from 103 to 105 F. the last two days.

Physical examination of the chest showed diminished breathing in the left lung, and a few fine râles.

Examination of the urine showed an enormous number of pus cells. Two days later some of the stool was drawn with a catheter and was found full of pus cells. Pus index 100. Diagnosis, pneumonia, pyelitis, enteritis.

August 25. Fever dropped to normal; left lower lobe consolidated; stools and urine still contain pus; hexamethylenamin and aromatic syrup of rhubarb given. Diet, barley water and buttermilk.

The baby slowly recovered.

CASE 6.—F. J. B., girl, aged 14 months.

June 27, 1917. Four days ago she became sick with vomiting, followed by diarrhea. She has been fed on certified milk, supplemented with cereals, broth and eggs. No other milk or ice cream has been given. She had fever the first twenty-four hours, none apparently since then; six to seven stools daily, slimy and watery in character.

Examination showed a small baby, fairly well nourished; temperature 99 F.; physical examination otherwise negative.

The stool obtained with a catheter was soft yellow, containing some fatty curds. Stool diluted one fourth contained from 30 to 40 pus cells to each field. Diagnosis, enteritis.

Diet, cereals with barley water and milk sugar. Sodium bicarbonate, magnesia, rhubarb given.

June 29. Feels much better; three stools today; temperature normal; stool firm; pus index 20. Diet, the same; bismuth subnitrate given.

July 3. One black stool daily; seems very hungry; weight 8,170 gm. Aromatic rhubarb given. Diet, $\frac{1}{2}$ pint of milk added to cereals daily.

July 12. Stools firm; good appetite; two or three stools daily; weight 8,210 gm.; temperature normal. Tincture quassiae and lactic acid given.

July 20. Stools normal; two or three stools daily, slightly sour. The infant now gets $1\frac{1}{2}$ pints of milk daily; weight 8,520 gm.

July 30. Stools good; sleeps well; one or two stools daily; feels fine; weight 8,710 gm. Diet, cereals, milk, fruit and vegetables.

The summer of 1917 was unusually cool, and no connection could be traced between atmospheric conditions and the onset of the diarrhea. Three cases ended fatally, all showed pus in the stool. Two of these cases were very severe forms of membranous dysentery and pus was passed by the teaspoonful every few minutes. In the majority of cases the infection could be traced to unboiled milk or ice cream. In three cases the source of infection could not be determined. Flies seem to have been factors in two cases. Evidence of contagion was found in three instances.

CONCLUSIONS

The summer diarrhea in St. Louis in 1917 was an inflammatory enteritis of infectious origin.

The examination of the stool for pus corpuscles is a valuable clinical aid in diagnosis.

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