

Acute Gastroenteritis in Infants*

(Analysis of 483 cases treated in an infant's ward)

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Gastroenteritis contributes greatly to the morbidity of infants and children in common pediatric practice. It is one of the major causes leading to death in infant age groups in developing countries. Often the associated malnutrition and bronchopneumonia complicates the clinical picture and leads to a poor prognosis.¹ Although the majority of infantile diarrheas reported are to be of unknown origin,² bacterial etiology is an important factor from the epidemiologic and therapeutic points of view.

In this study we will present our experience with acute gastroenteritis in 483 infants treated at the Contagion Service of the Hacettepe Children's Hospital within a period of 12 months.

Material and Methods

From September 1973 to September 1974, 483 infants with acute gastroenteritis defined as diarrhea with or without vomiting, fever and abdominal pain of less than two weeks duration, were admitted to the infants, contagion service. This comprised 10.4 % of all the medical pediatric admissions to this hospital.

The age of the patients ranged from 1 day to 3 years. One hundred and fifty three were female, 330 were male.

For the analysis of acute gastroenteritis, the following information was extracted from the charts: Age, sex, season of admission, type of dehydration, serum CO₂ and electrolytes, hemoglobin, throat and stool

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cultures, conditions associated with acute gastroenteritis, duration of hospital stay, assessment of malnutrition and outcome of the patient's illness.

Throat and stool cultures (either from the stools or by rectal swab) were obtained upon admission and were processed by the previously described methods.^{3,4} Any salmonella or shigella organisms recovered were grouped with use of commercial grouping sera. Typing of *E. Coli* was performed by the slide method against polyvalent OB antisera A and B (Difco labs).

Results

The ages of 483 children are tabulated in Table I. About 90 % of the patients were infants between 1 day and 12 months of age. The majority of the patients were admitted during the summer or autumn months (Figure 1).

TABLE I
AGE OF INFANTS WITH GASTROENTERITIS

Age	Number of cases	Percent
1-30 days	43	8.9
2-6 months	271	56.1
7-12 months	121	25.0
12-24 months	34	7.1
Over 24 months	14	2.9
Total	483	100

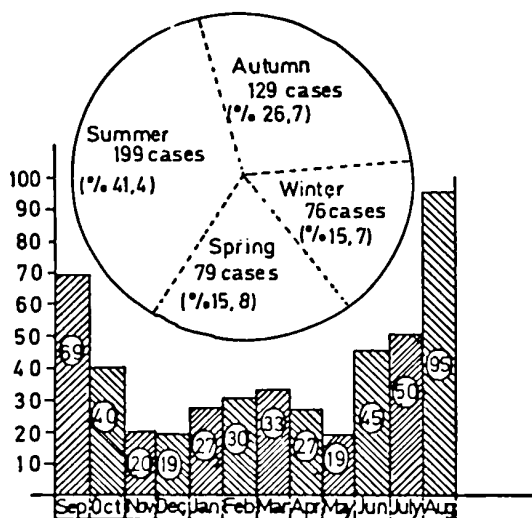


Figure 1

Seasonal incidence of acute gastroenteritis in infants and distribution of admissions into months

Two hundred and eighty three patients (58.5 %) had marasmus (Table II). Of these, about one forth had 1st degree, about half had 2nd degree and about one fourth had severe (3rd and 4th degree) malnutrition.⁵

TABLE II
SEVERITY OF MALNUTRITION IN 283 CASES

Degree of malnutrition	Number of cases	Percent
1 st	70	24.7
2 nd	139	49.2
3 rd	49	17.3
4 th	25	8.8
Total	283	100

In 419 patients serum electrolytes, CO₂ content and type of dehydration were determined. (Table III).

TABLE III
TYPE OF DEHYDRATION

Type of dehydration	Number of patients	Percent
Hypotonic (Na < 120 mEq/L)	41	9.7
Hypertonic (Na > 150 mEq/L)	49	11.6
Isotonic	329	78.7
Total	419	100

The majority of the patients had isotonic type of dehydration (78.7 %). Hypotonic and hypertonic type of dehydrations were observed in about 10 % of each. The incidence of hypertonic dehydration was higher in the newborn period (16.2 %) in comparison to the other age groups (Table IV). The same was true for hyponatremia in the age group of 7-12 months (12.3 %). The incidence of acidosis was higher in both groups, namely the age group of 1-30 days (49 %) and the age group of 2-6 months (44 %). Two thirds (65.8 % or 112 out of 170 cases) of the patients who had acidosis were infants between 1 day and 6 months old.

Anemia (hemoglobin less than 10.5 gm/dl) was seen in 33.4 % of the patients or in 140 cases (Table V).

TABLE IV
AGE DISTRIBUTION OF SERUM ELECTROLYTES IN 419 PATIENTS WITH ACUTE GASTROENTERITIS

Age	Total number	Number and % with hyponatremia	Number and % with hypernatremia	Number and % with isotonic dehydration	Number and % with acidosis	Number and % with hyperkalemia
1-30 days	40	4 (% 10)	7 (% 16.2)	29 (% 73.8)	19 (% 49)	1 (% 2.5)
2-6 months	234	18 (% 6.6)	29 (% 10.6)	187 (% 82.8)	103 (% 44)	12 (% 5.1)
7-12 months	111	15 (% 12.3)	10 (% 8.2)	86 (% 79.5)	34 (% 30.6)	9 (% 8.1)
13-24 months	24	4 (% 20.0)	0 (—)	20 (% 80.0)	8 (% 33.3)	6 (% 25)
2 years	10	0 —	3 (% 30.0)	7 (% 70.0)	6 (% 60)	0 —
Total	419	41 (% 9.7)	49 (% 11.6)	329 (% 78.7)	170 (% 40.5)	28 (% 6.6)

TABLE V
AGE DISTRIBUTION OF ANEMIA

Age	Number of patients	Percent
1-30 days	9	20.9
2-6 months	76	27.4
7-12 months	39	32.2
13-24 months	10	29.4
2 years	6	42.8

The stool culture results are tabulated in Table VI. The majority of the patients (79 %) had non-invasive *E. Coli* in their stool. 9.2 % of the patients had salmonella (paratyphi B.) The incidence of pathogenic *E. Coli* and *Klebsiella* were 3 %, *Shigella* and *proteus* were 1.8 % for each respective organisms, *pyocyaneus* was seen in 1.4 %. Throat cultures grew of normal flora in the majority (43.6 %). Beta hemolytic streptococcus was observed in 5.5 % of the patients (Table VII).

TABLE VI
STOOL CULTURE RESULTS IN INFANTS WITH ACUTE
GASTROENTERITIS

Type of Bacteria	Number of patients*	Percent
Non invasive <i>E. coli</i>	384	79 %
<i>Salmonella</i> (Paratyphi-B)	43	9.2 %
Pathogenic <i>E. coli</i>	15	3.0 %
<i>Klebsiella</i>	15	3.0 %
<i>Shigella</i>	8	1.8 %
<i>Proteus</i>	9	1.8 %
<i>Pyocyaneus</i>	7	1.4 %

*Some patients had more than one bacteria grown in cultures.

TABLE VII
THE RESULTS OF THE THROAT CULTURES

Type of Bacteria	Number of patients*	Percent
Normal flora	211	43.6 %
<i>E. coli</i>	99	20.4 %
<i>Staph aureus</i>	70	14.4 %
<i>A. Aerognes</i>	42	8.6 %
Beta hemolytic streptococcus	27	5.5 %
<i>Candida Albicans</i>	15	3.0 %
<i>Proteus</i>	10	1.8 %
<i>Pyocyaneus</i>	9	1.8 %

*Some patients had more than one bacteria grown in cultures.

Conditions and complications associated with acute gastroenteritis are summarized in Table VIII. In addition to accompanied marasmus in 58.5 %, bronchopneumonia was the most commonly associated infection (33.2 %). Then sepsis and urinary tract infections were other commonly associated conditions (29.3 % and 13.4 %).

TABLE VIII
CONDITIONS AND COMPLICATIONS ASSOCIATED
WITH ACUTE GASTROENTERITIS

Type	Number of patients	Percent
Bronchopneumonia	161	33.2 %
Malnutrition	283	58.4 %
Sepsis and other infections	142	29.3 %
Urinary tract infection	65	13.4 %
Rickets	39	8.0 %
Subdural effusion	19	3.9 %
Meningitis	12	2.4 %
Ileus	5	1.0 %

Table IX summarizes the duration of hospital stay in 413 patients. About half of the patients (45.3 %) required 4-7 days of hospitalization.

Seventy of 419 patients died (16.7 %). Forty of these (62.8 %) expired within the first three days of hospitalization. Twenty patients (28.5 %) died of various complications, 8 or more days after admission (Table X).

TABLE IX
DURATION OF HOSPITAL STAY

Duration of hospitalization	Number of patients	Percent
1-3 days	55	11.2 %
4-7 days	219	45.3 %
8-15 days	103	21.3 %
Over 15 days	36	7.4 %

TABLE X
DAY OF DEATH AFTER ADMISSION

The day patient expired after admission	Number of patients	Percent
1 st day	23	% 32.8
1-3 days	21	% 30.0
4-8 days	6	% 8.5
Over 8 days	20	% 28.5
Total	70	% 100.0

Discussion

Acute gastroenteritis is common in the infantile age groups and comprises high percentage of pediatric hospital admissions.⁶ This is more true for the developing countries. In fact 10.4 percent of the total admissions to Hacettepe Children's Hospital and more than half of the admissions (483 out of 944) to the infant contagion ward during a period of 12 month from September 1973 to September 1974, were due to acute gastroenteritis. Ninety percent of these patients were below the age of 12 months and two thirds of the total series were infants between one and six months in whom severe dehydration necessitated hospitalization. In our series, the incidence of diarrhea was higher during the summer and fall months when viral infections of the gastrointestinal tract are more prevalent in this country.

Types of dehydration were similar to those reported in the literature, mostly isotonic in type.⁷ The acidosis was more frequent in the first six months of age.

About sixty percent of our infants had marasmus, 33 % had anemia and one third of the patients had complicated bronchopneumonia or sepsis which again are reported to be common causes for pediatric admissions in this country.⁵ Those complications necessitated longer hospitalization. In fact, only 11 percent of the patients were discharged within the first 3 days after admission 45 % required a stay period of 4 to 7 days, one-fifth stayed up to 15 days and 17 percent needed a hospitalization of longer than two weeks.

Mortality among these 419 patients was 16.7 % which again fits previously published figures from this center.⁸ Forty-three or two-thirds of the infants expired during the early days, namely within 3 days of hospitalization. The late deaths occurred due to complicating conditions such as congenital heart disease, neonatal hepatitis, neoplasms, etc.

Bacteriological studies disclosed that most of the infants (43.6 %) had normal flora in the throat cultures. Among the gram negative organisms *E-Coli* and *A. aerogenes* were more prevalent, being seen in 20.4 % and 8.6 %, respectively. Beta hemolytic streptococci was encountered in 5.5 % of the infants. These figures are in accord with a recent report which analyses the throat culture results in three Ankara hospitals for children.⁹

In our series the stool cultures grew of non-pathogenic bacteria, namely non-invasive *E. Coli* in 79 % of the cases. Bacterial pathogens such as salmonella, shigella and enteropathogenic *Escherichiae coli* (EPEC) have generally been accepted as causative agents of gastroen-

teritis.¹⁰ *Salmonella paratyphi-B* was cultured in the stool of 9.2 % of the infants we studied. EPEC and shigella were grown in 3 % and 1.8 % of the patients. *Klebsiella* was found in 3 %, *proteus* and *pyocyaneus* were grown in 1.8 % and 1.4 % of the infants. Bacterial pathogens were reported to be responsible for acute infantile gastroenteritis in 36 % of the reported cases (varying from 4 % to 62 %).^{6, 10-16} Our figures are in accord with the reports in the literature. In a study carried out in infants and young children in a health center located in the suburb of Ankara, the incidence of EPEC was found to be 5 %.⁴ In the same study, examination of 125 healthy children in an adjacent village showed EPEC and shigella to be present in the stool cultures of 3.2 % and 0.8 % respectively.⁴ In this community *salmonella* and shigella infections in infants are sporadically seen¹⁷ and EPEC causing hospital epidemics have also been observed.^{3, 17} The published perennial studies from Europe and North America in children with diarrhea had given a mean virus isolation rate of 14 % (ranging from 2.5 % to 25 %).^{6, 11, 15, 16, 18, 19} However in many studies in children with acute gastroenteritis, neither viral, nor bacterial pathogens could be isolated in about 60 % of cases (ranging from 37 % to 96 %).^{6, 8, 12-14} Recently a causative virus in acute infantile diarrhea was described.²⁰ In various studies using electron microscopy techniques a structurally specific virus in stools from infants and children with acute gastroenteritis was identified throughout the world. The agent initially was termed as orbivirus,^{20, 21} others have suggested the name of rotavirus,²² reovirus-like agent²³ and duovirus.²⁴ The agent described by many centers is structurally, if not entirely identical. Now the name of infantile gastroenteritis virus (IGV) is preferred. IGV infection is estimated to be the cause of approximately 50 % of the cases of gastroenteritis in hospitalized patients under 6 years of age. Evidence in favor of IGV as a cause of disease in man comes from its observation in stools, intestinal juice and small bowel mucosa in acute disease.²⁰ It is rarely found in convalescent cases or control subjects and gave rise to infection when experimentally administered to an adult volunteer.²¹ Other viruses are being detected in the stools of patients with acute diarrheal disease, but their significance as causes of diarrhea has not been adequately assessed, particularly in children.

In the light of the above studies, it is conceivable to say that the majority of the infants in our series who had non-pathogenic bacteria in their stools might have been suffering from viral gastroenteritis. Future virologic studies in infantile gastroenteritis in this country might shed light on this subject.

Summary

A total of 483 infants between 1 day and 3 years of age who were admitted to the infant contagion ward of Hacettepe Children's Hospital because of acute gastroenteritis within a period of 12 months were studied. The seasonal incidence, types of dehydration, associated conditions, bacteriologic studies and factors influencing the course and outcome were analysed. Acute gastroenteritis was mostly observed in the summer and autumn months. The majority of the affected infants were younger than 6 months and isotonic type dehydration was the most common type. Infantile marasmus, bronchopneumonia, anemia, sepsis and urinary tract infections were the commonly associated conditions. Throat cultures disclosed normal bacterial flora in the majority. In our series, viral studies were not carried out, but 97 % of the patients had non-invasive *E. Coli* in their stools. About 20 % of the stool cultures grew from bacterial pathogenes including salmonella, EPEC, klebsiella, shigella and others, in decreasing frequency.

REFERENCES

1. An Account of the Activities of the Etimesgut Rural Health District 1970-1974. Published by Hacettepe Univ. School of Medicine, Institute of Community Medicine, Ayyıldız Mat. A.Ş. Ankara, 1975, p. 22.
2. Barbero, G. J.: Diarrhea. in "Nelson Textbook of Pediatrics" Xth Ed., eds. Vaughan III. V. C., Mc Kay R. J., W. Saunders Co., Philadelphia, 1975, p. 818.
3. Akman, M.: *Escherichia Coli* Diarrhea. A small hospital outbreak among infants caused by serotype 055B5, Turkish J. Pediatrics 3: 177, 1961.
4. Saatchi, A., Bertan, M., Akman, M. M. and Türet, S.: The prevalence and pattern of enteropathogenic *E. Coli*, *Shigella* and *salmonella* among infants and young children in the Etimesgut rural area. Turkish J. Pediatrics 11: 1, 1969.
5. Doğramacı, İ., Wray, J. D.: Severe infantile malnutrition and its management, Turkish J. Pediatrics 1: 129, 1958.
6. Cramblett, H. G. and Siewers, C. M. F.: The etiology of gastroenteritis in infants and children with emphasis on the occurrence of simultaneous mixed viral-bacterial infections. Pediatrics 35: 885, 1965.
7. Ironside, A. G., Tuxford, A. F. and Heyworth, B.: A survey of infantile gastroenteritis. Brit. Med. J. 3: 20, 1974.
8. Berkel, A. İ.: Epidemiology of infantile diarrheas in Turkey (paper presented at the First Aegean Seminar on Nutrition. İzmir Oct. 1962) Published in Turkish, by the Aegean Pediatric Society, İzmir 1962, p. 181.
9. Berkman, E.: Boğaz kültürlerinde gr (-) bakterilerin gittikçe artan miktarlarda bulunuşu. Mikrobiyoloji Bülteni 9: 237, 1975.
10. Cramblett, H. G., Azimi, P. and Haynes, R. E.: The etiology of infectious diarrhea in infancy with special reference to enteropathogenic *E. Coli*. Ann. N. Y. Acad. Sci. 176: 80, 1971.

11. Sommerville, R. G.: Enteroviruses and diarrhea in young persons. *Lancet* 2: 347, 1958.
12. Walker, S. J., Mc Lean, D. M., Roy, T. E. Mc Naughton, E. A. and Tibbles, J. A. R.: Infantile gastroenteritis: a search for viral antigens. *Canad. Med. Ass. J.* 83: 1266, 1960.
13. Goodwin, M. H., Jr., Mackel, D. C., Ganelin, R. S., Weaver, R. E. and Painc, F. J.: Observation on etiology of diarrheal diseases in Arizona. *Amer. J. Trop. Med.* 9: 336, 1960.
14. Buttiaux, R., Nicolle, P., Le Minor, S., and Gaudier, B.: Etudes sur les E. Coli de gastro-entérite infantile *Ann. Inst. Pasteur*, 91: 799, 1956.
15. Yow, M. D., Melnick J. L., Blattner, R. J., and Rasmussen, L. E.: Enteroviruses in infantile diarrhea, *Amer. J. Hyg.* 77: 283, 1963.
16. Lépine, P., Samaille, J., Virat, J., Carré, M. C. and Simon-Lavoine, N.: Enquete sur la fréquence et la signification de l'isolement des entérovirus au cours des gastroentérites infantiles, *Arch. Ges. Virusforsch*, 13: 201, 1963.
17. Berkman, E.: Personal communication.
18. Joncas, J., and Pavlanis, V.: Diarrhea and vomiting in infancy and childhood: Viral studies. *Canad Med. Assos. J.* 82: 1108, 1960.
19. Mc Lean, D. M., Mc Naughton, G. A., and Wyllie, J. C.: Infantile gastroenteritis: Further viral investigations. *Canad. Med. Assos. J.* 85: 496, 1961.
20. Bishop, R. F., Davidson, G. P., Holmes, I. H. and Ruck, B. J.: Virus particles in epithelial cells of duodenal mucosa from children with acute non bacterial gastroenteritis, *Lancet* 2: 1281, 1973.
21. Middleton, P. J., Szymanski, M. T., Abbott, G. D., Bortolussi, R. and Hamilton, J. R.: Orbivirus acute gastroenteritis in infancy. *Lancet* 1: 1241, 1974.
22. Kapikian, A. Z., Kim, H. W., Wyatt, R. G., Rodriguez, W. J., Cline, W. L., Parrott, R. H., and Chanock, R. M.: Reoviruslike agent in stools. Association with infantile diarrhea and development of serologic tests. *Science (Wash. D.C.)* 185: 1049, 1974.
23. Davidson, G. P., Bishop, R. F., Townley, R. R., Holmes, I. H., and Ruck, B. J.: Importance of a new virus in acute sporadic enteritis in children. *Lancet*. 1: 242, 1975.
24. Davidson, G. B., Bishop, R. F., Townley, R. R., Holmes, I. H. and Buck, B. J.: Importance of a new virus in acute sporadic enteritis in children. *Lancet* 1: 242, 1975.