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SALMONELLA GASTROENTERITIS IN CHILDREN*

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SUMMARY: Yurdakök K, Abo Asaker EAE, Berkman E. (Department of Social Pediatrics, Hacettepe University Institute of Child Health, Ankara, Turkey). Salmonella gastroenteritis in children. Turk J Pediatr 1998; 40: 69-78.

Among 20,100 children with gastroenteritis admitted to Hacettepe University İhsan Doğramacı Children's Hospital Diarrhea Training and Treatment Unit between April 1987 and December 1994, 508 Salmonella strains were isolated. Epidemiology, clinical pictures, laboratory findings, and outcome of these patients are discussed. Salmonella gastroenteritis represented 2.5 percent of all diarrheal cases during the study period. The highest number of isolations of Salmonella strains were reported between June and October. Salmonella serogroup B was the most common isolated strain (77%) followed by serogroup D (21%) and serogroup C (2%). Progressive decrease among group B isolations were noted between 1991-1994 with a concomitant increase in group D isolations. S. typhimurium was the most common serotype and overall represented 52 percent of the strains. Bloody diarrhea was found to be present in 27 percent of all cases. It is noted that the patients infected with group B strains had a higher rate of bloody diarrhea than the patients infected with group D strains (30% versus 15%, $p < 0.05$). Dehydration was present in 14 percent of the cases. We noted that severe dehydration (0.2%) and electrolyte disturbances (1.5%) were rare among our patients. none of the cases had a complication or an extraintestinal manifestation of Salmonella gastroenteritis. No deaths were reported. *Key words: Salmonella, gastroenteritis, children.*

Acute infectious diarrhea is still an important health problem among children in developing countries. Every year about 3.2 million children in these countries under five years of age die due to acute gastroenteritis[1]. Salmonella gastroenteritis continues to be one of the main causes of acute infectious diarrhea worldwide[2]. Although Salmonella gastroenteritis is a mild self-limiting infection in most individuals, infants are at the greatest risk for both dehydration and complications[3]. In this paper we reviewed the relative importance of Salmonella in the etiology of childhood diarrheal diseases as well as the clinical characteristics of children with Salmonella gastroenteritis admitted to the Diarrhea Training and Treatment Unit (DTTU) of Hacettepe University İhsan Doğramacı Children's Hospital.

Material and Methods

During the period from 1 May 1987 to 31 December 1994, 20,100 children with diarrhea under 16 years of age were admitted to our DTTU. This unit obtains routine fresh stool specimens from all patients for isolating and identifying

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Salmonella and Shigella. Stool cultures were positive for Salmonella in 508 cases. Among these, only the files of 415 patients were available for further analysis. Data obtained from the case files included history, age, sex, duration of Salmonella stool excretion, clinical and laboratory characteristics on admission, and the outcome.

Diarrhea is defined as a change in the child's normal stool pattern, characterized by an increase in the frequency (at least three discharges per day) and increase in the liquidity of fecal discharges. Diarrhea is accepted as acute when the duration is less than 14 days, persistent when it is more than 14 but less than 30 days, and chronic if it is more than 30 days. Dehydration is diagnosed and patients are managed according to WHO criteria[4]. Malnutrition is defined according to Gomez classification[5].

The specimens were inoculated onto plates of Shigella-Salmonella (SS) agar, Selenite F broth and eosin-methylene blue (EMB) agar. All media were incubated at 37 °C for 24 hours. Selenite F enrichment broth was incubated overnight and sub-cultured at 18 hours on to the Salmonella-Shigella (SS) agar. Salmonella strains are identified by standard biochemical tests, including inoculation of suspicious colonies into tubes of screening media [triple sugar iron agar (TSI), urease broth and indole broth]. Salmonella isolates suspected by above mentioned biochemical tests are further tested by the slide agglutination technique employing polyvalent and monospecific antisera for somatic (O) and flagellar (H) antigens to detect serogroups and serotypes (by using antisera from Difco Laboratories, Defroit, USA). The Kauffman-White serotyping scheme is used for classification[6]; however, Salmonella serotypes are not routinely identified in all cases due to the unavailability of antisera for flagellar antigens.

Stool is considered to be bacteriologically clear from Salmonella when two or three consecutive culture-negative stool samples are taken at one to three days' interval.

Data were analyzed using SPSS and Epi-info program. Analyses were also performed according to isolated Salmonella serogroups. The significance of differences for categoric data was tested by chi-square or Fisher's exact test. Student's t test and analysis of variance were used for parametric data. Non-parametric data were analyzed by Wilcoxon-Mann-Whitney U test.

Results

During the study period, 508 (2.5%) Salmonella strains were isolated among 20,100 diarrheal admissions. There were variations in the number of Salmonella isolates reported from year to year, with the lowest number being in 1988 and the highest reported in 1989 (1.2% and 3.3% of all diarrheal cases, respectively, $p < 0.05$) (Fig. 1). Although Salmonella gastroenteritis seemed to be occurring through all the months, most cases were seen between June and October. The highest number of isolations was reported in October and the lowest in December (12.4% and 4.5% of all diarrheal admissions, respectively) (Fig. 2).

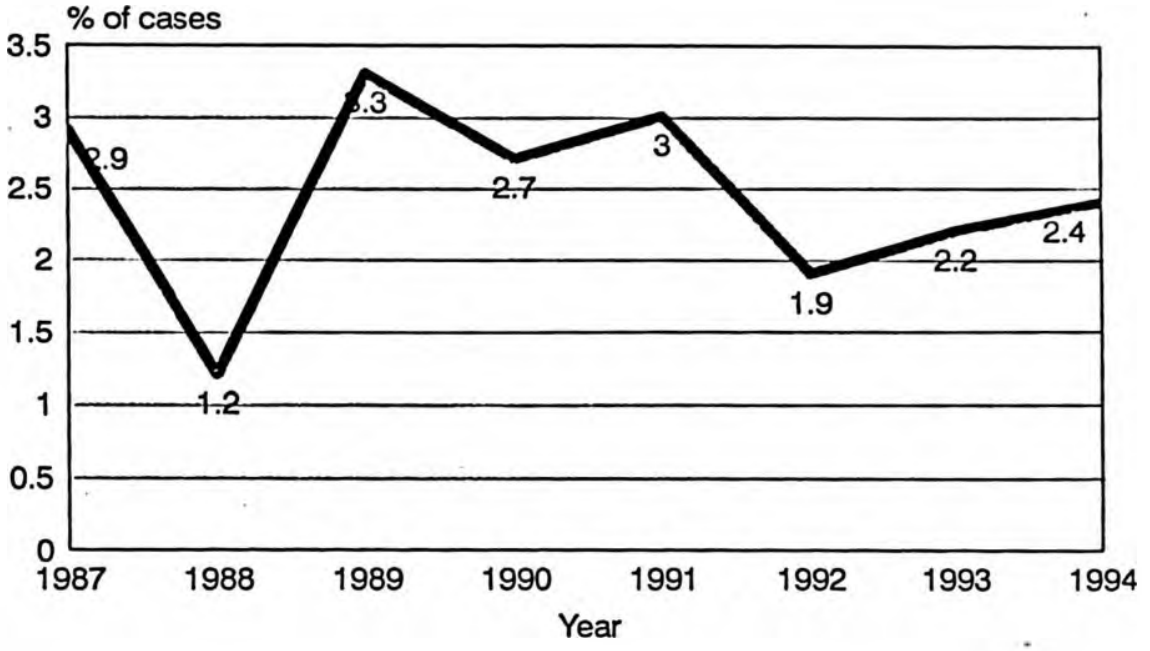

Fig. 1: Distribution of Salmonella gastroenteritis as percentage of all diarrheal admissions.

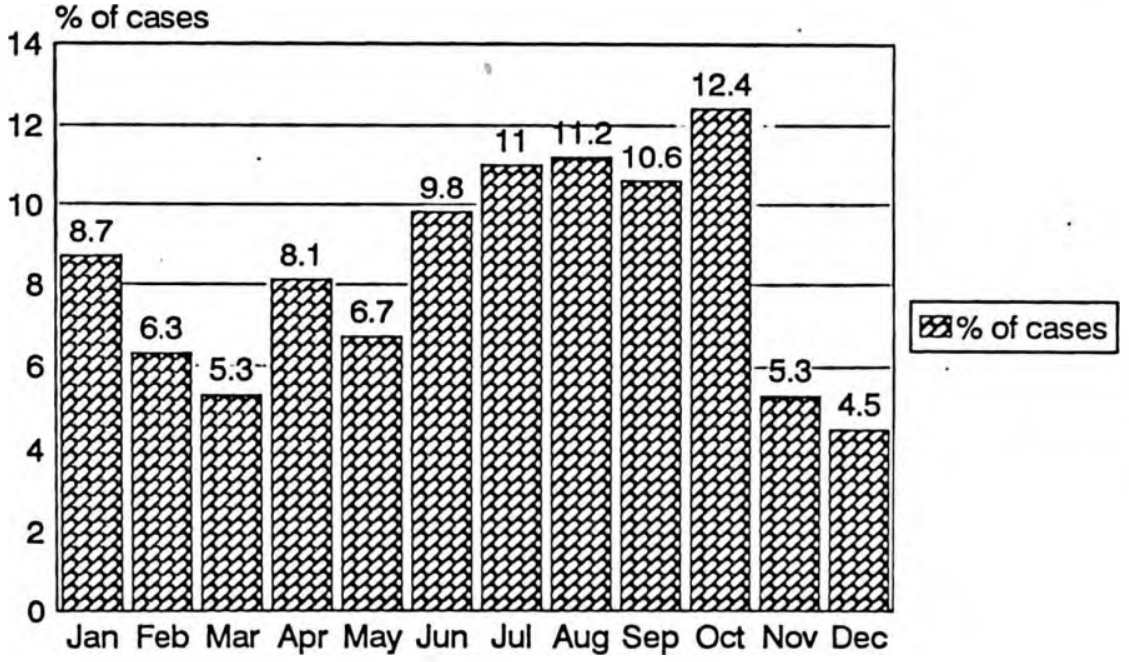

Fig. 2: Distribution of patients with Salmonella gastroenteritis by months during the study period.

Files of 415 patients with Salmonella gastroenteritis were available for further analysis. Male-female ratio was 1.47 (247/168). Salmonella serogroup B was the most common isolated strain (77%) followed by Salmonella serogroup D (21%) and Salmonella serogroup C (2%) (Table I).

Salmonella serotypes were determined in 247 of the 320 Salmonella serogroup B isolates. Among these, 88% (217/247) were Salmonella typhimurium and 12% (30/247) were Salmonella paratyphi B.

Table I: Clinical Characteristics, Laboratory Findings and Outcome of 415 Children with Salmonella Gastroenteritis

Features	No.	%
Age groups (months)		
0-3	30	7
3-12	121	29
12-60	170	41
> 60	94	23
Duration (days)*	5.1 ± 0.3	
No. of stool (per day)*	6.5 ± 0.2	
< 5	109	27
5-10	256	65
> 10	33	8
Blood in stool #	105/393	27
Mucus in stool #	214/390	55
Fever	222	54
Vomiting	213	51
Abdominal pain	96	23
Convulsions	7	2
Dehydration		
Mild	36	9
Moderate	21	5
Severe	1	0.2
Total	58	14
Electrolytes		
Hyponatremia #	4/74	5
Hypernatremia #	2/74	3
Hypokalemia #	5/74	7
Hyperkalemia #	4/74	5
Malnutrition		
First degree	131	32
Second degree	23	6
Third degree	1	0.2
Total	155	38
Duration of excretion (day)†*	11.7 ± 1.0	
Isolated Salmonella groups		
serogroup B	320	77
serogroup C	9	2
serogroup D	86	21
No. of associated infections♦	62	15
No. of hospitalized cases	14	3
No. of patients received antibiotics	114	27

* Values are mean ± SE.
# No./Screened cases.
† Data available in 197 cases.
♦ Respiratory and urinary tract infections.

Figure 3 and Table II show distribution of Salmonella serogroups by years. A progressive decrease among serogroup B isolations was noted between 1991-1994 with a concomitant increase in serogroup D isolations. However, serogroup B was still the most prevalent strain during the study period (Table II).

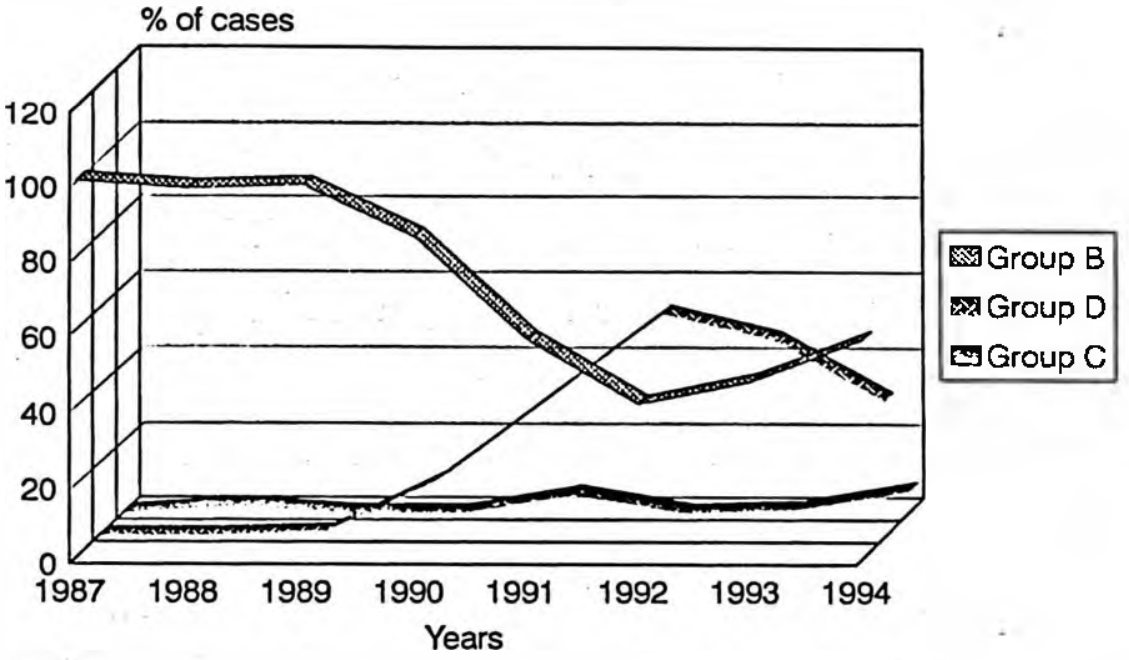

Fig. 3: Distribution of isolated Salmonella serogroups by years.

Table II: Distribution of Salmonella Groups by Years

	No. of Patients (%)							
	1987	1988	1989	1990	1991	1992	1993	1994
Group B	69 (100)	42 (98)	107 (99)*	55 (85)*,**	39 (58)**	16 (41)	24 (47)	38 (58)
Group D	0	0	1 (1)†	10 (15)†‡	25 (37)‡	23 (59)	26 (52)	24 (36)
Group C	0	1 (2)	0	0	3 (5)	0	1 (1)	4 (6)
Total	69	43	108	65	67	39	51	66

Statistical comparisons: *, ‡: $p < 0.05$, **: $p = 0.001$, †: $p < 0.001$.

Major presenting symptoms and signs are shown in Table I. Thirty-six percent of the patients were under one year of age, seven percent being younger than three months. Age distribution of patients according to isolated Salmonella serogroups is shown in Table III and Figure 4. Salmonella serogroup B was isolated significantly less in patients over five years of age than in infants aged between three and 12 months (69% and 84% respectively, $p < 0.05$) (Table III). In contrast, Salmonella serogroup D was identified significantly more in patients over five years of age than in patients between three and 12 months of age (31% and 13% respectively, $p < 0.05$) (Table III).

Table III: Age Distribution of Patients According to Salmonella Serogroups

Age Groups (Months)	Group B	Group D	Group C	Total
0-3	24 (80)	5 (17)	1 (3)	30
3-12	102 (84)*	16 (13)**	3 (3)	121
12-60	129 (76)	36 (21)	5 (3)	170
> 60	65 (69)*	29 (31)**	0 (0)	94
Total	320 (77)	86 (21)	9 (2)	415

Figures in parentheses show the percentage of patients in each age group.
Statistical comparison: *, **: $p < 0.05$.

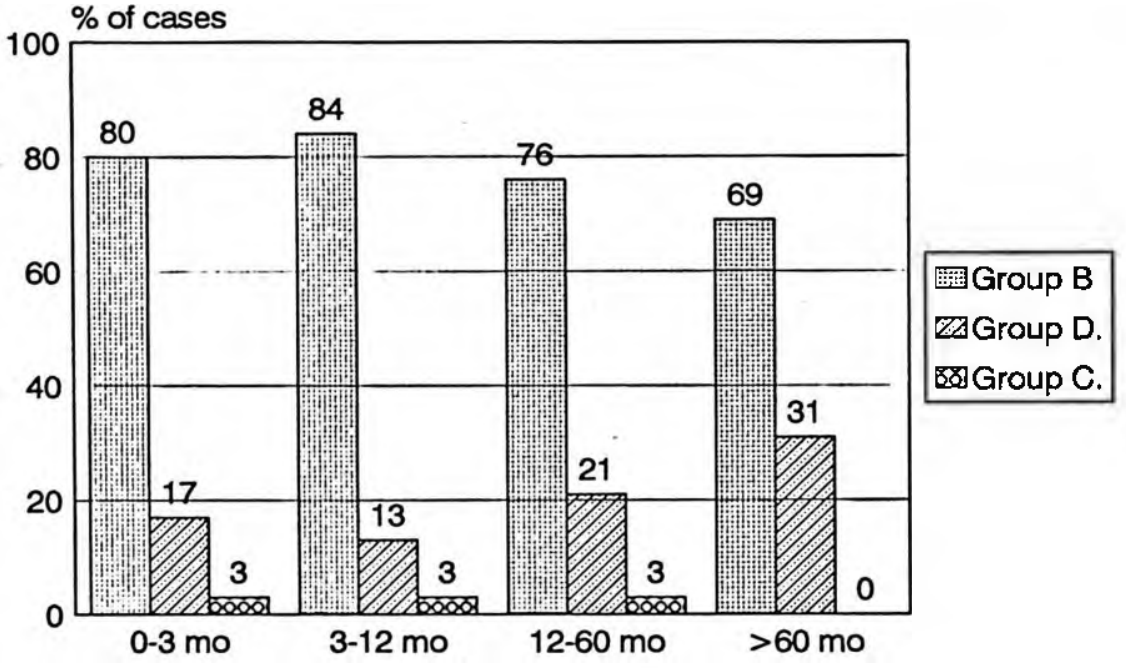

Fig. 4: Age distribution of patients with Salmonella gastroenteritis.

Duration of diarrhea on admission varied from one to thirty days with a mean of 5.1 ± 0.3 days. Nine patients (2%) had persistent diarrhea on admission.

Stool output varied from three to 20 times per day, with a mean of 6.5 ± 0.2. Eight percent of the patients had daily stool output of more than 10. Diarrhea was watery in 73 percent and bloody in 27 percent of the cases (Table I). Patients infected with group B strains had more bloody diarrhea on admission than those infected with group D strains (30% versus 15%, $p < 0.05$) (Table IV).

Fever was present in 54% and vomiting in 51% of the cases (Table I). The presence of fever and vomiting did not differ significantly among the serogroups (Table IV).

Abdominal pain was present in 96 cases (23%). Fifteen of them (3.6%) had a severe clinical picture resembling acute abdomen and required pediatric surgery consultation but none were diagnosed as having acute abdomen or required surgery.

Table IV: Clinical Characteristics and Outcomes of Patients According to Salmonella Serogroups

	Group B (n: 320)	Group D (n: 86)	Group C (n: 9)
Male/Female	189/131	52/34	6/3
Age (months)*	38.4 ± 2.6†	56.0 ± 5.4†	26.3 ± 8.2
Duration of diarrhea (days)*	5.8 ± 0.6†	3.0 ± 0.2†	3.6 ± 0.9
No. of stools (per day)*	6.6 ± 0.2	6.2 ± 0.4	7.4 ± 1.8
Blood in stool #	90/304 (30)†	12/80 (15)†	3/9 (33)
Mucus in stool #	170/301 (56)	39/80 (49)	5/9 (56)
Fever #	178/320 (56)	37/86 (43)	7/9 (78)
Vomiting #	161/320 (50)	50/86 (58)	2/9 (22)
Abdominal pain #	65/320 (20)†	29/86 (34)	2/9 (22)
Convulsion #	7/320 (2)	0/86 (0)	0/9 (0)
Dehydration #			
Mild	28/320 (9)	5/86 (6)	3/9 (33)
Moderate	15/320 (5)	6/86 (7)	0/9 (0)
Severe	1/320 (0.3)	0/86 (0)	0/9 (0)
Total	44/320 (14)	11/86 (13)	3/9 (33)
Malnutrition (degree) #			
First	104/320 (33)	25/86 (29)	2/9 (22)
Second	16/320 (5)	7/86 (8)	0/9 (0)
Third	0/320 (0)	1/86 (1)	0/9 (0)
Total	120/320 (38)	33/86 (38)	2/9 (22)
Duration of excretion days	11.7 ± 1.2	10.9 ± 1.4	20.7 ± 13.7
No. of hospitalized #	13/320 (4)	1/86 (1)	0/9 (0)

* Values are mean ± SD.
# No./screened cases.
† Statistical comparisons: $p < 0.05$.

Seizure was rare among our patients. Seven patients (2%) developed convulsions. One of them was hospitalized due to suspected meningitis, but cerebrospinal fluid examination was normal. Another patient had a history of epilepsy. Of the remaining five, three had febrile convulsions and the other two had hypernatremia.

Dehydration was present in 14 percent (58/415) of the cases. Severe dehydration and electrolyte disturbances were uncommon features (Table I).

Overall, fourteen patients (3%) were hospitalized. Septicemia had been suspected with initial clinical findings in three patients, but blood cultures were found to be positive in only one. Other hospitalizations were due to clinical deterioration such as weakness, high fever, severe vomiting, dehydration with

electrolyte disturbances, severe dehydration, encephalopathy, and clinical toxic appearance. All hospitalized patients responded to appropriate treatment and were discharged from the hospital. No deaths were recorded.

Antibiotics were given to 28 percent (114/415) of the patients.

One hundred ninety-seven patients were further followed up for Salmonella excretion in stool. Among them, 34.5 percent continued to have positive stool culture for more than two weeks. Duration of Salmonella excretion varied from five to 48 days with a mean of 11.7 ± 1.0 days. The mean duration of Salmonella excretion in patients under three months of age (n: 18) was 12.9 ± 2.7 days, while it was 13.9 ± 3.4 days in patients between three and 12 months of age (n: 47), 11.3 ± 1.0 days in those between 12-60 months of age (n: 89) and finally 9.8 ± 1.1 days in children over five years of age (n: 43). Differences in the mean duration of Salmonella excretion among the age groups were not significant (for all comparisons $p > 0.05$).

Patients who received antibiotics (n: 60) had a longer duration of Salmonella excretion than those without antibiotic treatment (n: 137) (15.4 ± 2.8 versus 10.1 ± 0.7 days, $p = 0.016$).

Regarding complications, only one among the clinically suspected patients proved to have bacteremia. None of our patients had extra-intestinal manifestations or any other complications.

Discussion

Salmonella represents 0-15 percent of all diarrheal cases in developing countries[2]. Despite yearly variations, the overall isolation rate of Salmonella in our series was 2.5 percent. Salmonella gastroenteritis has a peak incidence in the late summer and early fall, with the highest number of isolations being reported from July through October[7]. Similarly, most of our cases were reported between June and October, the highest being in October.

Previous reports indicate that the majority of Salmonella gastroenteritis cases occur among children less than one year old, which is explained to be due to dietary habits and reduced resistance to infection[8-10]. In our study, only 36 percent of the cases were under one year of age, seven percent being younger than three months. As breast-feeding provides protection from Salmonella infections, this may be explained by the high rate of breast-fed infants Turkey: 95 percent of children are breastfed and the median duration of breast-feeding is 12 months[11].

Similar to reports from the United States[7], Hong Kong[10], and Iraq[8], Salmonella group B, especially S. typhimurium, was the most frequently isolated serotype in our DTTU. However, since 1990, Salmonella group D has emerged as one of the major causes of Salmonella gastroenteritis, and this was the case in our

series, especially in the older children. An increasing isolation rate of serogroup D is also reported from the United States[12]. According to a study from Saudi Arabia, the majority of Salmonella gastroenteritis cases seen between July 1990 and June 1991 were due to serogroup D, and the mean age of the patients was 3.6 years[13].

Dehydration and electrolyte disturbances were not striking features in our series. One of the reasons for this may be the relatively lower frequency of stool output. Only eight percent of our patients had stool output more than 10 times per day while it was reported to be 26 percent by Lui et al.[10]. Moderate to severe dehydration was found to be present in 19 percent of their cases[10] and in the some percentage as reported by Yamamoto and Ashton[9], while it was present in only 5 percent of our cases. In both previously-mentioned studies, almost all patients were under 12 months of age, which may also contribute to the relatively higher dehydration rates.

Bloody diarrhea is known to be more frequent in younger children than in adults[14]. As their mean age was younger, Salmonella group B infected patients in our study had more bloody diarrhea on admission. Overall, bloody diarrhea was present in 27 percent of our patients. This was similar to the finding reported by Lui et al.[10] and Yamamoto and Ashton[9] where 19.5 and 34 percent of their cases, respectively, had bloody diarrhea.

Two percent of the patients with Salmonella gastroenteritis may have pseudoappendicitis[14]. In our study, almost four percent of our patients had severe abdominal pain requiring pediatric surgery consultation, but none of them were diagnosed to have acute abdomen or required surgery.

Regarding other complications, only one patient (0.2 percent of all cases) developed bacteremia in this study, which was improved with antibiotics (ceftriaxone). Yamamoto and Ashton[9] noted that complications (such as osteomyelitis and bacteremia with septic shock) occurred in three percent of their patients. The rare incidence of complications in our study may be explained by the increasing isolation rate of Salmonella group D since 1990 and its tendency to occur relatively in older age groups.

Death occurs rarely in Salmonella gastroenteritis. With the recent outbreak of S. enteritidis in the United States, less than 0.5 percent of cases resulted in death[12]. On the other hand, Lui et al.[10], reported that four percent of infants with Salmonella gastroenteritis died. In our study no death was recorded. This may be due to the relatively higher ages at the time the disease occurred, and the rare evidence of complications or dehydration.

The median duration of Salmonella excretion was approximately five weeks following Salmonella gastroenteritis[15]. Our data indicate that 34.5 percent of the patients continued to have a positive stool culture for two weeks following the

infection, and the mean duration of excretion was 11.7 ± 1.0 days. The cause of this short duration is most likely due to collection of specimens in most patients via rectal swabs instead of directly from the stool as they did not have diarrhea any longer. It is known that culture obtained from the stool is more likely to be positive than the specimens collected via rectal swabs[16]. Therefore, the length of Salmonella excretion in this study has limited reliability. Despite its limitation, our data showed that use of antibiotics prolonged Salmonella excretion, which is in agreement with the classical knowledge[17].

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