

1 Etiologic agents of acute diarrhea in sentinel surveillance sites in Vientiane Capital, Lao People's Democratic  
2 Republic, 2012-2015

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20

21 **Abstract**

22 Purpose: This study aims to identify the pathogens of diarrhea in Vientiane Capital, Lao People's Democratic  
23 Republic (Lao PDR).

24 Methods: The data of 2,482 patients who visited eight health facilities due to diarrhea in 2012-2015 were  
25 retrospectively reviewed. Stool or rectal swabs collected from all patients were tested for bacteria. Children who  
26 were under five years old were additionally tested for rotavirus.

27 Results: Of 2,482 cases, 1,566 cases were under five years old and at least one entero-pathogen was detected in  
28 475 cases (19.1%). *Salmonella* species was the most commonly detected bacterial pathogen. Enteropathogenic  
29 *Escherichia. coli* (EPEC) and *Salmonella* species was the major pathogen in the dry season and the wet season,  
30 respectively. Eighty-seven patients tested positive for multiple bacteria. Rotavirus was detected in 291 children  
31 under five years old (32.4%), mostly from October to April. The major bacteria of coinfection with rotavirus was  
32 EPEC followed by *Salmonella* species.

33 Conclusion: *Salmonella* species was the predominant bacterial pathogen of diarrhea of all ages and rotavirus was  
34 the predominant pathogen among children under five years old. Further studies examining other types of  
35 pathogens for diarrhea and the introduction of a rotavirus vaccine for children are needed in Lao PDR.

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37 Keywords: acute diarrhea; bacteria; etiologic pathogen; Lao PDR; rotavirus; Vientiane Capital.

38

39

40 **Introduction**

41 Diarrheal diseases account for one in ten child deaths during the first five years of life worldwide [1]. It is  
42 estimated that there are 800,000 fatalities by diarrhea globally every year, and the majority of diarrhea cases exist  
43 in South Asia and sub-Saharan Africa [2]. Diarrhea can occur from a variety of causes, but the most common  
44 causes are the consumption of food or drinks that are contaminated with pathogens such as bacteria, viruses, and  
45 parasitic organisms or toxins. Methods for prophylaxis of diarrhea, such as sanitation, safe drinking water, and  
46 basic hygiene practice have been improved. However, investigating the etiologic agents would help to understand  
47 the overall burden of pathogen-specific diarrheal disease [3]. The transmission of pathogens from person to person  
48 is also possible through poor hand hygiene practices [4].

49 Lao People's Democratic Republic (Lao PDR) is a landlocked country located in Southeast Asia, sharing borders  
50 with China, Myanmar, Vietnam, Cambodia, and Thailand. Approximately 6.5 million people live within an area  
51 of 236,800 m<sup>2</sup> with a population density of 27.4/km<sup>2</sup> [5]. According to the health profile statistics by World Health  
52 Organization (WHO), diarrhea accounted for 11% of deaths of Lao children below five years old in 2013 [6]. Few  
53 studies have examined the etiologic agents of diarrheal diseases in Lao PDR. Two studies were conducted on  
54 diarrheal outpatients in hospitals in Vientiane Capital. The main etiologic agents were rotavirus (22.0%),  
55 enteropathogenic *Escherichia coli* (EPEC, 21.5%), and *Shigella flexneri* (4.7%) in 1994 and 1995 [7].  
56 Enterotoxigenic *Escherichia coli* heat-stable enterotoxin (ETEC. ST, 17.2%), *Shigella* species (spp.) (16.8%), and  
57 serogroup-based EPEC (11.0%) were the main etiologic agents in 1996 and 1997 [8]. In another studies conducted  
58 at Mahosot Hospital, rotavirus was found to be the main cause of diarrheal diseases in children below five years  
59 old [9, 10].

60 In 2012, the Ministry of Health started the surveillance of the causative etiologies of acute diarrhea in Lao PDR,  
61 and eight diarrhea sentinel surveillance sites were established. The aims of the collaborating work were to describe  
62 the etiology of diarrhea and bacteremia in patients presenting to health facilities, to enhance the capacity of  
63 bacteriology staff for detection and isolation causative factors of diarrhea, to establish a diarrheal surveillance  
64 network between key central hospitals in Lao PDR, and to survey antimicrobial resistance of bacteria. This study  
65 aimed to report the information regarding etiologic causes of diarrhea in Vientiane Capital by secondary analysis  
66 of the laboratory surveillance data from 2012 to 2015.

67

68 **Materials and methods**

69 **Data collection**

70 The definition of diarrhea was passing of loose stools three or more times within 24 hours [11]. In the surveillance  
71 of the causative etiologies of acute diarrhea, the bacteriology unit of the National Center for Laboratory and  
72 Epidemiology (NCLE) collects socio-clinical data and examines stool or rectal swabs from all patients with  
73 diarrhea who visited eight diarrhea sentinel surveillance sites in Vientiane Capital (Pediatric Hospital, Sethathirath  
74 Hospital, Mahosot Hospital, Mittaphab Hospital, Sisattanak District Hospital, Hadtxayfong District Hospital,  
75 Sikhottabong District Hospital, and Ban-hom Health Center). Swabs that were more than 8 days old were not  
76 examined. The surveillance was approved as the joint work of the Ministry of Health with WHO by the Ministry  
77 of Health (approved activity number 1.44.19.1). This study included patients who visited the sentinel sites from  
78 January 2012 to December 2015. Patients who had possibly taken antibiotics before swab tests were not excluded.  
79

80 **Examinations for bacteria and rotavirus**

81 All specimens were tested for *Salmonella* spp., *Shigella* spp., *Vibrio cholera*, *Vibrio parahaemolyticus*,  
82 *Aeromonas* spp., *Plesiomonas shigelloides*, *Campylobacter* spp., EPEC, enteroinvasive *Escherichia coli* (EIEC),  
83 enterotoxigenic *Escherichia coli* heat-labile enterotoxin (ETEC. LT), ETEC. ST and enterohemorrhagic  
84 *Escherichia coli* (EHEC). Only specimens of patients who were under five years old were tested for rotavirus,  
85 due to financial constraints. SD Bioline Rota/Adeno rapid (Standard Diagnostic INC., Gyeonggi-do, Republic of  
86 Korea) and RIDASCREEN Rotavirus (R-Biopharm AG, Darmstadt, Germany) were used in 2012. SD Bioline  
87 Rota/Adeno rapid was used in 2013, and SD Bioline Rota/Adeno rapid and ProSpecT Rotavirus (Thermo Fisher  
88 Scientific Inc., Hampshire, UK) were used in 2014 and 2015. The total number of tested samples was 913,  
89 including 752 in the dry season (from November to April) and 161 in the wet season (from May to October).  
90 However, the results of 14 samples were unable to read.

91

92 **Polymerase chain reaction for identification of *Escherichia coli***

93 When specimens were negative for *Vibrio* spp., *Salmonella* spp., and *Shigella* spp. and positive for *Escherichia*  
94 *coli* (*E. coli*), polymerase chain reaction (PCR) was performed to determine the virulence of pathogenic *E. coli*.  
95 All primer sequences and PCR conditions were developed and modified by the Department of Bacteriology, the  
96 National Institute of Infectious Diseases in Japan. Two working primer mixes, MIX-DEC A and MIX-DEC B,  
97 were used to pathotype *E.coli* (Table 1) [12-14].

98

## 99 **Results**

100 Specimens of stool/rectal swabs from 2,482 patients with diarrhea were analyzed. The age ranged from one month  
101 to 98 years old and the median age was 1.9 years old. Most patients were younger than 5 years old (n=1,566,  
102 63.1%), and patients <1 year old accounted for 643 cases (26.0%) (Table 2). The percentage of patients who  
103 visited central hospitals was highest in the age group <1 year old followed by the group of 1-<5 years old. The  
104 percentage of males was 52.1% in all cases and higher than that of females in patients <5 years old. The dry season  
105 had more diarrheal patients compared to the wet season. The number of diarrhea cases of all ages and <5 years  
106 old peaked in February and the second highest peak was from October to November (Fig. 1A). Of the total  
107 specimens for bacteria identification, 475 specimens (19.1%) were positive for bacteria, including 354 cases  
108 (14.3%) of single bacterial pathogens, 87 cases (3.5%) of multiple bacterial pathogens, and 34 cases (1.4%) of  
109 coinfection of bacteria and rotavirus (Table 2). Bacteria-positive cases were consistently observed every month  
110 and the positive rate for bacteria ranged from 11.0% to 24.0% (Fig. 1A).

111 The number of cases whose specimens were positive for a single bacterial pathogen was higher in the age group  
112  $\geq 5$  years old (173 cases) than in the other two groups; 66 cases in the group of <1 year and 115 cases in the group  
113 of 1-<5 years (Table 2). The results of single bacterial pathogens showed that *Salmonella* spp. was predominantly  
114 found (26.3%) followed by EPEC (18.1%) and *Aeromonas* spp. (16.7%) (Table 3). The major pathogen was  
115 *Salmonella* spp. in children < 1 year, EPEC in children aged 1-<5 years old, and *Aeromonas* spp. in patients  $\geq 5$   
116 years old. *Salmonella* spp. and EPEC were the two major pathogens among children <5 years old.

117 Of 354 cases of single bacterial infection, 211 cases occurred in the dry season (Table 4). In the dry season, EPEC  
118 was the major pathogen (25.1%) followed by *Salmonella* spp. (23.7%) and *Aeromonas* spp. (14.7%). In contrast,  
119 the major pathogen in the wet season was *Salmonella* ssp. (30.1%). *Plesiomonas shigelloides* and *Vibrio*  
120 *parahaemolyticus* were detected more frequently in the wet season than in the dry season.

121 Multiple bacterial entero-pathogens were found in 87 cases and the predominant age group was the group  $\geq 5$  years  
122 old (45 cases). The major pathogens in mixed bacterial infections were ETEC. LT (31 cases), *Plesiomonas*  
123 *shigelloides* (24 cases), EPEC (23 cases), and *Salmonella* spp. (23 cases). Coinfection with EPEC and ETEC. LT  
124 was the most common combination that was found in 10 patients (Table 5).

125 Of specimens from 1,566 children who were under 5 years old, 899 samples were available for the results of  
126 rotavirus test, including 740 of 1,127 specimens (65.7%) in the dry season and 159 of 492 specimens (32.3%) in

127 the wet season. The specimens of 291 cases (32.4%) were positive for rotavirus. The positive rate for rotavirus  
128 was 39.8% (289 cases) and 1.2% (2 cases) in the dry season and the wet season, respectively. The highest positive  
129 rate was found in cases which occurred in January (53.8%) and rotavirus was not detected from June to September  
130 (Fig. 1B). Coinfections with bacteria and rotavirus were found in 34 cases including 12 cases under one year old  
131 and 22 cases aged 1-<5 years old. The major bacteria of coinfections with rotavirus was EPEC (12 cases) followed  
132 by *Salmonella* spp. (8 cases) (Table 6).

133

#### 134 **Discussion**

135 In this study, bacterial pathogens were identified in 475 of 2,482 samples, with a positive detection rate of 19.1%.  
136 This was lower than the detection rates in most previous studies that were conducted with patients of diarrhea in  
137 Asian and African countries and the rate was 20.1-44.2% [15-18]. This study included specimens that were  
138 transferred to the laboratory within 7 days after collection due to the limited budget and human resources.  
139 According to the practice guidelines for management of infectious diarrhea, the lower detection rate in this study  
140 might be because of problems associated with the testing procedures, such as inoculation within 2 hours, storage  
141 in a refrigerator if transportation was delayed, agar plates, enrichment broth, technical expertise, as well as the  
142 awareness of physicians in terms of diarrheal diagnosis [19, 20].

143 *Salmonella* spp. was the predominant bacterial cause of diarrhea among all patients. This result was the same as  
144 those of previous studies that examined pathogens among not only children aged under five years old, but also  
145 people of various ages worldwide [3, 18, 21]. The systematic review including 22 papers reported that *Salmonella*  
146 spp. was the major pathogen of outpatients with diarrhea who were five years old or older [3]. This study also  
147 found that *Salmonella* spp. was the major cause of diarrhea in the wet season. This result was consistent with that  
148 of two previous studies conducted in Senegal and Ho Chi Minh City [22, 23]. It was suggested that a higher  
149 temperature might increase the number of salmonellosis notifications through an increase of bacterial reproduction  
150 at various points along the food chain [24, 25], although there was no association between the prevalence of  
151 infections by *Salmonella* spp. and the average monthly rainfall [23]. However, this may have resulted because the  
152 studies were conducted in developed countries, such as Australia and the UK. It is still unexplained in developing  
153 countries including Lao PDR.

154 The positive rate for rotavirus among children aged under five years old was 32.4% and it was lower than those  
155 of the two studies at Mahosot Hospital in Vientiane Capital (53.9-55.9%). It may be because the previous studies

156 included only patients who were admitted to the central hospital due to diarrhea [9, 10]. Immunization for rotavirus  
157 has not been introduced in Lao PDR [26], although WHO recommends to include rotavirus vaccines in all national  
158 immunization programs [27]. Rotavirus infection was reported to be the predominant cause of diarrheal cases,  
159 especially in developing countries, and caused more than half of diarrheal deaths in children under five years old  
160 worldwide [28, 29]. This study showed a higher number of rotavirus infections in the dry season the same as the  
161 study in 2005-2007. However, this study did not test 41.7% of children under five years old. It was reported that  
162 the seasonality of rotavirus was less distinct in tropical countries and in low- and low-middle income countries  
163 [30, 11, 31, 32]. These results suggest that children who did not visit health facilities or lived in other provinces  
164 might have rotavirus infections with the higher incidence than this study. Rotavirus vaccine should be introduced  
165 as part of the national immunization program to protect young children from severe diarrhea in Lao PDR.

166 Coinfection of bacteria and rotavirus was found in 34 children under five years old (3.9%), but the number of  
167 coinfections could be more if all specimens were tested for rotavirus. The major bacteria of coinfection with  
168 rotavirus was *E. coli*, especially EPEC. This result was consistent with that of the previous study that was  
169 conducted in Vietnam [31]. This study did not examine the association between symptoms and pathogens.

170 Tokoeda et al. reported that coinfections of rotavirus and bacteria caused diarrhea for a prolonged period and  
171 severe dehydration [33]. Coinfections are difficult for physicians to diagnose and treat, and therefore the results  
172 of this study may be useful for physicians to understand about coinfections and causes of diarrhea.

173 There are some limitations to this study. First, the results of etiologic agents in this study may not be representative  
174 of the entire country because all sentinel sites were located in Vientiane Capital. However, most health facilities  
175 in rural areas cannot perform laboratory tests on patients with diarrhea, and the culture and climate are similar  
176 throughout the country. Therefore, the results of this study could be considered useful for medical professionals  
177 to understand the causes of diarrhea to provide treatment to patients in Lao PDR. Secondly, this study did not  
178 show the reason why the detection rate of bacteria or rotavirus was lower than that observed in previous studies  
179 in Lao PDR or other countries. It is possible that some bacterial pathogens were not detected owing to swabs with  
180 inadequate volume of stool or self-medication with antibiotics. In this study, 104 patients had taken antibiotics  
181 before the examinations. In Lao PDR, antibiotics can be obtained at pharmacies without a prescription, if the 104  
182 patients were excluded, the detection rate of pathogens might be higher in this study. Thirdly, 653 samples were  
183 not tested for rotavirus due to the limitation of financial support. We were unable to increase the possibility of  
184 rotavirus detection, as well as assess the true seasonality of rotavirus and coinfection of bacteria and rotavirus.

185 Stool specimens should be tested for rotavirus throughout the year in order to show the true seasonality of rotavirus  
186 as well as other types of pathogens, such as norovirus and protozoa, including giardia and amoeba.  
187 In conclusion, this study showed that bacterial pathogens were identified in 19.1% of patients with diarrhea of all  
188 ages and rotavirus was detected in 32.4% of children <5 years old in Vientiane Capital. *Salmonella* spp. was the  
189 predominant bacterial pathogen in single bacterial infections of all ages. Rotavirus was the predominant pathogen  
190 of diarrhea among children <5 years old. The numbers of diarrheal patients and rotavirus infections were higher  
191 in the dry season than the wet season. Rotavirus vaccine should be included in the national immunization program  
192 to prevent children's health in Lao PDR. Further studies examining other types of pathogens for diarrhea in the  
193 same and other provinces in Lao PDR will be needed in the future.

194

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199

#### 200 **Contributors**

201 Souphatsone Houattongkham, Eiko Yamamoto and Onechanh Keosavanh designed the study. Souphatsone  
202 Houattongkham, Noikaseumsy Sithivong, and Arounnapa Vongduangchanh collected the data. ouphatsone  
203 Houattongkham, Eiko Yamamoto and Souphalak Inthapatha carried out the analysis. Yu Mon Saw, Tetsuyoshi  
204 Kariya and Nobuyuki Hamajima provided the epidemiological advice. Souphatsone Houattongkham wrote the  
205 first draft and Eiko Yamamoto and Nobuyuki Hamajima revised the manuscript. All authors reviewed the  
206 manuscript and approved the final version of manuscript.

207

#### 208 **Compliance with ethical standards**

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213

214 **Conflict of interest**

215 The authors declare that there are no conflicts of interest.

216

217 **Ethical approval**

218 The study did not require an ethical approval.

219

220 **Informed consent**

221 The study did not require an informed consent.

222 **Figure legends**

223 Fig. 1 Numbers of patients with diarrhea caused by bacterial, rotavirus, and coinfections from 2012 to 2015  
224 according to the month of onset. The dry season is from November to April and the wet season is from May to  
225 October. A, Number of total patients and patients under five years old, and the number and the rate of patients  
226 whose specimens were positive for bacteria. B, Number of patients under five years old and the patients whose  
227 results of rotavirus were available, and the number and the rate of patients whose specimens were positive for  
228 rotavirus. The results of 899 cases were available, although 913 cases were tested but in 14 cases we were unable  
229 to read the results. Grey bold line, number of all-aged patients; black bold line, number of patients <5 years old;  
230 black thin line, number of patients <5 years old who tested for rotavirus, black line with black circle, number of  
231 positive cases for bacteria; black dot line with white circle, positive rate of bacteria, black line with black square,  
232 number of positive cases for rotavirus; black dot line with white square, positive rate of rotavirus.

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Table 1 Primers for subgroups of *Escherichia coli*

Gene	Orientation	Primer sequence (5' → 3')	Working primer mix
eaeA-new	F	AACGGCTATTTCCGCATGAG	MIX DEC A
eaeA-new	R	CACATAAGCMGGCAAAATAGCCTG	
bfpB	F	GACACCTCATTTGCTGAAGTCG	
bfpB	R	GCCCAGAACACCTCCGTTAT	
stx1	F	TATCTGGATTTAATGTTCGCATAG	
stx1	R	AGAACGCCCACTGAGATCATC	
mMK2	F	GAGTTTACGATAGACCTTTCGAC	
mMK2	R	GGCCACATATAAATTATTTTGCTC	
ST1a	F	GCAATTTTTATTTCTGTATTATCTT	MIX DEC B
St1a	R	GGATTACAACAAAGTTCACAG	
ST1b	F	TTTATTTTTCTTTCTGTATTGTCTT	
St1b	R	GGATTACAACACAATTCACAG	
lt	F	CTATTACAGAACTATGTTTCGGAATATC	
lt	R	GGGGGTTTTATTATTCCATACAC	
ipaH	F	G TTCCTTGACCGCCTTTCCGATACCGTC	
ipaH	R	GCCGGTCAGCCACCCTCTGAGRGTAC	

Table 2 Characteristics of patients with diarrhea

	Age group						Total	
	<1 (N=643)		1-<5 (N=923)		≥5 (N=916)		(N=2,482)	
	n	%	n	%	n	%	N	%
Sex								
Male	381	59.3	523	56.7	388	42.4	1,292	52.1
Female	262	40.7	400	43.3	528	57.6	1,190	47.9
Health facility <sup>a</sup>								
Central hospital	480	74.7	581	62.9	449	49.0	1,510	60.8
District hospital	108	16.8	240	26.0	317	34.6	665	26.8
Health center	55	8.6	102	11.1	150	16.4	307	12.4
Season <sup>b</sup>								
Dry season	434	67.5	693	69.2	468	51.1	1541	62.1
Wet season	209	32.5	284	30.8	448	48.9	941	37.9
Bacterial entero-pathogen								
Negative	551	85.7	758	82.1	698	76.3	2,007	80.9
Single bacteria	66	10.3	115	12.5	173	18.9	354	14.3
Multiple bacteria	14	2.2	28	3.0	45	4.9	87	3.5
Bacteria + rotavirus	12	1.9	22	2.4	-	-	34	1.4
Rotavirus								
Negative	256	68.6	352	66.9	-	-	608	67.6
Positive	117	31.4	174	33.1	-	-	291	32.4
Equivocal	6	-	8	-	-	-	14	-
Not tested	264	-	389	-	916	-	1,569	-

<sup>a</sup>Central hospital includes Pediatric Hospital, Sethathirath Hospital, Mahosot Hospital and Mittaphab Hospital, District hospital includes Sisattanak District Hospital, Hadtxayfong District Hospital and Sikhottabong District Hospital, and health center is Ban-hom Health Center.

<sup>b</sup>The dry season is from November to April and the wet season is from May to October.

Table 3 Single bacterial entero-pathogen of diarrhea in age groups

Entero-pathogen	Age group						Total	
	<1 (N=66)		1-<5 (N=115)		≥5 (N=173)		(N=354)	
	n	%	n	%	n	%	N	%
<i>Salmonella</i> spp.	34	51.5	23	20.0	36	20.8	93	26.3
EPEC	15	22.7	29	25.2	20	11.6	64	18.1
EHEC	5	7.6	5	4.3	7	4.0	17	4.8
EIEC	3	4.5	10	8.7	2	1.2	15	4.2
ETEC. LT	1	1.5	11	9.6	2	1.2	14	4
ETEC. ST	1	1.5	9	7.8	3	1.7	13	3.7
<i>Aeromonas</i> spp.	4	6.1	9	7.8	46	26.6	59	16.7
<i>Shigella</i> spp.	1	1.5	16	13.9	18	10.4	35	9.9
<i>Plesiomonas shigelloides</i>	1	1.5	3	2.6	25	14.5	29	8.2
<i>Vibrio parahaemolyticus</i>	0	0.0	0	0.0	11	6.4	11	3.1
<i>Vibrio cholera non 01/0139</i>	0	0.0	0	0.0	3	1.7	3	0.8
<i>Campylobacter</i> spp.	1	1.5	0	0.0	0	0.0	1	0.3

spp., species; EPEC, Enteropathogenic *Escherichia coli*; EHEC, Enterohemorrhagic *Escherichia coli*; EIEC, Enteroinvasive *Escherichia coli*; ETEC. LT, Enterotoxigenic *Escherichia coli* heat-labile enterotoxin; ETEC. ST, Enterotoxigenic *Escherichia coli* heat-stable enterotoxin.

Table 4 Seasonal variation of single bacterial entero-pathogen of diarrhea

Entero-pathogens	Dry season		Wet season		Total	
	n	%	n	%	N	%
<i>Salmonella</i> spp.	50	23.7	43	30.1	93	26.3
EPEC	53	25.1	11	7.7	64	18.1
EHEC	16	7.6	1	0.7	17	4.8
EIEC	10	4.7	5	3.5	15	4.2
ETEC. LT	12	5.7	2	1.4	14	4.0
ETEC. ST	9	4.3	4	2.8	13	3.7
<i>Aeromonas</i> spp.	31	14.7	28	19.6	59	16.7
<i>Shigella</i> spp.	22	10.4	13	9.1	35	9.9
<i>Plesiomonas shigelloides</i>	4	1.9	25	17.5	29	8.2
<i>Vibrio parahaemolyticus</i>	2	0.9	9	6.3	11	3.1
<i>Vibrio cholera non 01/0139</i>	1	0.5	2	1.3	3	0.8
<i>Campylobacter</i> spp.	1	0.5	0	0.0	1	0.2
Total	211	100.0	143	100.0	354	100.0

The dry season is from November to April and the wet season is from May to October.

spp., species; EPEC, Enteropathogenic *Escherichia coli*; EHEC, Enterohemorrhagic *Escherichia coli*; EIEC, Enteroinvasive *Escherichia coli*; ETEC. LT, Enterotoxigenic *Escherichia coli* heat-labile enterotoxin; ETEC. ST, Enterotoxigenic *Escherichia coli* heat-stable enterotoxin.

Table 5 Multiple bacterial pathogens of 87 patients with diarrhea

	<i>Salmonella</i> spp.	EPEC	EHEC	EIEC	ETEC. LT	ETEC. ST	<i>Aeromonas</i> spp.	<i>Shigella</i> spp.	<i>Plesiomonas shigelloides</i>	<i>Vibrio parahaemolyticus</i>	<i>Campylobacter</i> spp.	EPEC + ETEC.LT	EPEC + ETEC.ST	EHEC + ETEC. LT	EHEC + ETEC. ST	EHEC + <i>Salmonella</i> spp.	ETEC. LT + ETEC. ST	ETEC. ST + <i>Salmonella</i> spp.	<i>Salmonella</i> spp. + <i>Vibrio parahaemolyticus</i>	<i>Salmonella</i> spp. + <i>Plesiomonas shigelloides</i>	<i>Plesiomonas shigelloides</i> + <i>Vibrio parahaemolyticus</i>	Total
<i>Salmonella</i> spp.	-	4	1	0	2	1	5	1	5	3	0	0	0	0	0	0	0	0	0	0	1	23
EPEC	4	-	0	1	10	4	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	23
EHEC	1	0	-	2	5	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	1	12
EIEC	0	1	2	-	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	8
ETEC. LT	2	10	5	0	-	7	2	0	3	0	0	0	1	0	1	0	0	0	0	0	0	31
ETEC. ST	1	4	0	4	7	-	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	19
<i>Aeromonas</i> spp.	5	1	0	0	2	0	-	3	5	3	0	0	0	0	0	0	0	0	0	0	0	19
<i>Shigella</i> spp.	1	0	0	0	0	0	3	-	3	0	0	0	0	0	0	0	0	0	0	0	0	7
<i>Plesiomonas shigelloides</i>	5	1	1	1	3	0	5	3	-	4	0	0	0	0	0	0	0	0	0	1	0	24
<i>Vibrio parahaemolyticus</i>	3	0	0	0	0	0	3	0	4	-	0	0	0	0	0	0	0	0	1	0	0	11
<i>Campylobacter</i> spp.	0	1	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	1

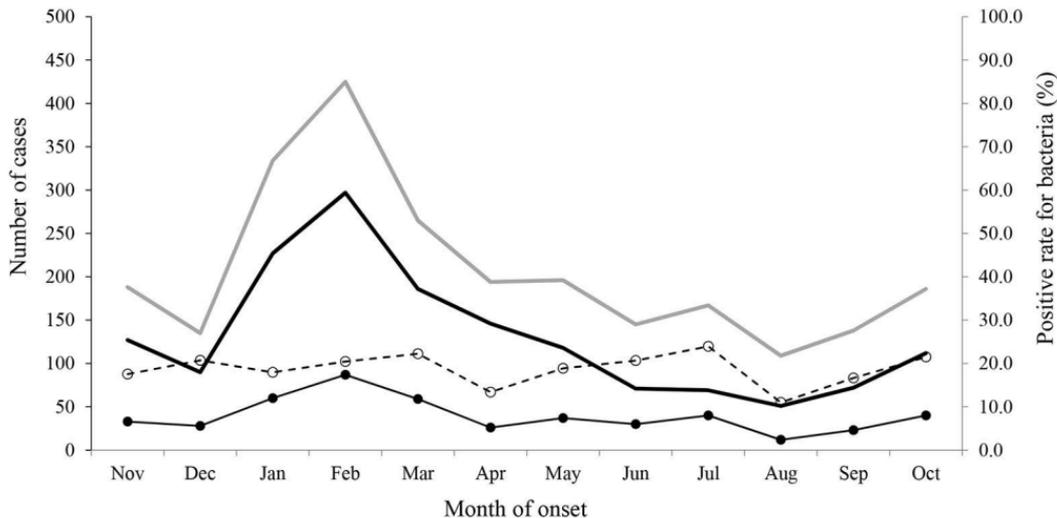
spp., species; EPEC, Enteropathogenic *Escherichia coli*; EHEC, Enterohemorrhagic *Escherichia coli*; EIEC, Enteroinvasive *Escherichia coli*; ETEC.LT, Enterotoxigenic *Escherichia coli* heat-labile enterotoxin; ETEC. ST, Enterotoxigenic *Escherichia coli* heat-stable enterotoxin.

Table 6 Bacteria of coinfections with rotavirus among children under five years old

Bacteria (+ rotavirus)	Age group		Total (N=34)
	<1 (N=12)	1-<5 (N=22)	
EPEC	4	8	12
EIEC	0	3	3
ETEC.LT	0	3	3
EHEC	0	1	1
EPEC + ETEC.LT	1	0	1
<i>Salmonella</i> spp.	5	3	8
<i>Aeromonas</i> spp.	1	1	2
<i>Shigella</i> spp.	0	2	2
<i>Aeromonas</i> spp. + <i>Salmonella</i> spp.	1	0	1
<i>Campylobacter</i> spp.	0	1	1

EPEC, Enteropathogenic *Escherichia coli*; EIEC, Enteroinvasive *Escherichia coli*; ETEC. LT, Enterotoxigenic *Escherichia coli* heat-labile enterotoxin; EHEC, Enterohemorrhagic *Escherichia coli*; spp., species.

A



B

