JIDC | THE JOURNAL OF INFECTION IN DEVELOPING COUNTRIES

Original Article

Incidence rates and clinical Symptoms of *Salmonella*, *Vibrio parahaemolyticus*, and *Shigella* infections in China, 1998–2013

Xu Lin Qi[1]*, Hai Xia Wang[2]*, Shu Rui Bu[1], Xiao Gang Xu[3], XiaoYan Wu[4], Dong Fang Lin[3]

[1] *Department of Infectious Diseases, Jinshan Hospital, Fudan University, Shanghai, China*
[2] *Department of Obstetrics and Gynecology. Jinshan Branch, the Sixth People's Hospital Affiliated to Shanghai Jiao Tong University, Shanghai, China*
[3] *Institute of Antibiotics, Huashan Hospital, Fudan University, Shanghai, China*
[4] *Department of Clinical Laboratory, The Second People's Hospital of Jiaxing, Jiaxing, Zhejiang, China*

* These authors contributed equally to the study.

Abstract

Introduction: The etiological and clinical characteristics of patients with infectious diarrhea have changed during the last decade in Shanghai.
Methodology: The records of 29,210 patients with infectious diarrhea in the outpatient department of the Jinshan Hospital (Shanghai, China) between January 1998 and December 2013 were analyzed.
Results: A total of 2,849 samples were positive for intestinal pathogenic bacteria including *Vibrio parahaemolyticus* (2,489; 84.0%), *Salmonella* spp. (235; 8.3%), and *Shigella* spp. (125; 4.4%). *V. parahaemolyticus* infections are mainly characterized by abdominal pain, nausea, and vomiting, whereas *Shigella* spp. infections can, in addition, induce fever. In contrast, *Salmonella* infections can produce all of these symptoms but in a smaller percentage of patients. During the 16-year study, both the number of patients and the positive infection rate declined. Notably, the rate of infections by *V. parahaemolyticus* decreased while the detection rates of *Salmonella* spp. increased year by year from 2006 on with the introduction of a new detection method.
Conclusions: *Salmonella* has been identified as the third-most frequent cause of diarrhea from 1998–2006, as the second-most frequent cause from 2006–2010, and as the most frequent cause from 2011–2013, which was mainly due to a sharp decrease of *V. parahaemolyticus* infections in 2011–2013. *Salmonella* strains collected in 2011–2013 showed high susceptibility to imipenem (100%) and meropenem (100%), whereas susceptibilities for ampicillin (39%) and piperacillin (40%) were low.

Key words: *Vibrio parahaemolyticus*; *Salmonella*; infectious diarrhea.

J Infect Dev Ctries 2016; 10(2):127-133. doi:10.3855/jidc.6835

(Received 03 March 2015 – Accepted 19 August 2015)

Introduction

Infectious diarrhea is a frequently occurring worldwide disease. According to a World Health Organization (WHO) report, the incidence of infectious diarrhea is high in the developing world [11]. Pathogens capable of causing infectious diarrhea are numerous and include viruses, bacteria, fungi, and parasites. *Shigella*, *Salmonella*, pathogenic *Escherichia coli*, and *Vibrio parahaemolyticus* are the main bacterial pathogens that cause infectious diarrhea. According to the data on foodborne disease outbreaks in some parts of China, monitored by the National Foodborne Disease Monitoring Network, a total of 5,770 events of food poisoning were detected in 162,995 patients between 1992 and 2001, 38.5% of which were caused by microorganisms (accounting for 50.9% of the total). Acute gastroenteritis caused by *V. parahaemolyticus* ranked first in these bacterial food poisoning incidents, and those caused by *Salmonella* were ranked third [12]. However, data collected in recent years have suggested that the incidence of infections caused by *V. parahaemolyticus* has declined, while the incidence of those caused by *Salmonella* has increased [14,15,24]. Various serious outbreaks of foodborne *Salmonella* infection have been reported worldwide [8-10,23].

V. parahaemolyticus is mainly found in seafood and often causes foodborne diseases due to the consumption of raw or cooked shellfish, lobster, or fish. The clinical symptoms include nausea, vomiting, abdominal pain, and watery diarrhea; these can be reduced by altering the diet and through better health education [5,6]. Adult patients with a *Shigella* infection show obvious symptoms of fever and diarrhea, and the bacteria are sensitive to chemical disinfectants and antibiotics,

which makes diagnosis relatively straightforward [1]. However, congeneric *Salmonella* are widespread in the natural world and grow well over a wide environmental temperature range (7°C–45°C). The infection risk is related to serum type and a person's existing health condition, with the elderly, children and those immunocompromised at the highest risk. *Salmonella* mainly causes typhoid, paratyphoid, acute gastroenteritis, and extra-intestinal inflammation (bacteremia, cholecystitis, pyelonephritis, *etc*.) [2,7]. Thus, *Salmonella* infections produce both digestive tract and systemic symptoms, and their various serum types make a rapid diagnosis difficult. Therefore, it is of obvious clinical interest to master the epidemiological and clinical characteristics of *Salmonella* to facilitate rapid diagnosis. Here, we report intestinal infections caused by *Salmonella* in a 16-year period in our hospital in China, together with an analysis of its clinical and epidemiological characteristics.

Methodology

Patient data

Data from 29,210 patients with infectious diarrhea in the outpatient department of Jinshan Hospital (Shanghai, China) from January 1998 to December 2013 were retrospectively analyzed, and included the results of stool cultures and clinical characteristics. Diarrhea cases were defined according to a five-step evaluation: 1. Does the patient really have diarrhea? Beware of fecal incontinence and impaction; 2. Rule out medications as a cause of diarrhea (drug-induced diarrhea); 3. Patient has had more than one loose stool, or clinically significant vomiting, over a two-week period with no underlying non-infectious cause, followed by a symptom-free period of three weeks which was considered as acute diarrhea, otherwise more than four weeks as chronic diarrhea [4]; 4. Categorize the diarrhea as inflammatory, fatty, or watery; 5. Consider factitious diarrhea [22]. The 2,849 patients' samples that were positive for *Shigella*, *Salmonella*, or *V. parahaemolyticus* were selected, and their epidemiological characteristics and clinical and laboratory data further analyzed.

Sample collection and analysis

Patients were asked to defecate into a clean bedpan; any stool with purulent blood or mucus feces were sampled with sterile bamboo and placed into a culture bottle for testing. Bacteria were separated by incubating the stool sample in SS (used for the separation of *Shigella* and *Salmonella*, Meixiang Company, Shanghai, China） and TCBS (thiosulfate, citrate, bile salts, sucrose, agar culture medium was used for the separation of *V. parahaemolyticus* (Meixiang Company, Shanghai,China). Suspicious colonies were selected for pure culture after 6–10-hour culture at 35°C. Traditional methods were used for bacteria identification before the year 2000, which included enrichment cultivation, selective separation culture, and biochemical identification.

Table 1. Number of patients with intestinal infections and the separation rate of the three main intestinal pathogens

Year	Sample number (*n*)	Patients who were infected (*n*)	Positive rate (%)
1998	2666	254	9.53
1999	2285	205	8.97
2000	2400	217	9.04
2001	2311	436	18.87
2002	2101	422	20.09
2003	2302	397	17.25
2004	1814	221	12.18
2005	1346	110	8.17
Mean ± SD	2153 ± 143.8	282.8 ± 120.0	13.0 ± 4.9
2006	1915	59	3.08
2007	1029	59	5.73
2008	1002	82	8.18
2009	1054	78	7.40
2010	1649	130	7.88
2011	941	84	8.92
2012	604	31	5.13
2013	940	64	6.81
Mean ± SD	1142 ± 150.3	73.4 ± 28.6	6.6 ± 1.9
P	0.0003		0.0006

P refers to the statistical significance of the means of patient numbers and the positive rate between the first 8 years and the last 8 years of the 16-year study.

After 2000, pure culture colonies were analyzed using an automatic bacteria identification instrument (VITEK-2 Compact, bioMerieux, Marcy l'Etoile, France) to identify the pathogens.

Serotyping was achieved at the Jinshan branch of the Chinese Center for Disease Control and Prevention in Shanghai. O and H antigens were characterized using commercial antisera (S&A Reagents Lab, Bangkok, Thailand), and phase 1 flagellar and phase 2 flagellar antigen agglutination was done using commercial antisera (Bio-Rad, Marnes-la-Coquette France). Reagents were purchased via Ningbo Tianrun Biological & Pharmaceutical Co., Ningbo, China. The serotypes were identified according to the Kauffmann-White scheme [16].

Statistics

SPSS version 10.0 software was used for data analysis. A Z test was used for a large sample size and a Mann-Whitney test was used if heterogeneity of variance was evident. A p value < 0.05 was considered to be statistically significant.

Results

General patient data

A total of 29,210 patients with acute diarrhea as their first symptom visited the intestinal outpatient department over 16 years. In this study, 26,395 stool samples were tested, with a total test rate of 90%. Of these patients, 2,849 (10.8%) were found to be pathogen positive (Table 1), including 2,489 (84.4%) cases of *V. parahaemolyticus*, 235 (8.3%) cases of *Salmonella*, and 125 (4.4%) cases of *Shigella* (Table 2). In addition, 3 cases of *V. alginolyticus* and 2 cases of *E. coli* were diagnosed but omitted for analyses in this study because of their low frequencies. The youngest and oldest patient with a *Salmonella* infection was 6 months and 83 years of age, respectively, with the average patient age being 35.6 ± 12.8 years. According to monthly records, *Salmonella* infections mainly occurred between April and November and were responsible for 79.6% of all infections. The highest rate was between May and September, which accounted for 83.4% of all cases.

Distribution and changes in the three main intestinal pathogens with time

Before 2003, more than 2,000 patients with an intestinal infection visited the hospital each year, but during the last 10 years, the number of patients attending the clinic steadily reduced, year by year, with a concomitant gradual decline in the positive detection rate of pathogenic bacteria. There was an average of 2,153 patients per annum during the first 8 years, with an average positive detection rate of 13.1%. In the last 8 years, there was an average of 1,142 patients, with an average positive detective rate of 6.4%. Both of these averages significantly decreased by about 50% ($p = 0.0003$, $p = 0.0006$, respectively) (Table 1). It is important to note that the positive detection rate of *V. parahaemolyticus* declined year by year and in contrast, the positive rate of *Salmonella* detection rose, particularly from 2006 on (Table 2).

Clinical features of Salmonella *infection*

In 235 cases of *Salmonella* infection, 57.9% of patients had abdominal pain, 50.6% had bouts of diarrhea > 5 times a day, 26.0% presented with

Table 2. Distribution of the three main intestinal pathogens

Year	Total number	*Salmonella*		*Vibrio parahaemolyticus*		*Shigella*	
		Strains number	Proportion (%)	Strains number	Proportion (%)	Strains number	Proportion (%)
1998	254	2	0.8	239	94.1	13	5.1
1999	205	1	0.5	204	99.5	0	0
2000	217	2	0.9	205	94.5	10	4.6
2001	436	2	0.5	420	96.3	14	3.2
2002	422	1	0.2	392	92.9	26	6.2
2003	397	0	0	393	99	4	1
2004	221	1	0.5	207	93.7	12	5.4
2005	110	0	0	97	88.2	13	11.8
2006	59	8	6.8	51	86.4	4	6.8
2007	59	18	27.1	39	66.1	3	5.1
2008	79	33	37.97	47	59.49	2	2.53
2009	77	26	33.77	51	66.23	0	0
2010	130	30	23.08	89	68.46	11	8.46
2011	84	51	60.71	20	23.81	13	15.48
2012	31	26	83.87	5	16.13	0	0
2013	64	34	53.13	30	46.88	0	0

moderate fever (average oral temperature 38.7°C ± 0.7°C), 18.3% had a combination of nausea and vomiting, and 40.4% had higher white blood cell counts in their stools. Notably, 90.5% of the patients had a history of eating unclean food. The shortest and longest latency before symptoms appeared after eating unclean food was 1 hour and 72 hours, respectively. In *Salmonella*-infected patients, symptoms such as vomiting, tenesmus, and dehydration occurred less frequently compared to *Shigella* and *V. parahaemolyticus*-associated infections (Table 3).

The serotype classification of *Salmonella* strains are shown in Table 4. The serotypes of the clinical infection cases were mainly *Salmonella typhimurium* (19.2%), *Salmonella enteritidis* (15.7%), *Salmonella* London (6.4%), and *Salmonella* B group (5.1%), followed by *Salmonella* Thompson, *Salmonella* Sao Paulo, *Salmonella* group D, *Salmonella* group C, *Salmonella* Choleraesuis, and *Salmonella* Aberdeen.

Drug sensitivity tests (Table 5) were performed on 111 cases of *Salmonella* infections over three years. The results showed that the drugs that *Salmonella* was sensitive to were mainly imipenem, meropenem, cefotaxime, cefoperazone, levofloxacin, and ciprofloxacin.

Only those patients with severe clinical symptoms or elderly patients were given anti-infection treatment. It is prohibited to administer quinolone drugs for patients under the age of 18, thus imipenem, meropenem, cefoperazone, or cefotaxime sodium were prescribed. Quinolone or cephalosporins were only given to adult patients.

Discussion

Our hospital provides the main medical service and health screening facilities of the local and surrounding areas for sick people. Many patients come to the intestinal outpatient department with diarrhea as the main symptom of their ailment. After medical data analysis of intestinal infectious diarrhea patients over the last 16 years, we found that both the number of patients and the pathogen positive separation rates were significantly decreased by about 50% ($p = 0.0003$, $p = 0.0006$), which might be attributed to improved hygiene when preparing food and to the widely publicized diet and health information in recent years (Table 1).

Specifically, the incidence of infectious diarrhea caused by *V. parahaemolyticus* declined over the 16 years, while the incidence of diarrhea caused by *Salmonella* has risen year by year, a change mainly reflected in the composition ratio. Until 2010, the actual number of isolated *V. parahaemolyticus* strains was still much higher than the number of isolated *Salmonella* strains, and our results also show that *V. parahaemolyticus* was the most common pathogen of infectious diarrhea in Jinshan Hospital, with abdominal pain, diarrhea, nausea, and vomiting being the main symptoms, which may also be accompanied by dehydration. Before 2006, infections due to *Shigella* were ranked second of the infectious diarrheal diseases without typical tenesmus and mucous bloody purulent stools. This was different from the traditional *Shigella* infection, suggesting that whether a *Shigella* infection exists should be confirmed in patients who do not exhibit the typical symptoms of a *Shigella* infection. After 2006,

Table 3. Comparison of the clinical symptoms of *Salmonella*, *Vibrio parahaemolyticus* and *Shigella* **infections.**

Clinical symptoms	*Salmonella* infection (*n* = 235)		*Vibrio parahaemolyticus* infection (*n* = 2489)		*Shigella* infection (*n* = 125)		*P*
	Case (*n*)	Proportion (%)	Case *(n)*	Proportion (%)	Case (*n*)	Proportion (%)	
Fever	61	25.96	248	9.96	50	40.80	0.007
Abdominal pain	136	57.87	2142	86.06	83	66.40	0.117
Nausea	74	31.49	1729	69.47	51	40.80	0.080
Vomiting	43	18.30	1251	50.26	37	29.60	0.015
Tenesmus	0	0	21	0.84	2	1.60	0.234
Dehydration	6	2.55	551	22.13	30	30.30	< 0.001
Stool frequency							
> 5 times	119	50.64	1057	42.47	87	69.60	< 0.001
≤ 5 times	116	49.36	1432	57.53	38	30.40	< 0.001
Increased interleukin in stool	38	40.4	926	37.20	99	79.20	< 0.001
Increased red blood cells in stool	18	19.1	619	24.87	91	72.80	< 0.001

P refers to the statistical analysis between symptom proportions of *Salmonella* and *Shigella* infections.

Table 4. Serotype distribution of 235 salmonella strains

Isolated strains	Strain numbers (*n*)	Proportion (%)
Salmonella typhimurium	45	19.15
Salmonella enteritidis	37	15.74
Salmonella B group	12	5.11
Salmonella C group	5	2.13
Salmonella D group	6	2.55
Salmonella Thompson	7	2.98
Salmonella Sao Paulo	6	2.55
Salmonella London	15	6.38
Salmonella Aberdeen	5	2.13
Salmonella Choleraesuis	5	2.13
Salmonella Algonac	4	1.70
Salmonella Potsdam	2	0.85
Salmonella Newport	2	0.85
Salmonella Potsdam	2	0.85
Salmonella Meleagridis	2	0.85
Salmonella Infantis	1	0.43
Salmonella Pomona	1	0.43
Salmonella Lomita	1	0.43
Salmonella Paratyph*i*	1	0.43
Salmonella Cottbus	1	0.43
Salmonella Montevideo	1	0.43
Salmonella Derby	1	0.43
Undifferentiated types	77	32.77

Table 5. Sensitivity analysis of 113 *Salmonella* strains, detected in 2011-2013, to common antibiotics

Antibiotics	Sensitivity	
	Number of sensitive strains	Sensitivity rate (%)
Ampicillin	43	38.7
Cefotaxime (ceftriaxone)	80	70.1
Ceftazidime	81	72.0
Cefepime	80	72.1
Levofloxacin	96	86.5
Imipenem	111	100
Meropenem	111	100
Cefoperazone / Sulbactam	81	73.0
Aztreonam	71	64.0
Piperacillin	44	39.6
Ciprofloxacin	90	81.1
Trimesulf	82	73.9

Salmonella infections ranked second, with abdominal pain, diarrhea, and fever being the main symptoms, which often occurred 12 to 24 hours after eating infected food. Typically, symptoms included mainly a watery stool was excreted 3 to 30 times daily, which occasionally contained mucous or bloody purulent. These symptoms were accompanied by moderate fever and/or chills, symptoms which lasted for three to five days in most adults, and even longer in old or weak patients. Severe dehydration could occur in patients suffering from serious vomiting and diarrhea. However, although the clinical manifestation of *Salmonella* infection in this study was in line with reports in the domestic literature [19,21], the symptoms of abdominal pain, nausea, and tenesmus could not be used to distinguish a *Salmonella* from a *Shigella* infection. *Salmonella* infections occurred all year round, were easy to contract from April to November, and occurred with a high incidence from May to October, consistent with previous reports of *Salmonella* infections in this region [3,13,18]. During the period 1998 to 2005, *Salmonella* infections were sporadically detected throughout the year, with one to two cases being diagnosed yearly, but no *Salmonella* infections were detected in 2003 and 2005. Since the second half of 2006, significantly more *Salmonella* infections were detected, which might be attributed to improved identification methods.

Zhang *et al*. reported that the frequency of *V. parahaemolyticus* infections was highest, followed by *Shigella* and *Salmonella* for infectious diarrhea cases in Shanghai from 2006–2011 [25], which is in line with our data until 2010, but contrary to our findings of 2011 because *Salmonella* was the major cause of acute diarrhea during this period in our study until 2013, which might be due to the fact that in our study, small, region-limited *Salmonella* outbreaks have been detected. However, the percentage of *V. parahaemolyticus* cases in acute diarrhea patients gradually decreased from 2006–2011. Seafood is mainly responsible for the spread of *V. parahaemolyticus*; therefore, the incidence of infections can be reduced by educating people about the absolute need to follow strict hygiene guidelines when preparing seafood.

In contrast, *Salmonella* infections can be spread through the fecal/oral route in a number of ways (*e.g.*, water, flies, mosquitos), and previous papers [8-10,23] have reported that outbreaks of *Salmonella* infection could be attributed to the consumption of unclean food contaminated by *Salmonella*. In the present study, the suspected unclean food, which may have caused *Salmonella* infections, mainly included ice cream, watermelon, seafood, and meat.

Diverse resistance patterns of various *Salmonella* strains to different antibiotics were found in our clinical study, which may be due to the different medical treatment expertise of doctors [17,20]. Nagshetty *et al*. [17] reported that the percentage of *Salmonella* Typhi isolates resistant to ciprofloxacin in India was 4.2%, while the susceptibility of *Salmonella* to ciprofloxacin in the present study was 79.7%.

Conclusions

New automated diagnosis techniques since 2006 have led to increased detection rates, particularly of *Salmonella* infections. Until 2006, *V. parahaemolyticus* was identified as the main diarrhea-causing bacteria followed by *Shigella* and *Salmonella*, which changed then from 2006–2010 to *V. parahaemolyticus* followed by *Salmonella* and *Shigella.* During the period of 2011–2013, *Salmonella* was identified as the most frequent diarrhea pathogen followed by *V. parahaemolyticus* and *Shigella*, which was mainly due to a sharp decline of *V. parahaemolyticus* infections, indicating that seafood as the major source of *V. parahaemolyticus* has been processed under improved hygienic conditions.

Acknowledgements

We thank Dr. Ya-Ning Zhang and Liu-Mei Ding for their help in analyzing the data in this study.

References

1. Bennish ML (1991) Potentially lethal complications of shigellosis. Rev Infect Dis 13 Suppl 4: S319-S324.
2. Brenner FW, Villar RG, Angulo FJ, Tauxe R, Swaminathan B (2000) *Salmonella* nomenclature. J Clin Microbiol 38: 2465-2467.
3. Cao ZC, Song CL, Ye YL, Zhang YY, Li L (2012) Analysis of *Salmonella* surveillance in patients with acute diarrhea in Jinshan District (2006-2010). J Prev Med Public Health 23: 9-11.
4. Chattaway MA, Harris R, Jenkins C, Tam C, Coia JE, Gray J, Iturriza-Gomara M, Wain J (2013) Investigating the link between the presence of enteroaggregative *Escherichia coli* and infectious intestinal disease in the United Kingdom, 1993 to 1996 and 2008 to 2009. Euro Surveill 18.
5. Daniels NA, MacKinnon L, Bishop R, Altekruse S, Ray B, Hammond RM, Thompson S, Wilson S, Bean NH, Griffin P M, Slutsker L (2000) Vibrio parahaemolyticus infections in the United States, 1973-1998. J Infect Dis 181: 1661-1666.
6. DePaola A, Hopkins LH, Peeler JT, Wentz B, McPhearson RM (1990) Incidence of *Vibrio parahaemolyticus* in U.S. coastal waters and oysters. Appl Environ Microbiol 56: 2299-2302.
7. Fabrega A, Vila J (2013) *Salmonella enterica* serovar *Typhimurium* skills to succeed in the host: virulence and regulation. Clin Microbiol Rev 26: 308-341.

8. Friesema IH, de Jong AE, Fitz James IA, Heck ME, van den Kerkhof JH, Notermans DW, van Pelt W, Hofhuis A (2012) Outbreak of *Salmonella Thompson* in the Netherlands since July 2012. Euro Surveill 17: 20303.
9. Hedberg CW, White KE, Johnson JA, Edmonson LM, Soler JT, Korlath JA, Theurer LS, MacDonald KL, Osterholm MT (1991) An outbreak of *Salmonella enteritidis* infection at a fast-food restaurant: implications for foodhandler-associated transmission. J Infect Dis 164: 1135-1140.
10. Kimura AC, Palumbo MS, Meyers H, Abbott S, Rodriguez R, Werner SB (2005) A multi-state outbreak of *Salmonella* serotype Thompson infection from commercially distributed bread contaminated by an ill food handler. Epidemiol Infect 133: 823-828.
11. Lamberti LM, Bourgeois AL, Fischer Walker CL, Black RE, Sack D (2014) Estimating diarrheal illness and deaths attributable to *Shigellae* and enterotoxigenic *Escherichia coli* among older children, adolescents, and adults in South Asia and Africa. PLoS Negl Trop Dis 8: e2705.
12. Lee JH, Lee JH, Kim MS, Park S G (2009) Analysis of foodborne disease outbreaks for improvement of food safety programs in Seoul, Republic of Korea, from 2002 to 2006. J Environ Health 71: 51-55.
13. Lin DF, Qi XL, Xu XG, Fan XM, Wu L G (2010) Clinical and pathological analysis of 2380 patients with bacterial infectious diarrhea. Chinese J Infect Dis 28: 103-106.
14. Liu XM, Chen Y, Guo YC, Wang ZT (2008) Foodborne diseases outbreaks in 2005 - Report of National Foodborne Diseases Surveillance Network in China. Chinese J Food Hyg 20: 506-509.
15. Liu XM, Chen Y, Guo YC, Wang ZT, Liu H, Dai Y (2010) Foodborne diseases outbreaks in 2006 - report of National Foodborne Diseases Surveillance Network in China. J Hyg Res 39: 331-334.
16. Murray P, Baron E, Pfaller M, Tenover F, Yolken R (1995) Manual of clinical microbiology. Washington DC: ASM Press. 1482 pp.
17. Nagshetty K, Channappa ST, Gaddad SM (2010) Antimicrobial susceptibility of *Salmonella Typhi* in India. J Inf Dev Ctries 4: 70-73.
18. Qi X L, Lin DF, Xu XG, Fan XM, Wu LG (2008) Analysis of *Vibrioparahaem Olyticus* gastrointestinal tract infections in 2247 cases. Chinese J Clin Med 15: 644-646.
19. Qu M, Huang F, Zhang X, Zhang DT, Liu GR, Cui ZG, Yan HQ, LiuY, He ZY, Dou XF, Kan B, Wang QY (2011) [Epidemiological characteristics and molecular typing of *Salmonella* in Beijing from 2008 to 2009.]. Zhonghua Yu Fang Yi Xue Za Zhi 45: 113-117. [Article in Chinese.]
20. Rahman BA, Wasfy MO, Maksoud MA, Hanna N, Dueger E, House B (2014) Multi-drug resistance and reduced susceptibility to ciprofloxacin among *Salmonella enterica* serovar Typhi isolates from the Middle East and Central Asia. New Microbes New Infect 2: 88-92.
21. Shen FJ, Wang S, Shu M, Wang YJ, Chen J, Han YJ (2014) Case-control study on *Salmonella* infection in huangpu district, Shanghai, 2008-2010. J ENVIRON OCCUP MED 31: 195-198.
22. Sweetser S (2012) Evaluating the patient with diarrhea: a case-based approach. Mayo Clin Proc 87: 596-602.
23. van Pelt W, Mevius D, Stoelhorst HG, Kovats S, van de Giessen AW, Wannet W, Duynhoven YT (2004) A large increase of *Salmonella* infections in 2003 in The Netherlands: hot summer or side effect of the avian influenza outbreak? Euro Surveill 9: 17-19.
24. Xu JF, Zhang, JZ (2012) Analysis of foodborne disease outbreaks in China from 2001 to 2010. Chinese Agricult Sci Bull 28: 313-316.
25. Zhang Y, Zhao Y, Ding K, Wang X, Chen X, Liu Y, Chen Y (2014) Analysis of bacterial pathogens causing acute diarrhea on the basis of sentinel surveillance in Shanghai, China, 2006-2011. Jpn J Infect Dis 67: 264-268.

Corresponding author

Dong Fang Lin
Institute of Antibiotics, Huashan Hospital, Fudan University
No. 12, Wu Lu Mu Qi Zhong Road
Shanghai 200040, China
Phone: 86 21 34189990
Fax: 86 21 67226966
Email: lindf150213@163.com

Conflict of interests: No conflict of interests is declared.