Prevalence of Salmonella *and* Shigella *spp. and Antibiotic Resistance Status in Acute Childhood Gastroenteritis*

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Abstract

Objective: Acute gastroenteritis is an important cause of morbidity and mortality in developing countries. Children under 5 years of age are more commonly affected, while 80% of deaths occur in children under 2 years of age. *Escherichia coli, Salmonella* spp., and *Shigella* spp. are the most common causative bacterial pathogens. Since the summer of 2014, a large number of *Salmonella* and *Shigella* gastroenteritis cases have occurred in our region, which is considered as a small local outbreak. We aim to report the features and antibiotic susceptibility of microorganism isolates obtained during this epidemic.

Material and Methods: Between July and September 2014, patients who were admitted to pediatric clinics and emergency services on account of acute gastroenteritis lasted less than 15 days were included in this retrospective study. Stool microscopy, stool cultures, and blood cultures were performed. *Salmonella* and *Shigella* strains were subjected to antimicrobial susceptibility testing.

Results: A total of 2425 patients were admitted because of acute gastroenteritis during the study period. *Salmonella* spp. and *Shigella* spp. were isolated in 113 children. The mean age of the children was 91.5±60.3 months (4-213 months). Of the 113 patients, 56% were male and 44% were female. *Shigella* spp. were found in 77 patients (3.2%), and *Salmonella* spp. were found in 36 patients (1.5%). *Salmonella enteritidis* was detected in 29 patients (80.5%), whereas *Salmonella typhimurium* was detected in 3 patients (8.3%). In addition, *Shigella sonnei* was identified in 63 patients (81.8%) and *Shigella flexneri* in 8 patients (10.3%). In contrast to ceftriaxone susceptibility in *Salmonella strains*, 9.1% of *Shigella strains* were found to be resistant to ceftriaxone. Ciprofloxacin resistance was found in 5.6% and 1.3% strains of *Salmonella* and *Shigella* spp. respectively. Although the ampicillin resistance values of 2 strains were close, trimethoprim-sulfamethoxazole (TMP) resistance was found in 89.6% *Shigella strains*.

Conclusion: *Salmonella* and *Shigella* are common bacterial pathogens. Resistance patterns must be known to select the most effective treatment. According to our study, ceftriaxone and ciprofloxacin appear to be the first choice of empirical treatment for acute bacterial gastroenteritis. Additionally, if the resistance states of ampicillin and TMP are known, these drugs can also be used as empirical treatment. *(J Pediatr Inf 2015; 9: 102-7)*

Keywords: Acute gastroenteritis, antibiotic resistance, child, *Salmonella* spp., *Shigella* spp.

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Introduction

Acute gastroenteritis is an important cause of morbidity and mortality for children especially in developing countries. It is known that nearly four million children die annually in these countries (1). While children under five years of age are more commonly affected, 80% of deaths occur in children under two years of age (2). Acute gastroenteritis cases are mostly infection-related. Bacteria, viruses and parasites are the gastroenteritis pathogens (3). *Escherichia coli*, *Salmonella* spp. and *Shigella* spp. are most prevalent bacterial pathogens causing gastroenteritis. *Salmonella* and *Shigella* are the significant causes of acute gastroenteritis (4). Infection occurs through the oral intake of contaminated water and foods. Furthermore, hygiene conditions and insufficiencies in sanitation implementations also pave the way for acute gastroenteri-

tis. Although clinical recovery is enabled through rehydration treatment in acute gastroenteritis cases except the invasive diseases, antibiotic treatment is also significant in some special instances. However, today antimicrobial resistance has turned into an important health problem. Therefore, it is beneficial for the health services to know gastroenteritis pathogens and antimicrobial susceptibility (5). In the period that started with the summer of 2014, many more *Salmonella* and *Shigella* gastroenteritis cases than normal season have occurred in our service area. The sudden increase in the number of cases has shown that there is a local epidemic. In this study we aimed to report the features of the isolates obtained and their antibiotic susceptibility; and to compare the isolates obtained in previous studies and their antibiotic susceptibility.

Material and Methods

Patients aged 0-18 years who were admitted to pediatric clinics and emergency services due to the diagnosis of acute gastroenteritis with story of shorter than 15 days and were followed up with an early diagnosis of acute gastroenteritis on outpatient or inpatient basis Between July and September 2014, were investigated retrospectively. Following the microscopic examination of the patients' stools upon their admittance, MacConkey agar and Salmonella Shigella (SS) agar were planted on sheep blood agar through lobed metal loops. Plates were incubated for 24 hours in an incubator. The colonies that were lactose negative in the medium were examined with the early diagnosis of *Salmonella* and Shigella. For this purpose, (1) TSI medium (Triple Sugar Iron) (three-sugared iron agar), (2) LIA medium (Lysine Iron Agar) (lysine-iron agar), (3) Crystensen ure agar medium, (4) Simon's sitrat agar medium, (5) MIO (motility-indol-ornithine) movement mediums were used. Mediums were incubated for 18 hours in the incubators and afterwards were evaluated for biochemical definition. The colonies thought to be salmonella were applied the Salmonella polyvalent-O-antiserum and were spared for type determination when agglutination grew. Type determination in *Salmonella* strains was done with the automatized Phoenix (Becton Dickinson, New Jersey, ABD) device. The colonies suspected to have *Shigella* were removed from TSI medium and suspended on a lamina. They were compared with antiserums and those giving out agglutination were defined as *Shigella*. Type determination was done by using the antiserums to be used for *S. sonnei* and *S. flexneri*. Sufficient amount of blood samples were planted on the BACTEC medium for culture. The strains diagnosed with Salmonella and Shigellatype bacteria were subjected to antimicrobial susceptibility test via the Kirby - Bauer disk diffusion method. Susceptibility was investigated by Ampicillin (10 µg), chloramphenicol (30 µg), tetracycline (30 µg), streptomycin (10 µg), TMP (25 µg), ciprofloxacin (5 µg), cefixime (15 µg), ceftriaxone (30 µg**)** disks. The zones around the disks were measured and grouped as susceptible and resistant according to the CLSI (Clinical and Laboratory Standards Institute) chart. Stool microscopy, stool culture, antimicrobial susceptibility test results and clinic information of the patients were obtained from the record files. Data of the patients were evaluated with the SPSS program.

Results

A total of 2425 patients were admitted because of acute gastroenteritis. Given the *Salmonella* spp. and *Shigella* spp. growth in the stool and blood cultures of children in their clinic information, a total of 113 children were included in the study. Children were aged 91.5±60.3 months (4-213 months). Of the 113 patients, 56% were male and 44% were female. While 17 children (15.1%) were two years old and below, eight children were one year old (7.1%) or younger. While culture growth was detected in 96.5% of the stools, they were found 3.5% in blood. Four patients who had growth in their blood did not have any growth in their stool culture. When the pathogens were examined, it was found that *Shigella* spp. grew in 77 (3.2%) patients and *Salmonella* spp. in 36 (1.5%) patients. 16 of the children (44%) in whom Salmonella grew, were female and 20 (56%) male. Regarding Salmonella infections that were subjected to typing, in 29 patients (80.5%), *S. enteritis* was the pathogen and in 3 patients (8.3%) *S. typhimurium* was the pathogen. No typing was done for the remaining four (11.2%) strains. Regarding Shigella infections that were subjected to typing, it was found that in 63 patients (81.1%) and *S. sonnei* was the pathogen, in 8 patients (10.3%), *S. flexneri* was the pathogen; and no typing was done for the remaining six (7.8%%) strains. Table I and Table II illustrate the antibiotic resistance in *Salmonella* and *Shigella* gastroenteritis.

When the resistance of *Salmonella* strains were compared in relation to serogroups, while the resistance of *S. typhimurium* to ampicillin (p=0.004), chloramphenicol (p=0.006), ciprofloxacin (p=0.006), tetracycline (p=0.017) and trimethoprim-sulfamethoxazole (TMP) (p=0.002) was statistically more significant than *S. enteritis*, no significant difference was found between the two strains in the resistance of streptomycin (p=0.501). When the antibiotic resistance of *Shigella* strains were compared in relation to serogroups, while TMP resistance (p=0.004) of *S. sonnei* was statistically higher than *S. flexneri*, no difference was found between the resistances of ampicillin (p=0.072), cefixime (p=1.00), ceftriaxone (p=0.538), streptomycin (p=0.722) and tetracycline (p=0.097).

Discussion

Acute gastroenteritis is one of the most prevalent childhood diseases. Salmonella and Shigella are the bacterial gastroenteritis pathogens causing significant morbidity and mortality. These infections cause clinical and epidemiological problems especially in developing countries (6). Salmonella may cause enteric fever, gastroenteritis, bacteremia, local infections and different clinical conditions such as asymptomatic carriage. Except some special circumstances, it usually generates a self-limiting disease table. It has been reported that annually 1,4 million Salmonella infection is seen in the United States, 15,000 of those cases are hospitalized and nearly 400 cases result in mortality (7). 3.3-8.4% *Salmonella* spp. was efficiently isolated from the samples from the pediatric patients who were admitted to the hospitals due to gastroenteritis in our country (8, 9). *Salmonella typhimurium* and *S. enteritis* are the most prevalently isolated types in our country as well as in the world. When the *Salmonella* strains are examined in the studies carried out, it is seen that the following were found as the pathogens: Keşli et al. (8) 52.4% *S. enteritis,* 43.9% *S. typhimurium*, Gülmez et al. (9) 61.4% *S. enteritis* and 6.4% *S. typhimurium* and Erdem et al. (10) 47.7% *S. enteritis*. In our study, *S. enteritis* was the most prevalent strain.

Shigella is also another pathogen of bacterial gastroenteritis. It may cause clinic conditions such as nausea, vomiting, watery diarrhea and bloody diarrhea. Shigella gastroenteritis is seen in 165 million cases all over the world. Furthermore, it causes mortality in one million cases (11). In our country, *Shigella* spp. has been shown 3.2-15.6% to be the pathogen in the samples taken from the patients admitted due to pediatric gastroenteritis cases (8, 9). In the United States, the most prevalent pathogens were *S. sonnei* (>75%) followed by *S. flexneri* (12). There have been some regional differences in our country; while *S. flexneri* was the most prevalently isolated type in 1990s, *S. sonnei* has recently been reported to have a higher rate in comparison to other types (9). In previous studies, the following were found as the pathogens: Altun et al. (13) *S. sonnei* 87% and *S. flexneri* 11.4%, Gülmez et al. (9) *S. sonnei* 55.6% and *S. flexneri* 33.3%. In our study, we found that *S. sonnei* was 81.8% and *S. flexneri* 10.3%.

Today, antimicrobial resistance is an important problem. It was reported that some *Salmonella* and *Shigella* strains were resistant to chloramphenicol, ampicillin, TMP and sulfonamides. This particular result required the use of antimicrobial agents such as fluoroquinons and third generation cephalosporin which were controversial (14). Full resistance of *Salmonella typhi* and *S. paratyphi* to fluoroquiadones is not now prevalently seen, it has been increasing all over the world. It was reported in India, Korea and Nepal that Full resistance to fluoroquiadones rose from 0% to 13% (15). It was found that while ciprofloxacin resistance of *S. typhi* and *S. paratyphi A* in Nepal between 1998-2002 was 1.6% and 3.9% respectively, it rose to 10.6% and 14.3% between 2008-2011 (16). In the studies done in our country, it has been revealed that ampicillin resistance was the most prevalent in *Salmonella* strains. Table III illustrates the studies done in Turkey (8, 9, 17-20).

Antibiotic susceptibility tests play a crucial role in the management of Shigella infections. In many geographic regions today, increased antibiotic resistance has been reported (21). In the United States, nearly 35% ampicillin and 67% TMP resistance is seen (15). According to the 2011 data of the National Antimicrobial Resistance Monitoring System, while 97% resistance was detected for ceftriaxone, azithromycin and ciprofloxacin, 34% ampicillin and 67% TMP resistance was found (15). The resistance pattern of the *Shigella* strains found in the studies done

Table 1. Antibiotic resistance of *Salmonella* and *Shigella* infections

	Salmonella **n=36 (%)**	***Shigella*** **n=77 (%)**
AMP	7 (19.4%)	13 (16.9%)
C	2 (5.6%)	0 (0%)
CİP	2 (5.6%)	1 (1.3%)
STR	7 (19.4%)	32 (41.6%)
SFK	0 (0%)	6 (7.8%)
SFT	0 (0%)	7 (9.1%)
TET	10 (27.8%)	24 (31.2%)
TMP	6 (16.8%)	69 (89.6%)

AMP: Ampicillin; C: Chloramphenicol; CİP: Ciprofloxacin; STR: Streptomycin; SFK: Cefixime; SFT: Ceftriaxone; TET: Tetracycline; TMP: Trimethoprim-Sulfamethoxazole

Table 2. Antibiotic resistance of *Salmonella* and *Shigella* strains

	S. enteritidis **n=29 (%)**	***S. typhimurium*** **n=3 (%)**	***S. flexneri*** **n=8 (%)**	***S. sonnei*** **n=63 (%)**
AMP	3 (10.3%)	3 (100%)	3 (37.5%)	8 (12.7%)
C	0 (0%)	2 (66.7%)	0 (0%)	0 (0%)
CİP	0 (0%)	2 (66.7%)	0 (0%)	1 (1.6%)
STR	5 (17.2%)	1 (33.3%)	4 (50%)	27 (42.9%)
SFK	0 (0%)	0 (0%)	0 (0%)	4 (6.3%)
SFT	0 (0%)	0 (0%)	1 (12.5%)	6 (9.5%)
TET	6 (20.7%)	3 (100%)	5 (62.5%)	17 (27%)
TMP	0 (0%)	3 (100%)	5 (62.5%)	62 (98.4%)

AMP: Ampicillin; C: Chloramphenicol; CİP: Ciprofloxacin; STR: Streptomycin; SFK: Cefixime; SFT: Ceftriaxone; TET: Tetracycline; TMP: Trimethoprim-Sulfamethoxazole

Table 3. Antibiotic resistance distribution pattern of the *Salmonella* types in our country

	AMP	C	CİP	SFX	SFK	SFT	TET	TMP
Keşli et al. (8)	%62.6	%60.7	3.1%		56.4%	49.4%	8.3%	3.4%
Gülmez et al. (9)	11.7%	3.7%	3.5%					5.8%
Baysallar et al. (17)	48.4%	29.5%	4%	11.3%			83.5%	36%
Eşel et al. (18)	68%	62%	0%			0%		0%
Şenses et al. (19)	48%			4.8%			33.3%	4.8%
Gündüz et al. (20)	27%	30%	0%					25%

AMP: Ampicillin; C: Chloramphenicol; CİP: Ciprofloxacin; STR: Streptomycin; SFK: Cefixime; SFT: Ceftriaxone; TET: Tetracycline; TMP: Trimethoprim-Sulfamethoxazole

Table 4. Antibiotic resistance distribution pattern of the *Shigella* types in our country

	AMP	C	CİP	STR	SFT	SFX	TET	TMP
Keşli et al. (8)	76.2%	85.7%	11.1%		9.5%		41.3%	11.1%
Gülmez et al. (9)	58.8%	18.8%	5.6%					72.2%
Altun et al. (13)	24.3%		0%			3.6%		74.2%
Çiftçi et al. (22)	63.7%	8.9%	4%				12.3%	23.3%
Akçalı et al. (23)	20%	3.3%	0%	76.6%	0%		66.6%	70%
Alıcı et al. (24)	19.1%		0%			0.8%		79.1%

AMP: ampicillin; C: chloramphenicol; CİP: ciprofloxacin; STR: streptomycin; SFK: cefixime; SFT: ceftriaxone; TET: tetracycline; TMP: trimethoprim-sulfamethoxazole

our country is shown in Table IV (8,9,13,22-24). It is seen that the highest one was ampicillin and TMP resistance.

In the study carried out in 2001 by İnce et al. from our clinic, it was found that in *Salmonella* gastroenteritis *S. enteritidis* was 68.2 %, *S. typhimurium* 17.1% and *S. paratyphi B* 7.3%; in *Shigella* gastroenteritis, 92.4% *S. sonnei* and 7.6 % *S. flexneri* were the pathogens (25). In our study, it was found that in *Salmonella* strains, 80,5% *S. enteritis* and 8.3% *S. typhimurium* and in *Shigella* strains 81.8% *S. sonnei* and 10.3% *S. flexneri* were the pathogens. The antibiotic resistance found in the two studies done in our clinic is illustrated in Table 5 (25). While no ciprofloxacin resistance was seen in the *Salmonella* strains in 2001, a new developing resistance was found in our study. The fact that no ceftriaxone resistance was found in both studies supports the view that ceftriaxone could be used as the first option in the empirical treatment of Salmonella gastroenteritis; and in addition, ampicillin and TMP treatments could be given if the resistance status was known. In *Shigella* gastroenteritis, on the other hand, it was revealed from the results obtained that ceftriaxone and ciprofloxacin could be used in the empirical treatment; and in addition, ampicillin and TMP treatments could be given if the resistance status was known. Furthermore, the increased ceftriaxone resistance in the *Shigella* strains is noticeable.

Although antimicrobial susceptibility among the Shigella types is different, this difference may vary from region to region depending on the empirical antibiotics. Their ability to develop resistance to A*mpisilin*, TMP and nalidixic acid has restricted their use in empirical treatment in dysentery (26). Instead of these drugs, ceftriaxone, azithromycin and ciprofloxacin are used in empirical treatment. However, it has been reported recently that resistance has increasingly been developing against these groups of drugs especially in Asia (27). When compared with the third generation ciprofloxacin resistance in *Shigella* types seen in Europe-Amerika and Asia-Africa between 1998-2012, it was revealed that the resistance in Asia-Africa was higher. Ceftriaxone, cefotaxime and ceftazidime resistance gradually increased between 2010-2012, it was found 14.2%, 22.6% and 6.2% respectively. However, these rates in Europe and America in the last 15 years have been less than 1%. Increased resistance has been reported especially for *S. sonnei* (28).

Shigella types carrying SHV, TEM, CTX-M type extended spectrum beta-lactamase (ESBL) enzymes have been reported. Furthermore, bacteria inclusive of OXA, AmpC and metallo-beta- lactamase have been defined and they are claimed to be responsible for the resistance of ceftriaxone (29). In the studies done in our country, the rate of 3.6-9.5% third generation cephalosporin resistance was found in *Shigella* types (8, 13). In our study, we found 9.1% ceftriaxone resistance in *Shigella* strains and also observed that this rate increased over time. The emerging result constitutes a significant risk for the likely bacteria in the future due to the transfer of especially the resistant gens amongst the bacteria.

Table 5. Results of the two studies done in our clinic

	Salmonella (2001)	*Salmonella* (2014)	*Shigella* (2001)	*Shigella* (2014)
AMP	23%	19.4%	18.1%	16.9%
C	14%	5.6%	8.3%	0%
CİP	0%	5.6%	0%	1.3%
STR	16%	19.4%	93.9%	41.6%
SFK	5%	0%	0%	7.8%
SFT	0%	0%	0%	9.1%
TET	16%	27.8%	82.5%	31.2%
TMP	9%	16.8%	69.6%	89.6%

AMP: Ampicillin; C: Chloramphenicol; CİP: Ciprofloxacin; STR: Streptomycin; SFK: Cefixime; SFT: Ceftriaxone; TET: Tetracycline; TMP: Trimethoprim-Sulfamethoxazole

Conclusion

Salmonella and *Shigella* are the prevalent bacterial pathogens and it is important to know the resistance patterns in order to implement their therapies efficiently. It will be enlightening to determine the local resistance status and know the changing resistance patterns. Consequently, antibiotic appropriate with the antibiogram of the patient should be given without any generalization in the treatment; thus, efficient treatment will have been ensured. In our study, it was revealed that in the treatment of acute bacterial gastroenteritis, TMP and ampicillin were no longer the first choice in treatment and instead ceftriaxone and ciprofloxacin could be used.

Ethics Committee Approval: There is no ethical committee approval because of this study aims to get the antibiogram results of the patients with *Salmonella* and *Shigella* increase and its evaluation.

Informed Consent: Written informed consent was not obtained from patients due to the retrospective nature of this study.

Peer-review: Externally peer-reviewed.

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References

1. Bern C, Martines J, de Zoysa I, Glass RI. The magnitude of the global problem of diarrhoeal disease: a ten-year update. Bull World Health Organ 1992; 70: 705-14.
2. Carlos CC, Saniel MC. Etiology and epidemiology of diarrhea. Phillips J Microbio Infect Dis 1990; 19: 51-3.
3. Samie A, Guerrant RL, Barrett L, Bessong PO, Igumbor EO, Obi CL. Prevalence of intestinal parasitic and bacterial pathogens in diarrhoeal and non-diarroeal human stools from Vhembe district, South Africa. J Health Popul Nutr 2009; 27: 739-45.
4. Wolf MK, Taylor DN, Boedeker EC, et al. Characterization of enterotoxigenic Escherichia coli isolated from US troops deployed to the Middle East. J Clin Microbiol 1993; 31: 851-6.
5. Rathaur VK, Pathania M, Jayara A, Yadav N. Clinical study of acute childhood diarrhoea caused by bacterial enteropathogens. J Clin Diagn Res 2014; 8: 1-5.
6. Fhogartaigh CN, Edgeworth JD. Bacterial gastroenteritis. Medicine 2009; 37: 586-93. [CrossRef]
7. Voetsch AC, Van Gilder TJ, Angulo FJ, et al. FoodNet estimate of the burden of illness caused by nontyphoidal Salmonella infections in the United States. Clin Infect Dis 2004; 38: 127-34. [CrossRef]
8. Keşli R, Bilgin H, Pirgon Ö, Feyzioğlu B, Güzelant A. Çocuklarda son üç yılda gaita örneklerinden izole edilen Salmonella ve Shigella suşlarının antimikrobik direncinin araştırılması (2008-2011). Türk Mikrobiyol Cem Derg 2012; 42: 66-72.
9. Gülmez D, Gür D, Hasçelik G, Güleşen R, Levent B. Ulusal enterik patojenler laboratuvar sürveyans ağına (uepla) dahil olan bir üniversite hastanesinin deneyimleri: dört yıllık Salmonella, Shigella ve Campylobacter verileri. Türk Mikrobiyol Cem Derg 2012; 42: 85-92.
10. Erdem B, Hasçelik G, Gedikoğlu S, et al. Salmonella enterica serotypes and Salmonella infections: a multicenter study covering ten provinces in Turkey. Mikrobiyol Bul 2004; 38: 173-86.
11. Kotloff KL, Winickoff JP, Ivanoff B, et al. Global burden of Shigella infections: implications for vaccine development and implementation of control strategies. Bull World Health Organ 1999; 77: 651-66.
12. Kolavic SA, Kimura A, Simons SL, Slutsker L, Barth S, Haley CE. An outbreak of Shigella dysenteriae type 2 among laboratory workers due to intentional food contamination. JAMA 1997; 278: 396-8. [CrossRef]
13. Altun B, Gür D. Hacettepe Üniversitesi İhsan Doğramacı Çocuk Hastanesinde 1999-2000 yılları arasında dışkı örneklerinden izole edilen Shigella türlerinin antibiyotiklere direnç profilleri. Mikrobiyol Bul 2011; 45: 609-16.
14. Rowe B, Ward LR, Threlfall EJ. Multidrug-resistant Salmonella typhi: a worldwide epidemic. Clin Infect Dis 1997; 24: 106-9. [CrossRef]
15. Centers for Disease Control and Prevention (CDC). National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS): Human Isolates Final Report, 2009. Atlanta, Georgia: US Department of Health and Human Services; 2010.

16. Parry CM, Threlfall EJ. Antimicrobial resistance in typhoidal and nontyphoidal salmonellae. Curr Opin Infect Dis 2008; 21: 531-8. [CrossRef]
17. Baysallar M, Küçükkaraaslan A, Albay A, Başustaoğlu AC, Gün H. Dışkı ve kan örneklerinden izole edilen Salmonella serotiplerinin insidansı ve çoklu antibiyotik diren¬ci. Klimik Dergisi 1995; 8: 32-5.
18. Eşel D, Telli M, Sümerkan B, Karaca N, Aygen B. Antimicrobial resistance among clinical isolates of Salmonella spp. in Kayseri. Infek Derg 2002; 16: 335-7.
19. Şenses Z, Baysallar M, Aydoğan H, Güçlü AÜ, Doğancı L. Kan ve dışkı örneklerinden izole edilen Salmonella ve Shigella izotlarının antibiyotik dirençleri. Gülhane Tıp Dergisi 2007; 49: 141-6.
20. Gündüz T, Tünger Ö, Sürücüoğlu S, Özbakkaloğlu B. Manisa bölgesinde soyutlanan Salmonella ve Shigella suşlarının antibiyotiklere duyarlılıkları. Türk Mikrobiyol Cem Derg 2002; 32: 216-9.
21. Shiferaw B, Solghan S, Palmer A, et al. Antimicrobial susceptibility patterns of Shigella isolates in Foodborne Diseases Active Surveillance Network (FoodNet) sites, 2000-2010. Clin Infect Dis 2012; 54: 458-63. [CrossRef]
22. Çiftçi İH, Aktepe OC, Altındiş M, Çetinkaya Z, Aşık G, Çalışkan K. Shigella türlerinde antimikrobiyal direnç değişimi: Sekiz yıllık izlem. Türk Mikrobiyol Cem Derg 2010; 40: 125-30.
23. Akçalı A, Levent B, Akbaş E, Esen B. Türkiye'nin bazı illerinde izole edilen Shigella sonnei suşlarının antimikrobiyal direnç ve "Pulsed Field" jel elektroforezi yöntemleri ile tiplendirilmesi. Mikrobiyol Bul 2008; 42: 563-72.
24. Alıcı Ö, Açıkgöz ZC, Gamberzade Ş, Göçer S, Karahocagil MK. Dışkı kültürlerinden 1999-2003 yılları arasında izole edilen Shigella türleri ve antibiyotiklere direnç oranları. Mikrobiyol Bült 2006; 40: 9-14.
25. İnce E. Çocukluk çağı akut gastroenteritlerinde Salmonella (Non Tifoidal Salmonella) ve Shigella sıklığı, antibiyotik direnci ve serotiplendirme tez çalışması (Uzmanlık Tezi). Ankara Üniv. 2001.
26. World Health Organization. Guidelines for the control of shigellosis, including epidemics due to Shigella dysenteriae Type 1; 2005. Available from: URL: (http://www.who.int/maternal_child_adolescent/documents/9241592330/en/,2005)
27. Rahman M, Shoma S, Rashid H, et al. Increasing spectrum in antimicrobial resistance of Shigella isolates in Bangladesh: Resistance to azithromycin and ceftriaxone and decreased susceptibility to ciprofloxacin. J Health Popul Nutr 2007; 25: 158-67.
28. Gu B, Zhou M, Ke X, et al. Comparison of resistance to third-generation cephalosporins in Shigella between Europe-America and Asia-Africa from 1998 to 2012. Epidemiol Infect 2015; 2: 1-13. [CrossRef]
29. Zhang R, Zhou HW, Cai JC, et al. Serotypes and extended-spectrum beta-lactamase types of clinical isolates of Shigella spp. from the Zhejiang province of China. Diagn Microbiol Infect Dis 2011; 69: 98-104. [CrossRef]