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Original Article

Epidemiology and Antimicrobial Resistance of Enteric Pathogens in Dhahira Region, Oman

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Abstract

Background: We reviewed the monthly laboratory surveillance reports and hospital laboratory database in Dhahira region, Oman.

Methods: All patients for whom a stool sample examination request was made from 1st January 2002 to 31st December 2006 (5 years) were included in the study. Antimicrobial resistance pattern was studied for 2 years period. The cultures were done using standard laboratory procedures and antibiotic sensitivity by Kirby Bauer disc diffusion method.

Results: Of the 85,210 stool samples examined, 18% showed positive result for one or more parasitic infection. The most common were *E. hystolytica* (7.1%), *Giardia* (7.9%) and *E. coli* (1.9%). A total of 7,830 cultures were done, among them 11.4% showed positive result for bacterial pathogen. The most common were *Salmonella* (5.8%) and *Shigella* species (4.4%). The antimicrobial susceptibility patterns of 265 bacterial pathogens were analyzed. Of the *Shigella* strains, 71.8% were resistant to trimethoprim/sulphamethoxazole (SXT) and 39.4% to ampicillin and 32.4% to tetracycline. *Salmonella* and *E. coli* strains were frequently resistant to ampicillin (12.5% and 47.7%, respectively)

Conclusion: This study provides important information on the prevalence and antimicrobial resistance pattern of enteric pathogens in Dhahira region population. SXT, ampicillin, and tetracycline are the drugs commonly associated with resistance.

Keywords: *Enteric pathogens, Antimicrobial resistance, Oman*

Introduction

Gastro-enteritis is a major public health problem in the world especially among developing countries. Diarrhea is one of the leading causes of mortality and morbidity in developing countries (1, 2). An estimated 1000 million diarrheic episodes (2.6 episodes per child per year) and 3.3 million deaths per year (range, 1.5-5.1 million per year) occur each year in children < 5 yr of age globally (1). Currently, with the widespread use of oral rehydration therapy strategies, diarrheal disease deaths have declined substantially in the developing world (3).

There has been a marked decline in diarrhea related mortality as well as morbidity in Oman, ever since the introduction of Control of Diarrheal Diseases (CDD) in 1985 which is now incorporated in the Integrated Management of Childhood Illnesses (IMCI) programme. Apart from oral rehydration therapy, general socio-economic development, improvement in environmental sanitation, safe water and health education also contributed to this decrease in Oman (4). Al Dhahira region has 207,015 inhabitants with 10.38% of them belong to < 5 yr of age (Census 2003). In Dhahira region, the incidence of diarrhoeal diseases in the year 2004 was 285 episodes per 1000< 5 yr children (5).

The main etiology of the diarrhea is related to a wide range of bacteria (such as, *Shigella* spp., *Salmonella* spp., *E. coli* and *Vibrio cholerae*) entero-parasites (*Giardia* spp. and *Entamoeba histolytica*), and viruses (Rotavirus, Adenovirus and Norwalk virus) (6, 7). In industrialized countries, rotavirus predominates and bacteria are commonly found in children from developing countries (8). The prevalence of *Shigella* and *Salmonella* was 10.6 and 2.1% respectively among children in Dhahira region, Oman (9).

The gradual increase in antimicrobial resistance among enteric pathogens especially in developing countries is a cause of concern. Over the past

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several decades, *Salmonella*, *Shigella*, *Vibrio cholerae* and *Campylobacter* spp. have progressively become resistant to most of the widely used and inexpensive antimicrobials (10).

In Dhahira region, most health institutions (especially primary health centers) where advanced laboratory facilities are limited, antibiotics are often used for empirical treatment of *Salmonella* and *Shigella* infections before a laboratory confirmation is made. The incidence and antibacterial resistance among enteric pathogens among populations may vary. Surveillance and antimicrobial resistance data is critical to draw conclusions about the epidemiology and resistance of enteric pathogens in this region. The epidemiology and resistance pattern among the enteric pathogens is scantily documented in Dhahira region, hence, this study sought to explore the epidemiology and antimicrobial resistance of important enteric pathogens in Dhahira region, Oman.

Materials and Methods

The health services in Dhahira region is a well defined, fully integrated government health system that provides virtually most medical care to the 207,015 residents. There is a universal coverage of healthcare services including laboratory tests in the region. There are two major hospitals (IRRH- Ibri Regional Referral Hospital and BWH- Buraimi Wilayat Hospital) with a network of 17 other primary health care facilities in the region. The culture facility is available in these two major hospitals. This is a hospital-laboratory record based study. All patients with the complaint of gastroenteritis for whom a stool sample examination request is made from 1st January 2002 to 31st December 2006 (5 yr) were included in the study. Antimicrobial resistance pattern for isolates was studied for 2 yr period. (1st March 2004-28th February 2006 in IRRH; 1st March 2005-28th February 2007 in BWH). This period was chosen because of the availability of the Health Information Management System (HIMS) database during that period. Physicians order stool tests based on the patient's presenting symptoms typically of a diarrhoeal illness. Samples for cultures referred from other primary care health institutions in the region are also being processed in these two hospitals. Stool samples were collected before antibiotic administration and bacterial cultures was done by applying standard microbiology laboratory method. Positive patient's information on age, gender, bacterial result and antibiotic resistance details was obtained from the HIMS at the two hospitals.

Laboratory procedure

The stool specimens were collected directly by patients in wide necked containers. A macroscopic examination was done upon receiving the sample. All the specimens were subjected to microscopic examination in saline and iodine preparation for pus, red blood cells, trophozoites, ova, cysts etc. Motility test and gram stained smears were examined in cases where Cholera was suspected.

The samples were cultured using standard microbiology techniques to observe *Salmonella-Shigella* and *V. cholerae* colonies (11).

Antibiotic sensitivity was done by Kirby Bauer disc diffusion method using Diagnostic Sensitivity Test (DST) agar (Mast Diagnostics, Merseyside, UK) as per the recommendation of National Committee for Clinical Laboratory Standards (NCCLS) (12).

We tested the following antibiotic discs; trimethoprim/sulphamethoxazole (co-trimoxazole), ampicillin, sulphamethoxazole, tetracycline, erythromycin, chloramphenicol, amoxicillin/clavulanic acid, cephalothin, nalidixic acid, gentamycin, cefuroxime, cefotaxime, ciprofloxacin, ceftazidime, ceftrioxone. The results were recorded as either sensitive or resistant in this study.

The data were collected in a pre-tested laboratory surveillance monthly performa and hospital database (HIMS). The data was computed and analyzed using Statistical Package for Social Sciences (SPSS version 9). Frequencies and proportions in categorical data were calculated. Appropriate 95% Confidence Intervals (CI) were calculated for prevalence proportional data.

Results

As shown in Table 1, a total of 85,210 stool samples were examined for microscopy in Dhahira region during the year 2002 to 2006. Approximately 18% of the total samples examined showed positive result for one or more parasitic infection; among them the most common laboratory isolations were *E. hystolytica/E. dispar* (7.1%), *G. lamblia* (7.9%) and *E. coli* (1.9%) followed by *Trichomonas* (0.6%), *Hymenolepiasis nana* (0.2%), roundworm (0.1%). Less commonly (0.1%), *Enterobius vermicularis*, *Trichuris trichiura, Tinea* spp. and hookworm were isolated.

A total of 7,830 cultures were done during the year 2002 to 2006, among them 11.4% showed positive result for a bacterial pathogen. *Salmonella* (5.8%) and *Shigella* species (4.4%) were the common enteric bacterial pathogens isolated. Less commonly (1.2%) include *Aeromonas hydrophila*, *E. coli*, *V. cholerae*, *Klebsiella*, *Pseudomonas* and *Plesiomonas shigelloides* (Table 2).

Fig. 1 shows the seasonal pattern of the more frequent organisms such as *E. hisolytica*, *Giardia*, *E. coli*, *Shigella* and *Salmonella* species (94.3%). A high prevalence of infection was seen in the month of March, April and July which correspond to the summer months (March-August) in Dhahira region. The prevalence was at its peak in the early summer month of March (12.6%).

Antibiotic resistance

A total of 265 isolated enteric bacteria from the stool samples that were tested for antimicrobial sensitivity for 2 yr period were analyzed. The median age of the patients was 3 yr (range, 1 month to 84 yr). The mean age was 12.3 with a wide Standard Deviation (SD)±17.5. Table 3 depicts the various characteristics of the bacterial isolates tested for antimicrobial sensitivity in Dhahira region. Approximately 63% of the cases were from IRRH which caters the 3 of the 5 Wilayats (districts) population in Dhahira region. Majority of the patients (58.5%) were < 5 yr and males (52.5%). Consequently, more samples were sent to the laboratory from Pediatrics department (59.6%). Majority of the isolates were *Salmonella* spp. (42.3%) followed by *Shigella* spp. (26.8%) and *E. coli* (24.5%). *S. flexneri* (49.3%) was the common species tested for antibacterial sensitivity among the *Shigella* species. Likewise *Salmonella* group B (31.3%) was the common group among the *Salmonella* strains.

Table 4 depicts the age distribution and common bacterial pathogens isolated. Nearly 94% (248/265) of the isolates were *Salmonella* spp, *Shigella* spp. and *E. coli* during 2 yr period. *Salmonella* spp. was the main enteric pathogen, both in younger and older children, whereas *Shigella* spp. was the most frequent pathogen isolated from the stools of children between 5-14 and individuals over 15 yr old. *E. coli* was less common (26.2%) in our study, notably occurring only in children between 1 and 4 yr old.

The antibiotic resistance of 71 strains of *Shigella*, 112 strains of *Salmonella* and 65 strains of *E. coli* that comprised 94% of the enteric bacterial pathogens are shown in Table 5. In total, the most frequent patterns of resistance were exhibited towards trimethoprim/sulphamethoxazole, ampicillin and tetracycline in that order. The ceftrioxone, cefotaxime, ciprofloxacin were least resistant to any of the bacterial pathogens and there was nil resistance to ceftrioxone. Of the *Shigella* strains, 71.8% were resistant to trimethoprim/ sulphamethoxazole, 39.4% were resistant to ampicillin, 32.4% to tetracycline and 19.7% to chloramphenicol. *Salmonella* strains were more commonly resistant to ampicillin (12.5%), trimethoprim/sulphamethoxazole (11.6%), tetracycline (6.3%) and chloramphenicol (3.6%). Low resistance rates were found to ceftrioxone, cefotaxime and ciprofloxacin among *Shigella* and *Salmonella* strains. The resistance pattern of different strains of *Shigella* and *Salmonella* were more or less similar. *E. coli* were frequently resistant to ampicillin (47.7%) and trimethoprim/ sulphamethoxazole (41.5%).

Nalidixic acid resistance was shown only by *S. flexneri* among *Shigella* spp.

Salmonella spp. demonstrated a lower frequency of resistance to ampicillin and trimethoprim/sulphame-

methoxazole compared with *Shigella* spp. and *E. coli*. Resistant to chloramphenicol and tetracycline was higher among *Shigella* spp. than *Salmonella* and *E. coli*. Ampicillin resistance was more commonly associated with *E. coli* compared to *Shigella* and *Salmonella* spp.

The resistance pattern was higher for all the tested antibiotics among less than 5 yr children when compared to the individuals who were more than or equal to 5 yr except for Chloramphenicol drug (data not shown).

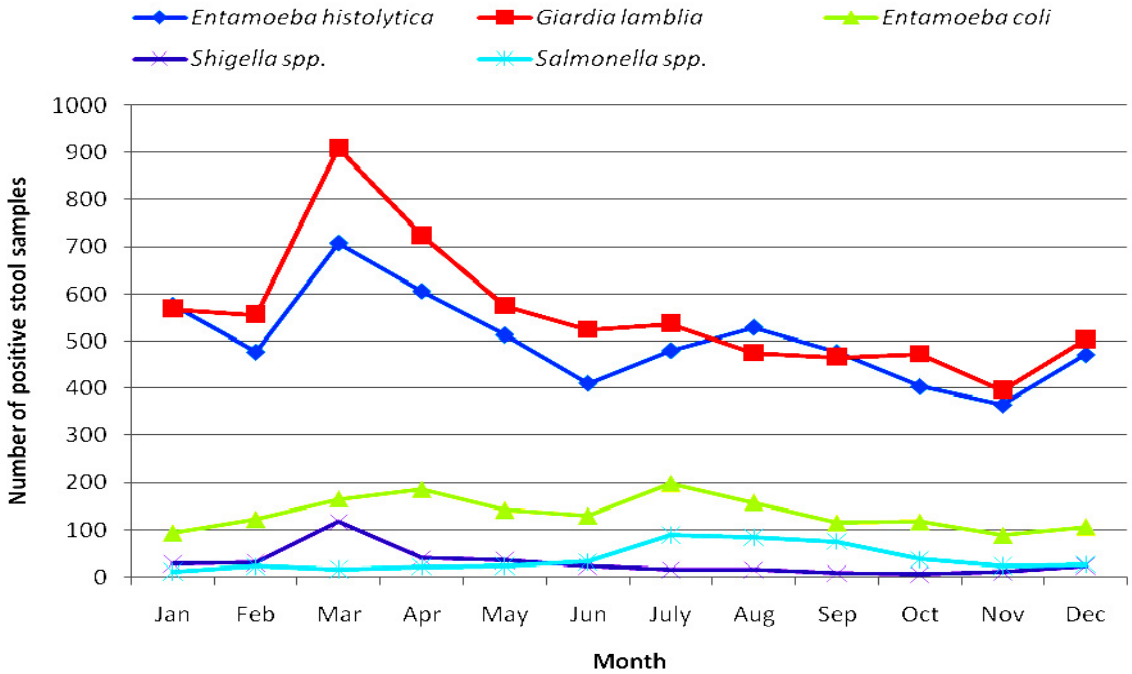

Fig. 1: Month-wise distribution of common enteric pathogens in Dhahira, Oman (2002-2006)

Table 1: Prevalence (%) of enteric parasites in Dhahira, Oman (2002-2006)

	2002	**2003**	**2004**	**2005**	**2006**	**Total**	
Total number of stool samples examined	18364	17876	14107	17056	17807	85210	CI
Total Positive	3540 (19.3)	3433(19.2)	2482(17.6)	2909(17.1)	2804(15.7)	15168(17.8)	17.5-18.0
Parasites isolated							
E. histolytica/E. dispar	1380(7.5)	1439(8.0)	941(6.7)	1085(6.4)	1169(6.6)	6014(7.1)	6.9-7.2
Giardia	1645(9.0)	1560(8.7)	1205(8.5)	1250(7.3)	1053(5.9)	6713(7.9)	7.7-8.1
Ent. coli	343(1.9)	257(1.4)	199(1.4)	370(2.2)	454(2.5)	1623(1.9)	1.8-2.0
Trichomonas	101(0.5)	106(0.6)	66(0.5)	114(0.7)	92(0.5)	479(0.6)	-
H. nana	19(0.1)	51(0.3)	26(0.2)	43(0.3)	24(0.1)	163(0.2)	-
Round worm	28 (0.2)	12 (0.1)	33 (0.2)	5 (0.0)	2(0.0)	80 (0.1)	-
E. vermicularis	10 (0.1)	4 (0.0)	3 (0.0)	28 (0.2)	3(0.0)	48 (0.1)	-
T. trichiura	9 (0.0)	2 (0.0)	4 (0.0)	3 (0.0)	1(0.0)	19 (0.0)	-
Tinea spp.	2 (0.0)	1 (0.0)	1 (0.0)	8 (0.0)	5(0.0)	17 (0.0)	-
Hook worm	3 (0.0)	1 (0.0)	4 (0.0)	3 (0.0)	1(0.0)	12 (0.0)	-

E. histolytica/ E. dispar - Entamoeba histolytica/ Entamoeba dispar, *Giardia- Giardia lamblia*, *Ent. coli -Entamoeba coli*, *H. nana - Hymenolepiasis nana*, *E. vermicularis - Enterobius vermicularis* and *T. trichiura - Trichuris trichiura*.
Note: Numbers in the parenthesis show percentage.

Table 2: Prevalence (%) of enteric bacterial pathogens in Dhahira, Oman (2002-2006)

	2002	2003	2004	2005	2006	Total	
Total cultures done	1549	1326	1022	1558	2375	7830	CI
Total Positive	194 (12.5)	195 (14.6)	103 (10.0)	178 (11.4)	227 (9.5)	897 (11.4)	10.8-12.2
Bacterial pathogens isolated							
Salmonella	65 (4.2)	59 (4.4)	62 (6.1)	111 (7.1)	159 (6.7)	456 (5.8)	5.3-6.4
Shigella	98 (6.3)	129 (9.7)	27 (2.6)	43 (2.8)	47 (2.0)	344 (4.4)	4.0-4.9
Others*	31 (2.0)	7 (0.5)	14 (1.3)	24 (1.5)	21 (0.8)	97 (1.2)	1.0-1.5

* *Aeromonas hydrophila*, *Vibrio cholerae, Escherichia coli*, *Klebsiella* spp., *Pseudomonas aeruginosa* and *Plesiomonas shigelloides*
Note: *Numbers in the parenthesis show percentage.*

Table 3: Bacterial pathogens and various characteristic groups from stool samples (2 years period) (N=265)

Group Characteristics	Isolates		95% CI
	n	%	
Hospital			
Ibri Hospital	165	62.3	-
Buraimi Hospital	100	37.7	
Referring Department			
Accident and Emergency	59	22.3	
General Medicine	42	15.8	-
Pediatrics	158	59.6	
Others	6	2.3	
Age group			
<1	59	22.3	17.7 – 27.7
1-4	96	36.2	30.7 - 42.2
5-14	27	10.2	7.1 – 14.4
15-24	33	12.4	9.0 – 17.0
≥30	50	18.9	14.6 – 24.0
Sex			
Male	139	52.5	46.4 – 58.4
Female	126	47.5	41.6 – 53.5
Bacterial Isolates			
Salmonella species	112	42.3	36.4 – 48.2
Salmonella group B	35	31.3	23.4 – 40.3
Salmonella group C	12	10.7	6.2 – 17.8
Salmonella group D	14	12.5	7.5 – 19.8
Salmonella non-groupable	51	45.5	36.6 – 54.7
Shigella species	71	26.8	21.8 – 32.4
Shigella dysenteriae	3	4.3	1.4 – 11.7
Shigella flexneri	35	49.3	38.0 – 60.6
Shigella sonnei	19	26.7	17.8 – 38.0
Shigella non-groupable	14	19.7	12.1 – 30.4
Escherichia coli	65	24.5	19.7 – 30.0
Vibrio cholerae	8	3.0	1.5 – 5.8
Others *	9	3.4	1.8 – 6.3

*****Aeromonas hydrophila*, *Klebsiella* spp., *Pseudomonas aeruginosa and Plesiomonas shigelloides*

Table 4: Distribution of common bacterial pathogens according to patients age (2 years period) (N=248)

Age (yr)	Bacterial Pathogen			Total
	***Salmonella* spp.**	***Shigella* spp.**	***Escherichia coli***	
<1	22 (40.0)	0	33 (60.0)	55 (100)
1-4	29 (31.5)	31 (33.7)	32 (34.8)	92 (100)
5-14	11 (35.3)	16 (64.7)	0	27 (100)
15-24	20 (64.2)	10 (35.8)	0	30 (100)
≥30	30 (67.7)	14 (32.3)	0	44 (100)
Total	112 (45.2)	71 (28.6)	65 (26.2)	248 (100)

Note: Numbers in the parenthesis show percentage.

Table 5: Percentage of antibiotic resistance in *Shigella* spp., *Salmonella* spp. and *E. coli* (2 years period) (N=248)

Antibiotic Tested	Bacterial Pathogen														Total (248)	
	Shigella species (N=71)						*Salmonella* species (112)						*E. coli* (65)			
	S.d	S.f	S.s	NG	Tot	%	B	C	D	NG	Tot	%	No.	%	No.	%
SXT	0	26	12	13	51	71.8	1	2	1	9	13	11.6	27	41.5	91	36.7
AMP	1	10	7	10	28	39.4	3	6	1	4	14	12.5	31	47.7	73	29.4
TCY	0	14	9	0	23	32.4	1	4	0	2	7	6.3	5	7.7	35	14.1
CHL	0	6	2	6	14	19.7	1	1	1	1	4	3.6	1	1.5	19	7.7
NAL	0	4	0	0	4	5.6	2	0	0	0	2	1.8	4	6.2	10	4.0
CTX	0	1	0	0	1	1.4	1	0	0	0	1	0.9	0	0	2	0.8
CIP	0	0	0	0	0	0	0	0	0	0	0	0	2	3.1	2	0.8
CRO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.0

Antibiotic abbreviations: SXT- Trimethoprim/Sulphamethoxazole (Co-trimoxazole), AMP- Ampicillin, TCY- Tetracycline, CHL- Chloramphenicol, NAL- Nalidixic acid, CTX- Cefotaxime, CIP- Ciprofloxacin and CRO- Ceftrioxone *Organism abbreviations:* S. d -*Shigella dysenteriae*, S. f – *Shigella flexneri* and S. s - *Shigella sonnei*, NG - Non-groupable and *E. coli* - *Escherichia coli*

Discussion

In this study 82.2% of the stool samples result was negative for any of the tested enteric bacteria (11.4%) and parasite (17.8%), which reflect the probable common etiology of viral infection (7, 13, 14). The common infections were *E. histolytica*/*E. dispar*, *Giardia*, *E. coli*, *Shigella* and *Salmonella* and the prevalence of intestinal parasites for instance, *E. histolytica*/*E. dispar*, *Giardia* and *E. coli* was marginally higher in our study (Table 1) compared to other studies conducted elsewhere (7, 14-16). A study conducted using KATO-KATZ technique among school children in Dhahira region had higher (38.7%) prevalence of intestinal parasitic infection (9). Low prevalence of other intestinal parasites indicates good general hygienic habits, better environmental sanitation and potable water in Dhahira region.

A prevalence of 11.4% bacterial pathogen isolation from stool cultures (2002 to 2006) fits in the wide range of bacterial pathogen prevalence of 4.8-45% (7, 14-19). Comparable to other studies (13, 17, 20) *Salmonella* species was the most common pathogen in our study, in contrast to studies where *Shigella* species was more common (7, 16, 19, 21).

The prevalence could be an underestimate in our study because, some of the pathogens were not tested (Viruses, *Campylobacter* and *Clostridium* spp.) and it has been reported that 11.2% of the children were given prior antibiotics before the case is referred to a referral hospital from the primary health facilities in Dhahira region (9).

Antibiotic resistance

This hospital -based records study is an effort to know the proportion and baseline antimicrobial resistance pattern of common enteric bacterial pathogens in the region for 2 yr period.

The 265 reviewed stool cultures from all age groups (1 month- 84 yr) in which enteric bacterial pathogen was detected, reveal a discretely higher prevalence in males and 1-4 yr children (the period when children contact with environmental pathogens increases considerably) similar to a study in Brazil (21).

As described earlier, *Salmonella* species was the most common pathogen in contrast to studies where *Shigella* species was more common. In our samples, *E. coli* was more frequently isolated when compared to the studies conducted in Jordan (20), but similar in New Caledonia and Djibouti (15, 22).

Shigella flexneri was the predominant sero group followed by *S. sonnei* in our study. This result is consistent with other reports from developing countries (10, 22-24). Conversely in other studies it was *S. sonnei* (18, 25) and *S. dysenteriae* (26). *Salmonella* group B was the common species in our study; however, *Salmonella* group D was the main causative agent in Indonesia (10). The group variation of *Shigella* and *Salmonella* in our study should be read cautiously because of sizable non-groupable strains reported.

The current study data indicate *E. coli* as the important causative agent of diarrhea in less than one year and *Shigella* among 1-5 yr old children. However, S*almonella* was common in all the age groups (table 4). Hence, these findings confirm the multi-susceptibility of *Salmonella*, in contrast to *Shigella* species and *E. coli* (17, 21). *Shigella* infection was nil among < 1 yr children in our study, signifying that maternal antibodies and breast-feeding may protect newborn and infants (27).

The proven relationship between summer months and isolation of enteric microorganisms (seasonal variation) was evident in our study also (17, 21), although it was common in rainy season in Manila and Lao People's Democratic Republic (7, 13).

Analogous to studies all over the world (10, 13, 17, 21, 22, 28), a high proportion of resistance to trimethoprim/sulphamethoxazole, ampicillin, tetracycline and chloramphenicol was observed among *Shigella* spp. in our study. As high as >90% resistance to trimethoprim/sulphamethoxazole have also been observed since 1995 in Thailand (29) and 73-95% resistance to ampicillin, trimethoprim/sulphamethoxazole, chloramphenicol and tetracycline in Indonesia (24). We noticed *Shigella* spp. were susceptible to ceftrioxone and ciprofloxacin like in USA (25). The *Shigella* spp. multi-resistance to ceftrioxone and ciprofloxacin is cause of concern in other countries (30). In our study, *S. flexneri* was more commonly associated with resistant to tetracycline, trimethoprim-sulphamethoxazole, chloramphenicol and ampicillin than S. sonnei and S. dysenteriae. However, the proportion of resistance was lower when compared to other studies (10, 21). We observed a low resistance (5.6%) to nalidixic acid compared to Rwandan study (23), however, the resistance shown only by S. flexneri in our study.

Similar to other studies (9, 21), the antibiotic resistance to *Salmonella* spp. was low in our study, in contrast to the Yemen study where more than two-thirds of the *Salmonella* isolates were resistant to nalidixic acid, chloramphenicol and co-trimoxazole while 42% were resistant to cefotaxime (28). Consequently, these drugs are to be used carefully in the treatment of *Salmonella* enteritis because multi-resistance is a cause of concern in developing countries (7, 10).

E. coli were commonly resistant to ampicillin and trimethoprim/sulphamethoxazole, in our study. However, the proportion was low in Brazil (21) and high in Djibouti (22).

These wide variations in the prevalence, bacterial species, and antibiotic sensitivity could be due to variation in the study methodology, agent, host and environmental factors that exists. Hence, it is important to identify the causative organism and its characteristics including the common bacterial species, presenting symptoms, antibiotic sensitivity in the vicinity to implement diagnostic norm, treatment strategy and preventive measures.

The resistance is due to a combination of a heavy burden of bacterial infectious diseases, low access to primary health care, inappropriate use of the available antimicrobial drugs, self-prescribing, availability of drugs without prescription for purchase in local pharmacies or open-air markets and the effect is compounded by a confusing array of proprietary drugs containing irrational mixtures of vitamins, stimulants, and steroids (31). The cause of the increase in R factor-carrying bacteria is due to the selective pressure caused by antibiotics and other chemo-therapeutic agents. It seems likely that the use of antibiotics for other non-medical purposes also helps the increase of the reservoir of R factors (10).

The use of antimicrobial agents in the treatment of diarrhea has greatly improved the quality of

life among residents in and travelers to developing countries. However, the problems associated with microbial resistance in diarrhoeal patients will continue to pose a challenge to public health workers (29). This challenge can be minimized if governments and associated public health services improve water quality and sanitation because non-medical interventions like health education regarding the general personal hygiene, provision of good sanitation and safe water have proved to be effective in the prevention of diarrhoea (32). Regulated use of antimicrobials may be necessary. Governments should also encourage the development or use of new vaccines to help reduce the incidence of diarrhoeal disease.

Further studies are needed to know diarrhea due to viral origin in Dhahira region and compare the resistance pattern over a period of time to know the increasing or decreasing trend in resistance pattern because an increasing trend in the resistance pattern has been observed by various researchers (10, 23).

In conclusion, our study suggests that *Shigella* spp., *Salmonella* spp. and *E. coli* are the most important bacterial pathogens especially among children in Dhahira region. Prescription of trimethoprim/sulphamethoxazole, ampicillin and tetracycline to gastroenteritis patients needs attention. The results of this study identified the spectrum of antimicrobial resistance pattern to the common pathogens in Dhahira region, Oman. These above mentioned resistant drugs are not recommended or vigilantly used for empirical treatment of gastroenteritis in Dhahira region particularly among children less than 5 yr. It also necessitates establishment of antibiotic resistance surveillance. Studies to determine the etiology of viral, unexplained diarrhea, and cost-effective algorithms for diarrhea diagnosis and antibiotic treatment are further considered obligatory.

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