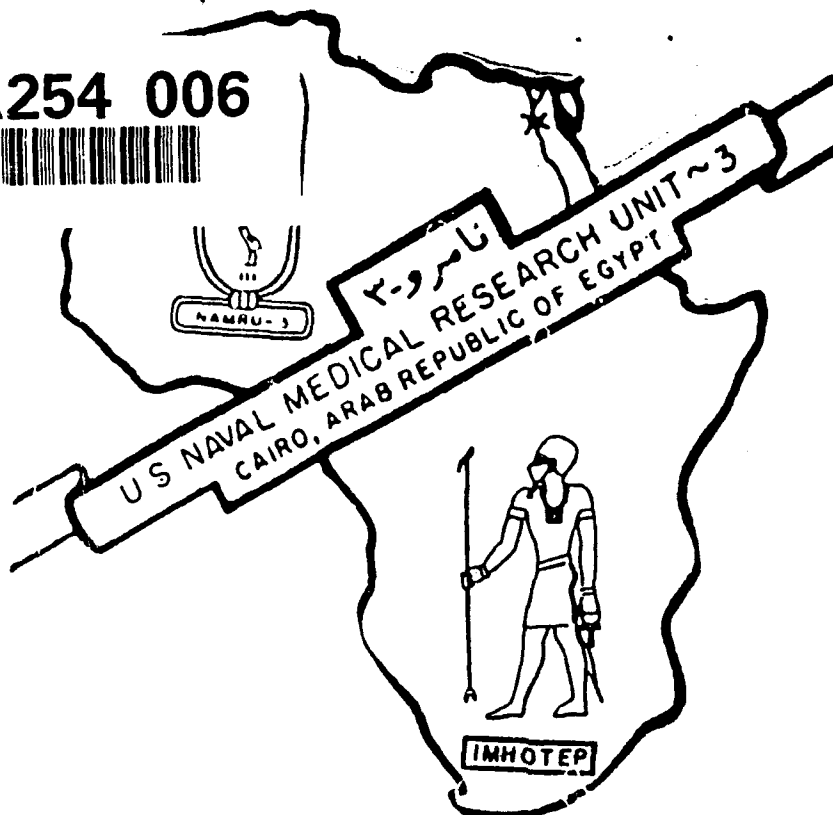


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TRAVELERS' DIARRHEA AMONG UNITED STATES
MILITARY PERSONNEL DURING JOINT AMERICAN-EGYPTIAN
ARMED FORCES EXERCISES IN CAIRO, EGYPT

BY

Richard L. Haberberger, Isis A. Mikhail, James P. Burans
Kenneth C. Hyams, Judy C. Glenn, Benedict M. Diniega, Steven
Sorgen, Noshay Mansour, Neil R. Blacklow and James N. Woody

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PSC 452, BOX 5000
FPO AE 09835-0007

92-22537



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Travelers' Diarrhea Among United States Military Personnel During Joint American-Egyptian Armed Forces Exercises in Cairo, Egypt

LT Richard L. Haberberger, Jr, MSC USNR*
Isis A. Mikhail, PhD*
LCDR James P. Burans, MSC USN†
CDR Kenneth C. Hyams, MC USN‡
LCDR Judy C. Glenn, NC USN§

LTC Benedict M. Diniega, MC USA||
LCDR Steven Sorgen, MSC USN¶
Noshy Mansour, PhD*
Neil R. Blacklow, PhD
CAPT James N. Woody, MC USN**

A study was conducted of travelers' diarrhea in a United States military population on deployment in Cairo, Egypt, during July and August 1987. Acute diarrhea requiring medical attention developed in 183 (4%) of 4,500 troops. A possible etiologic agent was identified in 49% of all diarrhea cases. Enteric pathogens associated with cases of diarrhea included: Enterotoxigenic *Escherichia coli* (17% ST-producers, 13% LT-producers, and 3% LT/ST-producers); *Shigella* (9%); *Campylobacter* spp. (2%); *Salmonella* (2%); and *Vibrio cholerae* non-01 serogroup (2%). Other enteric pathogens isolated from one episode each of diarrhea included *Aeromonas hydrophila* group, *Plesiomonas shigelloides*, and *Bacillus cereus*. *Yersinia enterocolitica*, enteroinvasive *E. coli*, intoxications by *Clostridium perfringens* and *Clostridium difficile*, and pathogenic enteric parasites were not found in any of the 183 patients with diarrhea. A survey of military personnel not requesting medical care indicated that up to 40% of troops may have had diarrhea during this deployment. Acute gastroenteritis is a potential cause of substantial morbidity in U.S. military personnel deployed to Egypt.

Introduction

It has been estimated that over 100 million travelers experience diarrhea each year.¹ Symptoms often start within 72 hours of arrival at a new destination. Left untreated, most infections resolve within several days, but 40% of travelers with diarrhea must adjust their travel plans and another 30% require bed rest.¹ Acute gastroenteritis has also been found to be a significant health risk for American military personnel.²

During July and August of 1987, a joint military operation between the United States and Egyptian Armed Forces was conducted in the desert area southwest of Cairo. The operation,

which lasted approximately 10 days with pre-deployment units arriving several weeks in advance, presented an opportunity to conduct a surveillance study of travelers' diarrhea in a large military population. The clinical, epidemiological, and microbiological characteristics of acute diarrhea in this U.S. military population were investigated at the United States Naval Medical Research Unit No. 3 (NAMRU-3), Cairo, Egypt. Risk factors associated with the development of diarrhea and in vitro antibiotic susceptibility patterns of bacterial enteropathogens were also determined.

Materials and Methods

Study Population

A total of 4,500 United States military troops, representing the four armed services, were monitored for gastrointestinal illness during a 40-day period from July 14 through August 22, 1987. Daily rounds were made of the aid stations and rapid deployment medical force (RDMF) units to insure that all military personnel seeking treatment for diarrhea and fitting the case definition were included in the study. A case of diarrhea was defined as three or more unformed stools or two unformed stools accompanied by nausea, vomiting, or tenesmus within a 24-hour period which could not be attributed to any pre-existing condition.²

Of the 4,500 troops, 183 reported to aid stations or an RDMF for treatment of diarrhea. Stools or rectal swabs were collected from those reporting for treatment, and an epidemiologic questionnaire was completed on each case. Serum samples were obtained from patients with fever accompanied by diarrhea. In addition, 26 comparison stool samples were collected from asymptomatic troops without diarrhea. Lastly, epidemiologic questionnaires were distributed to a grab-sample of 163 troops who did not seek medical treatment for diarrhea to evaluate their illness status and risk factors for the development of diarrhea.

Bacteriology

Stool specimens or rectal swabs were processed on site or transported on Cary-Blair with 5% sheep blood to NAMRU-3 within 12 hours of collection. Routine processing included streaking onto MacConkey, Hektoen, Thiosulfate-citrate-bile salts-sucrose media, *Campylobacter* Blood Agar Plate (CBAP), Cefsulodin-irgasan-novobiocin (CIN) media, Tryptic soy blood agar with 5% sheep blood and ampicillin, and into selenite broth enrichment. Selenite broth was subcultured onto Mac-

From the United States Naval Medical Research Unit No. 3, Cairo, Egypt.

* U.S. Naval Medical Research Unit No. 3, Cairo, Egypt, FPO New York 09527.

† U.S. Naval Medical Research Unit No. 2, Manila, the Philippines, APO San Francisco, CA 96528.

‡ U.S. Naval Medical Research Institute, Bethesda, MD 20814-5055.

§ Naval Medical Clinic, Quantico, VA 22134.

|| Command and General Staff College, Bldg 111, Section 1B, Fort Leavenworth, KS 66027-6920.

¶ U.S. Navy Environmental and Preventive Medicine Unit No. 7, Naples, Italy, Box 41, FPO NY 09521-4200.

** U.S. Naval Research and Development Command, Bethesda, MD 20814.

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Conkey and Hektoen enteric agar after overnight incubation at 37°C. CBAPs were incubated at 42°C for 48 hours in an oxygen-reduced atmosphere. All other media were incubated at 37°C. CIN plates were incubated at room temperature after 24 hours.

Cultures were examined for the following agents: *Salmonella*, *Shigella*, *Campylobacter*, *Yersinia*, *Aeromonas* spp., *Plesiomonas*, *Bacillus cereus*, enteroinvasive *Escherichia coli*, enterotoxigenic *E. coli* (ETEC), and vibrios. Standard procedures were used, including conventional screening sets of Kligler's iron agar, lysine iron agar, motility-indole-ornithine media, Christensen's urea agar, and the API 20E enteric system (Analytab Products, Inc., New York, NY). Bacterial pathogens were evaluated for their antimicrobial susceptibility patterns by the Bauer-Kirby method.³

Ten typical *E. coli* colonies were selected from each MacConkey plate, stored on nutrient agar stab cultures, and tested bi-weekly for heat-labile (LT) and heat-stable (ST) toxins by DNA probes (New England Nuclear Research Products, Boston, MA). *E. coli* colonies were also examined for enteroinvasiveness by testing those colonies which were non-motile and lysine decarboxylase negative by the guinea pig conjunctival method (Sereny test).

All enteric pathogen-free stool specimens were screened for the production of *Clostridium perfringens* toxin and *C. difficile* toxin by latex agglutination assays (Marion Scientific, Kansas City, MO).

Parasitology

Stools were emulsified in a merthiolate-iodine-formalin concentration solution for microscopic examination of intestinal parasites.⁴ Slides were also made directly from stool to identify fecal leukocytes⁵ and for examination by a modified acid-fast stain for *Cryptosporidia*.⁶

Results

Medical attention was sought for diarrhea by 4% (183/4,500) of the U.S. military personnel during their stay in Egypt. The mean age of symptomatic cases was 28.6 years (range, 17-54 years). One hundred-seventy one (93%) patients were men and 12 (7%) were women. Seventy-eight (43%) reported diarrhea during the first week in Egypt, and 143 (78%) were symptomatic by the end of the second week. Of the grab-sample of 163 troops without diarrhea who completed a ques-

tionnaire, 65 (40%) claimed to have had diarrhea but did not report to sick call.

A possible etiologic agent was identified in 49% of 183 diarrheal cases. ST-producing ETEC was the most commonly identified cause of diarrhea. It was found in 17% of the cases. LT-producing ETEC, the second most common infection, was identified in 13% of the cases, and both LT- and ST-positive *E. coli* were found in 3% of diarrhea samples. An ST-producing ETEC was the only enteric pathogen isolated from the stools of 26 asymptomatic comparison soldiers without diarrhea.

Other enteric pathogens isolated from diarrhea cases included *Salmonella* spp. (2%); *Shigella flexneri* (4%); *S. sonnei* (2%); *S. boydii* (1%); and, *S. dysenteriae* (1%). *Vibrio cholerae* non-O1 serogroup was isolated from three patients, two of whom were working as cooks.

Antibiotic resistance was frequently found to antimicrobials commonly used for prophylaxis and treatment of diarrhea (Table I). ETEC were found to be resistant to ampicillin (23%), doxycycline (10%), and trimethoprim-sulfamethoxazole (10%). For the different *Shigella* spp., resistance to these common antibiotics ranged from 0 to 100%. Except for one isolate of *Campylobacter laridis*, all pathogenic bacterial isolates were susceptible to two quinolone drugs, nalidixic acid and cinoxacin.

One case each of *Aeromonas hydrophila* group, *Plesiomonas shigelloides*, and *Bacillus cereus* were identified. No enterotoxin of *C. perfringens* or *C. difficile* was detected in this population, and no pathogenic parasites were identified in any of the cases or asymptomatic comparison stools.

Symptoms associated with the most frequent enteric bacterial pathogens are listed in Table II. Individuals reported having from 2 to 30 stools per day (mean, 5.8 per day). Most patients experienced similar symptoms, except fever was associated more often with *S. flexneri* infection. In addition, *Shigella* infections were associated with an increased number of stools, five or more per day. The presence of fecal leukocytes was not correlated with the type of isolated enteric pathogen.

An association between the development of diarrhea and eating locally-prepared food was found in the survey of 163 military personnel not requesting medical care. Of the troops who claimed to have developed diarrhea, 65% had eaten two or more locally-prepared meals compared to 27% of troops not complaining of diarrhea. Also, 38% of troops with diarrhea claimed to have had local drinks with ice compared to 16% of troops without diarrhea.

TABLE I
ANTIBIOTIC RESISTANCE OF THE MOST FREQUENTLY ISOLATED BACTERIAL PATHOGENS

Organism	Number of Patients	Percent Resistant				
		Ampicillin	TXS ^a	Doxycycline	Nalidixic Acid	Cinoxacin
ST-ETEC	31	23	3	3	0	0
LT-ETEC	23	22	17	17	0	0
LT/ST-ETEC	6	17	17	17	0	0
<i>S. flexneri</i>	8	25	0	25	0	0
<i>S. sonnei</i>	4	0	100	75	0	0

^a TXS = trimethoprim-sulfamethoxazole.

TABLE II
COMPARISON OF SYMPTOMS FOR DIFFERENT BACTERIAL PATHOGENS IN 183 PATIENTS WITH DIARRHEA

Symptoms	%LT-ETEC (n = 23)	%ST-ETEC (n = 31)	%LT/ST-ETEC (n = 6)	% <i>Shigella</i> <i>flexneri</i> (n = 8)	%No Isolated Pathogens (n = 93)
Headache	39	52	50	50	43
Chills	26	42	17	38	27
Fever	22	26	17	63	29
Nausea	39	48	33	25	53
Vomiting	9	19	0	13	26
Abdominal cramps	78	87	67	100	73
Hematochezia	4	0	0	0	5
Tenesmus	17	13	33	25	19
Myalgias	13	23	33	25	19
Arthralgias	9	16	50	25	13
Dizziness	26	52	33	38	27

Discussion

Even though soldiers usually ate individually packaged meals known as meals-ready-to-eat or ate at central mess halls, they frequently developed symptoms of gastroenteritis during this 1-month period in the summer of 1987. Acute diarrhea severe enough to cause individuals to seek medical attention developed in 4% of 4,500 U.S. troops. In addition, 40% of troops not reporting to sick call claimed to have had diarrhea. Acute gastroenteritis has the potential, therefore, to cause substantial morbidity in U.S. military personnel deployed to Egypt.

Eating locally-prepared food and the use of local ice were both associated with the development of diarrhea. It is therefore likely that most diarrheal cases were due to exposure to local food. Almost daily sightseeing excursions were conducted around Cairo, and despite preventive medicine briefings, 54% of the soldiers ate or drank local food and water, including ice, while on these excursions. Even with this exposure, however, these soldiers may have had less contact with indigenous enteropathogens than other travelers or expatriates living or traveling in Egypt, which decreased the number of diarrheal cases requiring medical care. These findings indicate that future efforts to prevent diarrheal illness may have to employ behavioral modification or perhaps the use of prophylactic antibiotics for key personnel.

A possible etiologic agent was identified in 49% of stool specimens received. As in other studies of acute diarrhea, ETEC was the most prevalent (33%) enteric pathogen detected.^{2,7,8} This finding is consistent with diarrheal studies which have been conducted in this area in the local population.^{9,10} Previous reports have also indicated that shigellosis is a major diarrheal threat in military populations in this region.^{11,12} This survey found *Shigella* spp. to be a common cause of diarrhea, but far less common than ETEC.

The susceptibility profile of isolated bacterial enteropathogens indicated resistance to many of the currently employed antimicrobial agents and little resistance to new quinolone drugs.¹³ With the exception of a single *Campylobacter lariidis* isolate, all bacterial enteropathogens were susceptible to both nalidixic acid and cinoxacin. In the absence of culture results, the newer quinolone agents should, therefore, be considered

alternative drugs for the treatment and prophylaxis of acute gastroenteritis in Egypt.^{14,15}

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Glenn, J.C., Diniega, B.M., Sorgen, S., Mansour, N., Blacklow,
N.R. and Woody, J.N.

U.S. Naval Medical Research Unit No. 3
PSC 452, Box 5000
FPO AE 09835-0007

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Naval Medical Research and Development
Command, National Naval Medical Center
Building 1, Tower 12
Bethesda, MD 20889-5044

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Acute diarrhea; Deployment; E. coli; Military personnel;
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