Helicobacter pylori Infection in Desert Storm Troops

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To determine whether military personnel deployed outside the United States are at increased risk of *Helicobacter pylori* infection, we evaluated U.S. Army personnel who served in the Persian Gulf from August 1990 to April 1991. Of 204 subjects from whom paired predeployment and postdeployment serum specimens were obtained, 76 (37%) were seropositive for IgG antibody to *H. pylori* before deployment by an enzyme-linked immunosorbent assay. Of the 111 initially seronegative subjects evaluated before and after a 7.5-month deployment, five (4.5%) seroconverted. The calculated annual seroconversion rate was 7.3%. In a postdeployment questionnaire, 62% of soldiers reported an episode of diarrhea while deployed, but there was not an increased rate of diarrhea or upper gastrointestinal symptoms in soldiers who were infected before deployment or in those who seroconverted. These data suggest that the risk of *H. pylori* infection increases during long-term deployment and that acute infection is not distinguishable from other gastrointestinal illnesses encountered during deployment.

Helicobacter pylori causes chronic infection of the stomach resulting in inflammation that is described pathologically as chronic superficial gastritis. There is strong evidence that *H. pylori* infection predisposes individuals to peptic ulcer and gastric carcinoma [1–3]. Serosurveys in the United States and other developed countries have found an infection rate among adults of ~1% per year [4, 5]. In developing countries, infection is much more prevalent, and the rate of infection during childhood is very high [1]. Modes of transmission are not clearly defined, but the lack of an animal reservoir and clustering of infection in families and institutionalized populations have suggested that person-to-person transmission (either fecal-oral or oral-oral) is the most likely route [1]. Persons who travel to developing countries are at risk for enteric diseases such as traveler's diarrhea, and it is possible that they might be at risk for *H. pylori* infection.

Acute *H. pylori* infection may result in upper gastrointestinal pain that causes considerable discomfort for several days to weeks, although asymptomatic infection also occurs [6]. Thereafter, the infection remains silent until years later when it may lead to ulcer disease or decades later when it may lead to cancer in some individuals. Serology is an accurate method to screen for *H. pylori* infection [5, 7]. In instances where exposure has been well documented, persons usually seroconvert within a few weeks of exposure and maintain elevated serum levels of IgG antibody for the length of infection, usually for the rest of their lives.

U.S. soldiers living under field conditions may be at greater risk of *H. pylori* infections than soldiers living in the United States. The deployment of >500,000 military personnel to the Middle East during the Persian Gulf War (termed Operations Desert Shield and Desert Storm) provided an opportunity to test this hypothesis. Operations Desert Shield and Desert Storm began with a buildup of U.S. troops in Saudi Arabia from August 1990 to February 1991; this buildup was followed by the invasion of Kuwait and Iraq that lasted <1 month. U.S. soldiers were exposed to enteric pathogens; there were high rates of diarrheal disease during the first 3 months in Saudi Arabia [8, 9]. The initial outbreak was primarily caused by enterotoxigenic *Escherichia coli* (ETEC), which was interrupted by banning the use of local salad vegetables. *Shigella sonnei* was the second most commonly isolated enteric pathogen and became more of a problem in the later buildup period after ETEC infection was controlled. We studied a group of deployed soldiers from the 82nd Airborne Division to determine the rate of *H. pylori* seroconversion during their deployment.

Methods

Subjects. We analyzed serum specimens from 204 healthy U.S. soldiers who were deployed to Saudi Arabia and Iraq during Operations Desert Shield and Desert Storm. The first blood specimen was collected on 17 August 1990, the day before deployment. The second specimen was collected on 16 May 1991, ~7.5 months after the first specimen was collected and 45 days after the soldiers returned to Fort Bragg, North Carolina. After centrifugation, samples were frozen at −70°C and thawed once before analysis. A postdeployment questionnaire was filled out by each soldier at the time the convalescent-phase serum sample was obtained.

Serology. Titers of IgG antibody to *H. pylori* were determined by the quality assurance laboratory at BioWhittaker

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Table 1. Characteristics of soldiers deployed to the Persian Gulf during Operations Desert Shield and Desert Storm from 19 August 1990 to 1 April 1991 (7.5 months) who participated in a serological study on *Helicobacter pylori*.

Characteristic	No. of all soldiers*	No. (%) of predeployment seropositive soldiers†	No. of predeployment seronegative soldiers		Infection rate (%) during 7.5 mo
			Remained seronegative‡	Seroconverted§	
Male	187	76 (40.6)	106	5	4.5
Rank					
E3–E4	140	55 (39.3)	82	3	7.9
E5–E7	42	19 (45.2)	21	2	11.8
O2–O3	5	2 (40.0)	3	0	0
Race					
White	136	45 (33.1)	87	4	4.4
Black	26	18 (69.2)	7	1	12.5
Hispanic	19	8 (42.1)	11	0	0
Other	3	3 (100.0)	0	0	0
Unknown	3	2 (66.7)	1	0	0
Company					
A	28	9 (32.1)	18	1	5.3
B	32	11 (34.4)	21	0	0
C	40	16 (40.0)	21	3	12.5
D	23	8 (34.8)	14	1	6.7
HHC	64	32 (50.0)	32	0	0

NOTE. Seventeen of 204 soldiers with indeterminate predeployment optical density titers of IgG antibody to *H. pylori* were not included in the analysis.
* Mean age (y) ± SEM (range): 23 ± 0.2 (19–37).
† Mean age (y) ± SEM (range): 23.1 ± 0.4 (19–35) (age missing for one soldier).
‡ Mean age (y) ± SEM (range): 22.9 ± 0.3 (19–37).
§ Mean age (y) ± SEM (range): 22.4 ± 0.9 (20–35).

(Walkersville, MD) by means of ELISA (Pylori Stat test kit, BioWhittaker) [10]. A cutoff optical density (OD) titer of <0.8 was used to define a negative test. An OD titer of 0.8 to 0.99 was defined as indeterminate, and an OD titer of ≥ 1.0 was defined as positive and indicative of *H. pylori* infection. Seroconversion (and evidence of recent infection) was defined as a ratio of postdeployment to predeployment OD titers of ≥ 1.5 and a postdeployment OD titer of ≥ 1.0 [11].

Statistical analyses. Proportions were compared by using the χ^2 test with Yates' correction or Fisher's exact test. A correlation coefficient was determined by using SPSS version 6.0 (SPSS, Chicago).

Results

The 204 soldiers who composed the study group were men from an airborne infantry battalion stationed at Fort Bragg. The mean age of the soldiers was 23 years (range, 19–37 years). The total time of deployment to the Persian Gulf was 225 days or ~7.5 months. Seventy-three percent of 187 soldiers were white, and most were junior enlisted soldiers (table 1). Before deployment, 76 (37%) of 204 soldiers were seropositive, as defined by an OD titer of IgG antibody to *H. pylori* of ≥ 1.0. The seropositivity rate among black soldiers (69.2%) was higher than that among white and Hispanic soldiers (33.1% and 42.1%, respectively; $P < .05$).

Table 2. Characteristics of soldiers who were seronegative for IgG antibody to *Helicobacter pylori* and who seroconverted while deployed to the Persian Gulf during Operations Desert Shield and Desert Storm from 19 August 1990 to 1 April 1991 (7.5 months).

Age (y)/sex	Race	Rank	Battalion	Company	OD titer of IgG to *H. pylori**		Ratio of predeployment to postdeployment OD titers
					Predeployment	Postdeployment	
25/M	Black	E5	2/505th	C	0.32	1.10	3.44
20/M	White	E3	2/505th	A	0.37	1.19	3.22
22/M	White	E5	2/505th	D	0.48	1.28	2.67
21/M	White	E4	2/505th	C	0.50	1.15	2.30
24/M	White	E4	2/505th	C	0.68	1.13	1.66

NOTE. OD = optical density.
* Determined by ELISA.

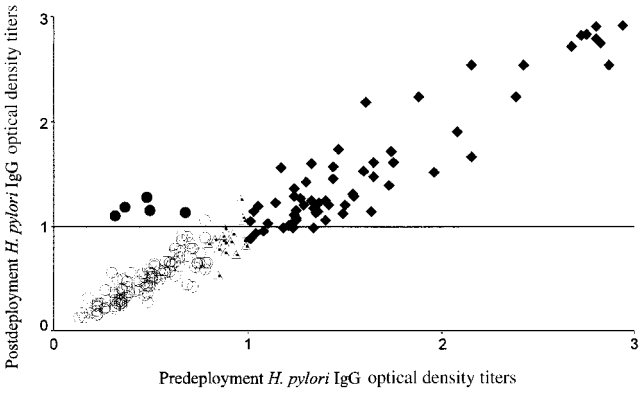

Figure 1. Correlation between predeployment and postdeployment serum levels of IgG antibody to *Helicobacter pylori* in U.S. soldiers deployed to the Persian Gulf for 7.5 months. Interpretation of predeployment optical density (OD) titers was as follows: seropositive ($n = 76$) (♦), seronegative ($n = 106$) (○), indeterminate ($n = 17$) (△), and seroconverion ($n = 5$) (●). An OD titer of ≥1.0 was the cutoff for seropositivity. Not shown are 14 paired OD titers of >3.0.

Of 111 soldiers who were seronegative before deployment, five (4.5%; 95% CI, 1.4–10.0) seroconverted during the 225-day deployment period. The calculated annual seroconversion rate was 7.3% (95% CI, 3.1–13.5). Four of five soldiers who seroconverted were white and one was black (P = NS). All persons who seroconverted were junior enlisted soldiers aged 20 to 25 years old. The ratio of predeployment to postdeployment OD titers of IgG antibody to *H. pylori* ranged from 1.66 to 3.44 (table 2). Except for the five persons who seroconverted, the OD titers of Ig antibody were remarkably constant from predeployment to postdeployment for the 204 soldiers ($r = 0.98$) (figure 1).

In the postdeployment questionnaire, 75% of soldiers said that they had been ill during deployment, and 45% said that they had had an illness that required a visit to the troop medical clinic. Diarrhea was reported by 62% of soldiers; nausea and/or vomiting, 23%; and fever, 21% (table 3). There was no significant association with any of these variables and predeployment seropositivity or seroconversion. Acute infection as defined by seroconversion appeared to be asymptomatic. A history of travel to the Far East, but not the Middle East, Africa, or Latin America, was found to be associated with predeployment seropositivity ($P < .05$). Dietary factors, such as consumption of water or ice, and crowding were not found to be associated with risk for *H. pylori* seroconversion (data not shown).

Discussion

In this study, we found that the incidence of *H. pylori* infection in U.S. soldiers deployed to Saudi Arabia was 7.3% per year. Previously, we found a rate of *H. pylori* seropositivity of 33% among U.S. military recruits aged 21–26 years old and estimated that the incidence among recruits aged 17–26 years old was 2.5% per year [10]. Although the prevalence was higher among blacks than among whites, the incidence among all race groups was the same. The estimated incidence among recruits was considerably higher than that among other cohorts of young adults, among whom the incidence has been estimated to be <1%. The higher representation of minority groups in the recruit population may partially explain the differences in

Table 3. Characteristics of illnesses and predeployment/postdeployment serostatus for IgG antibody to *Helicobacter pylori* in soldiers who were deployed to the Persian Gulf during Operations Desert Shield and Desert Storm from 19 August 1990 to 1 April 1991 (7.5 months).

Characteristic	No. of all soldiers	No. (%) of predeployment seropositive soldiers	No. of predeployment seronegative soldiers		Infection rate (%) during 7.5 mo
			Remained seronegative	Seroconverted	
Ill during deployment					
No	46	17 (40.0)	26	3	10.3
Yes	141	59 (41.8)	80	2	2.4
Went to clinic*					
No	103	42 (40.8)	57	4	6.6
Yes	83	33 (39.8)	49	1	2.0
Diarrhea					
No	72	28 (38.9)	41	3	6.8
Yes	115	48 (41.7)	65	2	3.0
Nausea and/or vomiting					
No	145	61 (42.1)	79	5	6.0
Yes	42	15 (35.7)	27	0	0.0
Fever					
No	147	60 (40.8)	82	5	5.8
Yes	40	16 (40.0)	24	0	0.0

* No clinic information was available for one soldier.

seroprevalence. The increase in incidence from 2.5% while living at home to 7.3% while living abroad under field conditions represents a major increase in risk.

Not all studies, however, have agreed with these findings. In another study of U.S. military personnel [11], five of 601 seronegative recruits seroconverted (annual incidence, 1.9%; 95% CI, 0.6–4.3%). In that study, the incidence was highest among shipboard personnel (2.8%; 95% CI, 0.9–6.3), while none of the 234 seronegative Desert Storm soldiers seroconverted. One possible explanation is that these troops did not arrive in Saudi Arabia until December, when rates of diarrheal disease were considerably lower than in the previous 4 months. In addition, none of 133 seronegative Swedish travelers seroconverted after a median of 44 days on holiday in developing countries [12].

There appear to be few consequences of acute *H. pylori* infection, and there were none that distinguished this illness from other gastrointestinal illnesses. Because infection may cause hypochlorhydria, either acute or chronic infection could be a risk factor for diarrheal disease. In Bangladesh, chronic *H. pylori* infection appeared to be a predisposing factor for cholera [13]. However, on the basis of the recall data that we had, the rates of *H. pylori* infection were very similar among soldiers who were ill and those who were not ill.

Diarrheal disease was common during Operations Desert Shield and Desert Storm. The rates of pathogen isolation suggested that ETEC and *Shigella* were the most common causes of illness [7]. There were also some well-documented epidemics of gastroenteritis associated with vomiting caused by Norwalk virus [14]. ETEC diarrhea is the major disease of travelers and is thought to be primarily spread by foodborne transmission [15]. There is no animal reservoir for *H. pylori,* and little epidemiological evidence exists for foodborne transmission of *H. pylori.* In contrast, transmission of *H. pylori* may be similar to that of *Shigella* or hepatitis A virus, where factors such as crowding and poor personal hygiene increase the risk of infection. The infection rate among submarine crews was found to be higher than that among land-based soldiers, perhaps because of the crowded conditions on board the submarine [16]. Thus, shigella infection may predict transmission of *H. pylori* and offer one reason why soldiers deployed to developing countries for months would be at higher risk for infection than travelers.

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