Clinical Medicine

Campylobacter Enteritis on Hopi and Navajo Indian Reservations

Clinical and Epidemiologic Features

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From June 22 through September 30, 1981, stool specimens from 522 Hopi and Navajo outpatients were cultured because of diarrheal illnesses at the Keams Canyon Indian Health Service Hospital, Arizona. Campylobacter jejuni *was isolated from the specimens of 26 (5%) of the patients. This pathogen was found as frequently as* Shigella *in patients younger than 2 years or older than 20 years, but was significantly less common in the 2- to 20-year age group (P<.000001).* Campylobacter *enteritis was indistinguishable clinically from shigellosis in adult patients, but in children younger than 5 years, a rectal temperature higher than 38°C (100.5°F) was significantly more common with* Shigella *than with* Campylobacter *infection (P=.003). In a field study of 20 families, we found that households with a case of* Campylobacter *enteritis were more likely than age- and community-matched controls to own farm animals (P=.05), but were not more likely to own household pets.* C jejuni *is less common than* Shigella *as a cause of summer seasonal diarrhea and dysentery among the Hopi and Navajos; the striking differences in the age-specific rates of these two infections suggest different routes of transmission.*

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Indian Health Service physicians report 45 to 66 new visits for "bacillary dysentery" per 10,000 Indian population per year, with the highest rates reported from southwestern tribes.[1] Before the recognition of *Campylobacter jejuni* as a common invasive enteric pathogen, it was assumed that these dysenteric illnesses were due principally to *Shigella* infection.[2] Because the symptoms of bloody diarrhea or fever are reported by most patients with *Campylobacter* enteritis, the clinical illness associated with this pathogen is often indistinguishable from shigellosis.[3-5] Because Indian Health Service case reports are based on clinical impression, we suspected that part of the excessive "dysentery" morbidity could be attributed to *Campylobacter* enteritis.

During the past decade, *C jejuni* has been associated with 3% to 14% of cases of clinical diarrhea in studies from developed countries.[3-8] In these clinic-based studies, *C jejuni* was most commonly associated with diarrhea in young adults and was relatively less common in infants and young children. Identification of the organism in stool specimens of healthy persons was rare.[6,8] In contrast, studies from developing countries suggest a much higher prevalence and a different age distribution of *C jejuni* infection. In Bangladesh, *C jejuni* was most commonly found in stool specimens

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from infants and young children who had diarrhea and was also found in specimens from 17.7% of healthy children.[9] These conflicting studies suggest that the epidemiology of *Campylobacter* enteritis differs in developed and developing countries. Because the epidemiology has not been described in an American Indian population, we designed this study to measure the proportion of cases of clinical dysentery associated with *C jejuni* among Indian patients, to define the age groups that are predominantly affected and to determine whether *C jejuni* and *Shigella* infections could be distinguished by clinical criteria or patient characteristics.

The study was conducted at the Keams Canyon Indian Hospital in northeastern Arizona, an Indian Health Service facility that serves about equal populations of Hopi and Navajos. Traditionally, the Hopi are village-dwelling agriculturalists,[10] whereas the Navajo live in scattered family encampments and are principally engaged in raising sheep or cattle in close proximity to their dwellings.[11] These farm animals are potential hosts for *C jejuni*.[12] Human *Campylobacter* infections have been associated with infection of household pets[13] and with drinking unpasteurized milk from dairies with infected cows.[14] Using cases identified by fecal culture at the hospital outpatient clinics, we conducted a controlled field investigation to determine how environmental and life-style factors—particularly contact between humans and animals—may have influenced the occurrence of *C jejuni* infection on these two reservations.

Patients and Methods

Cultures for *C jejuni*[6] and *Shigella,* using standard methods, were done in all patients with diarrhea seen at the Keams Canyon Hospital or field clinics between June 22 and September 31, 1981. All *Campylobacter* isolates were biochemically confirmed by the Enteric Bacteriology Section, Enteric Diseases Branch, Division of Bacterial Diseases, Center for Infectious Diseases, Centers for Disease Control, Atlanta.[12] Cases of diarrhea that were reported to the Indian Health Service surveillance system by hospital staff physicians as cases of "bacillary dysentery" were reviewed to determine, retrospectively, what proportion were associated with *C jejuni* or *Shigella.*

The age, sex and tribe of all patients in whom stool cultures were done during the study period were determined by medical records personnel, using the patient's identification number from laboratory logbooks. The medical records of all patients with *Campylobacter*-positive cultures were reviewed to record the staff physician's clinical observations at the time the specimen was obtained—that is, patient's body temperature, appearance of the stool and results of stool microscopic examination. The findings from these records were compared with those of 37 patients with *Shigella*-positive cultures (29 *Shigella flexneri,* 8 *Shigella sonnei*) during the same period who were selected if they had negative cultures for *Campylobacter,* they lived within the service area of Keams Canyon Hospital and their medical records were available for review at the hospital.

In the period June 22 to September 11, 1981, we visited the homes of *Campylobacter*-positive patients who were residents of the Hopi Reservation or the surrounding Navajo Reservation communities of Low Mountain, Jeddito, Whitecone and Pinon within ten days of the initial clinic visit. At each household, we interviewed all available family members using a pretested questionnaire to record any recent diarrheal illnesses in household contacts and to collect information about the home environment, including the ownership of and contact with domestic animals, the presence or absence of indoor plumbing and patterns of household water use. We determined total household water use in homes lacking tap water by noting the volume of water storage containers and the stated frequency of refilling. Rectal swab specimens were collected from adult household members who gave informed consent and from assenting minors whose parents gave consent. Rectal swab specimens were also collected from household animals with consent of the owners.

To evaluate potential household risk factors, we selected controls from among Keams Canyon Clinic patients without diarrhea seen during the same time period as persons ill with *C jejuni* and *Shigella* infections. Controls were matched by age group (4 years and younger, 5 to 14 years, 15 to 44 years and 45 years and older) and by community of residence. Matching by community also matched for tribe. Control-families were visited and interviewed by the same methods used for case-families.

Results

C jejuni was identified in the stool specimens of 26 (5.0%) of the 522 patients who had diarrhea during the surveillance period, 6 (6.7%) of the 89 patients reported to have had bacillary dysentery and 20 (4.6%) of the 433 patients who had diarrhea but not bacillary dysentery. *Shigella* was identified in specimens of 13.4% of all patients with diarrhea, 25.8% of the patients with bacillary dysentery and 10.9% of patients with diarrhea but not bacillary dysentery. Patients reported to have bacillary dysentery were significantly more likely than all other diarrhea patients to have *Shigella* identified in their feces ($\chi^2 = 13.0$; $P < .001$). The clinical impression of bacillary dysentery was not associated with isolation of *Campylobacter* ($\chi^2 = 0.3$).

Campylobacter was found most frequently in the stool specimens of children younger than 2 years and of adults older than 20 years (Table 1). In children younger than 2 years, the rates of *Campylobacter* and *Shigella* isolation were not significantly different; however, *Shigella* was identified ten times more often than *Campylobacter* in patients 2 to 14 years of age, a significant difference when compared with younger children ($P = .002$; χ^2). *Campylobacter* was more common in Navajo (6.3%) than in Hopi patients (3.4%), particularly among patients aged 10 years or older; how-

ever, these tribal differences were not statistically significant (Table 2).

Medical records were obtained for 21 of the 23 patients who had diarrhea and in whom *Campylobacter* was the only bacterial pathogen identified in their stool specimens. When these 21 cases were compared with 37 *Shigella*-positive cases, there were no statistically significant differences in the clinical presentations. Staff physicians empirically treated patients in both groups with antimicrobials with similar frequency (62% and 80%, respectively). When children and adult patients were considered separately, differences in the clinical presentations became apparent. Only 6 (40%) of the 15 *Campylobacter*-positive children younger than 5 years were febrile at presentation (temperature 38.1°C [100.5°F] or higher) compared with 13 (100%) of 13 *Shigella*-positive children in the same age group ($P = .003$; Fisher's exact test, two-tailed). *Campylobacter*-positive children also had a lower median rectal temperature (38°C [100.4°F]; range 35.9°C to 39.9°C) than did *Shigella*-positive children (39.7°C [103.4°F]; range, 38.1°C to 40.2°C; $P = .0005$; Mann-Whitney U test). The median oral temperatures for patients aged 5 years and older were similar in the two pathogen-specific groups (37.7°C [99.9°F]). In children younger than 5 years, there was also some evidence (though not statistically significant) to suggest that *Campylobacter*-positive patients were less likely than *Shigella*-positive patients to have gross blood in the stool ($P = .06$) or more than ten polymorphonuclear leukocytes per high-power field on fecal examination ($P = .06$). The clinical illness associated with *S flexneri* and *S sonnei* infections were similar by all measured criteria.

TABLE 1.—Campylobacter jejuni *and* Shigella *spp Isolations From 522 Outpatients Who Had Diarrhea, by Patients' Age, Keams Canyon Indian Health Service Hospital, June 22 to September 30, 1981*

Age Group	Stool Specimens Cultured Number	Positive for C jejuni Number (Percent)	Positive for Shigella Number (Percent)
0-11 mo	153	8* (5.2)	7* (4.6)
12-23 mo	56	5 (8.9)	9 (16.1)
2- 4 yr	51	2 (3.9)	17 (33.3)
5- 9 yr	27	1 (3.7)	7 (25.9)
10-14 yr	23	0 (. . .)	10 (43.5)
15-19 yr	15	0 (. . .)	1 (6.7)
20-39 yr	71	3* (4.2)	4* (5.6)
40-59 yr	58	3 (5.2)	9 (15.5)
60+ yr	54	2* (3.7)	6* (11.1)
Unknown	14	2 (14.3)	0 (. . .)
TOTAL	522	26 (5.0)	70 (13.4)

*One patient in each group had both *C jejuni* and *Shigella flexneri*.

TABLE 2.—Campylobacter jejuni *Identified in Hopi and Navajo Patients With Diarrhea, by Tribe and Age Group*

Age Group	Positive Isolates/Tested: Hopi Number (Percent)	Navajo Number (Percent)
<10 yrs	6/118 (5.1)	8/135 (5.9)
>10 yrs	2/66 (3.0)	6/77 (7.8)
All*	8/233 (3.4)	17/268 (6.3)

*Includes patients of unknown age.

TABLE 3.—*Animal Ownership by Ten Households of* Campylobacter *Enteritis Patients and Matched Control Households*

Animals	Case-Households Number	Control-Households Number
Pets	8	8
Dogs	7	8
Cats	6	6
Farm animals	7*	1*
Poultry	2	1
Sheep	3	1
Goats	2	1
Cows	0	1
Horses	2	1
Rabbits	2	0
All animals	9	9

*$P = .05$, McNemar's test.

In the household studies, diarrheal illnesses occurred in 4 (8%) of the 53 household contacts of cases and in 1 (2%) of the 49 household contacts of controls ($P = .4$; χ^2). Cultures were done in 6 of the 28 children younger than 15 years but none were positive for *C jejuni*. We also did cultures in nine cats, six dogs, eight sheep and five trapped rodents. The cultures of one cat and two dogs were positive for *C jejuni*.

In the ten case-households and ten matched controls, we found no association between cases and ownership of any single animal species; however, case-households were significantly more likely than controls to own farm animals (poultry, cattle, sheep, goats, horses or rabbits) ($P = .05$; McNemar's test). Ownership of household animals (dogs or cats) was similar in case- and control-households (Table 3).

Only 2 of the 20 households had indoor tap water (both were control households). The remaining 18 households obtained water from closed wells. If an estimate of 60 gal per household per day (based on community water system readings) is assumed for the two controls, then the median daily water use was less in case-households (8.0 gal) than in control-households (14.4 gal, $P = .04$, Wilcoxon test). Likewise, if homes with tap water are considered to have unlimited "storage" capacity, median household water storage capacity was less in case-households (47 gal) than in control-households (65 gal, $P = .04$).

Discussion

During the summer of 1981, *C jejuni* was identified in the stool specimens of 5.0% of Hopi and Navajo outpatients who had diarrhea, a frequency of isolation similar to that reported in other US populations.[3-5] During the same period, *Shigella* was found in 13.4% of our patients. Because geography and economics make routine follow-up difficult, antimicrobials are often used empirically by Indian Health Service physicians. An analysis of cases of diarrhea by the physician's clinical impression suggests that the reported

diagnosis of bacillary dysentery was associated with subsequent identification of *Shigella,* but was not predictive of *Campylobacter* infection. We therefore compared culture-proved cases of *Campylobacter* and *Shigella* enteritis to determine whether these infections could be distinguished on clinical grounds. Although we found no distinctive clinical features of *Campylobacter* infections, the diagnosis of shigellosis was strongly favored if the patient was between 2 and 14 years of age or had fever on presentation. For adults older than 20 years, the frequency of isolation of the two pathogens did not differ significantly, and there were no distinguishing clinical features.

In the ten households of *Campylobacter*-positive patients, diarrheal illness occurred in only 8% of household contacts; without knowing the source of infection for the index cases, however, the interpretation of this finding is difficult. In a recent study in Colorado, Blaser and associates interviewed and cultured specimens from household contacts within 48 hours of the identification of a *Campylobacter* case; 15% reported a diarrheal illness, and the stool specimens of 8 of the 12 ill contacts were positive for *C jejuni.*[15] In the only ill contact from whom we obtained a specimen, culture was negative for *C jejuni,* and the diarrhea attack rate in our case-households was not significantly different from that in control-households. Because we allowed up to ten days to locate the case-families, recall bias may have occurred in some instances, causing an underestimate of the household attack rates.

The association between cases and the ownership of farm animals probably explains why infection was more common in Navajo than in Hopi patients. Animals may be a source of infection for humans through direct contact or by ingesting unpasteurized milk or improperly cooked foods.[3,14] In this study, *Campylobacter* illness was not associated with household dogs, puppies, cats or kittens. Unpasteurized milk is not available at any of the reservation stores; families that own cows or goats do not milk them for home use. Although locally slaughtered mutton is frequently eaten, it is stewed thoroughly in most preparations. However, cross-contamination of cooking utensils or cutting surfaces by raw meat is a possible mechanism of transmission. Alternatively, transmission could occur during direct contact with farm animals, such as during the handling or shearing of sheep.

The association between low household water use or water storage capacity and *Campylobacter* enteritis may be related to inadequate amounts of water for personal hygiene. The unavailability of water is known to promote the person-to-person transmission of *Shigella,*[16,17] but this mode of transmission has rarely been suggested for *Campylobacter.*[18] Water has also been implicated as a vehicle of transmission in a few outbreaks[19,20]; it is an unlikely source of infection on the reservations because the cases were evenly distributed to several communities with independent water systems (all using ground water as a source). In general, families with adequate home water supplies live in new housing in village communities where farm animals are less likely to be kept, whereas families engaged in herding or ranching live in geographically isolated areas where water distribution systems do not exist. Because of the small number of households in the study, we could not determine which of these factors was most important.

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