The protective effect of urea, which has free access through the outer membrane, is probably due to the fact that the urease of *H pylori* is localised intracellulary as well as in the outer membrane, and is not greatly affected by the morphological changes of the outer membrane.[9] The susceptibility of the pleomorphic four day cultures to acid can not be attributed to any single bacterial form. Nevertheless, as a group, these cultures were unusually susceptible to hostile conditions.[7]

In summary, we found that the morphological changes which occur with longer incubation of *H pylori* have an inverse relation with the organism's resistance to an acidic environment. This observation suggests that older bacteria are less resistant to certain adverse conditions. The finding that the addition of urea to the medium almost reversed this phenomenon emphasises again the central role of urea in the survival of *H pylori* in acidic conditions. It also suggests that the morphological changes which occur with longer incubation are not associated with obvious changes in the urease activity of the bacteria.

1 Marshall BJ, Barrett LJ, Prakash C, *et al.* Urea protects Helicobacter (Campylobacter) pylori from the bactericidal effect of acid. *Gastroenterology* 1990;**99**:697–702.
2 Bode G, Malfertheiner P, Ditshuneit H. Pathogenic implications of ultrastructural findings in Campylobacter pylori related gastrointestinal disease. *Scand J Gastroenterol* 1988;**23**:(suppl 142):25–9.
3 Jones DM, Currey A. The genesis of coccal forms of Helicobacter pylori In: Malfertheiner P, Ditschuneit H, eds, *Helicobacter pylori, gastritis and peptic ulcer.* Berlin: Springer-Verlag, 1990:29-37.
4 Catrenich CE, Makin KM. Characterization of the morphologic conversion of Helicobacter pylori from bacillary to coccoid forms. *Scand J Gastroenterol* 1991;**26**: (suppl 181):58–64.
5 Mai U, Geis G, Leying H, Ruhl G, Opferkuch W. Dimorphism of Campylobacter pylori. In: Megraud F, Lamouliatte H, eds. *Gastroduodenal pathology and Campylobacter pylori.* Amsterdam: Elsevier, 1989:29–33.
6 Moran AP, Upton ME. Factors affecting production of coccoid forms by Campylobacter jejuni on solid media during incubation. *J Appl Bacteriol* 1987,**62**:527–37.
7 Lamana C, Mallette MF, eds. Chemical disinfection. In: *Basic bacteriology.* Baltimore: William and Wilkins Company, 1953:615–31.
8 Rose AH, ed. *Chemical microbiology. An introduction to microbial physiology.* 3rd Edn. London: Butterworths, 1976:118–399.
9 Nilius M, Bode G, Lehnhardt G, Malfertheiner P. In vitro inhibition of Helicobacter pylori urease: biochemical and ultrastructural analysis. *Eur J Clin Invest* 1991: 21:551–7.

J Clin Pathol 1994;47:174–175

Bacteraemia caused by *Campylobacter* spp

C Ladrón de Guevara, J Gonzalez, P Peña

Abstract

The genus *Campylobacter* has become increasingly recognised as the cause of various infections. *Campylobacter jejuni* and *C coli* cause acute gastroenteritis in man all over the world. *C jejuni* enteritis can lead to bacteraemia, but its actual incidence remains unknown.

Seven cases of bacteraemia caused by *C jejuni* or *C coli* are reported, from the blood of seven patients: five immune deficient adults; a newborn baby; and a patient who had had abdominal surgery. Patients who develop diarrhoea as a result of *Campylobacter* infection are at risk of bacteraemia thereafter.

(*J Clin Pathol* 1994;47:174–175)

Department of Microbiology, La Paz Hospital, Madrid
C Ladrón de Guevara
P Peña

Department of Internal Medicine
J Gonzalez

Correspondence to:
Dr C Ladrón de Guevara, Department of Microbiology, La Paz Hospital, Castellana 261, 28046, Madrid, Spain.

Accepted for publication 7 September 1993

Campylobacter jejuni enteritis may lead to bacteraemia, but its actual incidence remains unknown.[1] A few cases of prolonged *C jejuni* bacteraemia have been noted in adult immune deficient patients.[2]

We have recently isolated *C jejuni* and *C coli* from the blood of seven patients between April 1991 and October 1992.

Case reports

CASE 1

A 2 day old baby with jaundice caused by an isoimmunisation with the isoantibody anti-A had diarrhoea with mucus and blood. The clinical picture was of septicaemia, but examination yielded normal results. *C coli* was recovered from stool and blood cultures after 48 hours of incubation. Erythromycin (1000 mg orally a day) was given, and the patient's symptoms resolved.

CASE 2

A 41 year old man with a long history of alcohol related disease, including jaundice and other features of chronic liver disease, was admitted with diarrhoea and fever. Two of three blood cultures grew *C jejuni* after 72 hours of incubation. Fecal culture was also positive for this organism. Erythromycin, to which the bacterium was sensitive, was given and the patient was apyrexial after 24 hours. Thereafter, he had only mild diarrhoea which finished on the fourth day.

CASE 3

A 33 year old man was admitted to hospital with abdominal pain, fever, and increased

leucocytes, but there was no diarrhoea. Appendicitis was diagnosed. Surgery was required, and this was complicated by enteric fistula. After blood samples had been taken for culture gentamicin and clindamicin were given. One of three blood cultures grew *C jejuni* after 72 hours of incubation. Faecal culture was not carried out. After four weeks of treatment the patient was discharged.

CASE 4

A 61 year old woman, diagnosed as having colonic adenocarcinoma, was admitted to hospital after five days of fever, but without diarrhoea. Three blood cultures were taken in the emergency room. Three days later, *C coli* was identified in the three blood cultures. Ciprofloxacin was given intravenously.

CASE 5

A 15 year old haemophilic boy was admitted to hospital because of fever and abdominal pain associated with diarrhoea. A faecal sample and four blood samples were cultured. One of the four blood cultures grew *C jejuni* after 24 hours of incubation, and the faecal culture was also positive for this organism. The patient responded well to 12 days' treatment with erythromycin given orally.

CASES 6 AND 7

Two men of 29 and 36 years old, each with a history of intravenous drug misuse and HIV infection with severe immunosuppression, were admitted to hospital. Seven and 10 days beforehand, they had had fever and diarrhoea respectively. Blood cultures grew *C jejuni*, and faecal cultures were negative in one patient.

An automatic BACTEC 660 system was used. Blood was cultured in NR16B and NR17A bottles and examined daily. When a positive BACTEC signal (threshold 30) was obtained, the samples were cultured on trypticase soy agar with 5% sheep blood and chocolate agar IsoVitaleX (Becton Dickinson) at 35°C under microaerophilic conditions (5% CO_2, 95% air, 53% humidity). The strains were isolated from 16B aerobic bottles, but not from 17A anaerobic bottles. All strains were observed between 24 and 72 hours incubation directly from the blood culture bottle using Gram stain. They were Gram negative, motile, spiral or curved rods.

Faecal samples were cultured by methods that included culture for *Campylobacter* spp on Skirrow's blood agar, which contains vancomycin (10 mg/l), trimethoprim (5 mg/l), and polymyxin B (2500 IU/l) (Oxoid); and Preston campylobacter blood free medium with cefoperazone (32 mg/l) (Oxoid). The media were incubated at 43°C for 24 hours in a microaerophilic atmosphere (5% O_2, 10% CO_2) provided by microaerophilic systems (Campy Pak Plus BBL).

The suspected strains were examined for oxidase reaction, and tested for in vitro sensitivity to nalidixic acid and hippurate. In vitro, these strains were susceptible to erythromycin, cephalosporins, and trimethoprim sulphamethoxazole.

C jejuni is now recognised as a major cause of both endemic and epidemic gastroenteritis.[3 4] Unlike the closely related organism *Campylobacter fetus, C jejuni* is not frequently associated with bacteraemia.[2] *C jejuni* enteritis may lead to bacteraemia, but its actual incidence remains unknown.[1] *C fetus intestinalis* is an opportunist organism that infects adults, often elderly, debilitated persons, causing systemic illness, including bacteraemia. Similar cases of localised infections due to *C fetus* subspecies *intestinalis* secondary to bacteraemia, have been reported: patients with arthritis[5]; pericarditis;[6] and receiving continuous ambulatory peritoneal dialysis.[7 8] Strains of *C fetus* are highly resistant to the bactericidal activity of normal human serum. In contrast, *C jejuni* and *C coli* are said to be susceptible to the antibacterial activity of serum.[9]

In a study by Tee *et al* only 0·7% of patients with *C jejuni* diarrhoea had bacteraemia.[10] This may have been due to the fact that many strains of *C jejuni* appear to be serum susceptible. This susceptibility seems to require normal concentrations of complement and preformed antibody in the serum.[9] Immunocompromised patients who lack the capacity to respond with the production of antibody specific for *C jejuni* are susceptible to infection with this organism.

The strains of *Campylobacter* isolated from the blood of the patient with appendicitis complicated by enteric fistula, and the patient with colonic adenocarcinoma probably follow on from transluminal migration of intestinal bacteria after changes in the intestinal wall.[7] *C jejuni* and bacteraemia can occur in immune deficient patients and patients with changes in the intestinal wall with a minimum of symptoms. Five out of seven of our cases with bacteraemia caused by *Campylobacter* spp had previous or concomitant diarrhoea attributable to the same micro-organism. This suggests that *Campylobacter* spp penetrate through the intestinal mucosa in the absence of changes in the intestinal wall.

Patients who develop diarrhoea as a result of *Campylobacter* spp infection are at risk of bacteraemia from this organism.

1 Butzler JP, Skirrow MB. Campylobacter enteritis. *Clin Gastroenterol* 1979;**8**:737–65.
2 Johnson RJ, Nolan C, Wang SP, *et al.* Persistent Campylobacter jejuni infection in an immunocomprised patient. *Ann Intern Med* 1984;**100**;832–4.
3 Blaser MJ, Rellen LB. Campylobacter enteritis. *N Engl J Med* 1981;**305**:1444–52.
4 Karmali MA, Fleming PC. Campylobacter enteritis in children. *J Pediatr*, 1978;**94**:527–33.
5 Kutner LJ, Arnold WD. Septic arthritis due to Vibrio fetus. *J Bone Joint Surg* 1970;**52**:161–4.
6 Killiam HA, Crowder JG, White AC, Edmons JM Jr. Pericarditis due to Vibrio fetus. *Am J Cardiol* 1966;**17**: 723–8.
7 Veron S, Dominguez C. Campylobacter and peritoneal dialysis. *Ann Intern Med* 1982;**96**:534.
8 Ladrón de Guevara C, Selgas R, García-Perea A. A new case of peritonitis due to Campylobacter jejuni in CAPD. *Peri Dial Int* 1992;**12**:268–9.
9 Blaser MJ, Smith PF, Kohler PF. Susceptibility of Campylobacter isolates to the bactericidal activity of human serum. *J Infect Dis* 1985;**151**:227–35.
10 Tee W, Kaldor J, Dwyer B. Epidemiology of Campylobacter diarrhoea. *Med J Aust* 1986;**145**:499–503.