Clinical Communications

Chronic or recurrent *Campylobacter* enteritis in primary immunodeficiency: A UK national case-series and review of the literature

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Clinical Implications

Campylobacter infection is an important diagnosis to consider in primary immunodeficiency patients with chronic or recurrent diarrhea, particularly in those with very low diagnostic immunoglobulin levels. Macrolides, aminoglycosides, and/or carbapenems are promising treatment options for this potentially debilitating condition.

Campylobacter infection, usually by *Campylobacter jejuni*, is the most common cause of bacterial enteritis in the world. In healthy individuals, the infection is self-limiting, but in patients with immunodeficiency, recurrent or persistent symptomatic infection may occur. In this case series, we present a cohort of primary immunodeficiency patients with chronic or recurrent *Campylobacter* enteritis from the United Kingdom and review the previously published literature.

To identify relevant cases, a request was circulated via the UK Clinical Immunology mailing list, which includes 41 centers. Primary immunodeficiency (PID) cases with confirmed *Campylobacter* in stool or colonic tissue, by culture or PCR, and symptoms of longer than 3-month duration or 3 or more symptomatic flares, were included. Successful clearance of the infection was defined as resolution of symptoms and no recurrence for at least 3 months. In parallel, a literature review was performed to identify previously published cases in PubMed, using the terms "chronic," "recurrent," "*Campylobacter*," "enteritis," "diarrhoea," "immune deficiency," "immunodeficiency," and "hypogammaglobulinemia."

Six centers replied, reporting 13 cases of chronic or recurrent *Campylobacter* enteritis in total: 4 from Queen Elizabeth Hospital (Glasgow), 3 from Southmead Hospital (Bristol), 2 from Royal London Hospital (London), 1 from Frimley Park Hospital (Surrey), 1 from Derriford Hospital (Plymouth), 1 from Northern Care National Health Service Foundation Trust (Greater Manchester), and 1 from Gloucester Royal Hospital (Gloucester).

Patients were all adults, aged 21 to 71 years, with the vast majority (n = 12) having common variable immunodeficiency (CVID, Table I). Laboratory investigations at diagnosis revealed undetectable (<0.1 g/L) serum IgA in 85% (11 of 13) of cases and IgM in 62% (8 of 13). Where data were available, very low (<1 g/L) pretreatment serum IgG was seen in 67% (6 of 9) of cases. Low circulating B cells ($<0.1 \times 10^9$ cells/L), natural killer cells ($<0.1 \times 10^9$ cells/L), and T cells ($<0.67 \times 10^9$ cells/L) were seen in 58% (7 of 12), 33% (4 of 12), and 17% (2 of 12) of cases, respectively. In patients with normal B cells and where B-cell immunophenotyping was performed, 67% (2 of 3) had low (<2%) class-switched memory B cells (Table I).

The total duration of gastrointestinal symptoms varied from 10 months to 17 years, and symptoms were intermittent in 6 patients (Table II). Three patients also exhibited malabsorption and/or weight loss, and 4 had systemic symptoms and/or bacteremia. In all cases, *Campylobacter jejuni* was isolated, with 3 patients harboring strains that were resistant to multiple antibiotics. Detection was by stool culture in most (n = 11), but 2 patients were positive only by colonic tissue culture or PCR analysis. In certain patients, other potential causes of chronic diarrhea were detected, for example, colon inflammation, duodenal villous atrophy, and chronic norovirus infection (Table II). Clinically however, *Campylobacter* remained the most likely cause for their symptoms, with onset and resolution of the diarrhea coinciding with *Campylobacter* detection (Table II).

Fifty-eight percent (7 of 12) of patients were on adequate immunoglobulin replacement (serum IgG trough ≥ 8 g/L) when they developed enteritis (Table I). In patients who successfully cleared the infection and had no relapse, oral macrolides (n = 5, azithromycin, clarithromycin, or erythromycin) and intravenous carbapenems (n = 4, meropenem or ertapenem) were most commonly used, followed by aminoglycosides (n = 3, eg, neomycin), oral ciprofloxacin (n = 3), and coamoxiclav (n = 1), either alone or in combination.

A literature review identified 32 published cases of recurrent or persistent *Campylobacter* enteritis or multiple *Campylobacter spp*. stool isolation in PID (see Table E1 in this article's Online Repository at www.jaci-inpractice.org). Most were in X-linked agammaglobulinemia (XLA, n = 17), whereas 5 were in CVID and 3 in Good syndrome. Based on their diagnosis, very low or absent circulating B cells were expected to be present in at least 69% (22 of 32) of these cases, 18 with agammaglobulinemia and 3 with Good syndrome.

The total duration of symptoms varied from 3 months to 15 years and resulted in weight loss in 7 of 32 (22%) cases. Sixty-six percent (21 of 32) also developed *Campylobacter* bacteremia, in some cases recurrent. Most stool cultures revealed *C jejuni* (n = 25), with *Campylobacter coli* being isolated in 6 cases and 1 patient harboring both.

At least 20 of 32 (63%) patients were on immunoglobulin replacement when they developed enteritis, and these cases were more likely to clear the infection (80% vs 58% those who were not). The institution of immunoglobulin therapy alone led to resolution of the infection in 3 of 32 (9%) patients.[1,2] In those patients who successfully cleared the infection, oral macrolides were most commonly used (n = 10; erythromycin, clarithromycin, or azithromycin), followed by aminoglycosides (n = 5; neomycin, gentamicin, netilmicin, or kanamycin), carbapenems (n = 5; meropenem, biapenem, or imipenem),

TABLE I. UK cohort with PID and recurrent or persistent *Campylobacter* enteritis: Immunologic profile

Case	Immune deficiency	Comorbidities	Diagnostic serum immunoglobulin levels (g/L) & postvaccination responses (where data are available)	Diagnostic lymphocyte subsets ($\times 10^9$ cells/L)	Immunoglobulin replacement (at *Campylobacter* diagnosis)	Trough immunoglobulin level (at *Campylobacter* diagnosis)
1	CVID	Bronchiectasis, proliferative bronchiolitis, asthma, obesity, raised alcohol intake	Undetectable IgA & IgM	B cells 0.05, normal T & NK cells	IVIg 25 g every 3 wk	8 g/L
2	CVID	Excised brain tumor with residual learning difficulties, previous B-cell lymphoma, pulmonary nodules, splenomegaly	IgG 0.8, undetectable IgA & IgM	B cells <0.01, T cells 0.15, NK cells <0.01	IVIg 70 g every 2 wk	13.1 g/L
3	CVID	Intermittent low-level CMV and EBV viremia	IgG 19 (units /mL), undetectable IgA, IgM 0.11	B cells 0.02 T cells 0.14, NK cells 0.01 (class-switch memory B cells 0.9%, CD21 low B cells 6%)	IVIg 30 g every 3 wk	6.2 g/L
4	CVID	None	Undetectable IgG, IgA, & IgM with poor response to Pneumococcal polysaccharide vaccine	B cells <0.01, normal T cells, NK cells 0.03	SCIg 20 g every week	12.1 g/L
5	CVID (NFKB2 mutation)	Asthma, chronic rhinosinusitis	IgG 3.6, undetectable IgA, IgM 0.16 with poor response to Pneumococcal polysaccharide vaccine	B cells 0.01, normal T & NK cells	IVIg 40 g every 3 wk	10.9 g/L
6	CVID	Bronchiectasis, hypersplenism, ulcerative colitis	Undetectable IgA & IgM	NA	SCIg 14 g every week	11 g/L
7	XLA (btk mutation confirmed)	Bronchiectasis	IgG 0.73, undetectable IgA, IgM 0.29	B cells <0.01, normal T & NK cells	IVIg 40 g every 3 wk	10.4 g/L
8	CVID	None	IgG 0.7, undetectable IgA & IgM with poor response to Pneumococcal polysaccharide vaccine	Normal B, T, & NK cells (class- switch memory B cells 1%)	IVIg 35 g every 3 wk	7.5 g/L
9	CVID	Bronchiectasis	IgG 3.8, IgA 0.53, IgM 0.61 with poor response to Pneumococcal polysaccharide vaccine	Normal B, T, & NK cells	No (patient declined)	3.8 g/L

10	CVID	None	Undetectable IgA & IgM	B cells 0.03, normal T cells, NK cells 0.05	IVIG 30 g every 3 wk	NA
11	CVID	Interstitial lung disease, ischemic heart disease	Undetectable IgG, IgM, & IgA with poor response to Pneumococcal polysaccharide vaccine	Normal B, T, & NK cells (class- switch memory B cells 0.6%)	No (began after *Campylobacter* diagnosis)	<1.1 g/L
12	CVID	Bronchiectasis, chronic sinusitis	IgG 0.69, undetectable IgA & IgM with poor response to Pneumococcal polysaccharide vaccine	Normal B, T, & NK cells	SCIg 12 g every week	11.7 g/L
13	CVID	Liver nodular regenerative hyperplasia, monoclonal gammopathy of undetermined significance	IgG 3.37, IgA 0.38, IgM 0.25 with poor response to Pneumococcal polysaccharide vaccine	Normal B, T, & NK cells (class-switch memory B cells 6.3%)	No (patient declined)	3.4 g/L

CMV, Cytomegalovirus; *EBV*, Epstein Barr virus; *IVIg*, intravenous immunoglobulin; *NA*, not available; *NK*, natural killer; *SCIg*, subcutaneous immunoglobulin.
Undetectable = <0.1 g/L for IgA & IgM, <1 g/L for IgG.

tetracyclines (n = 4; doxycycline or minocycline), metronidazole (n = 3), fosfomycin (n = 2), ciprofloxacin (n = 1), and piperacillin (n = 1). Antibiotics were administered for a duration of 4 or more weeks in 7 of 32 (22%) cases.

Overall, recurrent or persistent *Campylobacter* enteritis may contribute to significant morbidity in patients with PID, including debilitating diarrhea, malabsorption, weight loss, electrolyte disturbances, and bacteremia. A high index of suspicion for *Campylobacter* infection should be kept in these patients, particularly in those who have previously tested positive. *Campylobacter* can persist in the intestinal tract only giving intermittent symptoms and reinfection is commonly by the same microorganism.[3] Furthermore, *Campylobacter* is difficult to grow even in specific culture media, and there are no validated consensus mechanisms to measure the bioburden in the gut flora, let alone eradication.[4] Colonic tissue culture or stool PCR may thus be necessary in patients with ongoing symptoms.[4] Other causes of chronic diarrhea should also be considered in these patients, particularly in those who remain symptomatic despite *Campylobacter* eradication.

Most cases in our series were patients with CVID (12 of 13), in contrast to previously published cases where XLA was the most frequent diagnosis (17 of 32). This may echo improvements in patient management, with more patients being treated with adequate immunoglobulin replacement in recent years. The fact that fewer patients were suspected to be bacteremic in our cohort compared with previously published literature (31% vs 66%) also suggests the latter.

The cases described above highlight the importance of humoral immunity in the prevention of chronicity or reinfection from *Campylobacter spp*. Previously published case reports suggest that patients who are on immunoglobulin therapy are more likely to clear the infection and immunoglobulin therapy alone led to eradication in a few cases. Most patients in our case series also had undetectable or very low diagnostic immunoglobulin levels. It is well established that most patients with CVID and XLA lack plasma cells in the lamina propria of their small and/or large intestine and this is important because the intestinal mucosa normally harbors the largest population of antibody-secreting plasma cells in the body.[5]

Interestingly, 58% of patients in our case series also had low or absent circulating B cells. This contrasts with what is known for CVID, where only 10% to 20% are expected to have low B cells.[6] This finding was echoed by the literature review, where 69% of patients were expected to have very low or absent circulating B cells based on their diagnosis. Low circulating B cells also seem to play an important role in the predisposition to other chronic gastrointestinal infections, like norovirus.[7] Finally, 42% of patients in our case series had inadequate serum immunoglobulin trough levels when diagnosed with *Campylobacter* enteritis. These observations suggest that patients with CVID who are not maintained on adequate immunoglobulin replacement are at a higher risk of infection. In patients with CVID and low B cells in particular, higher IgG therapeutic targets may need to be considered.

HIV-infected patients can also develop chronic or recurrent *Campylobacter* enteritis,[8] but even in these patients, humoral immunity seems to play a key role: HIV patients who fail to clear the infection have poor *Campylobacter*-specific antibody responses while low CD4 T-cell levels do not seem to correlate with a worse outcome.[9]

TABLE II. UK cohort with PID and recurrent or persistent *Campylobacter* enteritis: Clinical features, microbiology, and antimicrobial therapy

Case	Age at symptoms onset (y), sex	Gastrointestinal symptoms/ malabsorption, and duration	No. of *Campylobacter*-positive samples	Other GI investigations	Systemic symptoms	Unsuccessful antibiotic courses (temporary or no clinical improvement)	Successful antibiotic course (symptoms resolution & no recurrence for >3 mo)
1	42, M	Chronic diarrhea for 10 mo	10× *Campylobacter jejuni* (MCS stool, multiresistant)	Stool: calprotectin normal; negative for other bacteria, parasites, Norovirus, Enterovirus; GI endoscopy: chronic active pancolitis	None	Multiple PO clarithromycin, IV ertapenem, IV meropenem	IV 1 g once a day ertapenem for 4 wk with PO neomycin for 7 d
2	55, M	Intermittent diarrhea with malabsorption and weight loss for 8 y	13× *C jejuni* (MCS stool, multiresistant)	Stool: calprotectin >600 µg/g; Norovirus+, negative for other bacteria, parasites, Enterovirus; GI endoscopies: chronic villous atrophy in duodenum, widespread focal active colitis	Episodes of arthralgia, headache and fever but negative blood MCS for *Clostridium difficile*	PO doxycycline, clarithromycin, azithromycin, ciprofloxacin, cotrimoxazole	IV 1 g once a day ertapenem for 4 wk with PO neomycin for 7 d
3	53, M	Intermittent diarrhea for 17 y	3× *C jejuni* (MCS stool)	Stool: Norovirus+ negative for other bacteria, parasites; GI endoscopies: antral gastritis, increased intraepithelial lymphocytes and substantial villous atrophy in duodenum, mild active chronic inflammation without granulomata in colon	None (blood MCS not tested)	PO coamoxiclav, neomycin, rifaximin, immunoglobulin; IV meropenem, ertapenem	(spontaneous resolution)
4	60, M	Chronic diarrhea with malabsorption and weight /protein loss	3× *C jejuni* (PCR & MCS stool, multiresistant)	Stool: negative for other bacteria, parasites, Norovirus, Enterovirus, Adenovirus, Astrovirus, Rotavirus, Sapovirus; GI endoscopies: nil significant	Several episodes of bacteremia (MCS confirmed)	PO azithromycin; IV carbapenem, aminoglycoside, chloramphenicol	IV meropenem & aminoglycoside, PO ciprofloxacin

5	32, F	Chronic diarrhea for 2 y	4× *C jejuni* (PCR & MCS stool)	Stool: calprotectin 116 µg/g; Norovirus+, *Helicobacter pylori*+ Negative for other bacteria, parasites, Enterovirus, Adenovirus, Astrovirus, Rotavirus, Sapovirus	None (blood MCS not tested)	None	PO azithromycin 500 mg once a day with ciprofloxacin 500 mg twice a day for 3 wk
6	54, M	Chronic diarrhea for 10 mo	3× *C jejuni* (2× MCS & 1× PCR stool)	Stool: negative for other bacteria, parasites	None	PO erythromycin, azithromycin, coamoxiclav	(ongoing infection)
7	24, M	Intermittent diarrhea for 3 y	>10× *C jejuni* (MCS stool)	Stool: *H pylori*+, calprotectin 500 µg/g; negative for other bacteria, parasites, Norovirus, Adenovirus, Astrovirus, Rotavirus, Sapovirus; GI endoscopy: colon cryptitis with crypt abscesses	Episode of suspected bacteremia (blood MCS not tested)	PO ciprofloxacin, azithromycin	IV meropenem for 10 d
8	29, M	Intermittent diarrhea for 12 y	2× *C jejuni* (MCS stool)	None	None (blood MCS not tested)	None	PO clarithromycin
9	26, F	Chronic diarrhea for 6 mo with weight loss	1× *C jejuni* (MCS colonic tissue)	Stool: calprotectin 907 µg/g; negative for other bacteria, parasites; GI endoscopy: severe inflammation in lamina propria with cryptitis, crypt abscess formation and prominent lymphoid follicles in right & transverse colon, mild chronic inflammatory infiltrate in left colon, negative CMV stains	Fevers but negative blood MCS for *C difficile*	PO ciprofloxacin	PO azithromycin 500 mg once a day for 2 wk
10	60, M	Intermittent diarrhea for 15 y with weight loss	5× *C jejuni* (MCS stool)	None	None (blood MCS not tested)	None	PO erythromycin 500 mg 4 times a day for 2 wk

(continued)

TABLE II. *(Continued)*

Case	Age at symptoms onset (y), sex	Gastrointestinal symptoms/ malabsorption, and duration	No. of *Campylobacter*-positive samples	Other GI investigations	Systemic symptoms	Unsuccessful antibiotic courses (temporary or no clinical improvement)	Successful antibiotic course (symptoms resolution & no recurrence for >3 mo)
11	71, M	Intermittent diarrhea for 8 y	3× *C jejuni* (MCS stool)	Stool: negative for other bacteria, parasites, Norovirus, Adenovirus, Astrovirus, Rotavirus, Sapovirus; GI endoscopy: normal colon	None (blood MCS not tested)	PO clarithromycin 500 mg twice a day for 2 wk	(patient passed away)
12	48, F	Intermittent diarrhea for 4 y	4× *C jejuni* (MCS stool)	Stool: calprotectin >600 μg/g; negative for other bacteria, parasites, Norovirus, Adenovirus, Astrovirus, Rotavirus, Sapovirus	None (blood MCS not tested)	PO ciprofloxacin 500 mg twice a day for 2 wk, clarithromycin 3 d (not tolerated)	PO ciprofloxacin 500 mg twice a day for 2 wk
13	55, F	Intermittent diarrhea for 8 y	2× *C jejuni* (MCS stool)	Stool: negative for other bacteria, parasites, Norovirus, Adenovirus, Astrovirus, Rotavirus, Sapovirus; GI endoscopy: focal mild acute inflammation in cecum	None (blood MCS not tested)	None	PO clarithromycin 500 mg twice a day for 1 wk

F, female; *GI*, gastrointestinal; *IV*, intravenous; *M*, male; *MCS*, microscopy, culture & sensitivities, includes screen for *Salmonella*, *Shigella*, *Giardia*, *Escherichia coli O157*, *Cryptosporidium, Giardia*; PO, *per os* (by mouth); *PCR,* polymerase chain reaction.

In conclusion, *Campylobacter* enteritis is an important diagnosis to consider in patients with PID with chronic or recurrent diarrhea, particularly in those with very low diagnostic immunoglobulin levels. Diarrhea in CVID can be highly multifaceted and other potential causes should always be considered.

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TABLE E1. Previously published cases of chronic/recurrent *Campylobacter* enteritis or *Campylobacter spp*. stool isolation in PID

Lead author, year of publication	Age of onset (y), sex	Immune deficiency	Immunoglobulin replacement	Symptoms	No. of Campylobacter + stool samples	Failed treatments (temporary or no clinical improvement)	Definitive treatment (resulting in symptom resolution)
Aguilar-Company et al,[E1] 2016	64, F	CVID	IVIg every 3 wk	Diarrhea and hypovolemic shock	1× *Campylobacter jejuni*, 1× *Campylobacter coli*	NR	PO fosfomycin 3 g every 48 h for 6 wk
Barker et al,[E2] 2020	NR	CVID	NR	Intermittent diarrhea for 15 y	25× *C jejuni*	NR	NR
Merrick et al,[E3] 2022	70, F	CVID	IVIg 20 g every 2 wk	Intermittent diarrhea for 6 y, episode of bacteremia	6× *C jejuni*	PO clarithromycin, erythromycin, fosfomycin; IV meropenem; fecal microbiota transplant	NR
Ward et al,[E4] 1984	42, M	CVID	NR	Intermittent diarrhea, malabsorption, weight loss for 7 mo	3× *C jejuni*	PO chloramphenicol, erythromycin	IV metronidazole 2 g/d and neomycin 1 g/d
Lebar et al,[E5] 1985	39, F	CVID	None	Intermittent diarrhea, vomiting, and 2 episodes of bacteremia for 8 mo	2× *C jejuni*	NR	IV gentamicin 70 mg for a week; PO erythromycin 500 mg 4 times a day for 2 wk
Lebar et al,[E5] 1985	24, M	XLA	None	Intermittent diarrhea, vomiting, and 4 episodes of bacteremia for 8 mo	4× *C jejuni*	IV tobramycin	NR
Van de Bruele et al,[E6] 2010	15, M	XLA	IVIg every 4 wk	Diarrhea, weight loss, and 2 episodes of bacteremia for 18 mo	2× *C jejuni*	PO erythromycin; IV meropenem	PO doxycycline for 4 wk and azithromycin for 2 wk
Van der Meer et al,[E7] 1986	24, M	XLA	NR	Diarrhea, fever	4× *C jejuni*	PO cotrimoxazole, neomycin, doxycycline; IV gentamicin	NR
Schonheyder et al,[E8] 1995	23, M	XLA	NR	Weight loss and 2 episodes of bacteremia for 4 wk	1× *C coli*	Penicillin	IV netilmicin for 10 d and IVIg
Tokuda et al,[E9] 2004	22, M	XLA	IVIg every 3 wk	2 episodes of bacteremia in 5 mo	2× *C coli*	PO clarithromycin; IV ceftazidime, cefazolin, amikacin, panipenem/ betamipron	PO kanamycin 750 mg 4 times a day
Chusid et al,[E10] 1987	11, M	XLA	IVIg every 4 wk	Bacteremia for 6 wk	>3× *C coli*	NR	PO erythromycin; IV erythromycin, gentamicin, piperacillin
Hagiya et al,[E11] 2018	37, M	XLA	IVIg every 3 wk	3 episodes of bacteremia in 12 mo	1× *C coli*	PO tebipenem; IV cefazolin, meropenem	IV biapenem 600 mg twice a day; PO minocycline 100 mg twice a day for 2 wk, metronidazole 250 mg 4 times a day for 4 wk
Ariganello et al,[E12] 2013	11, M	XLA	IVIg every 4 wk	Intermittent diarrhea, and 2 episodes of bacteremia for 12 mo	1× *C jejuni*	PO ciprofloxacin; IV ceftriaxone, vancomycin	IV meropenem, clarithromycin

Rafi et al,[E13]2002	NR	XLA	IVIg every 4 wk	2 episodes of bacteremia in 2 y	1× *C jejuni*	IV erythromycin, ceftazidime	NR
Borleffs et al,[E14] 1993	23, M	XLA	IVIg every 3 wk	2 episodes of bacteremia in 6 mo	2× *C jejuni*	PO ciprofloxacin; IV imipenem	IV pentaglobin 500 mL every 3 wk
Borleffs et al,[E14] 1993	25, M	XLA	IVIg every 3 wk	3 episodes of bacteremia in 6 mo	3× *C jejuni*	PO ciprofloxacin; IV imipenem, erythromycin	IV pentaglobin 500 mL every 3 wk
Kim et al,[E15] 2017	18, M	XLA (suspected)	IVIg every 3 wk	Intermittent diarrhea, and 4 episodes of bacteremia for 18 mo	2× *C jejuni*	PO amoxicillin/ clavulanate, roxithromycin, clarithromycin, doxycycline; IV cefazolin, meropenem, amikacin	NR
Autenrieth et al,[E16] 1996	7, M	XLA	IVIg every 4 wk	Intermittent diarrhea, and 4 episodes of bacteremia for 18 mo	Several *C jejuni*	IV amoxicillin, doxycycline, imipenem, pentaglobin; PO bovine colostrum	PO ciprofloxacin 250 mg twice a day for 3 wk; IV maternal plasma for 5 wk
Arai et al,[E17] 2007	35, M	XLA	IVIg every 4 wk	4 episodes of bacteremia in 18 mo	2× *C coli*	IV cefepime	IV meropenem; PO minocycline
Van der Meer et al,[E7] 1986	24, M	XLA	IVIg	Intermittent diarrhea, and 5 episodes of bacteremia for >1 y	2× *C jejuni*	PO cotrimoxazole, neomycin, doxycycline; IM gentamicin	NR
Kerstens et al,[E18] 1992	24, M	XLA	SCIg	Intermittent diarrhea, and 3 episodes of bacteremia for 5 y	3× *C jejuni*	PO erythromycin, amoxicillin, flucloxacillin	IV imipenem 500 mg 4 times a day for 6 wk
Kerstens et al,[E18] 1992	26, M	XLA	SCIg	2 episodes of bacteremia in 2 wk	2× *C jejuni*	PO erythromycin; IV amoxicillin, flucloxacillin, gentamicin	IV imipenem 500 mg 4 times a day for 2 wk
Pines et al,[E19] 1983	28, F	Agammaglobulinemia	IVIg	Diarrhea, weight loss, for 3 mo	2× *C jejuni*	PO cotrimoxazole	PO erythromycin 1 g thrice a day and metronidazole 500 mg 4 times a day
Aguilar-Company et al,[E1] 2016	83, F	Good syndrome	IVIg every 2 wk	Intermittent diarrhea for 6 mo	1× *C coli*	PO amoxicillin /clavulanate	PO fosfomycin 3 g every 48 h for 4 wk
Tarr et al,[E20] 2001	57, M	Good syndrome	IVIg every 4 wk	Intermittent diarrhea with episodes of bacteremia for 7 mo	3× *C jejuni*	NR	Antibiotics (not specified)
Green et al,[E21] 1984	51, M	Good syndrome	NR	Chronic diarrhea and weight loss for 4 mo	1× *C jejuni*	NR	PO erythromycin 500 mg twice a day for a week
Lever et al,[E22] 1984	36, F	Hypogammaglobulinemia	IVIg every 2 wk	Intermittent diarrhea with weight loss for 6 y	5× *C jejuni*	PO erythromycin, tetracycline	IV erythromycin 600 mg thrice a day for 2 wk followed by PO 500 mg 4 times a day for 2 wk
Johnson et al,[E23] 1984	26, F	Hypogammaglobulinemia	None	Intermittent diarrhea and 4 episodes of bacteremia for 12 mo	6× *C jejuni*	PO amoxicillin, gentamicin, erythromycin; IV amoxicillin, gentamicin, tobramycin, amikacin	PO doxycycline 100 mg once a day for months

(continued)

TABLE E1. *(Continued)*

Lead author, year of publication	Age of onset (y), sex	Immune deficiency	Immunoglobulin replacement	Symptoms	No. of Campylobacter + stool samples	Failed treatments (temporary or no clinical improvement)	Definitive treatment (resulting in symptom resolution)
Moore et al,[E24] 2001	NR, M	Hypogammaglobulinemia	NR	Intermittent diarrhea and 4 episodes of bacteremia for 2 y	2× *C jejuni*	NR	NR
Ahnen et al,[E25] 1982	63, M	Hypogammaglobulinemia	NR	Intermittent diarrhea for 2 y	4× *C jejuni*	PO erythromycin	PO erythromycin
Ahnen et al,[E26] 1982	39, F	Hypogammaglobulinemia	NR	Intermittent diarrhea for 25 y	2× *C jejuni*	PO erythromycin	NR
Ponka et al,[E26] 1983	67, F	Hypogammaglobulinemia	NR	Diarrhea and weight loss for 4 mo	2× *C jejuni*	PO erythromycin	PO erythromycin 250 mg 4 times a day for 3 wk

F, female; *IM*, intramuscular; *IV*, intravenous; *IVIg*, intravenous immunoglobulin; *M*, male; *NR*, not reported; *PO*, *per os* (by mouth); *SCIg*, subcutaneous immunoglobulin.

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