Comparison of Characteristics of Patients Infected by *Campylobacter jejuni*, *Campylobacter coli*, and *Campylobacter fetus*

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A large database of *Campylobacter* isolates precisely identified at the species level was used to compare patients’ characteristics. In a multivariate analysis, *Campylobacter coli* was found more often in older patients and in patients having traveled abroad and less often in summertime than *Campylobacter jejuni*. *Campylobacter fetus* infection occurred in much older patients and in hospitalized patients with a systemic disease.

Thermotolerant *Campylobacter* spp. are recognized as the leading cause of bacterial enteric infections worldwide, while *Campylobacter fetus* often causes systemic infection.

A subset of French clinical laboratories participates in the surveillance of *Campylobacter* infection, carried out by the National Reference Centre (NRC) for Campylobacters and Helicobacters under the leadership of the Institut de Veille Sanitaire (InVS), sending approximately a quarter of campylobacters isolated in France to the NRC.

Our aim was to use this large database (>22,000 strains) to look for differences in the characteristics of the patients and the circumstances under which these *Campylobacter* species were isolated.

(The results of this study were presented as posters at the European Congress of Clinical Microbiology and Infectious Diseases, London, United Kingdom, 2012, and at the Réunion Interdisciplinaire de Chimiothérapie Anti-infectieuse, Paris, France, November 2012.)

Network of laboratories. The laboratories sending strains were not randomly selected but were contacted from the list of laboratories already sending isolated *Salmonella* species to the corresponding NRC. A survey performed in 2009 showed that equal proportions of all strains isolated came from the different regions, with a few exceptions (InVS-NRC, unpublished data). The methods used by these laboratories to isolate *Campylobacter* species were fairly uniform, including the use of Karmali medium or Campyloisol (bioMérieux, Marcy l’Etoile, France) but no filtration techniques.

Identification of campylobacters at the NRC. All of the *Campylobacter* isolates were identified by phenotypic methods at the genus level. From 2003 to 2009, identification to species level was performed both by standard phenotypic methods and a real-time PCR targeting the *gyrA* gene (accuracy, 99.9%) to differentiate *Campylobacter jejuni* and *Campylobacter coli* (1). In the case of negative results, primers specific for *C. fetus* were used. If no result was obtained, a PCR specific for *Arcobacter* species was carried out (2). These PCRs allowed the identification of approximately 99% of the isolates. For the remaining 1%, the 16S rRNA gene was sequenced. In 2010, these methods were replaced by matrix-assisted laser desorption ionization–time-of-flight (MALDI-TOF) mass spectrometry identification, which has an accuracy of 99.4% for *C. jejuni* and 100% for the other *Campylobacter* species (3).

Susceptibility testing was performed by disk diffusion with the same methods and cutoffs from the Comité de l’Antibiogramme de la Société Française de Microbiologie (CA-SFM) that have been used during all the years.

Database analysis. The following information was collected: patient age, patient gender, month of isolation, region of France, whether the disease was part of an outbreak or a sporadic infection, whether the patient had traveled abroad, whether the patient was hospitalized or an outpatient, type of specimen, and quinolone and ampicillin resistance of the isolated strain.

Univariate and multivariate analyses were performed on the characteristics of the different species using the program SPSS v. 11.5.

A total of 22,244 isolates, obtained from both hospital and private laboratories, were studied between 2003 and 2010 (Table 1). No significant difference between the proportions of the different species was observed in different years.

Comparison between *C. jejuni* and *C. coli* infection. Two regression models were performed, one without antibiotics (Table 2) and the other with antibiotics, and gave similar results; i.e., age, travel, and season, after adjustment for the other variables, remained significantly different for *C. jejuni* and *C. coli*. A higher risk of being infected by *C. coli* was found in older persons (34.6 years) compared to *C. jejuni* (27.5 years), a person who had traveled abroad in the preceding 2 weeks had a higher risk of being infected by *C. coli*, and in the summertime (May to September), a person had a higher risk of being infected by *C. jejuni* than *C. coli*.

Comparison of *C. jejuni*/*C. coli* versus *C. fetus*. The same analyses were performed for the thermotolerant campylobacters *C. jejuni* and *C. coli* taken together versus *C. fetus*. In the multivariate analysis (Table 2), the difference in the mean age of infected patients, 28.6 years for *C. jejuni*/*C. coli* versus 68.4 years for *C. fetus*, was very significant. *C. fetus* infection led much more often to hospitalization than *C. coli* or *C. jejuni* infection. Furthermore, *C. fetus* was isolated more often from blood samples than *C. coli* or *C. jejuni*.
the hotter period of the year (10). Furthermore, eating habits tend
than 22,000 cases of infection by Campylobacter
The main advantage of this study is the large number of cases
for which precise species identification was carried out, i.e., more
Tabelle 2 Regression model comparing Campylobacter infectionsa
C. jejuni. C. jejuni/coli were significantly more often isolated dur-
C. fetus (P < 0.001).
The number of Campylobacter and related bacterial isolates
identified at the French National Reference Center, 2003 to 2010

<table>
<thead>
<tr>
<th>Species or subspecies</th>
<th>No. (%) of isolates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Campylobacter jejuni</td>
<td>17,625 (79.23)</td>
</tr>
<tr>
<td>Campylobacter coli</td>
<td>3,393 (15.25)</td>
</tr>
<tr>
<td>Campylobacter fetus</td>
<td>875 (3.93)</td>
</tr>
<tr>
<td>Campylobacter lari</td>
<td>95 (0.42)</td>
</tr>
<tr>
<td>Campylobacter upsaliensis</td>
<td>27 (0.12)</td>
</tr>
<tr>
<td>Campylobacter hyointestinalis</td>
<td>9</td>
</tr>
<tr>
<td>Campylobacter jejuni subsp. dayeii</td>
<td>3</td>
</tr>
<tr>
<td>Campylobacter sporum subsp. sporum</td>
<td>1</td>
</tr>
<tr>
<td>Campylobacter concisus</td>
<td>1</td>
</tr>
<tr>
<td>Arcobacter butzleri</td>
<td>172 (0.77)</td>
</tr>
<tr>
<td>Arcobacter cryueroophilus</td>
<td>13</td>
</tr>
<tr>
<td>Arcobacter skirrowii</td>
<td>1</td>
</tr>
<tr>
<td>Helicobacter pullorum</td>
<td>15</td>
</tr>
<tr>
<td>Helicobacter canadensis</td>
<td>12</td>
</tr>
<tr>
<td>Sutterella wadsworthiensis</td>
<td>1</td>
</tr>
<tr>
<td>Anaerobiospirillum succiniciproducens</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>22,244</td>
</tr>
</tbody>
</table>

* Percentage of isolates.

C. fetus, a bacterium leading to severe life-threatening infections (7), is the third
most prevalent cause of Campylobacter infections (approximately 4% of the cases).
The large number of C. jejuni and C. coli isolates allowed us to
compare the characteristics of the corresponding infection, for
which there are very limited data in the literature. There is a 7-year
difference in the mean age of C. jejuni-infected patients (27.5
years) and C. coli-infected patients (34.6 years) (P = 0.001). A
difference in age of borderline significance was also found in the
study by Gillespie et al. (5), while the mean age was higher, 38.5
years for C. jejuni versus 42.9 years for C. coli. This difference
appears to be real but cannot be explained.
Travel abroad is a prominent risk factor for Campylobacter
infection in some northern countries, like Norway, where it
occurred in 65% of the cases (8), but less common in others, like
Scotland (17%) (9), where it is in the same range as in France.

In our study, we showed that C. coli is more frequently associ-
ated with a history of a travel abroad (P = 0.001) and is probably
linked to eating habits in countries in the south (Morocco, West
Indies, India, etc.). A similar association was found in a subgroup
of patients of South Asian origin (5). C. jejuni infection, unlike C.
coli infection, has a marked seasonality, and its occurrence almost
doubles in the summertime. This can be explained by a higher
contamination of food, especially poultry, with C. jejuni during
the hotter periods of the year (10). Furthermore, eating habits tend
to be different in the summertime, with consumption of more

barbecued, undercooked poultry and possibly cross contamination
of salads.
In contrast to other reports, a large number of C. fetus isolates
were identified in this study. The main reason is that campylobac-
ters from all specimens were included, not only those from feces.
Indeed, almost 80% were isolated from systemic infections, but
21.7% were still isolated from feces (n = 190), in contrast to the
unique C. fetus isolate among 3,764 campylobacters found in
stools in England and Wales (5). A possible explanation lies in the
recommends made in France to incubate stool cultures at
37°C and not at 42 or 43°C like in most countries, to compensate
for the lack of thermotolerance of C. fetus. The differences ob-
served in the characteristics of C. fetus infection versus C. jejuni/C.
coli infections are the well-known difference in the mean age of
approximately 40 years, in line with the type of patients affected,
who are often immunocompromised with an underlying disease
and very often hospitalized.

There are, however, limits to this study, since detailed infor-
mation on the eating habits and other risk factors were not col-
clected, nor do we have information on the severity and outcome of
infection. We must also acknowledge that the infections observed
most likely represent severe infections, since almost one-third of
the patients were hospitalized.

Furthermore, the strains received depend on the methods of
isolation used by the clinical laboratories all over the country.
However, because a filtration method is seldom used and anaero-
bic incubation not performed, we lack strains of species such as
Campylobacter concisus, which appear to be common in surveys
targeting this organism.

Despite these limitations, the present study gives the opportu-
nity to obtain interesting information of public health value for
these pathogens of major importance, the cost of which has been
estimated at 1.7 billion dollars in the United States (11).

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REFERENCES
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