Differential Features of Foodborne Gastroenteritis Outbreaks of Known and Unknown Etiology

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Abstract

Foodborne diseases (FBD) are a major cause of disease and death, but their etiologies are not always known. Factors associated with determination of the etiologic agent of FBD outbreaks reported to the Department of Health in Catalonia (Spain) during 2002 to 2005 were studied. For each outbreak, the year, number of persons affected, hospitalization, and availability of samples from patients, food handlers, and foods were collected. The delay between the date of onset of symptoms of the second case and the report to the surveillance unit was calculated. The relationship between explanatory variables and determination of the cause of each outbreak was studied by logistic regression. The causal agent was identified in 242 (73.3%) of 330 outbreaks. Factors associated with determining the etiologic agent of the outbreak in the univariate analysis were availability of samples from cases (odd ratio [OR] of 6.0, 95% confidence interval [CI] of 3.2 to 11.1), hospitalization (OR of 5.1, 95% CI of 2.6 to 11.1), availability of samples from food handlers (OR of 2.7, 95% CI of 1.6 to 4.5), size ≥ 10 cases (OR of 2.2, 95% CI of 1.3 to 3.2), availability of samples from food (OR of 1.8, 95% CI of 1.1 to 3.0), and the last year of study (OR of 1.9, 95% CI of 1.0 to 3.6). In the multivariate analysis, hospitalization (adjusted OR of 5.1, 95% CI of 2.4 to 11.2), size ≥ 10 cases (adjusted OR of 2.1, 95% CI of 1.2 to 3.7), and the year 2005 (OR of 2.1, 95% CI of 1.1 to 4.0) remained associated. Collection and processing of clinical samples from cases and appropriate laboratory diagnoses of all possible etiologies of FBD, including viruses, are very important. Efforts by physicians and public health services to coordinate and improve their activity in these areas may help provide more accurate knowledge concerning the etiologies of FBD outbreaks and lead to more effective preventive procedures.

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MATERIALS AND METHODS

In Catalonia, a region located in the northeast of Spain with more than 7 million inhabitants, all physicians must report any suspected FBD outbreaks to the Department of Health (9, 17). The suspicion may be triggered by one or more sources, including spontaneous consumer reporting, physician inquiry on presentation of an affected person or, less frequently, by microbiology laboratory report of isolates. Once the suspicion is confirmed, an epidemiological study is begun by technicians of the territorial public health services to identify the factors facilitating the outbreak as early as possible and take the correct control measures and to identify the etiologic agent and the food vehicle. The etiologic agent is investigated by culture to isolate and identify enteric bacteria and viruses and selectively for parasites. At the end of the investigation, a health report reflecting the data obtained and the action taken is made.

We analyzed reports of FBD outbreaks reported to the Department of Health between 1 January 2002 and 31 December 2005. For each outbreak, the following variables were collected: year of occurrence, number of cases, number of hospitalized cases, availability of clinical samples from cases and food handlers involved in the manufacture of suspected foods, the delay in reporting the outbreak to the territorial surveillance units responsible for initiating the investigation, and the availability of food samples for laboratory analysis. An outbreak of FBD was considered of known etiology when an etiological agent was laboratory confirmed in at least one clinical sample from a case or from the food vehicle epidemiologically implicated. Because sensitive techniques for viral diagnoses were only included in microbiological analyses made by public health laboratories in Catalonia from 2005, two different periods were considered, 2002 to 2004, and 2005. The delay in the report was considered as the time between the onset of clinical symptoms of the second case (the first case may be sporadic and therefore is not subject to compulsory report) and the date of report by physicians to the territorial surveillance unit. Household outbreaks were excluded because it is much more difficult to determine the etiology due to the limited number of persons affected and the lack of comparison groups.

The statistical analysis was made with the SPSS 15.0 for Windows software. A logistic regression model with the etiologic agent (known or unknown) as a dichotomizing variable was constructed. The explanatory variables were analyzed by univariate analysis and then adjusted by a multivariate model. Adjustment of the final model was assessed by using the Hosmer and Lemeshow test (13).

The number of samples from patients and the delay in the report (measured in days) were considered as categorical variables, with two levels (delay less or more than the median value of 2 days). The variables samples from food handlers and samples from food were treated as binary variables (1 if collected and 0 if not collected). The variable hospitalization was also considered a binary variable, and the variable size was constructed from the number of persons affected (0 when <10 and 1 when ≥10). Pearson’s correlation test was used to assess colinearity between independent variables. The χ² test was used to determine independence of predictive variables, and the level of statistical significance was set at α = 0.05.

RESULTS

During the study period, a total of 669 FBD outbreaks were reported to the Department of Health, of which 360 (53.8%) were nonfamilial outbreaks, and of these, 30 were excluded as no report was available. The 330 remaining outbreaks affected 7,276 people, with a mean of 22.05 (standard deviation of ±83.5) and a median of 7 (range of 2 to 1,435). Outbreaks occurred in restaurants (76.7%), schools (8.3%), bakeries (6.3%), hospitals and long-term health care facilities (4.7%), summer camps (3.6%), and others (7.5%).

The causal agent was identified in 242 (73.3%) of 330 outbreaks. The distribution of the outbreaks according to etiology is shown in Figure 1. Table 1 shows the number of outbreaks and distribution of the study variables globally and by year. Of the 242 outbreaks in which the etiology was identified, samples were collected from patients in 220 (90.9%) outbreaks (median of 4 samples per outbreak, range 1 of 172), food handlers in 190 (78.5%) outbreaks (median of 3 samples per outbreak, range of 3 to 19), and foods in 127 (52.5%) outbreaks. In 115 (47.5%) outbreaks, the number of persons affected was ≥10. There were hospitalized cases in 82 (33.9%) outbreaks. In 122 (50.4%) outbreaks, the delay in notification was ≥2 days.

Of the 88 outbreaks in which the etiologic agent was not determined, samples were collected from patients in 55 (62.5%, median of 1 sample per outbreak, range 0 of 11), food handlers in 51 (58%, median of 1 sample per outbreak, range 0 of 12), and foods in 33 (37.5%) outbreaks. The number of affected persons was ≥10 in 26 (29.5%) outbreaks. Hospitalization was required in 8 (9.1%) outbreaks. In 51 (58%) outbreaks, the delay in reporting was ≥2 days.

The results of the univariate and multivariate logistic regression analysis to determine the association between independent variables and the dependant variable (known etiology) are shown in Table 2. The variables associated most closely with the etiology of the outbreak were the availability of samples from patients (odds ratio [OR] of 6.0, 95% confidence interval [CI] of 3.2 to 11.1), hospitalization of patients (OR of 5.1, 95% CI of 2.6 to 11.1), the availability of samples from food handlers (OR of 2.7, 95% CI of 1.6 to 4.4), size ≥10 cases (OR of 2.2, 95% CI of 1.3 to 3.6), and the year 2005 with respect to previous years (OR of 1.9, 95% CI of 1.0 to 3.6). No association was found with delayed notification. The variables hospitalization of cases and availability of clinical samples from cases, showed a correlation (P ≤ 0.0001), and therefore only hospitalization of cases was included in the multivariate analysis.

In the multivariate analysis, variables associated with determination of the cause of the outbreak were hospitalization of cases (adjusted OR of 5.1, 95% CI of 2.4 to 11.2), size ≥10 cases (adjusted OR of 2.1, 95% CI of 1.2 to 3.7), and the year 2005 (adjusted OR of 2.1, 95% CI of 1.1 to 4.0).

DISCUSSION

FBD are increasing worldwide (27), possibly due to a combination of the increasing complexity of the food supply chain, greater difficulties in determining when pathogens are introduced into foods, and changes in demographics (aging of the population) and life styles (more people working
outside the home who do not have time to prepare meals, and more people studying or working away from home), which means that more people are at risk for FBD (5, 15, 23, 26). Given the impact outbreaks may have on food safety policies, quality of the investigations of outbreaks is critical in reducing illness and developing better prevention strategies (3, 27). Therefore, the results of studies of the factors influencing the success of investigations should be carefully considered. In this study, three factors were associated with determining the etiology of outbreaks: hospitalization of cases, the size of the outbreak, and the year of occurrence (the proportion of outbreaks in which the cause was determined was highest in the last year of the study period).

In countries or regions with universal health coverage (as in Catalonia where access to medical care is universal, FIGURE 1). Distribution of outbreaks of foodborne disease, according to etiology, in Catalonia from 2002 to 2005.

![Graph showing distribution of foodborne disease outbreaks by etiology.]

TABLE 1. Distribution of study variables in annual outbreaks of foodborne disease

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<thead>
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<tbody>
<tr>
<td>Samples from patients</td>
<td>67 (81.7)</td>
<td>59 (86.8)</td>
<td>77 (80.2)</td>
<td>72 (85.7)</td>
<td>275 (83.8)</td>
</tr>
<tr>
<td>Samples from food handlers</td>
<td>64 (78.0)</td>
<td>43 (63.2)</td>
<td>63 (65.6)</td>
<td>67 (79.8)</td>
<td>241 (73.0)</td>
</tr>
<tr>
<td>Samples from foods</td>
<td>46 (56.1)</td>
<td>27 (39.7)</td>
<td>44 (45.8)</td>
<td>43 (51.2)</td>
<td>160 (48.5)</td>
</tr>
<tr>
<td>Hospitalized patients</td>
<td>24 (29.3)</td>
<td>20 (29.4)</td>
<td>24 (25.0)</td>
<td>22 (26.2)</td>
<td>90 (27.3)</td>
</tr>
<tr>
<td>Size of outbreak (≥10 affected)</td>
<td>45 (54.9)</td>
<td>35 (51.5)</td>
<td>26 (27.1)</td>
<td>35 (41.7)</td>
<td>141 (42.7)</td>
</tr>
<tr>
<td>Time of delay (≤2 days)</td>
<td>52 (63.4)</td>
<td>38 (55.9)</td>
<td>44 (45.8)</td>
<td>39 (46.4)</td>
<td>173 (52.4)</td>
</tr>
<tr>
<td>No. of outbreaks</td>
<td>82</td>
<td>68</td>
<td>96</td>
<td>84</td>
<td>330</td>
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TABLE 2. Foodborne disease outbreaks; study variables according to determination of etiology and results of the univariate and multivariate logistic regression analysis

| Variable                        | Etiology Known | Unknown | Etiology Adjusted models OR (95% CI)\(^a\) Univariate Multivariate |
|---------------------------------|----------------|---------|-------------------------------------------------|-----------------------------|
| Samples from patients           | 220            | 55      | 6.00* (3.24–11.10)                               |
| Samples from food handlers      | 190            | 51      | 2.65* (1.57–4.47)                               |
| Samples from foods              | 127            | 33      | 1.84* (1.12–3.03)                               |
| Hospitalized patients           | 82             | 8       | 5.12* (2.63–11.11)                              |
| Size of outbreak (≥10 affected) | 115            | 26      | 2.16* (1.28–3.64)                               |
| Time of delay (≤2 days)         | 122            | 51      | 1.36 (0.83–2.22)                                |
| Year 2005, with respect to previous years | 69             | 15      | 1.94* (1.04–3.61)                               |

\(^a\) P < 0.05.
and free), hospitalization of cases may be interpreted as a reflection of the severity of the outbreak, as patients are normally hospitalized due to older age or comorbidities, but not due to higher economic status or other social factors (24). Therefore, underdetection of severe cases of FBD is unlikely. In outbreaks with hospitalized patients, the study of clinical samples is routine; in addition, these outbreaks usually attract more media attention (due to initiatives by the public health services or affected groups) than do outbreaks requiring only outpatient care, and often result in legal procedures. These factors may help to explain why laboratory and epidemiological investigations are more exhaustive in outbreaks with hospitalizations, and therefore, the etiology is determined more frequently.

Larger outbreaks are more easily detected, because as more people are affected, there is a greater likelihood of them consulting the health services and, thus, of an outbreak being suspected. Exclusion of household outbreaks, due to limits on the information available in most cases contributed, we believe, to the robustness of the results and also coincides with recommendations of some reports (14) to study outbreaks with a specific minimum size separately. The year 2005 was also associated with determining the etiology of outbreaks. The greater availability in public health laboratories in Catalonia since 2005 of diagnostic techniques such as reverse transcription PCR, which is more sensitive than the enzyme immunoassay for the diagnosis of viral gastroenteritis outbreaks (12, 29), may explain this association (18).

The study had some limitations. One is underreporting of outbreaks, as only outbreaks reported to the public health services were included. Wheeler et al. (30) found that in England and Wales, for every laboratory report of a gastroenteritis pathogen to the National Reference Center, there were 136 cases of gastroenteritis in the population. In addition, notifications of isolates or detection of infectious agents by laboratories do not usually provide information on whether the disease is foodborne (1). For this reason, we consider that notification of a suspected outbreak by physicians to the public health services is vital in determining the burden and trends of FBD outbreaks.

The World Health Organization estimates that the reported incidence of FBD is less than 10%, or perhaps even less than 1%, of the real incidence (19). Gallay et al. (10) reported that the proportion of outbreaks of salmonellosis reported to public health services was only 15% of all outbreaks of salmonellosis, which is included in the diagnostic protocols of nearly all health centers and public health services. It is estimated that reported cases of gastroenteritis due to norovirus should be multiplied by 1,500 to estimate the real incidence (30).

However, we do not believe that underreporting of outbreaks differed significantly between outbreaks in which the etiologic agent was determined and those in which it was not, and therefore probably had little influence on the results. Another possible limitation is that some non-outbreak episodes could have been included. The fact that two people who share a common meal subsequently experience diarrhea does not necessarily mean that they have the same illness, or that this constitutes an outbreak. Therefore, it is useful to analyze larger outbreaks separately when investigating the epidemiology of FBD outbreaks (14). However, it seems unlikely that the suspicion of a reported outbreak that is confirmed by a team of epidemiologists would not be an outbreak. Even so, because household outbreaks were excluded, it is unlikely that non-outbreak episodes were included in this study.

Hoffman et al. (12) found that the main reason for not investigating outbreaks is the delay in reporting. However, our results coincide with the findings of Jones et al. (14) in the United States, who concluded that it is unclear why the etiology of outbreaks in which specimens were collected promptly was not identified more often than in those with delayed collection. It is recognized that, although time has passed since the onset of cases and the exposure has ceased, investigation of the outbreak remains important, and should be carried out by the public health services in order to apply corrective measures and reduce the risk of new outbreaks in the same setting (22).

In conclusion, our results highlight the importance of the correct collection and processing of clinical samples from hospitalized and nonhospitalized cases and from food samples, and the need to improve laboratory capacity for the diagnosis of all possible etiologies of FBD, including viral gastroenteritis. In outbreaks where routine stool testing does not yield an enteric pathogen, the availability and use of a reference laboratory to pursue further investigation is critical. Efforts by physicians and public health services to coordinate and improve activity in these areas may help to provide knowledge more accurate of the causes of outbreaks of FBD and lead to more effective control measures.

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REFERENCES


