Listeriosis Outbreak Associated with the Consumption of Rillettes in France in 1993

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An outbreak of listeriosis involving 38 patients occurred in France between 18 June and 5 October 1993. The epidemic clone was characterized by serovar 4b, phagovar 2671:108:312, and DNA macrorestriction patterns 12 and 13. Thirty-one case-patients were materno-neonatal patients and 7 patients were nonpregnant adults. Preliminary analysis of a case-control study implicated a pork product, rillettes, of a particular brand (odds ratio, 18; 95% confidence interval, 2.2–208) as the vehicle of infection. Rillettes is a ready-to-eat food prepared with ham meat cooked with grease. The implicated lots of rillettes were recalled in mid-August, and the French authorities issued a warning to the general public. Microbiologic analysis of unopened plastic cans of rillettes confirmed the results of the case-control study 3 weeks after the recall. Final analysis showed that the rillettes was the major vehicle of the outbreak but suggested that other brand A meat products could also have been involved.

Although listeriosis is not as common as some other foodborne diseases, such as salmonellosis and campylobacteriosis, it has become an important public health problem because of its severity (meningitis, encephalitis, sepsis, fetal death, prematurity) and its high case-fatality ratio (33%) [1]. Immunocompromised people, neonates, pregnant women, and the elderly are most at risk of listeriosis. Several outbreaks of listeriosis have occurred during the past decade in North America [2–4] and Western European countries [5–8], mostly involving dairy and meat products. The national surveillance of foodborne diseases is mainly laboratory-based in France, with isolates collected in a National Reference Center (NRC) laboratory.

For routine surveillance of listeriosis, Listeria isolates are characterized at the NRC for Listeria (Pasteur Institute, Paris) by serogrouping and phage-typing. Pulsed-field gel electrophoresis is done immediately when there is an increase in the number of isolates belonging to a particular serovar and phage-variant combination. The NRC for Listeria notified the Ministry of Health at the end of July 1993 of a cluster of 10 case-patients caused by isolates of an unusual lysovar, all identified after 18 June 1993. No case-patients with this strain had been detected in France since 1 January 1993. The suspected outbreak was confirmed when 8 additional case-patients were notified 2 weeks later. On 13 August, the Réseau National de Santé Publique (RNSP) was requested to coordinate the investigation of the outbreak. Here we describe the results of the investigations, which identified the main vehicle of the outbreak (a pork product called rillettes of a particular brand), and the preventive measures to control the outbreak.

Methods

Case-control study. All hospital microbiology laboratories throughout France were informed of the outbreak by mail on 19 August and were requested to send all human isolates of Listeria monocytogenes identified since 1 May 1993 to the NRC. The date of diagnosis of listeriosis was defined as the date of sampling of the specimen that yielded L. monocytogenes.

A case-patient was defined as a patient from whom an epidemic strain of L. monocytogenes was isolated from a normally sterile site between 18 June and 5 October 1993. The epidemic strain was defined as an L. monocytogenes isolate characterized by serovar 4b, phagovar 2671:108:312, and pulsovars 12 after cleavage with Apal and 13 after cleavage with Smal [9]. Case-patients were classified as materno-neonatal when the strain was isolated from a pregnant woman, a neonate, or a fetus. If the epidemic strain was isolated from both the mother and the newborn, the case-patient was counted once. The pregnancy outcome was classified according to gestational age (World Health Organization, International Classi-
fication Disease-10 classification): preterm delivery (≤37 weeks of gestation), term delivery (>37th week of gestation), and fetal death (death of a fetus before expulsion whatever the gestational age). Other case-patients were classified as not associated with pregnancy. Clinical information on each case-patient was collected from the attending physician.

A national matched-pair case-control study was done to identify the vehicle of the outbreak. It was coordinated by the RNSP and carried out through district public health officers. Four pregnant healthy women of the same gestational age (±4 weeks) as the pregnant case-patients or as the mother of the neonate or fetus case-patients and attending the same hospital were matched with each materno-neonatal patient. For case-patients not associated with pregnancy, 2 controls of similar age (±10 years) were selected from patients with the same underlying disease hospitalized at the same time as the case-patient. For each case-patient, the choice of the matched control was left to the attending physicians. Controls for patients with no known underlying disease were selected by the general practitioner of the case-patient. Case-patients and their matched controls were interviewed by telephone on their food consumption during the month before onset of illness of the case-patient. Food consumption of a case-patient and matched controls was documented by use of a standardized questionnaire that included >100 food items known to be at risk for listeriosis (mainly dairy and meat products). Brand names for each food, type of packaging, frequency of consumption, and food store from which purchased were recorded.

On the basis of a preliminary analysis of the case-control study suggesting that rillettes could be the vehicle of the outbreak, a sample of case-patients and controls who had eaten rillettes were further interviewed with another questionnaire about their food handling, food storage, and hygiene practices and food habits, and all case-patients were reinterviewed on their history of rillettes consumption since May (brand, date of consumption, date of purchase). Secondary data obtained from reinterviews were not used in the case-control analysis.

The incubation period was defined as the delay between date of consumption of brand A rillettes and date of onset of symptoms of listeriosis.

Microbiologic study. Ministry of Agriculture (MOA) officers sampled 17 food specimens still available in the refrigerators of 12 patients and 508 plastic cans of brand A rillettes that had been retailed by the producer; Officers of the Directorate General on Competition, Consumer Affairs and Fraud Repression (DGCCRF), Ministry of the Economy, collected 338 specimens of meat products (27 brand A rillettes, 247 brand A meat products, 74 meat products other than brand A) from the food stores where the case-patients had made their purchases. In addition, some L. monocytogenes isolates from cans of rillettes removed from the market by food store managers or returned by the consumers were submitted to the NCR. The plant incriminated by the case-control study was inspected a few days after the recall by MOA officers, who sampled the environment of the various production lines and of an experimental production line of rillettes.

L. monocytogenes was detected from food and environmental samples by use of the US Department of Agriculture protocol [10]. These isolates and human isolates were characterized at the NRC using the API-Listeria system (bioMérieux, Marcy-l’Etoile, France), serogrouped with polyclonal and unabsorbed anti-serogroup 4 and anti-serogroup 1/2 sera for screening, and phage-typed with the phages specific for isolates serogroup 4 of the international set of Listeria bacteriophages (except phage 3551). Isolates of the epidemic phagovar were further serotyped by use of the reference method and characterized by DNA macrorestriction pattern analysis with Apal and SmaI.

Statistical analysis. The association between the consumption of food items and the occurrence of illness was measured by the odds ratio (OR) with 95% confidence interval (CI) by use of Epi Info software, version 5.01a (CDC, Atlanta). A preliminary unmatched analysis of the case-control study was done on 13 case-patients and 18 controls on 19 August to obtain rapid identification of the vehicle. Matched-pairs analysis was based on 21 case-patients and their matched 77 controls who had been interviewed before the warning issued by French authorities, and conditional logistic regression was performed with Egret software, version 0.26.06 (Statistics and Epidemiology Research, Seattle).

Results

The outbreak. A total of 38 case-patients (31 materno-neonatal patients and 7 patients not associated with pregnancy), were identified between 18 June and 5 October 1993 (figure 1). These epidemic case-patients accounted for 14% of listeriosis patients identified by the NRC during the same period. The epidemic strain had been responsible for <1% of listeriosis cases from 1987 to 1992. Most case-patients of the outbreak (81%) lived in western France, and 12 of the 22 regions were involved (isolation rate, 0.23–2.8 cases-patients/10⁶ population). During this period, the overall rate of identification of listeriosis in France was 3.8 cases-patients/10⁶ population (range, 0–19.2).

Clinical findings. The outcome for the 31 materno-neonatal case-patients (median age, 26 years; range, 20–34) included 9 fetal deaths (median gestational age, 23 weeks; range, 13–29), 12 premature births (5 with severe prematurity <32 weeks), and 10 term births. As 1 neonate died at 4 days old, the overall mortality was 3.2%. Other case-patients were classified as not associated with pregnancy (OR, 14.1; CI, 2.6–76.6). The information on consumption related to 8 brand A meat products that were associated with listeriosis in the univar-
iate analysis (OR, >2) was included in a multivariate analysis of risk factors for listeriosis that used a stepwise backward elimination of nonsignificant meat product variables. The final model included two significant variables: brand A rillettes (OR, 10.9; CI, 2.1–54.4) and brand A country pâté (OR, 5.0; CI, 1.0–24.1). Preliminary analysis done to obtain data for decision makers had shown that case-patients were more likely to have eaten rillettes purchased in food store A than were controls (OR, 18; CI, 2.2–208).

Analysis of the questionnaire on food habits showed that frequency of consumption of rillettes was not different between case-patients and controls who ate rillettes but that case-patients tended to store rillettes longer than did controls (>6 days: 12 of 25 vs. 9 of 32; \( P = .12 \)) and that case-patients were more likely than controls to consume the same can of rillettes during several meals (>4 meals: 11 of 23 vs. 7 of 31; \( P = .05 \)). Consumption of raw smoked breast of pork was quite common (20%) and similar between case-patients and controls.

Case-patients’ history of consumption of meat products of brand A. The 35 case-patients interviewed had contact with brand A products: 30 had eaten rillettes purchased from chain A, 4 had eaten other brand A meat products, and 1 patient had had a family member consume brand A rillettes. The incubation period was estimated for 9 patients who ate brand A rillettes and no brand A pâté. The incubation period was shorter for 3 patients not associated with pregnancy (11, 12, 19 days) than for the 6 pregnant women (16, 18, 28, 38, 42, 88 days). The 3 patients not associated with pregnancy with an estimated incubation period were not immunosuppressed, and all had a neurologic form of listeriosis. For the pregnant case-patient with a suggested long incubation period (88 days), listeriosis was diagnosed at delivery at week 37 of gestation, >2 months.

### Table 1. Clinical findings and outcome of 7 case-patients not associated with pregnancy.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Age (years)</th>
<th>Underlying conditions</th>
<th>Clinical presentation</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>F</td>
<td>73</td>
<td>None</td>
<td>Meningoencephalitis</td>
<td>Cure</td>
</tr>
<tr>
<td>M</td>
<td>39</td>
<td>None</td>
<td>Meningitis</td>
<td>Cure</td>
</tr>
<tr>
<td>M</td>
<td>57</td>
<td>Ankylosing spondylitis treated with nonsteroid anti-inflammatory drugs</td>
<td>Meningoencephalitis</td>
<td>Death</td>
</tr>
<tr>
<td>F</td>
<td>66</td>
<td>Breast cancer with metastasis</td>
<td>Sepsis</td>
<td>Cure</td>
</tr>
<tr>
<td>M</td>
<td>75</td>
<td>Hip prosthesis</td>
<td>Focal infection</td>
<td>Cure</td>
</tr>
<tr>
<td>M</td>
<td>61</td>
<td>Cirrhosis</td>
<td>Meningitis</td>
<td>Cure</td>
</tr>
<tr>
<td>M</td>
<td>59</td>
<td>Cirrhosis</td>
<td>Sepsis</td>
<td>Cure</td>
</tr>
</tbody>
</table>
over the consumption of two cans of rillettes purchased “on special offer.”

Food investigations. The epidemic strain was isolated from 15 of 508 unopened cans of brand A rillettes sampled before their sell-by date by MOA officers (contamination rate, 3%), from 2 of the 3 brand A rillettes sampled from the 12 refrigerators, and from 4 of 247 brand A meat products (smoked pork breast, 1; pâté de campagne, 2; liver pâté, 1) sampled by DGCCRF officers. In addition, the epidemic strain was isolated from 20 brand A rillettes cans removed from the market by food store managers and from 11 cans returned from consumers.

The analysis of the contamination level of samples from 28 unopened cans, done before the sell-by date, showed that 16 contained <100 cfu/g, 7 contained 100–1000 cfu/g, and 5 contained >10,000 cfu/g. Two opened cans of rillettes returned by consumers 2 weeks before the sell-by date were heavily contaminated with the epidemic strain (>10,000 cfu/g). The sell-by dates on the cans of rillettes containing the epidemic strain (1 day of rillettes production corresponded to one production batch) indicated that at least 14 batches of rillettes had been contaminated between 22 July and 16 August.

Plant investigations. Brand A meat products were distributed by one chain of food stores (chain A) and were produced in a single plant. The plant produced various pork meat products, with rillettes accounting for 5% of the total production. Rillettes was made of ham meat and grease cooked at 98°C for 3 h and was packaged in plastic cans or in jars. Reviews of routine microbiologic testing at the plant since January indicated that coliforms had been isolated from the production line of rillettes in May and that a strain of L. monocytogenes had been isolated in July from a raw product (smoked breast). This isolate had been identified by the NRC as an epidemic strain. Two epidemic strains were isolated from the 25 samples taken during the inspection (smoked pork breast, hood over the frankfurter processing chain). A second set of samples taken in November 1993 included an epidemic strain in one of the two automatic-process filling and packaging machines of rillettes.

Production was definitively resumed after a negative control sample in January 1994.

Control measures in the plant. The quality assurance at the plant was completely reviewed. The following corrective measures were implemented: separation of raw material and cooked product areas with walls built between production lines; writing of Hazard Analysis Critical Control Point (HACCP) procedures; reinforcement of bacteriologic monitoring of working surfaces, raw material, and all final products; checking time-temperature cooking conditions against L. monocytogenes; post-pasteurization of rillettes after packaging; and labeling of sliced smoked breast packaging “to be cooked.”

Discussion

The effectiveness of the case-control study, which identified the source of this outbreak after only 6 days of investigation, is unusual for a listeriosis outbreak. Epidemiologic findings were reinforced by the isolation of 1 epidemic strain in the incriminated plant in July. On the basis of these results, the manufacturer decided to recall the rillettes and to stop its production. Microbiologic analysis of samples of unopened cans of rillettes confirmed the results of the case-control study 3 weeks after the recall.

This is the first example of a warning from the French health authorities to the general population based on evidence gathered in a case-control study. As the shelf life of the rillettes was 45 days, the warning recommended that susceptible groups should not eat rillettes of this brand and should seek medical advice if necessary. The sharp decrease in materno-neonatal cases after the warning suggests that the recommendations made by Public Health authorities stimulated pregnant women with fever to seek medical advice and that appropriate timely treatment, especially of those who had consumed rillettes, may have reduced the number of cases in this population (figure 1).

As the proportion of epidemic strains among the overall isolates of L. monocytogenes was small, there was no big increase in isolates being submitted to the NRC, and therefore, we assume that the outbreak would not have been detected as rapidly if phage typing had not been routinely available. This outbreak was detected almost immediately because the epidemic strain had a very unusual phagovar.

The statistical analysis concluded that brand A meat products were the vehicle of this outbreak. Brand A rillettes was the major vehicle, but other products, such as pâté, made in the same plant could have also been involved. The isolation of the epidemic strain in several meat products sampled at the retail level supports this conclusion. The presence of the epidemic strain in the environment of the plant and the end of the outbreak 2 months after the control measures had been instituted are additional evidence that products processed in this plant were the source of the outbreak.

The most probable primary source of L. monocytogenes in the plant was certainly to be found on swine, but during this

| Table 2. Distribution of case-patients interviewed before warning and matched controls, by brand A food products consumed: univariate analysis. |
|-----------------|-----------------|-----------------|
| **Product**     | **Cases** (n = 21) | **Matched controls** (n = 77) |
|                 |                  | Matched odds ratio (95% confidence interval) |
| Liver pâté      | 42.9%            | 15.6%           | 6.6 (1.6–26.2) |
| Country pâté    | 38.1%            | 9.1%            | 5.7 (1.6–20.4) |
| Pork rillettes  | 61.9%            | 16.9%           | 14.1 (2.6–76.6) |
| Cooked ham      | 52.4%            | 36.4%           | 3.4 (0.9–12.7) |
| Uncooked ham    | 33.3%            | 13.0%           | 2.6 (0.9–7.9) |
| Dry sausage     | 47.6%            | 20.8%           | 3.0 (1.1–8.1) |
| Garlic sausage  | 28.6%            | 3.9%            | 8.1 (1.5–42) |
| Frankfurter sausage | 38.1%      | 16.9%           | 7.3 (1.5–35) |

NOTE. Data are % who consumed indicated product.
outbreak, no possibility was offered to trace back at the farm level the origin of carcasses. The production of rillettes increased in May for a special-offer sale; thus, time of disinfection was shortened, which seemed less effective, as shown by the isolation of coliforms on the production line of rillettes. There could have been contamination during packaging because of cross-contamination between the raw material area and the cooked product area. This was suggested by the isolation of the epidemic strain in different parts of the plant and from the surface of a machine that held the plastic cans during filling and packaging. This contamination of surfaces closely associated with the processed meat is a potential source of meat product contamination according to the results of previous investigations [11]. During the packaging, rillettes could have been contaminated during the filling of the can, and contamination may have involved the rillettes in the inner part of the can.

Although the production of pâté was more extensive, its contribution to the outbreak seemed less important. Post-process contamination of pâté during handling would have been restricted to the surface, and the shelf life of pâté, twice as short as that of rillettes, would give less time for *L. monocytogenes* to grow. The epidemic strain was also found on uncooked products, such as smoked breast of pork. Interviews showed that this product is sometimes eaten without cooking and thus should be included in the group of products at risk of listeriosis.

The contamination of the process seemed continuous, since several batches were contaminated. The level of contamination seemed low; 57% of the cans removed from the market had $<100$ cfu/g. The high contamination rate found in cans returned by consumers is in favor of an amplification of the contamination at the consumer’s home. The special-offer sale of batches of two cans of rillettes at the beginning of the outbreak could also have led to a longer storage of the products by the consumer. Epidemiologic findings suggested that some food handling habits could be at risk. Further studies on food handling of the consumers could be useful to identify practices at risk in order to adapt recommendations to prevent listeriosis in patients at risk.

It is unclear why 82% (31/38) of cases were pregnancy-related. This proportion remained particularly high until mid-August (27/30). Analysis of data collected by the French Observatory of Food Consumption indicated that rillettes consumers were younger, lived more frequently with young children, and had a lower socioeconomic status than nonconsumers of rillettes [12]. Thus, pregnant women were perhaps by their food habits more frequently exposed to the contaminated product than the other groups at risk, immunocompromised and elderly people.

There are very few data on the incubation period of listeriosis. The median was 31 days (range, 11–70) in a California outbreak [3], and more recently, 2 pregnant women contaminated at the same meal had incubation periods of 22 and 29 days [13]. In this study, cases remembered the date of consumption quite well when it was $<1$ month before their illness. Incubation periods $>1$ month were identified for pregnant women who knew the date of purchase of the rillettes and could then remember the date of consumption. The date recorded was the date corresponding to the last day of consumption. One-third (3/12) of the cases occurred after 1 month in the present outbreak. So as not to miss any valuable information during an investigation of an outbreak of listeriosis, cases should be interviewed on their consumption during the 2 months before the isolation of *L. monocytogenes*. Incubation periods of patients not associated with pregnancy were estimated only for patients with the same clinical findings (meningitis or nonimmunosuppressed patients). The findings on incubation period can therefore not be generalized for immunosuppressed patients or for focal forms of disease.

The cost of an outbreak of listeriosis is difficult to calculate. We estimated, using the average national hospitalization cost reported by the statistics department of the Caisse Nationale d’Assurance Maladie, Paris, 1883 FFr/day (regular hospitalization) and 4432 FFr/day (intensive care) (US$1 = 5 FFr), a global hospitalization cost of 1,726,630 Ffr (US$345,326). The concern for public health is not only the cost of hospitalization but the number of deaths and the psychological trauma to patients and to parents of neonates who died or were born very prematurely. Roberts and Pinner [14] evaluated the costs of listeriosis in the United States and showed that the medical costs were $<10\%$ of the total estimated costs of listeriosis if the loss of productivity and the psychological trauma due to the high death rate and the severity of the illness were taken into account. The economic consequence of this outbreak was that the producer stopped all rillettes production for 6 months, and the meat products of this brand were discredited for 1 month following the recall. Sales of other brands of rillettes also dropped dramatically in France during this month.

This outbreak stresses the need to implement procedures in the meat industry that can identify critical control points and so reduce the risk of contamination of the final product. In this plant, HACCP hazard analysis was important to correct practices at risk, in particular by the change in the flow diagram to avoid cross-contamination between raw and cooked products and between people working in these two parts of the plant. Shelf storage should be determined on the basis of knowledge of the behavior of *L. monocytogenes* in each specific product and on the knowledge of consumers’ food handling practices. Special offers on products at risk sold in larger amounts and therefore stored a longer time should perhaps be reconsidered. Populations known to be at risk and, more generally, all consumers should also be educated with dietary counseling and food handling recommendations.

Acknowledgments

We thank the following for assistance with this investigation: the staff of the Réseau National de Santé Publique: J. C. Desenclos,

References