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Food-borne outbreak investigation

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Abstract. The aim of food-borne outbreaks investigation is the identification of the causative agent, the implicated food and the contributory factors that led to the food-borne outbreak, in order to control them and prevent the occurrence of similar outbreaks. There are several steps in the investigation of food-borne outbreaks: outbreak detection, defining and finding cases, generating hypotheses, testing the hypotheses and finding the source, and controlling the outbreak. Different steps can happen at the same time. Pathogens typing information added to the epidemiological data are of great value in the investigation of food-borne outbreaks. At European level, the European Centre for Diseases Prevention and Control (ECDC) is supporting molecular typing initiatives. Web based tools together with social networks can facilitate the investigation of food-borne outbreaks. Investigation of food-borne outbreaks varies among the European Union Member States. Almost half of the food-borne outbreaks reported in Spain are supported by microbiological or epidemiological evidence. In order to improve control and prevention of food-borne outbreaks it would be essential to have more outbreaks supported with strong epidemiological and/or microbiological evidence.

Keywords. Food-borne outbreak – Microbiology – Epidemiology – Control – Public Health.

Investigation des flambées épidémiques d'origine alimentaire

Résumé. *La finalité de l'investigation des flambées épidémiques d'origine alimentaire est l'identification de l'agent causal, des aliments impliqués et des facteurs favorables ayant mené à ce désordre lié aux aliments, afin de les contrôler et d'empêcher la survenue de flambées similaires. Il y a plusieurs étapes dans l'investigation des flambées épidémiques d'origine alimentaire : détecter la flambée, définir et trouver des cas, émettre des hypothèses, tester les hypothèses et trouver la source, et contrôler la flambée épidémique. Des étapes différentes peuvent avoir lieu en même temps. L'information sur les types de pathogènes ainsi que les données épidémiologiques sont d'une grande valeur pour l'investigation des flambées épidémiques d'origine alimentaire. À l'échelle européenne, le Centre Européen pour la Prévention et le Contrôle des Maladies (ECDC) apporte son soutien aux initiatives de typage moléculaire. Des outils basés sur le web ainsi que les réseaux sociaux peuvent faciliter l'investigation des flambées liées aux aliments. L'investigation des flambées d'origine alimentaire varie parmi les États membres de l'Union européenne. Près de la moitié des flambées d'origine alimentaire rapportées en Espagne sont étayées par des preuves microbiologiques ou épidémiologiques. Afin d'améliorer le contrôle et la prévention des flambées d'origine alimentaire, il serait essentiel d'avoir davantage de flambées étayées par de fortes preuves épidémiologiques et/ou microbiologiques.*

Mots-clés. *Flambée épidémique d'origine alimentaire – Microbiologie – Épidémiologie – Contrôle – Santé publique.*

I – Introduction

According to Directive 2003/99/EC, a food-borne outbreak is an incidence, observed under given circumstances, of two or more human cases of the same disease an/or infection, or a situation in which the observed number of human cases exceeds the expected number and where the cases are linked, or are probably linked, to the same food source.

The aim of food-borne outbreaks investigation is the identification of the causative agent, the implicated food and the contributory factors that led to the food-borne outbreak, in order to control them and prevent similar outbreaks.

There are several steps in the investigation of food-borne outbreaks: outbreak detection, defining and finding cases, generating hypotheses, testing the hypotheses and finding the source, and controlling the outbreak. Different steps can happen at the same time.

II – Outbreak detection

The first step for outbreak investigation is detection. Sometimes it is not easy to detect an outbreak if the ill persons are not in a specific place or apparently are not over the expected number. Human and technical resources are crucial for outbreak investigation. As an example Fig. 1 shows food-borne outbreaks reported to the National Centre of Epidemiology (CNE) in Spain, from 1976 to 2012. There was an increase in the number of outbreaks reported around 1985-1986. The increase was due to a decentralization of the health competencies in Spain and to the assignment of people and money to the autonomous regions for public health activities.

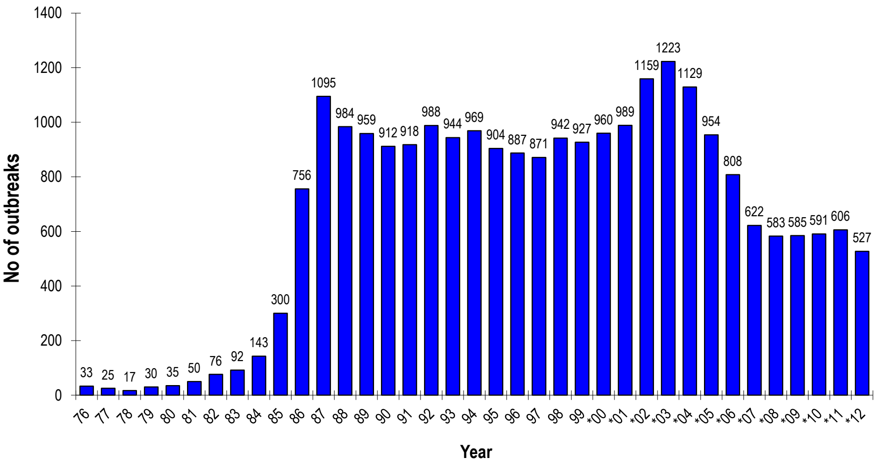

Fig. 1. Food-borne outbreaks, Spain 1976-2012* (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology). *Provisional data.

Pathogens typing (serotyping, phagotyping, pulse field gel electrophoresis (PFGE), etc.) helps to detect clusters/outbreaks that otherwise could have been missed. At EU level, alleged food-borne events (called urgent inquiries (UI)) are shared through the Food and Waterborne Diseases (FWD) network, coordinated by the European Centre for Diseases Prevention and Control (ECDC). Members of the network are: EU MS, Australia, Canada, Iceland, Japan, New Zealand, Norway, South Africa, Switzerland, Liechtenstein, Turkey and United States. The main objective of the sharing of UI is to allow the detection of multi-country outbreaks and thereafter facilitate the investigations. For sharing UI, ECDC launched a web based secured communication platform. This platform is the Epidemic Intelligence Information System for FWD (EPIS-FWD).The participation in EPIS is voluntary. Moreover, European Union (EU) Member States (MS) have to communicate some public health events to the Early Warning and Response System (EWRS) (European Commission and Council of Europe, 2013) and to World Health Organization (WHO) according to the International Health Regulations (World Health Organization, 2008).

In December 2010, two EU countries communicated through EPIS, an increase about Salmonella Poona. This information led to an investigation of the S. Poona cases detected in Spain in that year. Epidemiological information together with microbiological information from the National Reference Laboratory for Salmonella identified an outbreak that started at the beginning of 2010 and continued until the second half of 2011 due to S. Poona of a specific PFGE pattern. The outbreak was not detected previously due to the small number of cases per month (Fig. 2) (Red Nacional de Vigilancia Epidemiologica, 2011).

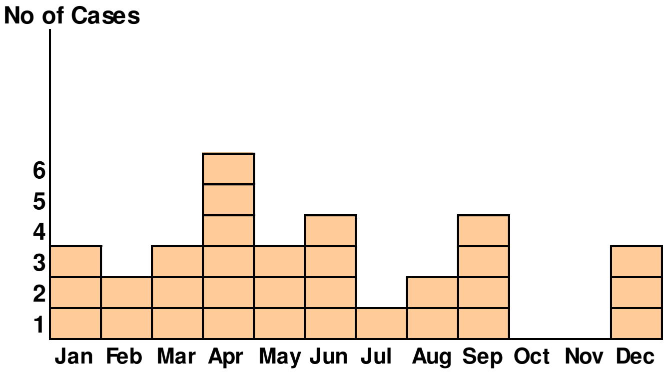

Fig. 2. ***Salmonella Poona*** **cases. Spain 2010 (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology).**

A molecular typing pilot project for food and water borne diseases, coordinated by ECDC, started at the end of 2012. The project included human isolates of *Salmonella*, *Listeria monocytogenes* and Shiga toxin-producing *Escherichia coli* (STEC). The number of Member States (MS) voluntarily participating in the pilot project, increased from 11 MS at the beginning to 18 at the end.

The objective of the project was to "improve the detection and verification of dispersed clusters and outbreaks of Salmonella, Listeria and STEC by setting up real-time molecular surveillance for human cases and link up and harmonise these typing methods with food, feed, and animal strains". Molecular typing could facilitate early detection of national or international outbreaks.

Spain participates in the molecular typing pilot project for Salmonella and STEC, but not Listeria. Nevertheless, PFGE is carried out for Listeria outbreaks investigation. In September 2012 the CNE was informed of two listeriosis cases in pregnant women from the same autonomous region, with onset of symptoms one day apart, that consumed the same type of cheese bought in two shops of the same type. Epidemiological information together with microbiological information (same PFGE patterns) led to prospective and retrospective identification of 11 cases belonging to the outbreak. The number of cases was small and they appeared along four months in six different autonomous regions. Usually outbreaks with few cases, that are spread out and not restricted to a relatively short period of time are difficult to identify.

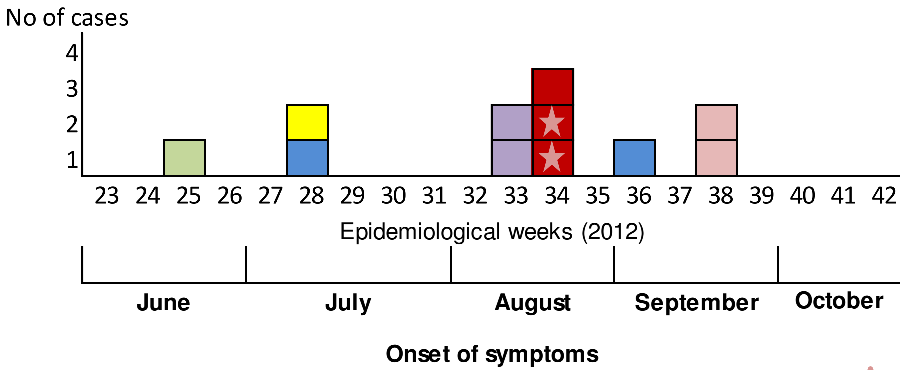

Fig. 3. Listeria cases. Spain 2012. Each colour shows one autonomous region. ★ Index cases (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology).

Whole genome sequencing is the typing technique which has the highest discriminatory power. However, for food-borne outbreaks investigation, methods with lower discriminatory power are sufficient for many diseases as far as public health is concerned. As figure 4 shows, *Salmonella* serotyping in Spain is performed at least in 57.4% of the Salmonella outbreaks, serotypes different from Enteritidis and Typhimurium are reported in 1.2% of the Salmonella outbreaks. These less frequent serotypes are not detected on a routine basis by many laboratories, but information on rare serotypes could help to identify an outbreak. Phagotyping of more frequent serotypes is carried out in Spain only at the National Reference Laboratory; this technique is not performed by all EU Member States.

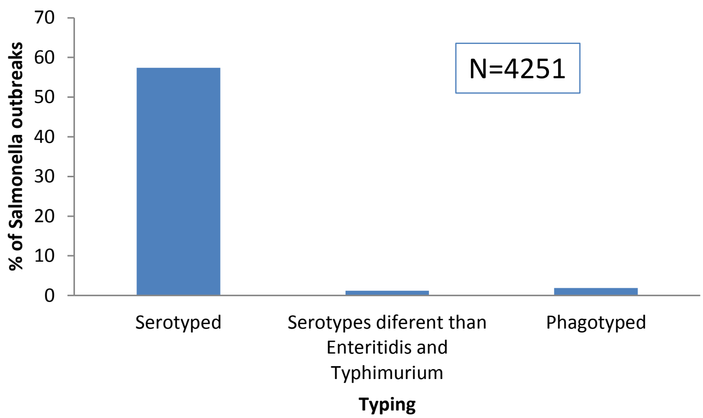

Fig. 4. Salmonella food-borne outbreaks, Spain 2002-2012* (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology). *Provisional data.

III – Defining and finding cases

Case definition will be defined in order to decide if a person belongs to the outbreak under investigation. Case definitions may include features of the illness, the pathogen (including molecular typing information), restrictions on time, place and person. Case definition should be simple and practical. At the beginning of the investigation it could be more sensitive to find as many cases as possible, being more specific as more information is available. There might be different case definitions for confirmed, probable and possible cases. The representation of the number of cases over time is the epi curve.

To look for cases, epidemiological surveillance records, laboratory records, hospital admission records, etc could be used. Recently web based tools and social networks have been used with this purpose too. As an example, gastroenteritis cases among people attending the Nowhere festival in 2013 in Spain were reported by the participants to the festival organizers through e-mail. The NOrg team (Nowhere Organisation team) creates an online questionnaire in order to receive more information on the sicknesses involved, together with information coming from e-mails and social media discussions (Judith, Olivier, Christen, 2013).

Another example is shown on the *Salmonella Poona* outbreak occurring in Spain in 2010 related to infant formula. A very active facebook group was created among parents of the cases. As a result of that, many cases were identified, including 9 asymptomatic persons. Moreover, more cases were identified as epidemiologists were alerted in order to send Salmonella isolates from children under 1 year old to the National Reference Laboratory for serotyping and molecular typing (Red Nacional de Vigilancia Epidemiologica, 2011).

IV – Generating hypotheses

Description of the situation would lead to the generation of hypotheses. Questionnaires are developed in order to analyse possible exposures. Information related to the disease (clinical symptoms) and the causative agent, place (municipality, restaurant, school, class room, etc.), time, person features (age, sex, occupation, etc) and exposures (food, travel, animals, etc.) is collected through the questionnaires.

For the *Salmonella Poona* outbreak occurring in Spain in 2010-2011, 83% of cases were under one year old, and 93% of those from 0 to 6 months old. Description of cases generated the hypotheses that infant formula could be involved in the outbreak (Red Nacional de Vigilancia Epidemiologica, 2011).

Answers to the questionnaire depend on memories of cases. For the *Salmonella Poona* outbreak the first questionnaire developed included information on food consumed 72 hours before onset of symptoms and as the median time for interviewing cases with onset of symptoms in 2010 was 8 months, it included food preferences too. Questions focused on infant formula consumption were easier to be remembered the time later than consumption of other foods (Red Nacional de Vigilancia Epidemiologica, 2011).

V – Testing hypotheses and finding the source

To test the hypotheses different methods could be used. Two main methods are analytic epidemiologic studies and food testing. According to the European Food Safety Agency (EFSA), epidemiological evidence (whether descriptive or analytical) can be strong or weak, although good analytical evidence is superior to evidence from the systematic evaluation of cases. Similarly, microbiological evidence can be strong or weak (European Food Safety Authority, 2014).

Last EU summary report on zoonoses, zoonotic agents and food-borne outbreaks from EFSA and ECDC (EFSA and ECDC. 2014) shows wide variability in the type of evidence for outbreak investigation among EU MS. For some countries where the evidence for all the outbreaks reported was strong and some other countries where all the outbreaks reported were supported by weak evidence. In line with that, the proportion of outbreaks in which analytical versus descriptive studies has been performed, varied among the countries. The same report shows that the proportion of outbreaks with strong evidence varies with the causative agent.

Spanish data on food-borne outbreaks from 2002 to 2012 shows that the proportion of outbreaks where the causative agent is not known is 32% (Fig. 5). This percentage decrease from 33.4% in the period 2002-2009 to 28.2% for 2010-2012, being statistical significant (X2=17 p<0.001).

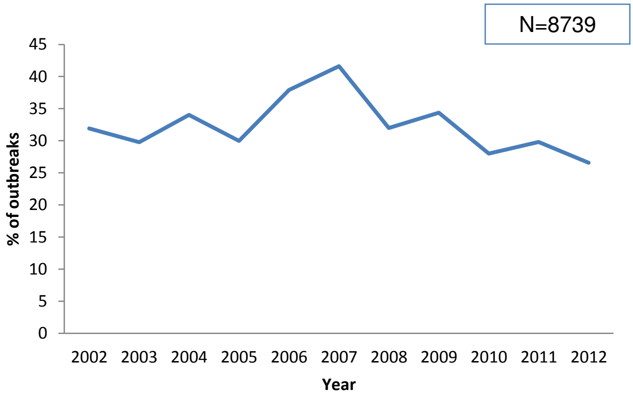

Fig. 5. Food-borne outbreaks with unknown causative agent. Spain 2002-2012* (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology). *Provisional data.

Food-borne outbreaks from Spain show that epidemiological evidence is more frequently used than microbiological evidence (Fig. 6), 43% of outbreaks reported any type of evidence (whether epidemiological and/or microbiological). Difficulties to obtain evidence are: starting of the investigation long after the outbreak occurred (cases cannot remember exposures, food items are not available), difficulties to detect the pathogen in the foodstuff (for instance, low quantity of Salmonella in infant formula is common), multiple foodstuffs contaminated or foods that are difficult to remember as herbs and spices. In the 8739 food-borne outbreaks reported in Spain, from 2002 to 2012, no outbreak was linked to herbs or spices.

Figure 7 shows the outbreaks where at least one sample (from cases, food, environment, or food handler) has been analysed. There were 27% of outbreaks with no sample analysed.

No foodstuff was mentioned in 30% of outbreaks, as it is shown in Fig. 8. Eggs and egg products were reported in 45% of the outbreaks, followed by shellfish with 8% of the outbreaks, as is shown in Fig. 9.

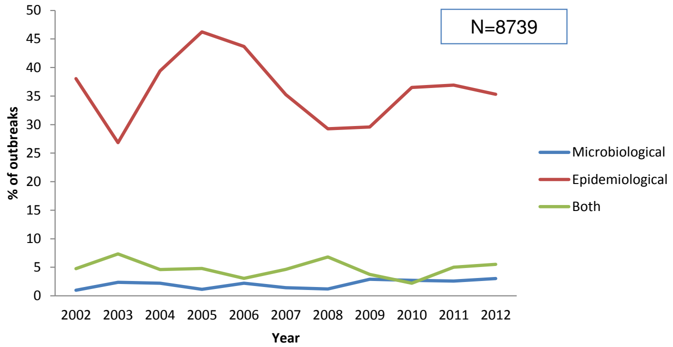

Fig. 6. **Food-borne outbreaks according to type of evidence, Spain 2002-2012* (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology). *Provisional data.**

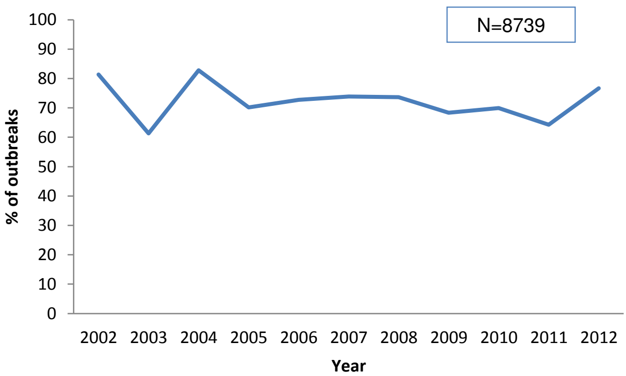

Fig. 7. **Food-borne outbreaks with at least one sample analysed, Spain 2002-2012* (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology). *Provisional data.**

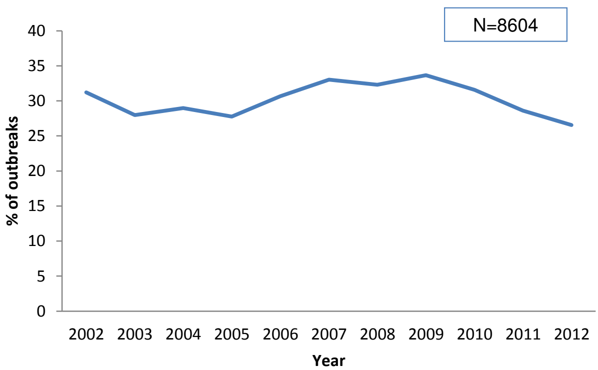

Fig. 8. **Food-borne outbreaks mentioning a specific food, Spain 2002-2012* (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology). *Provisional data.**

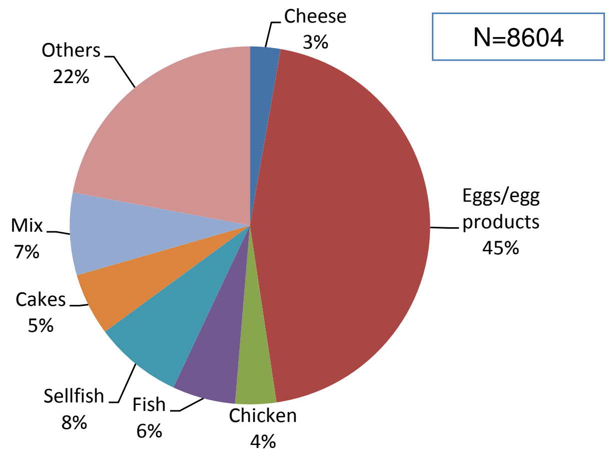

Fig. 9. Food-borne outbreaks according to reported food, Spain 2002-2012* (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology). *Provisional data.

Regarding contributory factors, 31% of the outbreaks did not report any contributory factor. Cross contamination was mentioned among 18% of the contributory factors, followed by storage time and/or temperature abuse, and contaminated ingredient (Fig. 10).

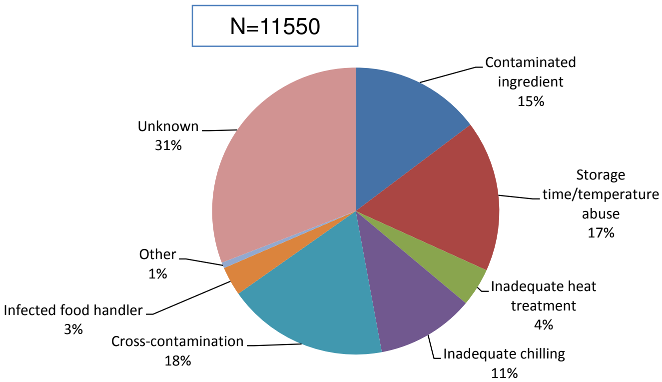

Fig. 10. Contributory factors reported in food-borne outbreaks, Spain 2002-2012* (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology). *Provisional data.

VI – Controlling the outbreak

Control of the outbreak has to be done along the investigation, measures can be adapted according to the results of the investigation. It is not necessary to wait for the epidemiological or microbiological evidence, public health authorities should act according to the precautionary principle in order to protect public's health.

It has to be decided when the outbreak is over, after cases stopped, surveillance has to continue to be sure that cases do not start again.

Implemented measures for the food-borne outbreaks reported in Spain from 2002 to 2012 were shown in Fig. 11. Main implemented measures were facilities inspection and hygiene education.

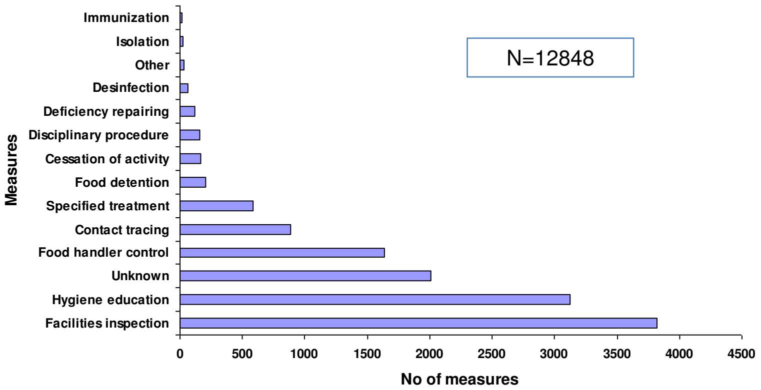

Fig. 11. Food-borne outbreaks according to implemented measures, Spain 2002-2012* (Source: National Network of Epidemiological Surveillance; Elaboration: National Centre of Epidemiology). *Provisional data.

VII – Conclusions

Pathogen typing information added to the epidemiological data is of great value in the investigation of food-borne outbreaks. At European level ECDC is supporting molecular typing initiatives.

Web based tools together with social networks can facilitate the investigation of food-borne outbreaks.

Investigation of food-borne outbreaks differs among EU Member States.

To achieve a higher proportion of food-borne outbreaks supported by strong epidemiological and/or microbiological evidence would lead to better prevention and control of them.

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