Infectious diseases Health and environment

Assessment of waterborne outbreaks investigated in France since 1998 and key recommendations

Summary report

During the past ten years, ten waterborne disease outbreaks were detected and investigated in France. Based on the experience acquired during these surveys, a practical guide for investigating this type of outbreak was edited.

This guide describes each one of the survey stages, and comes with annexes containing practical tools to help with the survey (examples of questionnaires for collecting data from different partners, lists of resource persons and structures, recommendations regarding the collection and transport of samples, etc.) and the management (recommendations regarding the conditions of use of water contaminated by Cryptosporidium, etc.). They also present additional useful information, such as the number of distribution units ranked according to the number of people served and per district, the number of microbiological contaminations observed over the past years; an etiological orientation table for gastroenteritis and other waterborne infections; a summary of the ten outbreaks investigated between 1988 and 2006.

This document is primarily aimed at the Ddass (Departmental Health and health affairs management) and Cire (interregional epidemiological units) professionals, but also at the other players involved (doctors, drinking water operators, etc…)

Detection and surveillance of infectious epidemics linked to tap water ingestion

Waterborne Infectious diseases are a major public health concern in developing countries. In developed countries, waterborne disease may also occur and have a major impact on public health as was the case in Milwaukee (Wisconsin, U.S.A) in 1993 involving 400,000 people and causing a hundred deaths, or more recently in Walkerton, Canada, in the year 2000 leading to 2,300 victims and six deaths. Nevertheless, it is difficult to assess their global impact, since many of these outbreaks go undetected.

Detecting and investigating these outbreaks is mandatory in order to limit their development and avoid relapses.

Important lack of detection

Over the last ten years, ten outbreaks linked to the drinking water supply network were fully investigated in France; they all involved exposure of a large population (between 1,000 and 60,000 people), a high rate of attack, and a large number of infected people – more than one thousand on average for each epidemic. In total, 9,000 people were affected, 70 of them as inpatients.

In each case, the outbreak was acute gastroenteritis (AGE), most of the time involving norovirus and Cryptosporidium sp, but also campylobacter and rotavirus, which indicate fecal contamination of the water. No waterborne disease epidemic involving other pathogens known as being communicable by water such as hepatitis A or Shigella was detected during that period of time.

Outbreak detection relies most often on the report of AGE case clusters by doctors or by people in charge of facilities hosting or receiving the public (schools, retirement homes, etc…), or on the identification of water contamination through regulatory monitoring, followed by a quick epidemiological investigation. This enables the detection of large scale outbreaks, but overlooks smaller ones which are probably in larger numbers.

Late reporting

Water based AGE outbreaks usually progress very quickly. For the 10 epidemics described in France since 1998, the epidemic peak was reached in a matter of 2 to 10 days. Reporting should therefore be made as fast as possible. These 10 outbreaks, were reported relatively late, within an average of five days after the onset.

Why does reporting take such a long delay? What events happening upstream from the first cases could be reported earlier on? What steps must be taken, and by whom for better and more timely reporting, thus enabling warnings to be issued? How to enhance support from the relevant partners?

Detailed analysis of the management of these 10 outbreaks lead to the identification of a number of shortcomings at different levels: from the reporting of incidents or events happening upstream from water distribution, to the specific consumers' reporting. This analysis also enabled the identification of health information sources which could be used for early detection of waterborne disease epidemics.

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Health control from the local health authorities (Ddass): compliance to regulations rather than warnings for outbreak threats

Water monitoring performed by the Directions départementales des affaires sanitaires et sociales (Ddass), the French local health authorities in charge of health and social affairs, aims at ensuring water quality compliance with the Public Health Code criteria. Distribution units (26,680 of them in France), range from small ones serving hamlets to large units serving more than 1,000,000 people. Water monitoring is performed daily for the largest units, only up to 3 times per year for the smallest ones. Health control relies on bacteriological analyses performed with culture techniques which do not give quick results (up to 72 hours). Therefore, due to the small number of checks performed in a number of distribution units, and due to the time required to obtain results, water monitoring is not adapted to the early identification of events leading to waterborne disease outbreaks. This monitoring was actually not designed to be a warning tool. All the information collected at that time feeds a database called "Sise-eaux", where one can also find information regarding water production and distribution systems.

Operator reports

If we trace back the chain of events leading to the origin of distributed water contamination, we can identify several levels: water resource contamination, processing failure, contamination between the processing unit and the tap.

The Padea ("Pollutions accidentelles des eaux d'alimentation" or Accidental drinking water contamination) study, launched by the Ministry of Health and the RNSP (Réseau national de santé publique – National Public Health Network) between 1991 and 1994, enabled the identification of 192 accidental network contaminations. Overall, contamination more often penetrates upstream from the hydraulic system or the catchment (77% of cases), than at the level of the distribution network (20%). If we limit ourselves to the six events at the root of the AGE epidemics, the percentage of introductions at the network level increases (50%). This difference can be explained by the fact that, when contamination hits the resource, it goes through the processing plant where it can be identified, treated, or evacuated by emptying the tanks. In contrast, when contamination is directly introduced into the distribution network, there are no warning signs at the plant level.

Contamination of the resource…

Microbiological contamination waste water, runoff water contaminated by manure, etc. represents one fourth of all resource contaminations, and one third of the deep resource contaminations. Surface waters are more often hit by hydrocarbons and pesticide contamination. In 15% of groundwater contamination cases, contamination enters directly at catchment level, mostly during floods.

Microbiological contamination of the resource appears most often during heavy or extended periods of rain. Runoffs trigger the overflow of sanitation systems, or drain runoffs spread over farmland, and dung water which stagnates in farmyards towards rivers. Heavy rains should therefore call for the operator's increased vigilance.

…. treatment deficiencies…

All AGE outbreaks for which the contamination introduction point is located upstream from the plant, are, by definition, linked to treatment deficiencies. In France, in three out of five resource contamination linked outbreaks, chlorination malfunction was identified or strongly suspected. It was noted during the Gourdon (46) outbreak in August 2000 [Campylobacter combined with a rotavirus] generating 2,600 cases for an exposed population of 7,000 people, or the 1993 shigellosis epidemic, which hit several municipalities in the suburbs of Le Havre, and was responsible for one thousand cases.

Even though chlorine disinfection acts mainly on bacteria, a lack of chlorination leads to bacterial outbreaks. This sensitivity of pathogens to chlorine varies greatly. If the most common bacteria such as Escherichia coli are highly sensitive to it, certain parasites, and most particularly Cryptosporidium are highly resistant and require the use of other types of treatments [filtration, UV radiations].

… and backflow

More than half of the outbreaks are due to backflow. This type of event requires the existence of connections between the drinking water network, and the waste water tank, such as, for instance, the treated urban network [which nevertheless remains loaded with micro-organisms] within a waste water treatment plant. Certain connections are lawful, provided they are protected by anti-backflow devices. Others are banned, such as connections with the waste water networks. If the hydraulic connection is effective, a depression within the drinking water network [for instance a pipe burst or intensive withdrawal such as when putting out a fire], or overpressure inside the waste water network will be sufficient for contaminated water flows to penetrate the drinking water network.

Reporting the most significant operational incidents

Any event suggesting a probable drinking water network contamination should immediately be communicated to the local authorities in charge of outbreak management, in other words the Ddass.

Therefore, certain environmental signs, such as non compliant microbiological analysis results, incidents such as a catchment flooding, disinfection failure exceeding two hours, large pipe bursting, or incidents occurring during network maintenance, etc. should be reported to the Ddass. For instance, the outbreak exposing 60,000 people in Strasbourg in May 2000 happened

after an intervention on the network, which was not performed according to the good engineering practices.

Drinker's complaints' feedback

In France, 66% of the population drinks tap water. The only available national data regarding tap water drinkers in France are those of the Inca survey going back to 1999. Sixty-seven per cent of the population said they drank tap water at least on occasion. Important regional disparities were noted, with, on the one hand, the western and northern regions where only 51% of people said they drank tap water; on the other hand, the South-West and the regions of Rhône-Alpes and Auvergne, where this percentage reached 79%.

It is now mandatory for producers to keep a complaint registry. Consumers most often complain about the taste of chlorine, the presence of limestone and low pressure, and sometimes about the water rusty color. These complaints are not linked to any health risk. But, certain consumer complaints are good indicators of microbiological contamination; particularly clusters of user complaints linked to "sewerlike" or "swamplike" odors, a brown color, a turbidity blurring transparency or suspicious looking water suggesting organic contamination. Such information is never reported to the Ddass. However if it were known, timely control measures could be implemented, thus preventing or limiting an outbreak. For instance, during the 2003 Divonne outbreak, 90% of the AGE cases could have been prevented if the complaints received by the operator or the city hall had been passed on to the Ddass.

The analysis of the survey of the ten recent outbreaks showed that these were linked to the introduction of waste water, and had all been preceded by consumer complaints, clearly indicating microbiological contamination. Users are strongly encouraged to give up drinking tap water, and to report to the city hall or the operator when discovering this type of situation upon opening their tap.

Regulated or spontaneous health reporting

The mandatory reporting of collective foodborne toxi-infections (Tiac) enables the detection of waterborne disease outbreaks. Several of them were detected this way thanks to the reporting of grouped cases of gastroenteritis in community facilities. A number of spontaneous reports of events, without any monitoring or warning systems attached, have been useful. An unusually high number of sick children off school, an increase in sales, or a shortage of antidiarrheals, an unusually high number of patients consulting for an AGE are potentially the most specific signs to detect an ongoing waterborne disease outbreak. The spontaneous report of such events enabled the identification of two of the ten outbreaks investigated since 1998.

Outbreak management

As soon as an AGE outbreak has been detected, environmental and epidemiological investigations, as well as crisis management follow a clearly defined procedure, involving different actors, including the Ddass staff and the drinking water operators. The Ddass are in charge of investigating and managing the outbreak. Regarding surveys, they may rely on the "Institut de veille sanitaire" (the French Institute for Public Health Surveillance) or its regional branches, the interregional epidemiological units (Cire). The Biotox-eaux network, covering ten defense area laboratories – metropolitan France and overseas territories – which is in charge of interventions on drinking water networks in case of accidental or malicious operations, is also available in order to support the labs responsible for routine water control. This device may be activated 24h/24 and 7 days out of 7.

From reporting to warning

As soon as a signal has been established as presenting a potential risk for public health, a warning is issued. How is this risk assessed?

At the exception of situations when the signal is immediately explicit enough to show the existence of a health threat, shifting to warning mode requires the conduct of exploratory investigations. These surveys are epidemiological, environmental and microbiological.

The epidemiological survey enables to confirm the existence of an outbreak, to determine its onset and geographical extent, and to give indications on the pathogens involved. Most of the time, this descriptive survey lead by the Ddass, is a phone survey where doctors are asked about the number of patients consulting for an AGE. Pharmacists and laboratory biologists may also be questioned. The survey may also help determine, among others, which sector of the water distribution network was contaminated according to the correspondence between the sector where the cases appeared, and the water distribution area. This stage may lead to the formulation of hypothesis regarding the introduction point of contamination in the network.

The environmental exploratory survey, lead by Ddass agents in close cooperation with the operator, is aimed at defining the geographical extent of the distribution area, at collecting information regarding the drinking water supply system and its operation during the pre-epidemic period. The information collected directly from the operator regarding recent events in the production/distribution network may help identify the contamination source and its extension through the network. In case of a backflow, the geographical position of the first cases may also give an indication as to the position of the contamination introduction point. During the 2001 outbreak in Dracy-le-Fort (71), with 560 cases out of a population of 1,100, this municipality was the only one hit while the distribution unit served several. Moreover, within the impacted municipality, the first cases appeared in the neighborhoods of a water treatment plant. The hypothesis of a local contamination of the network due to contaminated water backflow enabled a quick identification of the contamination introduction point.

Confronting the collected information during epidemiologic and environmental surveys is a crucial step before issuing a warning. This step goes hand in hand with a definition of

the situation and actions. There are multiple decision making criteria for deciding to issue a warning. Even if, at present, only high numbers of cases and regulatory distributed water analysis results are used for initial reporting, additional information such as the information held by the operator is often necessary to confirm a waterborne disease epidemic. This means issuing a warning and taking the relevant measures, the first of which is to ban the use of water for drinking.

Moving on to the warning phase means setting up a multidisciplinary survey/management cell coordinated by the prefect.

This cell must have epidemiological and water engineering competences owned by the Ddass, a knowledge of the operating of the network during the exposure period by the operator of the suspected facilities (the mayor or the private operator if water management has been delegated), and mayors representing the municipalities involved. Other experts may be called upon depending on circumstances and requirements.

Informing water drinkers

Measures to be taken at the local level so as to limit the impact of contamination, depend mostly on exploratory survey results.

Restrictive water usage measures must be taken as soon as the population's risk of exposure has been confirmed.

Even if water shut downs are sometimes necessary after such outbreaks, they are rarely implemented since they carry risks: water backflow due to the depression created within the network, unavailability of water for putting out potential fires, and health hazard linked to the accumulation of excreta. In practice, emergency information, for instance the use of a car fitted with loudspeakers works as effectively and quickly as water shut down. But if the contamination is unknown, and may contain highly toxic products, the authority decides to shut down water. The necessary consistency between health authorities and the operator's messages is also important, even if they do not necessarily share the same interests. The analysis of the waterborne disease epidemics investigated during the past decade has shown that in the past, contradicting messages were conveyed to the users.

Additional surveys

The additional survey also comprises epidemiological, environmental and microbiological investigations. These investigations, mainly aimed at acquiring knowledge, are most often optional. But, they are sometimes necessary when the distributed water liability or the circumstances of the accident have not been clearly established after the exploratory survey.

The descriptive epidemiological investigation aims at developing a case definition, record cases and collect associated data.

It enables the description of the case's characteristics, helps determine the contamination period and the area it covers, gives information on involved pathogens, and helps formulate hypotheses regarding the waterborne origin. Therefore, it specifies and adds to the information collected during the exploratory survey. During a second phase, an analytical epidemiological survey can be conducted in order to test the different hypotheses generated by the descriptive analysis. The design choice (retrospective cohort *versus* case control) depends on circumstances and on the hypothesis to be tested.

These investigations are usually conducted by the Ddass staff, supported, when necessary, by the Cire or the InVS epidemiologists. The environmental investigation sometimes aims at confirming waterborne disease exposure, identifying the source of the contamination and the point of introduction when these goals have not yet been reached. Most of the time, however, they involve more complex work such as hydrogeological studies designed to identify vulnerabilities of the aquifer used for water supply.

The microbiological investigation aims at searching for micro-organism(s) in patients and in the water, and comparing them. The main micro-organisms at the root of a waterborne disease epidemic are faecal micro-organisms, in either humans or animals, amongst which mainly enteric viruses can be found (norovirus, rotavirus, etc.), as well as viruses which do not give a gastro enteric syndrome such as hepatitis A virus, bacteria (Campylobacter, Salmonella, Shigella, Yersinia enterocolitica, Shiga-toxin producing Escherichia coli (STEC), etc.), as well as parasites (Cryptosporidium and Giardia, Toxoplasma).

In 2004, an InVS survey showed that few laboratories performing water analysis had the capacity to perform all of these analyses. The "Biotox-eaux" network laboratories can perform all of the necessary analyses, and can additionally be activated at any time.

Water sampling must be performed urgently because contamination traces are quickly evacuated. Knowing the pathogens involved is useful for the network cleaning operations. A chlorinated shock is efficient on bacteria, but when parasites are present, the only solution is to flush the network. Since most of the time it is easier to identify the causative agent through stool analysis rather than in water; looking for pathogens in water is not an emergency.

Descriptive epidemiological survey, an alternative method: Health Insurance data

Health Insurance (Assurance-Maladie) has developed a "medico-financial" database of healthcare consumption containing, amongst others, data related to the reimbursement of prescribed drugs. This data can be used to count the number of consultations for AGE at day and municipality levels, for residents and also for tourists residing in France.

This source has already been used in order to estimate ex post facto the impact of outbreaks, using a very limited amount of resources, based on face-to-face or telephone interviews with cases.

We must also develop systems enabling an active detection of excessive AGE cases at the municipal level, which may indicate a possible waterborne epidemic. Therefore, a system based on the Health Insurance database is currently being studied. Its objective is to develop a weekly automated analysis of drugs reimbursement data, in order to detect an increase in the number of cases for this pathology, within six pilot departments.

Developing the culture of reporting

Detecting waterborne outbreaks by people on the field, and their reporting to the Ddass can be greatly perfected. For the reasons stated above, the French drinking water monitoring, which mainly focuses on water quality, is weakly adapted for early detection of waterborne disease epidemic risk situations. Operators' feedback given to the health authorities, regarding any incident or event which may induce water network contamination, is essential. Amidst this information, grouped population complaints represent an early warning system in cases of drinking water network contaminations. The predictive value of operational incidents (chlorination failure, pipe bursts…) regarding the epidemic risk, will be carefully studied.

It is therefore important to develop the culture of reporting from all of the players holding information: first the operators, for relevant and timely environmental reporting, no matter what the distribution network size may be; and doctors, biologists, pharmacists and institution managers. In order to be efficient, this information needs to be conveyed to the Ddass, which means raising the awareness of all of these players.

The full reports are available at: www.invs.sante.fr/
Beaudeau P, Vaillant V, de Valk H, Mouly D. Guide d'investigation des épidémies d'infection liées à l'ingestion d'eau de distribution. Saint-Maurice (Fra) : Institut de veille sanitaire, février 2008, 19 p.
Beaudeau P, de Valk H, Vaillant V, Mouly D. Détection et investigation des épidémies d'infection liées à l'ingestion d'eau de distribution. Saint-Maurice (Fra) : Institut de veille sanitaire, décembre 2007, 108 p.

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Key words: waterborne infectious disease, outbreak investigation, microbiological contamination, tap water, environmental investigation

Suggested citation:
Therre H, de Valk H, Vaillant V, Beaudeau P, Mouly D. Assessment of waterborne outbreaks investigated in France since 1998 and key recommandations. Summary report. Saint-Maurice (Fra): French Institute for Public Health Surveillance, August 2008, 5 p. Available at: www.invs.sante.fr

French Institute for Public Health Surveillance, 12 rue du Val d'Osne 94 415 Saint-Maurice Cedex France – Tél. : 33 (0)1 41 79 67 00 – Fax : 33 (0)1 41 79 67 67 www.invs.sante.fr – **ISBN-NET** : 978-2-11-098785-3 – **Produced by** : Diadeis-Paris – Legal deposition : August 2009