

National surveillance capacity of water-related diseases in the WHO European Region

M. Blasi, M. Carere and E. Funari

ABSTRACT

Water-related diseases continue to cause a high burden of mortality and morbidity in the countries of the European Region. Parties to the Protocol on Water and Health are committed to the sustainable use of water resources, the provision of safe drinking water and adequate sanitation to all people of the European Region, and to the reduction of the burden of water-related diseases. A specialized Task Force is implementing a work plan aimed at strengthening the capacity for water-related disease surveillance, outbreak detection and contingency planning. Parties to the Protocol are obliged to set targets, and report on progress on water-related disease surveillance. The present paper aims to provide a baseline assessment of national capacities for water-related disease surveillance on the basis of the replies to a questionnaire. This was prepared in English and Russian and administered to 53 countries, 15 of which replied. The results confirm the heterogeneity in surveillance systems, the weakness of many countries to adequately survey emerging water-related diseases, and the need for specific remedial action. The findings of the exercise will form the basis for future action under the Protocol on Water and Health.

Key words | European Region, Protocol on Water and Health, surveillance systems, waterborne diseases, water related diseases

M. Blasi
M. Carere
E. Funari (corresponding author)
National Institute for Public Health,
Viale Regina Elena 209,
00161 Rome,
Italy
E-mail: enzo.funari@iss.it

INTRODUCTION

Water-related diseases (WRDs) contribute heavily to the burden of communicable diseases and mean any significant adverse effects on human health, such as death, disability, illness or disorders, caused directly or indirectly by the condition, or changes in the quantity or quality, of any waters. They are particularly important in developing countries, where diarrhoeal diseases kill an estimated 1.8 million people each year (WHO 2005). In these countries, diarrhoea accounts for 17% of all deaths among children under five years old (United Nations 2006). An estimated 94% of the burden of diarrhoeal disease is attributable to the environment, and associated with risk factors such as unsafe drinking water, lack of sanitation and poor hygiene (Prüss-Üstün & Corvalán 2006). According to the World Health Organization (WHO), unsafe water and sanitation is one of the five leading risk factors. It is estimated that the global burden risk of pathologies due to contaminated

drinking, ambient and recreational waters, as well as poor sanitation and hygiene, corresponds to 4% of global DALYs ((disability-adjusted life years), a time-based measure used for assessing the overall burden of a disease, that combines years of life lost due to premature mortality and years of life lost due to time lived in states of less than full health) (WHO 2009a). WHO reports that these risks particularly affect populations in low-income countries, especially in the Regions of South-East Asia and sub-Saharan Africa, and many countries of the WHO European Region. The health burden of water-borne diseases in all countries of the European region indeed is still considered 'significant' and emergent diseases have been reported in areas where they had been previously undetected (see the most recent report on food- and waterborne outbreaks jointly published on 28 January 2010 by EFSA and ECDC: The Community Summary Report on

trends and sources of zoonoses, zoonotic agents and foodborne outbreaks in the European Union in 2008, 8 *The EFSA Journal* (2010), 1496, p. 274; see also WHO Europe, Consultation on Waterborne Disease Surveillance, Budapest, 9–10 May 2006, Final report by Hiroko Takasawa, p. 3). In this Region, at the end of the 20th century, 32,800 deaths were registered from diarrhoeal diseases (WHO 2009b).

The more developed countries of the European Union are not exempt from WRDs (WHO/UNECE 2007; ECDPC 2009), especially with regard to emerging pathogens and the emerging issue of small-scale and community-operated water supply and sanitation systems, even if the disease incidence is lower. Emerging pathogens comprise different groups of newly detected micro-organisms (e.g. for water-related pathogens: *Cryptosporidium parvum*, *Legionella pneumophila*) or pathogenic mutants (e.g. *Vibrio cholerae* O139). They include also micro-organisms causing new human-pathogenic conditions (*Campylobacter* spp.), those identified to be the cause of a well-known infectious disease (hepatitis E virus), or for which the association with a well-known malignant or degenerative disease has been newly detected (*Helicobacter pylori*). Human diseases caused by emerging pathogens are associated with the growing number of people with reduced immunocompetence, age (demographic transition), drugs and medical treatment, and new and complex technical applications of water, e.g. dental units, air conditioning, cooling towers, spas, etc. (WHO 2003). Populations living in rural areas are subject to a higher risk of some infectious diseases than other citizens. Higher fragility of these areas is due to the diffuse environmental contamination of faecal material coming from domestic and wild animals, poor sanitation management, use of groundwater for drinking, often without disinfection, inadequacy of water quality control and lack of community awareness of the potential risks. Some studies have indeed demonstrated a higher incidence of communicable diseases in these areas than in urban ones (Solecki *et al.* 2007; Lake *et al.* 2009; Norval *et al.* 2009).

WRD include all the pathologies caused by the diverse risk factors occurring in water which can be directly (e.g. drinking and bathing waters) and indirectly (e.g.

consumption of aquatic organisms and crops) transmitted. They are often not easy to recognize; it is particularly difficult to distinguish them from foodborne diseases, especially those of the faecal–oral route. These latter can be also transmitted due to contamination of hands, utensils and clothing, especially when domestic sanitation and hygiene are poor. Yet, identifying water as the source responsible for the transmission of disease is strongly encouraged in order to minimize possible spreading of the outbreak and to promote management measures aimed at preventing future dangerous exposure. The real burden of WRDs is underestimated for at least two reasons. First, surveillance systems for their detection are typically inefficient in countries at all levels of socioeconomic development (Poullis *et al.* 2002; WHO 2004); second, when the disease is not severe enough, people do not seek medical attention at all. Yet, failure to detect cases or outbreaks of WRDs is not a guarantee that they do not occur.

Hence, reducing the burden of these diseases is a priority public health goal which can be reached by promoting suitable preventive measures to ensure adequate quality and quantity of water, for example by using the approach of the WHO Water Safety Plans (WHO 2004) and surveying the health status of communities.

A dedicated surveillance system tailored on WRDs would provide a relevant added value, as they:

- identify outbreaks or incidents of water-related disease or significant threats;
- give prompt and clear notification to public authorities;
- define/estimate the burden of WRDs;
- use data and information to identify communities and critical situations where there are problems with WRDs;
- promote intervention measures to control and prevent WRDs;
- target resources toward critical areas with priority needs;
- assess the effectiveness of the implemented water and sanitation interventions in reducing diseases.

WRD surveillance systems can be especially useful in countries with limited resources, where interventions should be designed to be feasible, effective and economical.

For example:

- information on the incidence of typhoid fever may indicate the need for targeted vaccine campaigns in specific geographic locations;
- information on epidemic and endemic giardiasis and cryptosporidiosis in communities that use surface waters supplies may indicate the need for water filtration processes because chlorination is not very effective against these pathogens;
- information on outbreaks of a waterborne disease in adequately treated piped water supplies may indicate intrusion problems in the water distribution system and the need for booster chlorination systems in the distribution system or additional water treatment on a household level;
- information showing a high prevalence of helminth infections may suggest the need for improvements in sanitation and increased availability of water for hand washing.

The goals of a WRD surveillance system should be linked to specific and achievable public health objectives such as eliminating waterborne typhoid fever or reducing the incidence of paediatric gastroenteritis. Surveillance systems should be designed to provide reliable data that are relevant to the waterborne diseases of the region. Good waterborne disease and outbreak surveillance systems can provide important information for designing and implementing water and sanitation interventions to improve public health. Finally, data from these surveillance systems are also useful for defining research priorities and improving water-quality regulation development.

One of the main tools of the Protocol on Water and Health (UNECE 1999) to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes (hereinafter called 'the Protocol'), to prevent, control and reduce WRDs, is to set up, improve or maintain national and/or local surveillance and early-warning systems. At the first meeting of the Parties (a Party in the context of the Protocol means a State or a regional economic integration organization which has consented to be bound by this Protocol and for which this Protocol is in force) to the Protocol (held in Geneva 17–19 January 2007), one of the activities approved was

the assistance to Parties and non-Parties in establishing and/or strengthening these surveillance systems. A task force was created with the aim to accomplish this task. One of the first activity of the Task force was to prepare a questionnaire aimed at assessing the current capacity for WRD surveillance in Parties and non Parties of the European Region, in order to draw a baseline and identify the main gaps to be filled up for an effective improvement. This paper presents and discusses the main results of this activity.

METHODOLOGY

The questionnaire was structured into the following thematic sections: general aspects, structure-coordination and reporting, case confirmation ability, capacity of response, outbreak detection, laboratory capability, epidemic preparedness, data characteristics, training, and database and mapping and public information.

The questionnaire as well as information on registration, access and compiling of the online version were sent to the national focal points for the [Protocol on Water and Health \(2001–2003\)](#) in the countries that ratified, and all 53 countries served by the WHO Regional Office for Europe.

The questionnaire focused on priority, emerging and locally important WRDs identified in the context of the Protocol. Priority WRDs, diseases of high epidemic potential, are defined as dangerous diseases with severe health consequences and with high tendency for secondary spreading; they include cholera, shigellosis, enterohaemorrhagic *Escherichia coli*, typhoid fever and viral hepatitis A. Emerging diseases are of secondary importance and are caused by sporadic outbreaks of pathogens like *Campylobacter*, *Cryptosporidium*, *Giardia intestinalis* and *Calicivirus*. Locally important WRDs refer to diseases such as the blue-baby syndrome, arsenicosis, viral infections (particularly noroviruses) and parasitic diseases.

RESULTS

Fifteen countries replied to the questionnaire: Andorra, Finland, Germany, Belgium, Czech Republic, Italy, Norway,

Armenia, Georgia, Slovakia, Turkey, Belarus, Estonia, Hungary, and the Republic of Moldova. On the basis of child and adult mortality rates, these countries have been grouped into WHO/UNECE sub-regions (ESR) A (Andorra, Finland, Germany, Belgium, Czech Republic, Italy, Norway), B (Armenia, Georgia, Slovakia, Turkey) and C (Belarus, Estonia, the Republic of Moldova, Hungary). Generally, the replies were provided by the Ministries of Health or Institutes of Public Health. The original questions of the questionnaire together with the responses are summarized below.

General aspects

All the 15 countries have a mandatory surveillance system on communicable diseases, where all the priority WRDs are generally surveyed. Only enterohaemorrhagic *E. coli* is not surveyed in two EUR-A countries. Emerging WRDs appear to be considered of lower priority in some of the respondent countries. Indeed one country of EUR-A and one of EUR-C do not consider these diseases at all in their surveillance systems. Two countries (in EUR-A and EUR-B) do not include enteric protozoa in their surveillance systems.

More specifically, the following emerging WRDs are not surveyed:

- campylobacteriosis in two countries (in EUR-A and EUR-C);
- cryptosporidiosis in six countries (four in EUR-A, one in EUR-B and one in EUR-C);
- giardiasis in four countries (two in EUR-A, one in EUR-B and one in EUR-C);
- legionellosis in one EUR-C.

Locally important WRDs, as expected, are controlled in countries where they are relevant (especially because either of the endemicity of the diseases or their occurrence at high levels in natural waters used for drinking):

- methaemoglobinaemia in two countries of EUR-B and EUR-C (in another country of this latter sub-region this surveillance is in preparation);
- arsenicosis in one EUR-B country;
- viral infections, particularly norovirus, in seven countries (three from EUR-A, one from EUR-B and three from EUR-C);

- parasitic diseases in three EUR-A, two EUR-B and three EUR-C countries (their surveillance is in preparation in another EUR-C country).

Structure, coordination and reporting

All the countries have dedicated, mandatory WRD surveillance systems, with the exceptions of two EUR-A countries. All the countries but one (from EUR-A), have a coordinating body at national level that elaborates standardized surveillance notification forms to gather communicable disease surveillance data, but five countries (three from EUR-A, one from EUR-B and one from EUR-C) do not have specific mandatory reporting forms for WRDs. In addition, these notification forms do not include the possible vehicle of infection (water, foods, etc.).

In one country from EUR-A and another of EUR-C, the notification form for emerging diseases does not require the identification of the environmental sources of the transmission of the disease.

The possible vehicle of infection (water, foods, etc.) is not considered in the notification forms in three EUR-A, one EUR-B and one EUR-C countries. Later confirmation of the exposure route is not envisaged in specific reporting forms in five countries (two from EUR-A, one from EUR-B and two from EUR-C). The potential environmental sources responsible for WRDs are not considered at all in the notification forms in five countries (three from EUR-A, one from EUR-B and one from EUR-C). One country in the EUR-B region does not investigate environmental sources that may be responsible for emerging diseases and one country in the WHO Regional Office for Europe-A region does not investigate environmental sources that are responsible for parasitic diseases.

Case confirmation ability

Case confirmation by laboratory analysis is mandatory in several countries, with the following exceptions: two EUR-A countries for any WRDs; one country in EUR-C for *Shigella*; one country in EUR-A for *Cryptosporidium* and *Giardia*; one country in the EUR-B region for *Campylobacter*, *Cryptosporidium*, *Giardia* and *Legionella*.

In general a national laboratory capability to confirm the etiological agents does exist with the following exceptions: one country in EUR-C for any WRDs; one country in EUR-A for cholera, enterohaemorrhagic *E. coli*, shigellosis, typhoid fever and all emerging WRDs; one country in EUR-B for hepatitis A and all emerging pathogens; another country from EUR-B has laboratory capability only for legionellosis.

The aetiological agents responsible for priority WRDs are generally detected by routine laboratory analysis in ten countries: five from EUR-A, three from EUR-C and two from EUR-B, with the following exceptions: all the aetiological agents in one country of EUR-A; hepatitis A viruses in one country from EUR-B and one of EUR-C; enterohaemorrhagic *E. coli* in one country from EUR-A and one from EUR-B; *Salmonella typhi* and *S. paratyphi* in one EUR-A country.

The aetiological agents responsible for emerging WRDs are detected by routine laboratory analysis in three countries (two from EUR-B and one from EUR-A). The following are not detected: any *Campylobacter* sp. nor *L. pneumophila* in one EUR-B country; *C. parvum* and *Giardia lamblia*, *G. duodenalis* in two countries from EUR-A and EUR-B; *Campylobacter* in one EUR-C country. One country in the EUR-A sub-region detects only *Legionella*.

Public information

Seven countries from EUR-A have a public awareness programme on the importance on WRD and the relationship between water hygiene and health. Ten countries have an integrated information system, accessible to the public, about long-term trends, current concerns and successfully handled past problems in water and health: six of these are from EUR-A, one from EUR-B and three from EUR-C. Five countries from EUR-A, one from EUR-B and three from EUR-C do not have an information system on rights and entitlements to water.

Six countries have dedicated web sites: one from EUR-A, four from EUR-B and one from EUR-C. One country from EUR-B has a very developed web site that provides adequate information to the public, such as:

- (a) awareness programme on the importance of WRDs in the formal education system – in subject ‘environmental education’.

- (b) activities for the public such as World Water Day;
- (c) cooperation with the Public Health Authority to publish weekly reports concerning infections of environmental origin;
- (d) annual reports in the area of health and the environment;
- (e) reports on trends in water and health problems;
- (f) annual reports on drinking water.

Data characteristics

Case information (age, sex and occupation) is requested in the notification form:

- fully in five countries (four from EUR-A, and one from EUR-B and EUR-C);
- almost completely in four countries (two from EUR-A, one from EUR-B and one from EUR-C);
- lower or much lower in other four countries (one each from EUR-A and EUR-B and two from EUR-C).

Location information (district, region, municipality, travel-related) is requested in the notification form:

- fully in three countries (one per sub-region);
- partially in other countries;
- not at all in one country of EUR-A.

Other information (outbreaks, time, sentinel) is requested in the notification form:

- fully in one country from EUR-C;
- partially in other countries.

Basic statistics and trend analysis are performed by many countries but not in two (one from EUR-A and one from EUR-B).

Generally all the countries have established action threshold for WRDs.

- For some severe diseases like cholera and typhoid fever the threshold is generally one case.
- In some countries the threshold is two cases.
- The highest reported threshold is 10 in the case of hepatitis A in a country from EUR-C.

Outbreak detection

Drinking water as the exposure route of priority WRD pathogens is generally identified in centralized water

supply systems. This source of exposure is not investigated: in three countries from EUR-A and one from EUR-B; in two countries from EUR-B and two from EUR-C when cases of viral hepatitis A occur. Two countries from EUR-B and EUR-C do not identify the exposure route for any emerging WRDs.

In small-scale community, private and unregulated water supply systems, exposure routes are identified as follows:

Priority diseases: drinking water as exposure route is identified:

- in one country from EUR-A and one from EUR-B for all priority WRDs;
- in seven countries (one from EUR-A, two from EUR-B and four from EUR-C) partially;
- in two countries (one from EUR-A and one from EUR-B) not at all.

Emerging diseases: this exposure route is identified:

- fully in two countries (one from EUR-A and one from EUR-B);
- partially in some other countries;
- not at all in five countries (three from EUR-A, one from EUR-B region and one from EUR-C).

Food products from aquaculture (shellfish, clams, mussels) when suspected as possible cause of WRDs are investigated:

- fully in three countries (two from EUR-A and one from EUR-C);
- sometimes in two countries (one from EUR-B and one from EUR-C);
- not at all in four countries (two from EUR-A, one from EUR-B and EUR-C).

Irrigated agriculture products are investigated:

- fully in two countries (one from EUR-B and EUR-C);
- occasionally in four countries (one from EUR-A, two from EUR-B and one from EUR-C);
- not at all in five countries (two from EUR-A and EUR-B and one from EUR-C).

Recreational water is identified:

- fully in two of EUR-A and one of EUR-B;
- almost completely in other two countries of EUR-C, with the exception of hepatitis A;

- not at all in four countries (three from EUR-A and one from EUR-B);
- occasionally in four countries (two from EUR-B and two from EUR-C).

Epidemic preparedness

Epidemic preparedness and response plans for outbreak of WRD are not available at all in six countries (three from EUR-A, one from EUR-B and two from EUR-C regions); three countries (two from EUR-B and one from EUR-C region) elaborate these plans for priority WRDs.

Emergency supplies of drugs were available during 2009:

- in seven countries (two from EUR-A, four from EUR-B and one from EUR-C region);
- partially in one country from EUR-A (to treat giardiasis and legionellosis);
- not at all in one country from EUR-A and one from EUR-C for hepatitis A.

Emergency supplies of vaccines were available during 2009:

- in three countries from EUR-A and one from EUR-C to prevent hepatitis A;
- in one country from EUR-A and one from EUR-C to prevent typhoid fever;
- not at all for any infection in one country from EUR-A, two countries from EUR-B and one from EUR-C.

Emergency medical supplies were available during 2009:

- not at all in one country from EUR A, one from EUR-B and two from the EUR-C region;
- partially in one country from EUR-A for treating viral hepatitis A.

Emergency water treatment supplies were available during 2009:

- not at all in two countries from EUR-A, one from EUR-B and one from EUR-C (excluding cholera);
- partially in one country from EUR-C (not available for emerging pathogens).

Information related to emergency outbreaks is not adequately provided to the public, in five countries (three from the EUR-A and two from the EUR-C region).

Also, response plans related to WRD outbreak are not adequately provided to the public in most countries (five from the EUR-A, two from the EUR-B, and four from the EUR-C).

Response capacity

Almost all countries are capable of starting intervention measures within 48 h from notification; one country from EUR-C has an organization that ensures intervention measures within 4–5 days after notification in case of giardiasis outbreaks.

Training

Periodic training courses on surveillance systems are performed in all the countries with two exceptions (one from the EUR-A and one from the EUR-B region). Nevertheless, WRD are not addressed by the training courses in five countries (four from the EUR-A and one from the EUR-B).

One country from the EUR-A and one from the EUR-C region would appreciate international support for such training courses. Another country from the EUR-C has specifically underlined the need of support in training courses on methods and financial aspects.

Databases and mapping/geographical information system resources

Central computerized databases for cases and outbreaks of WRDs are available in some countries but not in five (four from the EUR-A and one from the EUR-B region). Geographical information system (GIS) resources are partially used in nine countries (three from the EUR-A, EUR-B and EUR-C regions) but not in two countries from the EUR-A and one country from the EUR-C region. GIS use in the sector of communicable diseases is ongoing in one EUR-A country. Four countries are planning GIS courses (one from the EUR-A and EUR-B regions, and two from the EUR-C region).

DISCUSSION AND CONCLUSION

We are aware that this paper is based on the replies to the questionnaire from a relatively small number of countries. Moreover, these replies have some important limits. Indeed, they have been elaborated by central representatives of the countries on the basis of the information available to them and their specific responsibilities. The questionnaire covers different and heterogeneous sectors; hence it is possible that at least in some of these sectors the information provided is not comprehensive. In spite of these and possibly other limits, we do believe that the information gathered with the questionnaire provides useful indications on the surveillance systems on WRDs in the European UNECE/WHO Region and allows identification of the main gaps needed to be bridged for their improvement.

From the analysis of the replies, it is possible to underline the following.

Priority WRDs are generally surveyed in all the countries of the three UNECE/WHO sub-regions. Emerging WRDs are considered less and as expected, locally important WRDs are monitored in few countries, denoting their endemic features and possibly diverse country capabilities.

Almost all the countries have dedicated, mandatory WRD surveillance systems. There are different organizations in the surveillance system structure but generally they include a central coordination body (Ministry of Health or other Ministries or public Institutes of Health or Epidemiology), regional (district) and local structures. A standardized notification form to report outbreaks is generally mandatory. Hospitals, physicians and clinical laboratories generally compile and send out notifications of cases and outbreaks of WRDs. Sometimes these notifications are also provided by a sentinel laboratory network. The reporting systems are often paper-based, hence they miss the important advantages provided by a national electronic reporting system (Domeika *et al.* 2009). Generally, cooperation among the diverse institutional actors (environment, health, water management, etc.) is unusual, with some exceptions where cooperation is excellent. In one country from the EUR-B region, the integration of activities is ensured by the national government through the establishment of specific provisions that define tasks for relevant cooperative sectors.

Laboratory identification of aetiological agents is generally mandatory for priority diseases. Nevertheless, some countries have no or only poor capability to confirm the pathogen responsible for emerging WRDs. In general, information to the public is poor, even though some countries pay particular attention to this activity. At central level, the notification forms do not require adequate information on cases of WRDs (possible vehicle of infection; later confirmation of the exposure route; potential environmental sources responsible for water contamination, case information-age, sex and occupation; location information-district, region, municipality, travel-related).

Outbreaks of priority WRDs are detected especially when caused by drinking water from centralized water supplies. Lower capacity of outbreak detection is observed for emerging WRDs and for small-scale water supplies. Rarely aquaculture (shellfish, clams, mussels), irrigated agriculture products and bathing waters are investigated as possible vehicles of WRD transmission, in spite of their possible relevance (Shuval 1986; WHO 1989; Levine *et al.* 1993; Bean *et al.* 1996; National Research Council 1996; Montanari *et al.* 1999; Henrickson *et al.* 2001; Blasi *et al.* 2008). Epidemic preparedness, response plans and training activities are generally scarce; GIS is almost never applied.

In general no important differences between the three European sub-regions are observed in the organization of the WRD surveillance. The 15 countries that replied to the questionnaire have rather heterogeneous surveillance and early warning systems on WRDs, very likely reflecting the situation of the entire WHO European Region. From the information gathered through the questionnaire it seems possible to generalize by saying that there is, in general, room for the improvement of these surveillance systems. A general effort should be made in filling the main gaps of every country, according to their established priorities. Special attention should be paid to promoting a better integration of activities between different institutional actors. For instance, once an outbreak is recognized by local health authorities and water is among the suspected causes, it is crucial to start environmental analysis promptly. The success of these activities relies on the existing relationships between different institutional actors and competences. Hence, their integration should be ensured, for instance by establishing a local 'outbreak management

team', with representatives of local health units, environmental agencies, water treatment works, etc.

Public information on WRDs is often weak or absent. This is contrary to the provisions of the UNECE Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (known as Aarhus Convention of 1998), which states that people have precise rights to receive correct, complete, prompt and transparent information. An adequate base of education would also increase the population capability to manage emergency situations (for instance, learning the use of simple household treatment techniques).

Beyond outbreaks caused by contaminated drinking waters, greater capacity is needed to detect WRD outbreaks and cases in rural areas and those associated with recreational activities and consumption of aquatic animals or irrigated crops.

All the countries should plan for epidemics: adequate uses of emergency drugs, vaccines, medical and water treatment supplies should be foreseen and the public should receive proper information. From this point of view, it is noteworthy mentioning that many diseases have a clear seasonality and that a considerable percentage of outbreaks caused by exposure to contaminated water occur after floods or heavy rains. Information from laboratories that routinely monitor the quality of water should be promptly provided to the surveillance system when microbiological indicators show high increases of their concentrations. All this information might be even better used, of course, for preventive purposes.

A quick and effective capacity to respond is necessary to reduce the spread of the outbreak, identify and isolate the source of infection, promote the necessary management actions and investigations. Where possible GIS techniques should be implemented. Training courses on surveillance systems specifically addressed to WRDs should be promoted, when necessary with international support. Physicians with the task to notify WRD cases and outbreaks should be aware of these diseases. For this purpose, in setting up or improving the surveillance systems, they should be trained or at least informed with specific documentation.

The surveillance system in every country should include the surveillance of WRDs at least in critical areas, that are those where WRD outbreaks occur or where WRD is

endemic. Moreover, for drinking waters these areas may correspond to areas:

- where supplies are constituted by surface waters;
- with occurrence of livestock farming close to the drinking water supplies;
- subject to droughts where drops of pressure in the water distribution system may favour intrusion of organic materials;
- when supplies are from lakes affected by cyanobacterial blooms (Funari & Testai 2008);
- with small-scale water supplies;
- in industrial areas.

For aquatic organisms and especially mussels critical areas are:

- coastal waters close to towns, industrial areas, livestock farming or affected by the occurrence of marine algae capable of producing algal toxins (FAO 2004);
- internal waters close to towns, industrial areas, livestock farming or affected by the occurrence of cyanobacterial blooms (fish, shrimps).

For crops especially critical areas are those that are supposed to be consumed fresh and are in areas where they are irrigated with surface waters contaminated by industrial, urban and livestock waste waters.

Critical areas in bathing waters are waters where the different waste waters are discharged, affected by toxic algal (e.g. *Ostreopsis ovata*) and cyanobacterial blooms. Spas may especially transmit diseases as those caused by *Legionella*, *Giardia*, *Cryptosporidium*, etc. Particular importance should be given to *Cryptosporidium*, which is frequently associated with treatment venues (Yoder et al. 2009).

Finally, the surveillance systems on WRDs should focus on certain periods of the years because of the seasonality of the diseases. The incidence of communicable diseases is higher in specific seasons or times as well as the cyanobacterial and algal densities.

In conclusion, WRD surveillance systems should be at least be set up in the above mentioned areas and activities should be intensified at the most critical times.

To this end, an outbreak management team (OMT) should be set up at the local health unit, headed by a

public health officer reporting to the local director of public health. The OMT should be composed of representatives of the waterworks and sanitation system, the water department of the regional environmental agency, and an expert in hygiene and environmental medicine. This group should integrate skills and knowledge otherwise fragmented. They should promote all the initiatives needed to protect the health of the population.

In case of a WRD outbreak, the local OMT should:

- review the evidence for an outbreak;
- identify the population at risk;
- decide on control measures;
- provide quick and adequate information to the public;
- make arrangements for the commitment of personnel and resources.

A clear way forward is to link routine health surveillance data with data on the quality and distribution of water supplies in the same area. There have been a number of examples on how this can work in practice. Examples include:

- the use of GIS to map the distribution of cases of illness in relation to the geographical boundaries of different water systems to determine whether illness rates are greater in people drinking from one water source compared to others;
- time-series analysis where reports of illness are linked to data from routine water quality measurements to determine whether illness rates increase after deterioration in water quality results;
- prospective studies and enhanced surveillance in areas known to have poorer quality of drinking water.

Finally, the OMT should apply principles and measures of the WHO water safety protocol (WSP) in order to ensure a safe access to water and its resources. The key steps of the WSPs are:

- assemble the team to prepare the WSP;
- document and describe the water supply area;
- undertake a hazard assessment and risk characterization to identify how hazards can enter into the water supply;
- assess the existing or proposed system, including a description of the system and a flow diagram;
- identify control measures to reduce and control the risks;

- define how control measures are to be monitored to ensure acceptable performance of the WSP;
- establish procedures to verify that the WSP is working effectively and will meet the health-based targets;
- develop supporting programmes as well as training, hygiene practices, standard operating procedures, upgrading and improvement, and research and development;
- prepare management procedures, including corrective actions, for normal and incident conditions;
- establish documentation and communication procedures; these can have a large impact on the efficacy of certain removal processes;
- review periodically each WSP.

In conclusion, in our view, the surveillance systems on communicable diseases should include the specific aspects of WRDs. In the European Union with the publication of the decision 2119/98/EC, a network for the epidemiological surveillance of communicable diseases was created (ECDPC 2009). Since then, Member States notify some communicable diseases on the basis of the decisions 2000/96/EC and 2002/253/EC, which includes diseases common to those of the [Protocol on Water and Health \(2001–2003\)](#) (cholera, viral hepatitis A, campylobacteriosis, cryptosporidiosis, giardiasis, enterohaemorrhagic *E. coli*), and others that can be transmitted by water (listeriosis, leptospirosis). Hopefully, the surveillance systems should be integrated paying specific attention to WRDs.

REFERENCES

- Bean, N. H., Goulding, J. S., Lao, C. & Angulo, F. J. 1996 Surveillance for foodborne-disease outbreaks. United States, 1988–1992. *MMWR* **45** (no. SS-5).
- Blasi, M. F., Carere, M., Pompa, M. G., Rizzuto, E. & Funari, E. 2008 Water related diseases outbreaks reported in Italy. *J. Water Health* **13**, 1–11.
- Domeika, M., Kligys, G., Ivanauskienė, O., Mereckienė, J., Bakasenas, V., Morkunas, B., Berescianskis, D., Wahl, T. & Stenqvist, K. 2009 Implementation of a national electronic reporting system in Lithuania. *Euro Surveill.* **14** (13).
- ECDPC 2009 *European Centre for Disease Prevention and Control Annual Epidemiological Report On Communicable diseases In Europe*. 2009 Report on The State Of Communicable Diseases in the EU and EEA/EFTA Countries.
- FAO 2004 Marine biotoxins. In: *Food and Nutrition Paper 80*. Food and Agriculture Organization of the United Nations, Rome, pp. 5–49.
- Funari, E. & Testai, E. 2008 [Human health risk assessment related to cyanotoxin exposure](#). *Crit. Rev. in Toxicol.* **38**, 97–125.
- Henrickson, S. E., Wong, T., Allen, P., Ford, T. & Epstein, P. R. 2001 [Marine swimming-related illness: implication for monitoring and environmental Policy](#). *Environ. Health Perspect.* **109**, 657–650.
- Hlady, W. G. & Klontz, K. C. 1996 [The epidemiology of Vibrio infections in Florida, 1981–1993](#). *J. Infect Dis.* **173**, 1176–1183.
- Lake, I. R., Nichols, G., Harrison, F. C. D., Bentham, G., Kovats, R. S., Grundy, C. & Hunter, P. H. 2009. [Using infectious intestinal disease surveillance data to explore illness aetiology; a cryptosporidiosis case study](#). *Health & Place* **15**, 333–339.
- Levine, W. C., Griffin, P. M. & the Gulf Coast Vibrio Working Group 1993 [Vibrio infections on the Gulf Coast: results of first year of regional surveillance](#). *J. Infect. Dis.* **167**, 479–485.
- Montanari, M. P., Pruzzo, C., Pane, L. & Colwell, R. R. 1999 [Vibrios associated with plankton in a coastal zone of the Adriatic Sea \(Italy\)](#). *FEMS Microbiol. Ecol.* **29**, 241–247.
- National Research Council 1996 [Use of Reclaimed Water and Sludge in Food Crop Production. Committee on the Use of Treated Municipal Wastewater Effluents and Sludge in the Production of Crops for Human Consumption](#). National Research Council. National Academy Press, Washington DC.
- Norval, J., Strachan, C., Gormley, F. J., Rotariu, O., Ogden, I. D., Miller, G., Dunn, G. M., Sheppard, S. K., Dallas, J. F., Reid, T. M. S., Howie, H., Maiden, M. C. J. & Forbe, K. J. 2009 [Attribution of Campylobacter infections in Northeast Scotland to specific sources by use of multilocus sequence typing](#). *J. Inf. Dis.* **199**, 1205–1208.
- Poullis, D. A., Attwell, R. W. & Powell, S. C. 2002 [An evaluation of waterborne diseases surveillance in the European Union](#). *Rev. Environ. Health* **17**, 149–159.
- Protocol on Water and Health 2001–2003 [Waterborne Disease Surveillance: Goals and Strategies](#). Report on a meeting of a working group, 29–30 November 2001, Budapest, p. 4; Second Meeting of the Signatories to the Protocol on Water and Health, 2–4 July 2003, Geneva.
- Prüss-Üstün, A. & Corvalán, C. 2006 [Preventing Disease Through Healthy Environments: Toward An Estimate of the Environmental Burden of Disease](#). WHO, Geneva.
- Shuval, H. I., Adin, A., Fattal, B., Rawitz, E. & Yekutieli, P. 1986 [Wastewater irrigation in developing countries: health and technical solutions](#). World Bank Technical Paper N° 51, prepared by WHO and Leeds University, World Bank Publisher, Washington, DC.
- Solecki, O., MacRae, M., Ogden, I. & Strachan, N. 2007 [Can the high levels of human verocytotoxigenic Escherichia coli O157 infection in rural areas of NE Scotland be explained by consumption of contaminated meat?](#) *J. Appl. Microbiol.* **103**, 2616–2621.

- United Nations 2006 *UN Statistical Division. Progress towards the Millennium Development Goals, 1990–2005*. The United Nations, New York.
- WHO 1989 *Health Guidelines for the Use of Wastewater in Agriculture and Aquaculture*. Report of a WHO Scientific Group. Technical Report Series No. 778, World Health Organization, Geneva.
- WHO 2003 *Guidelines for Safe Recreational-Water Environments. Volume 1. Coastal and Fresh waters*. World Health Organization, Geneva, 219 pp.
- WHO 2004 *Guidelines for Drinking water third edition Volume 1 Recommendations Drinking water Quality*.
- WHO 2005 *World Health Report 2005*. World Health Organization, Geneva.
- WHO 2009a *Global Health Risks – Mortality and burden of disease attributable to selected major risks*. WHO Geneva, available from URL: http://www.who.int/healthinfo/global_burden_disease/global_health_risks/en/index.html (accessed 13 July 2011).
- WHO 2009b http://www.who.int/healthinfo/global_burden_disease/CRA_Disease_Dth6_2004.xls (accessed 13 July 2011).
- WHO/UNECE 1999 *Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes UNECE*. United Nations, Geneva. GE.06-26870-January 2007-4.290. ECE/MP.WAT/17. Available from: <http://www.unece.org/env/documents/2000/wat/mp.wat.2000.1.e.pdf> (accessed 18 August 2011).
- WHO/UNECE 2007 First meeting of the Parties to Protocol on Water and Health to the 1992 Convention on the Protection and Use of Transboundary Watercourses and International Lakes. Item 7 of the provisional agenda. Surveillance of water-related diseases. ECE/MP.WH/2007/5. Available from: <http://live.unece.org/fileadmin/DAM/env/documents/2008/wh/wg.1/ece.mp.wh.wg.1.2008.1.e.pdf> (accessed 18 August 2011).
- Yoder, J. S., Hlavsa, M. C., Craun, G. F., Hill, V., Roberts, V., Yu, P. A., Hicks, L. A., Alexander, N. T., Calderon, R. L., Roy, S. L. & Beach, M. J. 2009 *Surveillance for waterborne disease and outbreaks associated with recreational water use and other aquatic facility-associated health events- United States, 2005–2006*. CDC Publication available at <http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5709a1.htm> (accessed 13 July 2011).

First received 11 March 2011; accepted in revised form 9 June 2011. Available online 4 August 2011